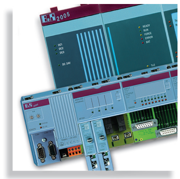


B&R SYSTEM 2005 User's Manual

B&R SYSTEM 2005

User's Manual

Version: **4.0 (October 2003)**

Model No.: **MASYS22005-E**

Chapter 1 • General Information

1. Manual History

Version	Date	Model No. and Product ID	Comments
4.0	October 2003	**MASYS22005-E** B&R 2005 User's Manual	Update, new modules included (AI780, CP340, CP380, CP382, DI875, EX282, IF686) New accessories included (TB108, TB112 and new Compact Flash)
3.0	May 2002	**MASYS22005-E** B&R 2005 User's Manual	Update, new modules included (AO360, CP360, DO486, DM486, IF772, NC352 and UM161) New accessories included (MC112, TB704 and TB708) Software operation with B&R Automation Studio™
2.0	December 2000	**MASYS22005-E** B&R 2005 User's Manual	Update, new modules included
1.0	August 1999	**MASYS22005-E** B&R 2005 User's Manual	B&R SYSTEM 2005 and B&R SYSTEM 2010 divided into separate handbooks New model number and product ID. Update, new modules included
2.0	April 1998	**MASYS2HW2-E** B&R 2005 / B&R 2010 User's Manual	Update, new modules included Descriptions expanded and improved
1.0	June 1996	**MASYS2HW2-E** B&R 2005 / B&R 2010 User's Manual	First edition

Table 1: Manual history

2. Safety Guidelines

2.1 Introduction

Programmable logic controllers (e.g. PLCs, etc.), operating and monitoring devices (e.g. industrial PCs, Power Panels, mobile panels, etc.), as well as B&R uninterruptible power supplies, have been designed, developed and manufactured for conventional use in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that without the implementation of exceptionally stringent safety precautions could lead to death, injury, serious physical damage or loss of any other kind. Such risks and hazards include in particular the use of these devices to monitor and/or control nuclear reactions in nuclear power plants, flight control systems, flight safety systems, mass transportation systems, medical life support systems and weapons systems.

When using both programmable logic controllers and operating and monitoring devices as control systems in conjunction with a Soft PLC (e.g. B&R Automation Runtime or comparable products) or a Slot PLC (e.g. B&R LS251 or comparable products), the safety precautions applying to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) in accordance with applicable national and international regulations must be observed. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as installation, commissioning and service may only be carried out by qualified personnel. Qualified personnel are persons familiar with transport, mounting, installation, commissioning and operation of the product and have the respective qualifications (e.g. IEC 60364). National accident prevention guidelines must be followed.
The safety guidelines, connection descriptions (rating plate and documentation) and limit values listed in the technical data must be read carefully before installation and commissioning and must be observed.

2.2 Intended Use

Electronic devices are generally not fail-safe. In the event of a failure on the programmable control system, operating or monitoring device or uninterruptible power supply, the user is responsible for ensuring that other devices that may be connected, such as motors, are made secure.

2.3 Transport and Storage

Devices must be protected from excessive stress (mechanical load, temperature, humidity, aggressive atmosphere) during transport and storage.

2.4 Installation

- The installation must take place according to the documentation using suitable equipment and tools.

- The devices are only allowed to be installed without voltage applied and by qualified personnel.
- General safety regulations and nationally applicable accident prevention guidelines must be observed.
- Electrical installation must be carried out according to the relevant guidelines (e.g. line cross section, fuse, protective ground connection).

2.5 Operation

2.5.1 Protection against Touching Electrical Parts

To operate programmable logic controllers, operating and monitoring devices and uninterruptible power supplies, certain components must carry dangerous voltage levels of over 42 VDC. A life-threatening electrical shock could occur if you touch these parts. This could result in death, severe injury or material damage.

Before turning on the programmable logic controller, the operational and monitoring devices or the uninterruptible power supply, ensure that the housing is properly connected to protective ground (PE rail). The ground connection must be established even when testing the operating and monitoring devices or the uninterruptible power supply as well as when operating them for only a short time.

Before turning the device on, make sure that all voltage carrying parts are securely covered. During operation, all covers must remain closed.

2.6 Safety Notices

Safety notices are organized as follows:

Safety Guidelines	Description
Danger!	Disregarding the safety regulations and guidelines can be life-threatening.
Caution!	Disregarding the safety regulations and guidelines can result in severe injury or major damage to material.
Warning!	Disregarding the safety regulations and guidelines can result in injury or damage to material.
Information:	Important information for preventing errors

Table 2: Safety guidelines

3. Definition of Terms

Term	Explanation
SG3	System Generation 3 (SG3) - CPUs with Motorola processors. The following CPUs belong to this series: CP260, IF161, IP161, XP152, CP100, CP104, CP152, CP153, CP200, CP210, CP430, CP470, CP474, CP476, CP770, CP774, PP21, PP41
SG4	System Generation 4 (SG4) - CPUs with Intel processors. The following CPUs belong to this series: PP100, CP340, CP360, CP380, CP382, AR102, AR105, AR010, AR000

Table 3: Definition of Terms

4. B&R SYSTEM 2000 Controller Generation

The B&R 2000 controller generation is an automation system that provides new levels of performance, functionality and operational safety. The B&R 2003, B&R 2005 and B&R 2010 systems cover the entire application range, from simple logic controllers to complex decentralized automation systems.

The systems have different structures, expandability, modularity and CPU performance. These systems are very closely related and therefore meet the fundamental requirements for complete centralized and decentralized compatibility for the programmer.

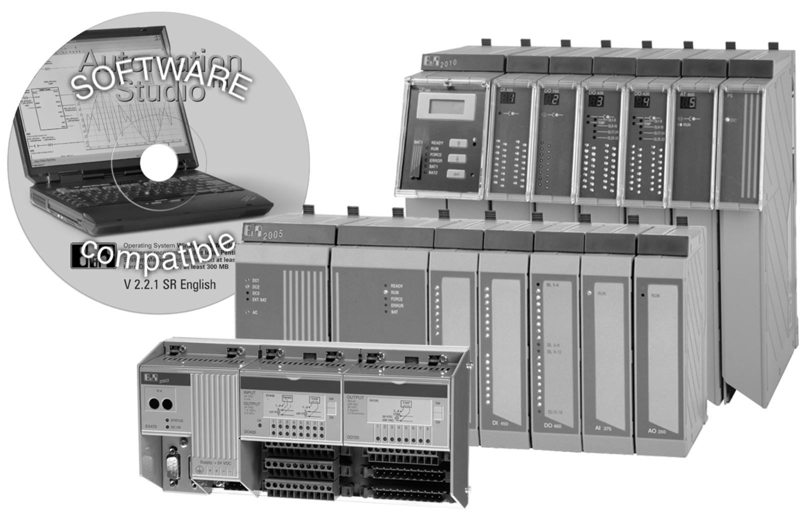


Figure 1: B&R SYSTEM 2000

4.1 B&R SYSTEMS 2005 Characteristics

4.1.1 Hardware

- Hardware modularity
- Network-capable
- Communication interfaces to HMI
- PLC and industrial computer functionality
- EMC according to EN61131-2
- Secure I/O bus protocol
- Remote I/O points
- Combined I/O and system bus
- Bit or word processing in a single cycle
- Enhanced performance through multiple I/O bus systems

4.1.2 Software

- Multitasking operating system for PLC and industrial computer applications
- Powerful PLC programming languages
- High-level language programming
- Exact control over PLC timing
- Simple programming software with Windows user interface
- Project management on the programming device

4.2 PLC (Programmable Logic Controller)

The PLC kernel consists of powerful standard computer components. The processors are supported by RISC processors which enable communication tasks to be carried out simultaneously allowing faster processing of I/O signals.

Most CPUs use a modular interface concept. Various bus or network systems can be efficiently integrated in the B&R SYSTEM 2005 using plug-in interface modules.

The computer kernel uses components which build the functionality of an industrial PLC. Bit, byte and word access is possible in a single cycle which increases speed when mixing PLC links and industrial computer functionality.

The B&R SYSTEM 2005 has a combined system and I/O bus. On this bus, modules are operated which are needed for both industrial computer functionality and connecting the interface to the machine or device. System modules are e.g. additional processor modules, remote master, network modules etc. Naturally, the bus is multiprocessor-capable.

The I/O bus operates e.g. digital and analog I/O modules, positioning modules, intelligent I/O processors, etc.

If there is insufficient space available on the main rack for your application, further I/O modules can be operated on up to four expansion racks. This procedure is called local expansion or I/O bus expansion. Data transfer to these expansion racks is made simultaneously and with secure protocol.

4.3 System Interface

The system interface is the sum of all I/O modules, i.e. the interface between PLC and the machine/system being controlled. All B&R SYSTEMS 2005 I/O modules are electrically isolated from external disturbances using suitable EMC measures (standard EN61131-2). I/O modules are enclosed (plastic housing), so that the technician cannot come into contact with the electronics at installation.

The length and structure of the I/O bus can be adjusted to the requirements of the machine/system. That means the connection points for I/O signals do not have to be in the same location as the PLCs CPU. Using a combination of local and remote I/O bus segments (remote I/O) allows the optimal structure to be created for the respective application. I/O modules are installed on the machine/system where they are needed. Cabling to the PLC kernel is reduced to a two conductor or fiber optic cable.

4.4 Industrial PC

The combined I/O bus and system bus is multiprocessor-capable and therefore can hold further computer units capable of dealing with additional tasks.

4.5 Network Capability

Network capability and the possibility to communicate with systems from other manufacturers have become a must for all industrial controllers. The B&R 2000 PLC family meets many of these requirements using system-wide and multi-system communication possibilities.

4.6 Software Concept

Special attention was given to simple operation and programming. Standard PLC programs run cyclically, i.e. the program is repeated in a loop. To increase efficiency, the B&R SYSTEM 2000 also offers the possibility to use various tasks with different cycle times. In this way, time critical program sections (e.g. reaction to trigger signals) can be processed faster than the evaluation of slower events (e.g. polling keys).

4.7 Programming

Programming is carried out using B&R Automation Studio™. Several programming languages are available:

- Automation Basic (previously PL2000)
- ANSI C
- IEC 1131 Ladder Diagram (LAD)
- IEC 1131 Sequential Function Chart (SFC)
- IEC 1131 Structured Text (ST)
- IEC 1131 Instruction List (IL)

Differences in data type names between B&R Automation Studio™ and PG2000:

Resolution	B&R Automation Studio™ (IEC1131-3)	PG2000
1-bit	BOOL	BIT
8-bit with sign	SINT	INT8
8-bit without sign	USINT	BYTE
16-bit with sign	INT	INT16
16-bit without sign	UINT	WORD
32-bit with sign	DINT	INT32
32-bit without sign	UDINT	LONG
Floating point display 32-bit	REAL	FLOAT

Table 4: Differences in data type abbreviations between B&R Automation Studio™ and PG2000

5. B&R 2005 Control System

5.1 Modular Construction

The B&R 2005 is made up of individual modules that are housed in plastic. The modules (with the exception of the power supply and the CPU) can be inserted in any order on a backplane. The power supply must always be located on both far left slots of the backplanes. The CPU must be operated directly next to the power supply.

Both the bus system and the supply lines are on the backplane. Backplanes are available in different lengths (6, 9, 12 and 15 slots).

5.1.1 Mounting the Backplane

The backplane is installed on a mounting rail (DIN EN 50022 - 35 x 7.5 mm). This mounting rail is attached conductively to the back wall of the switching cabinet.

In addition to mounting rail installation, the backplane can also be screwed directly onto the back wall of the switching cabinet.

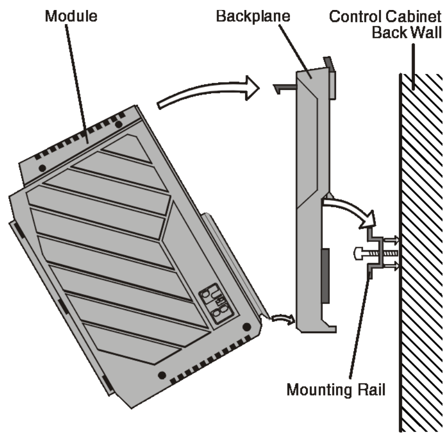


Figure 2: Mounting the B&R SYSTEM 2005 backplane

5.2 Combined System and I/O Bus

There is a combined I/O and system bus on every B&R 2005 backplane. Therefore, system and I/O modules can be inserted on the main backplane. The backplane where the CPU is installed is the main backplane.

This has the following advantage:

- Only one backplane type is required for main and expansion backplanes (eases stock management)

Differences to B&R 2010:

- Slower access of I/O data (only applies to the main backplane)
- Limited number of module slots per backplane
- More space in the switching cabinet

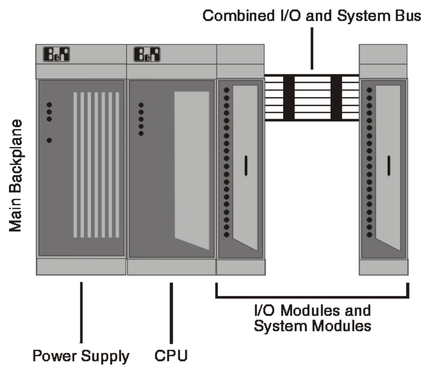


Figure 3: Combined system and I/O bus

5.3 Supply Voltage

The supply voltage for the B&R 2005 control system is provided by a power supply that must be connected to the far left slot on the backplane.

5.4 Single Row Terminal Block

B&R 2005 modules are normally connected using a single row terminal block.

Pin assignments for the individual modules are described in Chapter 3 "B&R 2005 Modules".

The construction of the terminal block has the following advantages for the PLC user:

- The terminal block can be easily removed using two ejection levers on the module
- The terminal blocks are available with screw clamps and also with cage clamps

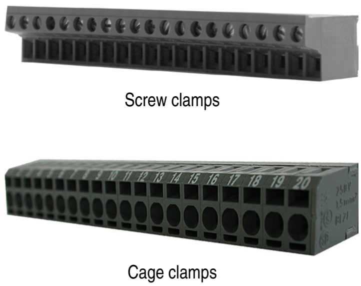


Figure 4: TB170 terminal block

5.5 Application Memory (APM)

B&R 2005 CPUs have the memory for both application programs and the operating system either integrated in the module or provided on an additional Compact Flash memory card.

6. Expansions for B&R 2005

6.1 Expansions of Local I/O Buses

The main backplane can hold a maximum of 11 I/O and/or system modules. However, it is still possible to expand. To do this, the following modules are required:

6.1.1 Expansion Master

The EX350 bus controller is used as an expansion master: The bus controller is a power supply insert.

6.1.2 Expansion Slave

A power supply module is used as an expansion slave. This power supply module is equipped with an additional interface, which allows connection of I/O bus expansions. The power supply must be plugged into the far-left slot of an expansion backplane. A maximum of 4 expansion backplanes can be connected.

The connection cable between the expansion master and expansion slave is available in two lengths (1 m or 2 m).

6.1.3 Example of Local I/O Bus Expansion

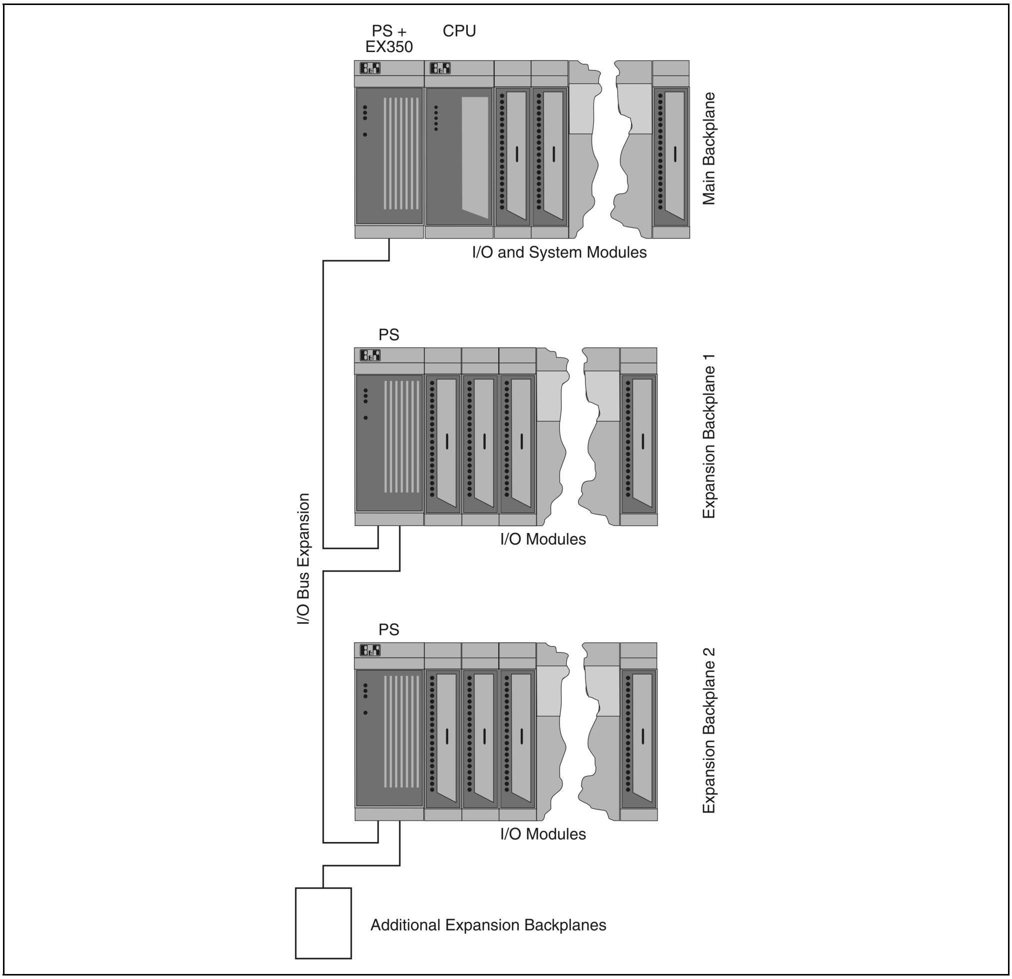


Figure 5: Local I/O bus expansion

6.2 Remote I/O Bus

The remote I/O allows remote I/O modules (up to 1200 m) to be connected to the CPU. The following modules are required when implementing a remote I/O system:

6.2.1 Remote Master

The remote master is a system module and must be inserted on the main backplane (combined system bus and I/O bus). Up to 31 remote slaves can be connected to a remote master.

6.2.2 Remote Slave

The EX250 bus controller is used as remote slave. The bus controller is a power supply insert. The remote slave communicates via a shielded twisted pair cable with the remote master. A maximum of 13 I/O modules are operated on each remote slave.

6.2.3 Cabling

In a remote I/O system, remote slaves at distances of up to 1200 m are connected with the remote master using a shielded twisted pair cable.

Transfer Distance (without repeater)	
100 kBit/s	Up to 1,200 m
181 kBit/s	Up to 1,000 m
500 kBit/s	Up to 400 m
1000 kBit/s	Up to 200 m
2000 kBit/s	Up to 100 m

Table 5: Transfer distance of a remote I/O system

6.2.4 Example of Remote I/O System

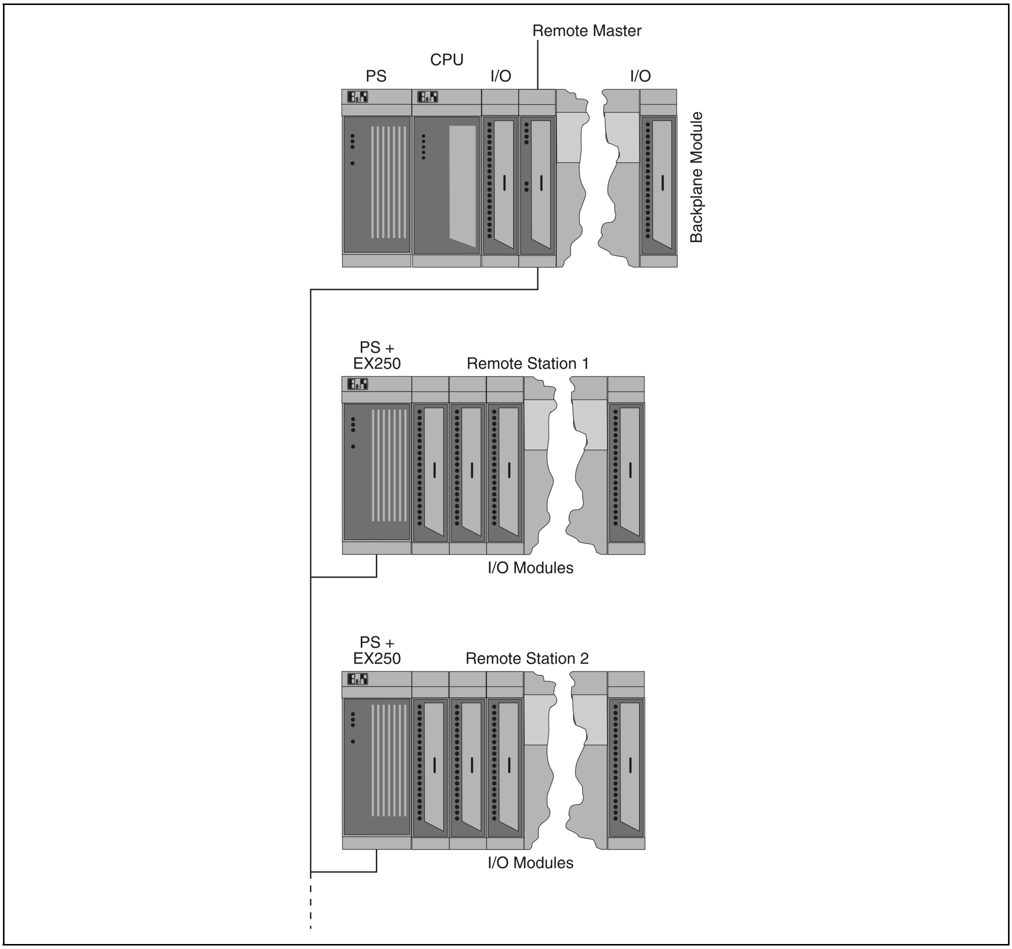


Figure 6: Remote I/O system

7. Combination Options

7.1 Local I/O Bus

7.1.1 Connecting B&R 2005 to B&R 2010

A B&R 2005 expansion backplane is coupled to a B&R 2010 expansion master using a power supply with expansion slave. The entire configuration can have a maximum of four B&R 2005 expansion backplanes.

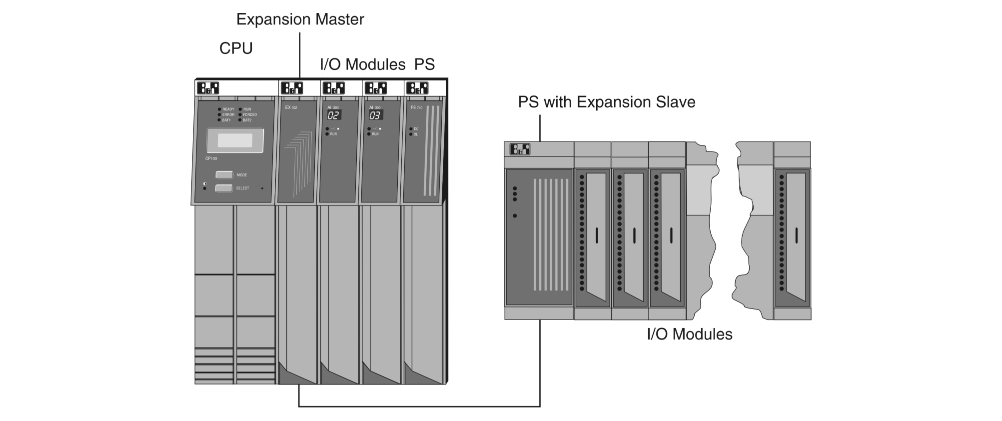


Table 6: Connecting B&R 2005 to B&R 2010

7.1.2 Connecting B&R 2010 to B&R 2005

A 2010 I/O bus is coupled to the 2005 expansion master using the expansion slave. A maximum of twenty 2010 I/O modules can be connected in this way.

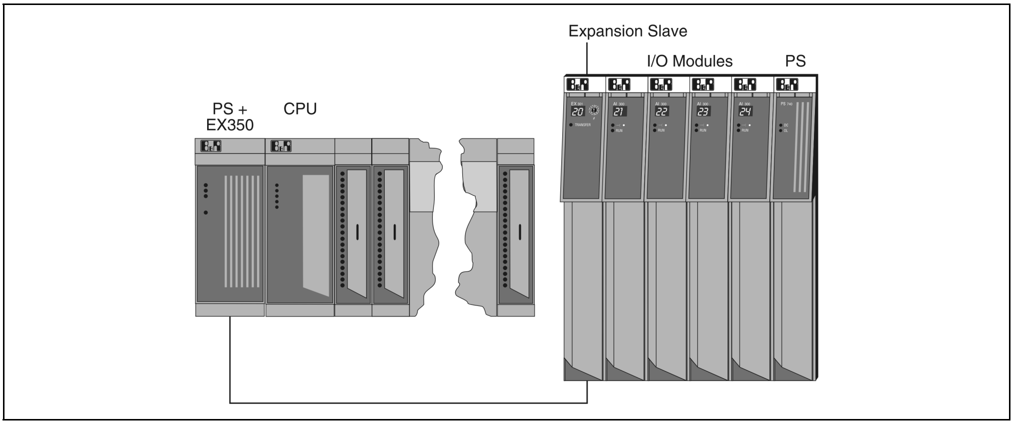


Table 7: Connecting B&R 2010 to B&R 2005

7.2 Remote I/O Bus

Up to 31 remote slaves can be connected to a remote master (B&R SYSTEM 2005, B&R SYSTEM 2010 or B&R SYSTEM 2000 Logic Scanner), and the B&R 2003, B&R 2005 and B&R 2010 systems can be combined as desired.

Each remote slave starts a new I/O bus. The maximum number of slots available depends on the type of slave.

Slave Type	Number of Slots
2010	Max. 99 (cascaded)
2005	Max. 13
2003	Max. 8

Table 8: Number of slots depending on the slave type

8. PROFIBUS Network

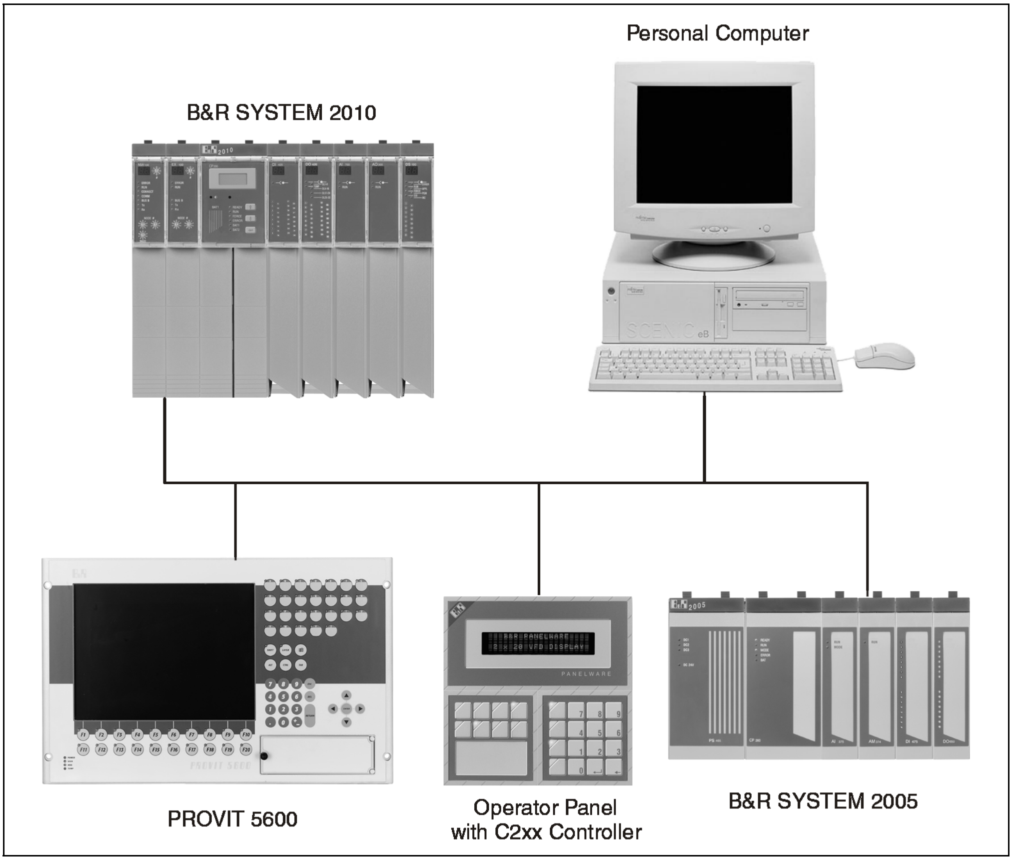


Figure 7: PROFIBUS network

The PROFIBUS (process fieldbus) is an open fieldbus with standardized communication functions.

Transfer Distance (without repeater)	
19.2 kBit/s	Up to 1,200 m
93.75 kBit/s	Up to 1,200 m
187.5 kBit/s	Up to 1,000 m
500 kBit/s	Up to 400 m

Table 9: Transfer distance in a PROFIBUS network

Chapter 2 • Installation

1. Dimensions and Installation

1.1 PLC Modules

The B&R 2005 consists of both single-width and double-width modules. The width corresponds to the number of slots required:

Width	Slots
Single-width	1
Double-width	2

Table 10: Width of B&R SYSTEM 2005 PLC modules

The measurements given are installation measurements. The depth of the backplane must be added to the total depth of the PLC.

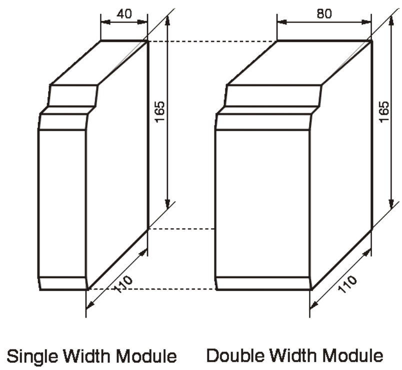


Figure 8: B&R SYSTEM 2005 module dimensions

1.2 Basic Module Design

The following elements can be found behind the module door:

- Status LEDs
- Node number switch
- Reset button
- Connection plug

Openings are provided in the module door with most modules so that LEDs can be read without the door being open.

A label strip can be inserted on the inside of the module door which can be seen from the outside.

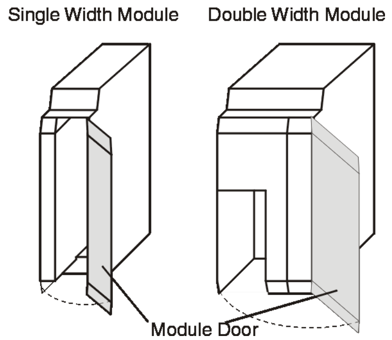


Figure 9: Basic module design

1.3 Module Racks

All 2005 backplanes are constructed in the same way. The only difference is the number of slots available:

Number of Slots	Backplane	Length x
6	BP155	240 mm
9	BP152	360 mm
12	BP151	480 mm
15	BP150	600 mm

Table 11: B&R SYSTEM 2005 module rack

When installing backplanes, make sure to leave at least 20 mm on the left and right for the fastening levers.

Backplane Dimensions:

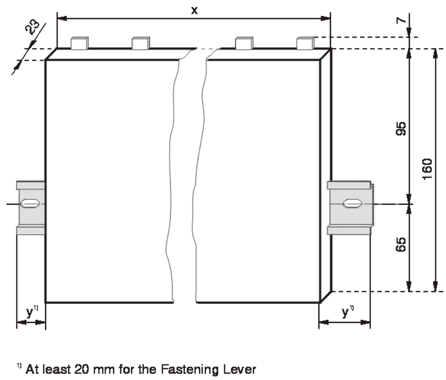


Figure 10: Backplane dimensions

1.4 Mounting Rail

A mounting rail, which conforms to the DIN EN 50022 standard, is required for mounting the PLC. The mounting rail is fastened to the back wall of the cabinet.

Follow the manufacturer's installation instructions

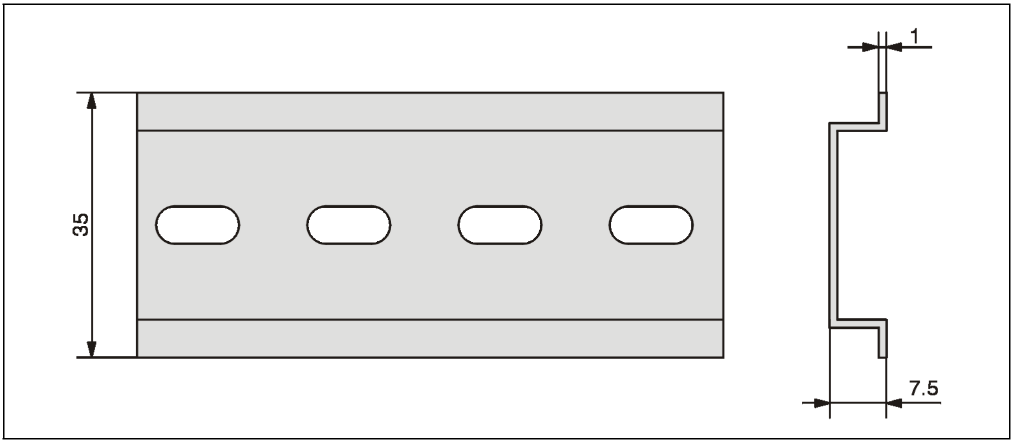


Figure 11: Mounting rail

1.5 Installation

The installation should only be carried out by qualified personnel!

The installation of the PLC takes place in the following order:

1) Install mounting rail (see Section 3.1 "Grounding the Mounting Rail", on page 70)

2) Install the backplane

3) Mount the PLC modules

Installing the Backplane

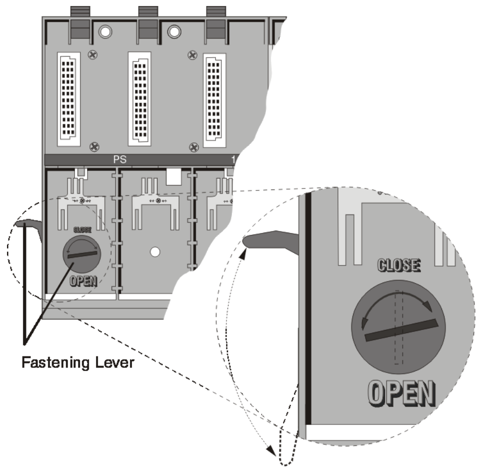
The following steps are to be taken in order to attach the backplane onto the mounting rail:

a) Set all fastening levers to the "OPEN" position.

b) Hang the backplane on the desired position on the mounting rail

c) Set all fastening levers to the "CLOSE" position with a screwdriver. The screw head slot must be **in a horizontal position** to guarantee the required contact pressure for proper EMC characteristics. Turning the fastening lever also places the contact spring under pressure which creates the proper contact.

Removing backplane modules is done in reverse order.



Fastening lever in OPEN and CLOSE position

Figure 12: Fastening lever positions

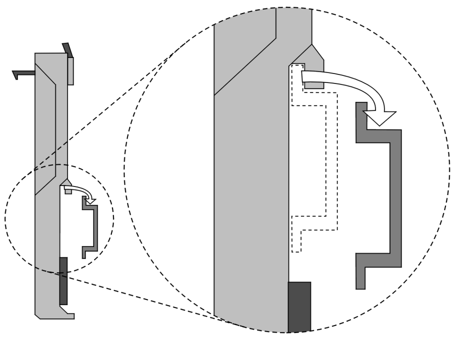


Figure 13: Installing the backplane on the mounting rail

Mount the PLC modules

After the backplane has been fastened securely to the mounting rail, the PLC modules can be mounted in the appropriate backplane slots. A module is installed in the following order:

a) Using the module support hook, hang the module on the base hook latch of the backplane:

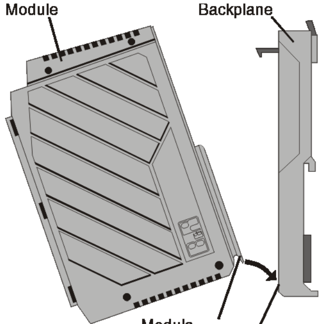


Figure 14: Installing the module

b) Tilt the module back until the upper fastening clip of the base plate clicks into place.

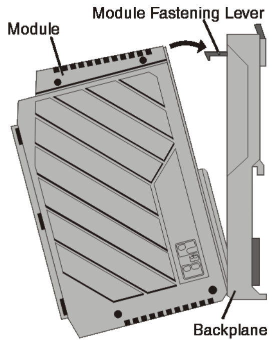


Figure 15: Tipping the module back

To **remove** PLC modules, follow the same directions in reverse order.

Pressing the module fastening lever (1) will unclip the locking mechanism. The module can then be tilted forward (2) and removed from the backplane (3).

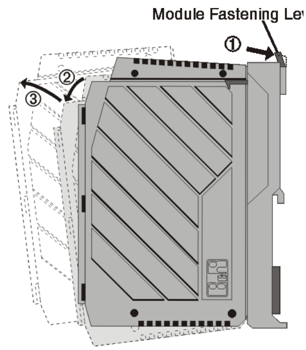


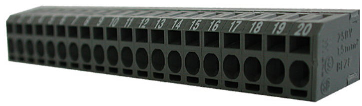
Figure 16: Removing a module

1.6 TB170 Terminal Block

Single row 20-pin terminal blocks, which can be removed with two ejection levers, are used to wire most modules.

Terminal blocks are also available with screw clamps and with cage clamps.

Screw clamps



Cage clamps

Figure 17: TB170 terminal block

Inserting and Removing the Terminal Block

The terminal block is inserted into the pin connector provided on the I/O module. The pin connector is behind the module door.

Inserting

Push the terminal block in the direction indicated by the arrow below.

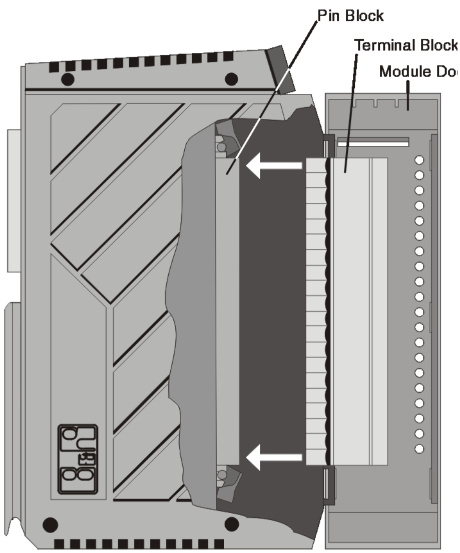


Figure 18: Inserting a terminal block

Removing

By pressing the ejection lever (using a screw driver), the terminal block is forced out of the pin connector and can then be easily removed by hand.

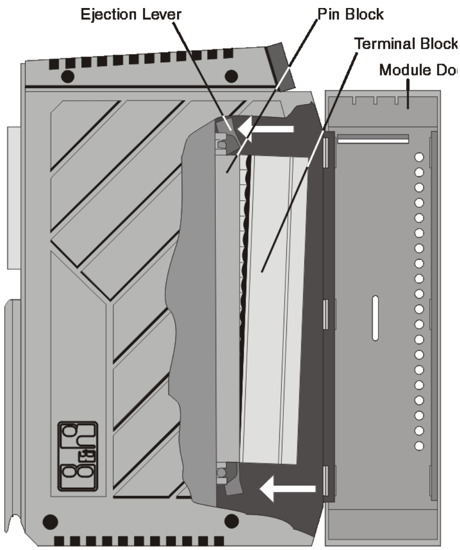


Figure 19: Removing terminal block

Cabling Terminal Blocks

All cables (cable bundles) are to be run down from the terminal blocks.

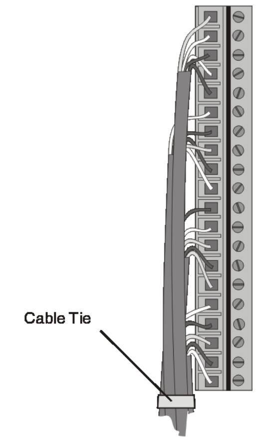


Figure 20: Cabling terminal blocks

A cable tie is used to relieve stress on the terminal block and is attached to the slots provided on the module housing.

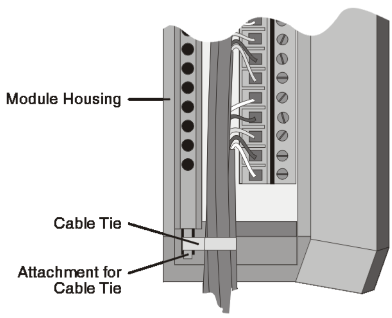


Figure 21: Stress relief using cable ties

2. System Configuration and Power Supply

2.1 B&R SYSTEM 2005

The following guidelines apply when configuring every B&R 2005 system:

- **System modules** are only allowed to be inserted on the main backplane.
- **Empty slots** must be filled with dummy modules.
- The **power supply** must always be located in the two furthest left slots (1 and 2) for both main and expansion backplanes.
- The **CPU** can be operated on the main backplane directly next to the power supply.
- Counting for **module addressing** begins at slot 3 which has address 1 on every backplane.
  The module addressing for system modules begins with address 0 (0, 1, 2, etc.) if using an operating system (CPU) older than version 1.10.

2.1.1 Local Bus without Expansion

Basic Design

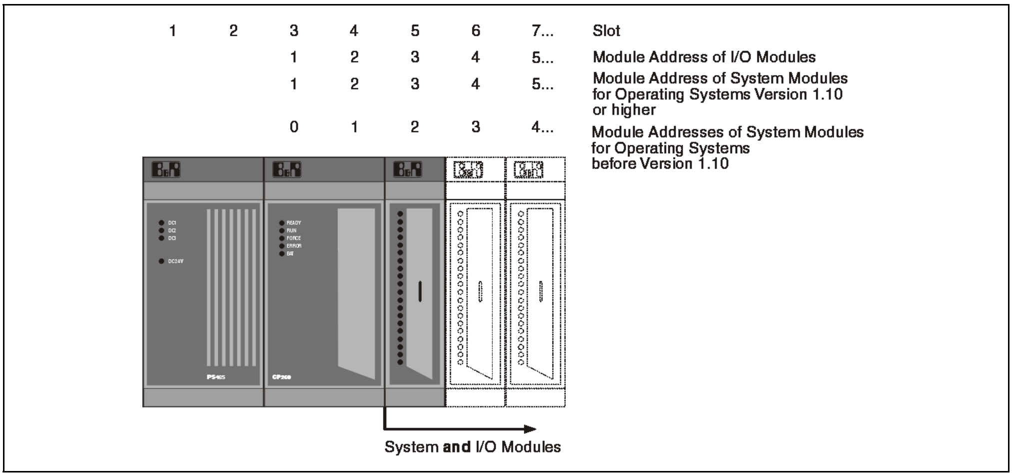


Figure 22: Basic design

Both system modules and I/O modules can be inserted on the main backplane of the B&R 2005. The order in which these modules are placed is not important.

The **power requirements** are met by only **one** power supply. If the power provided by the supply unit is insufficient due to the layout of the backplane, the system can be expanded (see Section 2.1.2 "Local Bus with Expansion", on page 56) by installing I/O modules on an expansion backplane.

Example

- The following modules are used in a system:

Amount	Module	Bus	Power Consumption [W]					
			Per Module			Σ		
			5 V	24 V	Total	5 V	24 V	Total
1	CP260 CPU	System or I/O bus	5.7	2.3	8	5.7	2.3	8
1	AT660 Temperature module	I/O bus	1.25	4.75	6	1.25	4.75	6
1	NW150 Network module	System bus (only on Main backplane)	7	---	7	7	---	7
1	AO350 Analog output module	I/O bus	1	4	5	1	4	5
4	DI475 Digital input module	I/O bus	1.5	---	1.5	6	---	6
3	DO480 Digital output module	I/O bus	1.5	1	2.5	4.5	3	7.5
					Σ=	**25.45**	**14.05**	**39.5**

Table 12: Example for power output table

- The PS465 module can be used as the power supply. The power comparison indicates that the power provided by the power supply is sufficient. Therefore, the system does not have to be expanded.

Power At	PS465	Example
5 V	40 W	25.45 W
24 V	50 W	14.05 W
Total	60 W	39.5 W

Table 13: PS465 power comparison - example system

The system could be organized as follows:

Figure 23: System organization

The modules require 14 slots and can be operated on a backplane with 15 slots (BP150). The last slot is occupied by a BM150 dummy module.

2.1.2 Local Bus with Expansion

Basic Design

Both system modules and I/O modules can be inserted in any order on the backplane of the B&R 2005. All I/O modules can be operated on every expansion backplane (maximum 4).

In order to expand the B&R 2005 in this way, the following points must be noted:

- A power supply with expansion slot is to be used on the main backplane. The EX350 bus controller is used as an expansion master in this expansion slot.
- Power supplies with expansion slaves are to be used on the expansion backplanes.
- Cables are available from B&R for connecting expansion master and slaves:

Length	Model Number
1 m	0G0010.00-090
2 m	0G0012.00-090

Table 14: Cable for I/O bus expansion

- Cabling: see Figure 24 "Local bus with expansion", on page 57.

The process image is created on expansion plates by the expansion master. This task is handled by the CPU on the main backplane. Therefore, if I/O modules are put on expansion backplanes the load on the CPU is decreased.

Example of Local I/O Bus Expansion

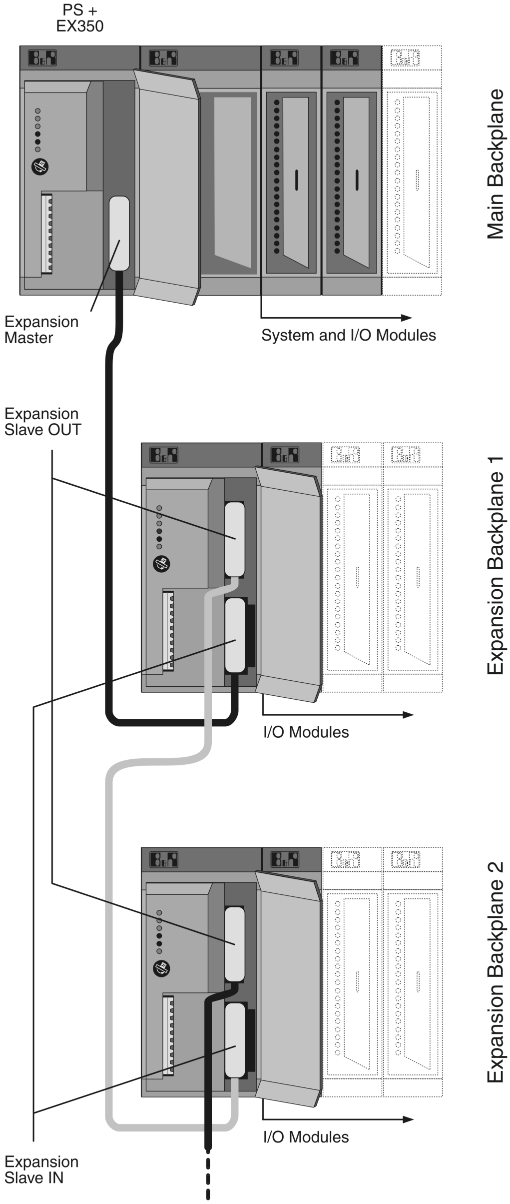


Figure 24: Local bus with expansion

2.1.3 Remote I/O Bus

Remote I/O allows remote I/O modules to be connected to the CPU over long distances. A bus cable is used to connect the **Remote Master Module** and up to 31 **Remote Slaves**. A new I/O bus which can address a maximum of 13 modules begins with every slave.

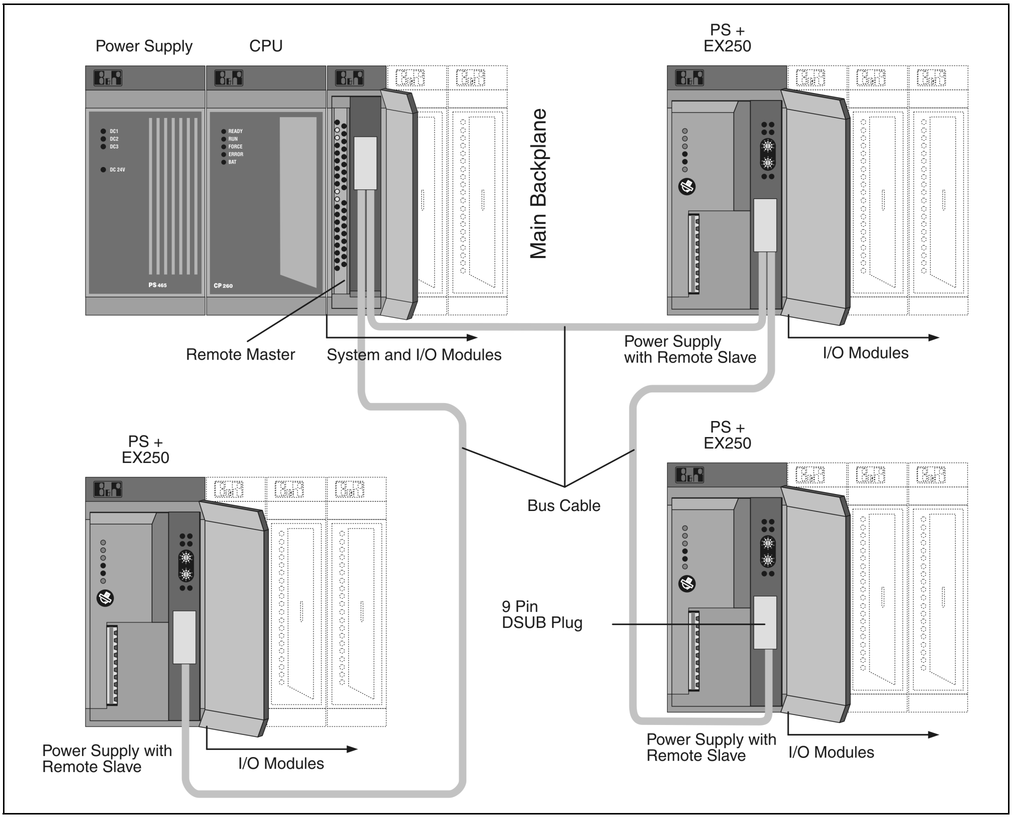


Figure 25: Remote I/O Bus

The maximum distance of a remote system depends on the transfer rate:

Distance [m]	Transfer Rate [kBit/s]
1200	100
1000	181
400	500
200	1000
100	2000

Table 15: Distances of a remote system

Note the following:

- The remote master is a system module and must therefore be situated on the main base plate.
- The remote slave is in a power supply module on the expansion backplane.
- The slave address is set with a node number switch on the remote slave. This number is then used for addressing a remote I/O bus.

Wiring Remote Master and Slave Modules

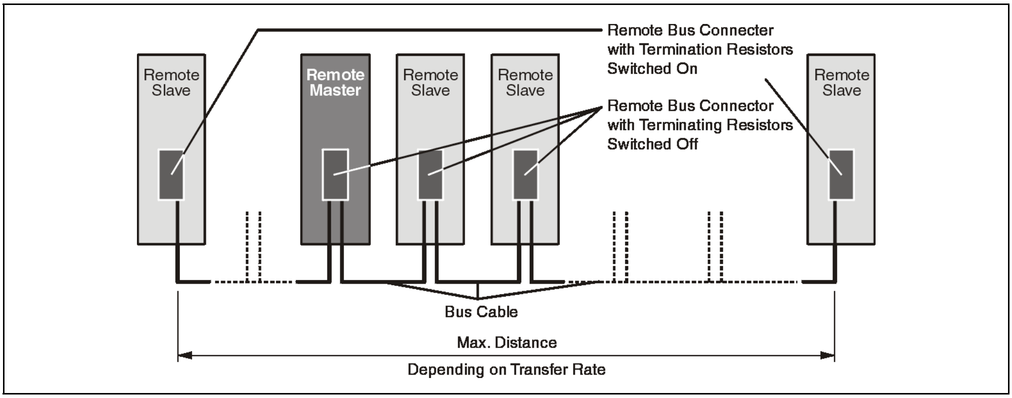


Figure 26: Wiring remote master and slave modules

<u>Bus Cable</u> (according to DIN 19245, Part 3)

The remote master and slave modules are connected using two twisted pair cables which must conform to the following specifications.

Specifications	
Wave Impedance	135 - 165 Ω (3 - 20 MHz)
Distributed Capacitance	<30 pF / m
Loop Resistance	<110 Ω/ km
Wire Diameter	> 0.64 mm
Wire Cross Section	> 0.34 mm²

Table 16: Specifications for the two twisted pair cables

The twisted pair cable must be terminated on both ends with a terminating resistor.

Bus Cable ↔ Station Connection

The two wires of the bus cable are connected to the individual stations as follows:

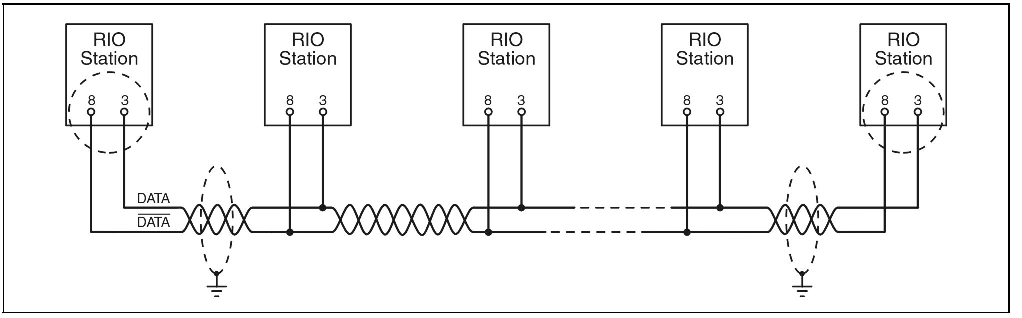


Figure 27: Bus cable ↔ Station connection

Terminating Resistors

The remote bus is fitted with terminating resistors at both ends. Terminating resistors are integrated in all B&R remote bus connectors 0G1000.00-090. The terminating resistors can be turned on or off.

Resistor Diagram

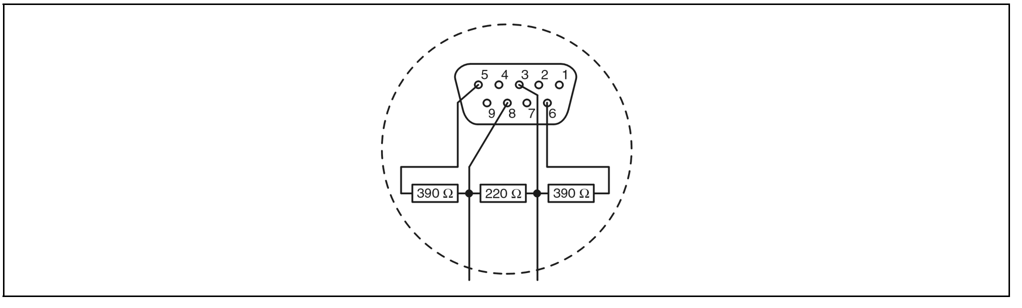


Figure 28: Resistor diagram

Remote Connector

Model Number: 0G1000.00-090

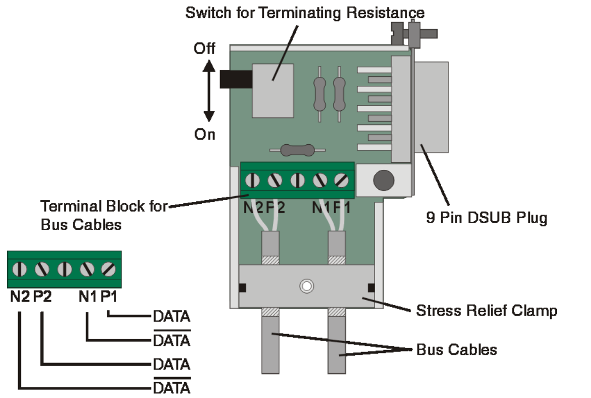


Figure 29: Remote connector

2.1.4 PROFIBUS

The cabling described for the remote I/O bus (bus cable, terminating resistors) is also used for PROFIBUS. The PROFIBUS network modules available from B&R are NW150 for the B&R SYSTEM 2005 and NW100 for the B&R SYSTEM 2010.

2.1.5 RS485 Network

The cabling described for the remote I/O bus (bus cable, terminating resistors) is also used for an RS485 network.

2.2 Configuring a Mixed System

2.2.1 Bus Expansion

An expansion slave of a 2010 or 2005 system can be coupled to an expansion master of the other system. The following restrictions must be noted:

2005 to 2010

Expansion slaves from 2005 expansion backplanes can be connected directly to a 2010 expansion master (maximum 4 per 2010 system). For this type of expansion, both interfaces of the 2010 expansion master can be used. Only the following configurations are permitted.

Interface	Number of Expansion Slaves		
	Configuration		
	1	2	3
1	4	0	2
2	0	4	2

Table 17: Permitted configurations

Depending on the chosen configuration, the expansion backplane number must be addressed in the programming system with the following numbers:

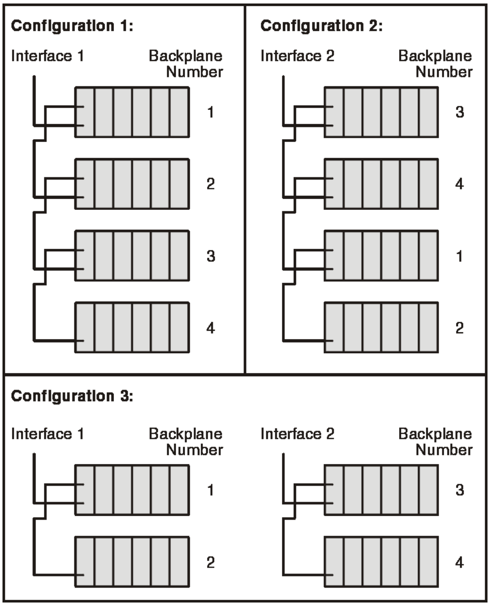


Figure 30: Backplane numbers for addressing

2010 to 2005

B&R 2010 I/O modules can be connected to a 2005 expansion master with an expansion slave (which has a power supply module inserted into the expansion slot), or to a 2005 expansion slave (Expansion Slave OUT).

The module address of the 2010 expansion slave is set with a node number switch, from where the 2010 I/O module addresses begin. Settings are made in steps of ten (00, 10, ..., 90). A maximum of 20 I/O modules can be installed on one of these bus segments. However, it is possible to use up to 99 modules with a 2010 expansion master.

2.2.2 Remote I/O Bus

A remote master (B&R SYSTEM 2005, B&R SYSTEM 2010 or B&R SYSTEM 2000 Logic Scanner) can be connected with up to 31 remote slaves. It is also possible to mix the B&R 2003, B&R 2005 and B&R 2010 systems.

Each remote slave starts a new I/O bus. The maximum number of slots available depends on the type of slave.

2.3 CAN Fieldbus

2.3.1 CAN Bus Features

- Low costs
- High noise immunity through differential signals
- Bus structure
- Open system
- Fast data transfer for small data packages (up to 8 bytes)
- Error detection by means of CRC (Cyclic Redundancy Check) and frame testing -> hamming distance 6
- Predictable transmission time for highpriority messages (real-time behavior)
- Easy to use

2.3.2 Bus Length and Cable Type

The type of cable used depends largely on the required bus length and the number of nodes. The bus length is mainly determined by the bit rate.

The following bus lengths are permitted with a maximum oscillator tolerance of 0.121%:

Distance [m]	Transfer Rate [kBit/s]
7306 [1)]	10
3613 [1)]	20
1397 [1)]	50
658	100
510	125
215	250
67	500

Table 18: Bus length and transfer rate

1) In accordance with CiA (CAN in Automation), the maximum bus length is 1000 m.

Relationship between the number of nodes and bus length for certain cable types using B&R default settings:

Cable 1	Belden YR 29832, 4.15 ns/m
Cable 2	Lapp Cable 2170204, 4.15 ns/m

Table 19: Cable type

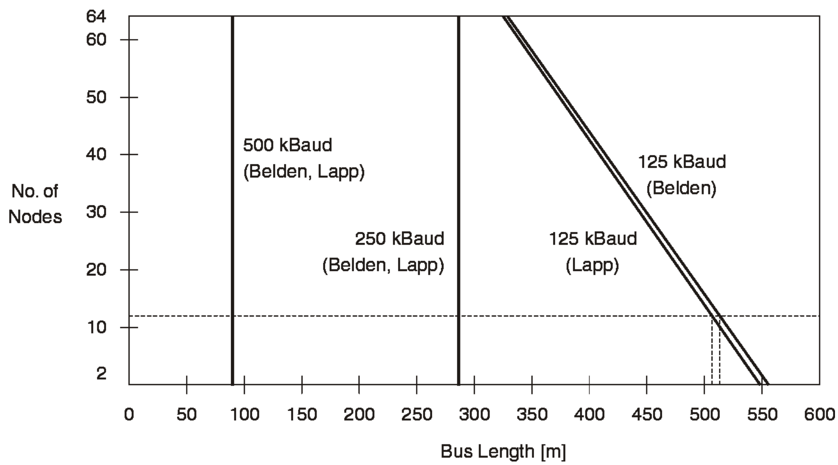


Figure 31: Relationship between the number of nodes and bus length

Example for 12 nodes:

Manufacturer	Baud Rate	Bus Length	Baud Rate	Bus Length	Baud Rate	Bus Length
Belden	500 kBaud	90 m	250 kBaud	286 m	125 kBaud	513 m
Lapp	500 kBaud	90 m	250 kBaud	286 m	125 kBaud	506 m

Table 20: Bus length for 12 nodes depending on the baud rate

2.3.3 Wiring

Bus Cable - Station Connection

A 4 conductor twisted pair cable should be used for the bus cable.

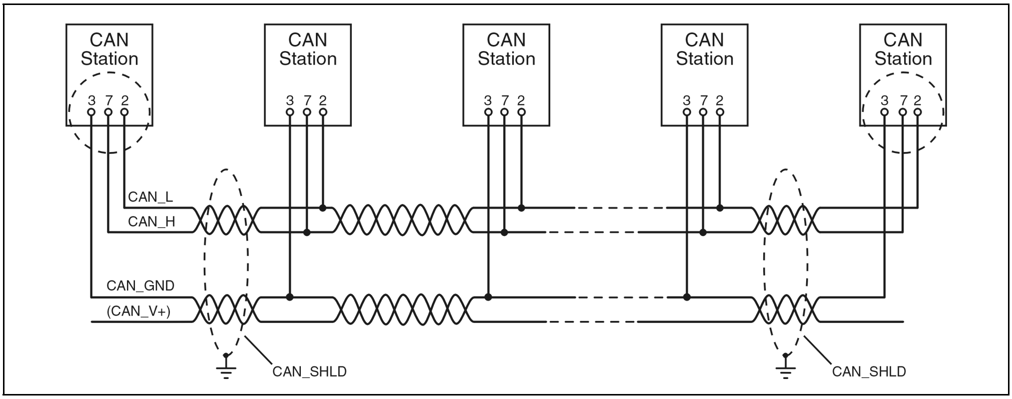


Figure 32: Bus Cable - station connection

CAN Signals for CiA/CAL

CAN Signal	B&R Product ID	Description
CAN_GND	CAN⊥	CAN Ground
CAN_L	CAN_L	CAN Low
(CAN_SHLD)	SHLD	Shield
CAN_H	CAN_H	CAN High
(CAN_V+)	---	CAN Supply 8 - 15 V, optional

Table 21: CAN signals for CiA/CAL

All CAN interfaces from B&R are supplied internally, therefore CAN_V+ does not have to be connected in CAN networks which do not contain devices from other manufacturers.

Branch Lines

Branch lines should be avoided if possible. However, it is possible to connect nodes to the bus with a branch line as long as the distance is less than 30 cm.

Terminating Resistance

CAN networks are cabled using a bus structure where both ends of the bus are equipped with terminating resistors.

9-pin DSUB Plug

For modules using a CAN interface, terminating resistor pins are assigned in the 9-pin DSUB plug as shown in the following diagram.

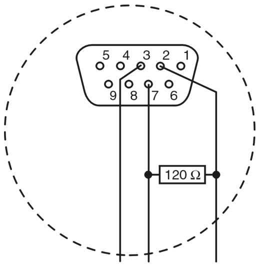


Figure 33: Terminating resistor connections for 9-pin DSUB plug

The terminating resistor is already integrated in the CAN bus plug 7AC911.9 available from B&R. The terminating resistor can be turned on or off.

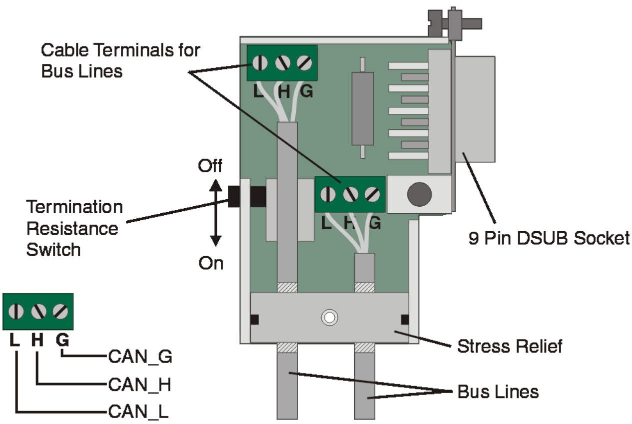


Figure 34: CAN bus connector 7AC911.9

4-pin Multipoint Connector

For modules using a CAN interface, terminating resistor pins must be assigned in the 4-pin multipoint connector as shown in the following diagram.

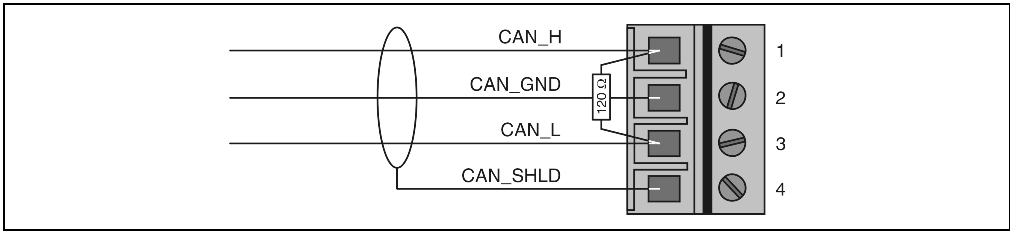


Figure 35: Terminating resistor connections for 4-pin multipoint connector

A 4-pin terminal block and a 120 Ω terminating resistor are delivered with the module.

3. Grounding and Shielding Measures

In most applications, industrial controllers are installed in switching cabinets. Electromagnetic switching elements (relays, contactors), transformers, motor controllers and frequency inverters etc. are also found in these switching cabinets. Different kinds of electromagnetic interference inevitably exist in such switching cabinets.

Generally this kind of interference cannot be avoided. However, if suitable grounding, shielding and other protective measures are taken, the negative influence of the devices can be considerably reduced. These protective measures include control cabinet grounding, module grounding, cable shield grounding, protective circuits on electromagnetic switching elements, and correct use of cables (choosing the proper cable cross section and type)

Grounding has essentially two different functions:

- Protective grounding
- Dissipation of electromagnetic disturbances

With the B&R 2000 controller generation both the dissipation electromagnetic disturbance and the grounding is done through the mounting rail.

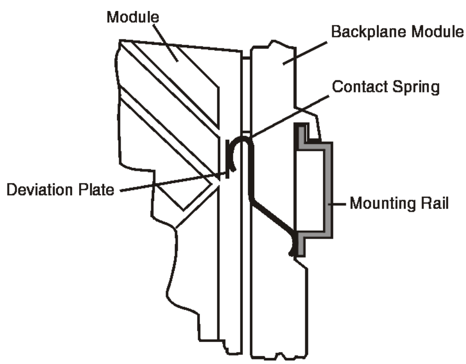


Figure 36: Dissipation of electromagnetic disturbance and grounding via the mounting rail

3.1 Grounding the Mounting Rail

For grounding purposes, a good conductive connection between the mounting rail and the metal back wall is required. The mounting rail is to be connected conductively to the back wall. This is achieved by inserting a contact washer with the fastening screw:

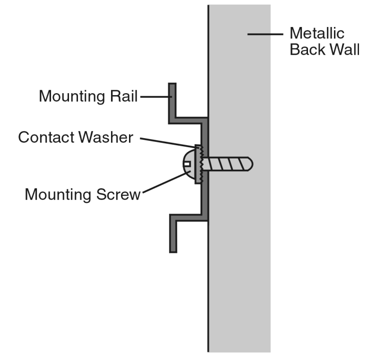


Figure 37: Grounding the mounting rail

For lacquered or coated back walls, an adequate connection is only guaranteed if the screw has been threaded into the back wall. If this is not the case, a contact washer must be must be placed between the fastening nut and the backplane.

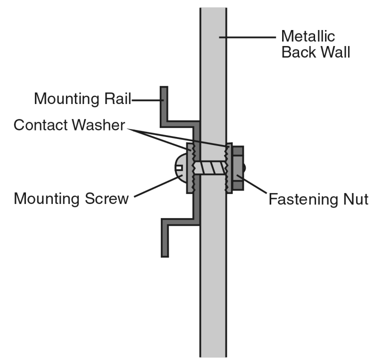


Figure 38: Using a contact washer with lacquered or coated back walls

The switching cabinet back wall must be connected with GND (⏚)

3.2 Grounding Terminal Strip

It is advisable to mount a grounding terminal strip underneath the PLC. This should be conductively connected to the screws of the control cabinet back wall. The cable shield and module connections must also be attached to this grounding strip:

The distance between the grounding strip and the PLC is limited to a maximum of 15 cm. No electromechanical switching elements (relays, contactors, etc.) are allowed to be attached between the PLC and the grounding strip. A cable duct is usually mounted directly below the PLC. A grounding strip should also be used underneath bus expansions (I/O bus segments, remote I/O bus).

a ...... Metal, grounded control cabinet back wall

b ...... Conductive screw attachment to the control cabinet back wall

c ...... Grounding terminal strip

d ...... Mounting rail

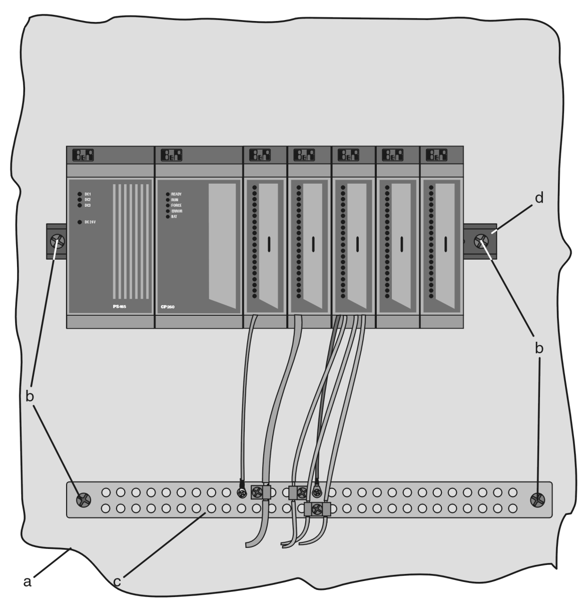


Figure 39: Grounding terminal strip

3.3 Cable Shield Grounding

The following connections are made with shielded cables (possible exceptions are listed in the individual module descriptions):

- Analog I/O
- Interface cables
- Encoder cables

The cable shield is to be grounded at both ends. On the PLC side, the grounding is made to the terminal strip underneath the housing.

If any differences in potential exist between the PLC and connected elements, transient current flows over the cable shield (often causes the cable to get warm), then the following steps should be taken: The cable shield is to be separated and bridged with a high-quality capacitor (ceramic or foil capacitors of at least 47 nF with a low impedance at high frequencies).

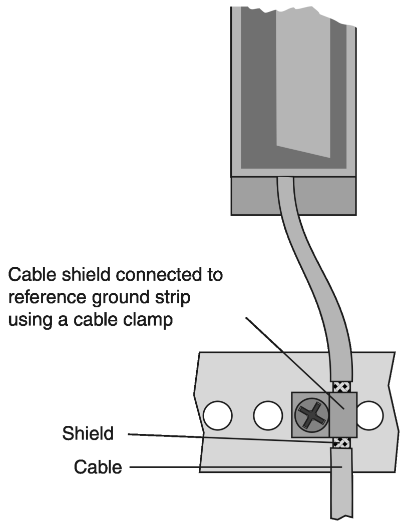


Figure 40: Cable shield grounding

3.4 Using DSUB connectors

DSUB connectors must be equipped with a metal-plated connector housing.

The shield is connected directly to the plug housing. Connecting the shield by twisting it before attaching it considerably reduces the shielding effect and should therefore be avoided.

If metallic screw clamps are not available, the cable shield can be externally grounded with a grounding clamp (see Section 3.3 "Cable Shield Grounding", on page 72).

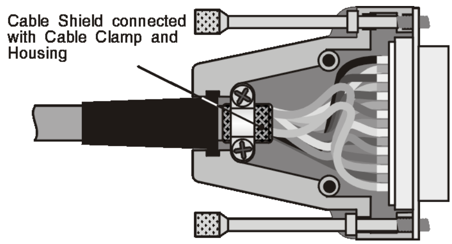


Table 22: Using DSUB connectors

4. Wiring

There are two basic types of cables used for B&R 2000 control systems:

- Shielded cables: interface cables, cables for analog signals
- Cable for digital signals

These two cable types should be separated running through different channels. If cables of different groups are run in the same channel over a long distance, a metallic, grounded partition should keep them apart.

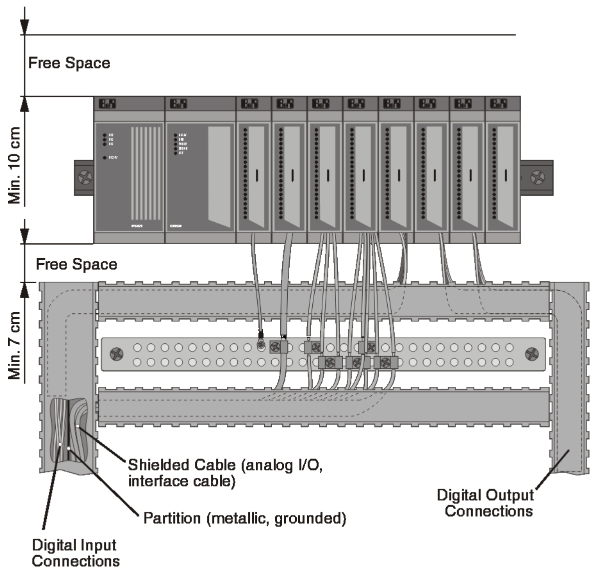


Figure 41: Wiring

The proposed cable arrangement is only possible if the order of the modules corresponds with:

Figure 42: Layout of the module

5. External Protective Circuit

An external protective circuit is necessary for relay output modules. The internal protection is used for increasing the lifespan of the relay and improve the EMC properties as well.

The external protection circuit can be installed either on the switching load, or between the terminal block and load. Most manufacturers of solenoid operated valves and contactors offer suitable protective circuit devices for the respective elements.

Possible protective elements are:

- RC element: can be used for D.C or A.C.
- Varistor: usually used for A.C.
- Inverse diode: can only be used for D.C.
- Diode/Z-diode combination: can only be used for D.C. This type of protective circuit allows faster switch-off times.

6. Installation Guidelines

- The B&R 2005 controller should only be mounted horizontally. There must be must at least 10 cm free space above the modules and at least 7 cm free space underneath the modules. The cooling vents are not allowed to be covered.
- Due to load carrying capacity reasons and electromagnetic compatibility, the mounting rail should be screwed into the grounded, metal back wall at intervals of 10 cm.
- The maximum environmental temperature during operation (usually 60° C) refers to the air temperature underneath the modules (air inlet).
- Sufficient distance must be left between devices which cause high electromagnetic interference (e.g. frequency converters, transformers, motor regulators, etc.). The distance between the devices and the PLC should be as large as possible. If possible they should be shielded using a metal partition (VACOPERM® 7).

Inserting and Removing Modules

- Modules should never be inserted or removed while the PLC is switched on (except I/O modules).
- Unplug cabled connectors before modules are removed.
- Power connectors are not allowed to be inserted or removed if voltage is still being supplied (remove power).

Inserting and Removing I/O Modules while the Controller is Running

I/O modules are allowed to be inserted and removed under the following conditions:

- Connectors are not allowed to carry voltages and must be removed.
- When inserting the module, please note that it takes approx. 2 s to tip the module back into place.
- Unless switching a module during operation is supported by the software, removing a module causes an emergency stop of the controller.

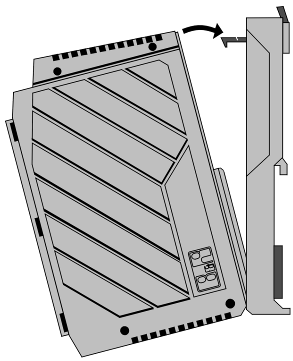


Figure 43: Inserting and removing I/O modules while the controller is running

7. Storage and Storage Temperatures

For modules that do not have buffer batteries or rechargeable batteries, a storage temperature of -20 to +70° C is allowed. Modules with buffer batteries or rechargeable batteries are allowed to be stored at a temperature of -20 to +60° C. If applicable, other temperatures are listed in the technical data for the modules.

8. Environmental Temperature during Operation / Relative Humidity

The following values are valid for all 2005 modules if no other values are listed in the "Technical Data" section.

Environmental Temperature during Operation	0 to 60°C
Relative Humidity	5 to 95%, non-condensing

Table 23: Environmental temperature during operation / relative humidity

Chapter 3 • B&R 2005 Modules

1. Module Overview B&R 2005

The "Power" column contains values for the power provided or the power required by the module. In this way, a power balance can be calculated quickly and easily for a certain hardware configuration.

The power provided by the power supply modules is shown with a "+" sign. The power required by a module is shown with a "–" sign.

To calculate the power balance, the positive and negative power values should be added together. The sum is not allowed to be less than zero.

1.1 Modules in Alphabetical Order

Name	Description	Main Backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
0G2001	2005 positioning accessory, cable for operating system download directly from the PC to the NC154					0G2001.00-090	606
AC240	Battery module for two 9 V block cells, separate slot					0AC240.9	602
AI350	8 8 voltage inputs ±10 V, 12-bit resolution	•	•	$82	-1 / -3.5 / -4.5	3AI350.6	313
AI375	8 voltage inputs 0 - 10 V, 12-bit resolution	•	•	$80	-1 / -3.5 / -4.5	3AI375.6	313
AI775	8 current inputs 0 - 20 mA, 12-bit resolution	•	•	$81	-1 / -3.5 / -4.5	3AI775.6	325
AI780	8 single channel isolated current inputs 0 - 20 mA, 16-bit resolution	•	•	$84	1.5 / --- / 1.5	3AI780.6	337
AM050	4 voltage inputs 0 - 10 V, 4 voltage outputs ±10 V, 12-bit resolution	•	•	$88	-1.5 / -5 / -6.5	3AM050.6	376
AM051	4 current inputs 0 - 20 mA, 4 current outputs 0 - 20 mA, 12-bit resolution	•	•	$89	-1.5 / -5 / -6.5	3AM051.6	389
AM055	5 voltage inputs 0 - 10 V, 3 voltage outputs ±10 V, 1 potentiometer voltage +10 V, 12-bit resolution	•	•	$97	-1.5 -5.5 incl. pot. voltage -7	3AM055.6	402
AM374	4 inputs 0 - 10 V / 0 - 20 mA, 4 outputs ±10 V / 0 - 20 mA, signal can be switched in 2 groups	•	•	$8A	-1.5 / -5 / -6.5	3AM374.6	416

Table 24: Overview of B&R 2005 modules, sorted alphabetically according to product ID

Name	Description	Main Backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
AO350	8 voltage outputs ±10 V, 12-bit resolution	•	•	$A0	-1 / -4 / -5	3AO350.6	361
AO360	8 voltage outputs ±10 V, 16-bit resolution	•	•	$A2	-1.1 / -4 / -5.1	3AO360.60-1	366
AO775	8 current outputs 0 - 20 mA, 11-bit resolution	•	•	$A1	-1 / -4.5 / -5.5	3AO775.6	370
AT350	4 inputs for PT100 sensors (3-line)	•	•	$93	-1 / -3 / -4	3AT350.6	438
AT450	4 inputs for PT100 sensors (4-line)	•	•	$92	-1 / -3 / -4	3AT450.6	438
AT660	8 inputs for FeCuNi sensors with type L + J, NiCrNi sensors with type K, raw value measurement	•	•	$95	-1.25 / -4.75 / -6	3AT660.6	451
BM150	Dummy module	•	•			3BM150.9	607
BP150	Backplane with 15 slots					3BP150.4	90
BP150	Backplane with 15 slots, backup battery					3BP150.41	90
BP151	Backplane with 12 slots					3BP151.4	90
BP151	Backplane with 12 slots, backup battery					3BP151.41	90
BP152	Backplane with 9 slots					3BP152.4	90
BP152	Backplane with 9 slots, backup battery					3BP152.41	90
BP155	Backplane with 6 slots					3BP155.4	90
BP155	Backplane with 6 slots, backup battery					3BP155.41	90
CP260	2005 CPU, 4 MB DRAM, 850 KB SRAM, 512 KB FlashPROM, 2 insert slots, 1 PCMCIA slot, 1 RS232 interface	•		$27	-5.7 / -2.3 / -8	3CP260.60-1	120
CP340	2005 CPU, x86 233 Intel compatible, 16 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-4.5 / -1 / -5.5	3CP340.60-1	129
CP360	2005 CPU, Pentium 266, 32 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.	•		---	-11 / -3 / -14	3CP360.60-1 [1)]	129
CP380	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert modules for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-13 / -3 / -16	3CP380.60-1	129
CP382	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 3 insert slots for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-13 / -4 / -17	3CP382.60-1	129

Table 24: Overview of B&R 2005 modules, sorted alphabetically according to product ID (cont.)

Name	Description	Main Backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
DI450	16 digital inputs, 24 VDC, 4 counter inputs, gate/period measurement	•	•	$08	-2 / --- / -2	3DI450.60-9	203
DI475	16 digital inputs, 24 VDC, 10 ms switching delay	•	•	$01	-1.5 / --- / -1.5	3DI475.6	216
DI476	16 digital inputs, 24 VDC, 1 ms switching delay	•	•	$07	-1.5 / --- / -1.5	3DI476.6	216
DI477	32 digital inputs, 24 VDC, 1 ms switching delay, connection: DSUB connector	•	•	$05	-1.5 / --- / -1.5	3DI477.6	220
DI486	32 digital inputs, 24 VDC, 1 ms switching delay, connection: terminal	•	•	$09	-1.2 / --- / -1.2	3DI486.6	226
DI695	16 digital inputs, 120 / 230 VAC, 50 ms switching delay	•	•	$B2	-1.5 / --- / -1.5	3DI695.6	233
DI875	16 Namur inputs, 8.05 VDC, 1 ms switching delay	•	•	$B4	-1.3 / -4.8 / -6.1	3DI875.6	238
DM455	8 digital inputs, 24 VDC, 2.5 µs, 8 transistor outputs, 0 - 50 VDC, 1 A	•	•	$20	-3.5 / --- / -3.5	3DM455.60-2	186
DM476	16 digital inputs, 24 VDC / 24 VAC, 1 ms, 16 transistor outputs, 24 VDC, 0.4 A	•	•	$62	-2.5 / --- / -2.5	3DM476.6	291
DM486	16 digital inputs, 24 VDC, 1 ms, 16 FET outputs, 24 VDC, 0.5 A	•	•	$63	-1.2 / --- / -1.2	3DM486.6	301
DO479	16 transistor outputs, 24 VDC, 0.5 A	•	•	$40	-1 / --- / -1	3DO479.6	249
DO480	16 transistor outputs, 24 VDC, 2 A	•	•	$41	-1.5 / -1 / -2.5	3DO480.6	256
DO486	32 FET outputs, 24 VDC, 0.5 A	•	•	$42	-1.2 / --- / -1.2	3DO486.6	263
DO650	16 relay outputs, 24 VDC / 120 VAC, 2 A	•	•	$03	-0.7 / -3.3 / -4	3DO650.6	272
DO690	8 Triac outputs, 120 VAC, 1 A	•	•	$61	-1.5 / --- / -1.5	3DO690.6	277
DO750	8 relay outputs, 24 VDC / 230 VAC, 3 A	•	•	$04	-0.7 / -2.3 / -3	3DO750.6	272
DO760	8 relay outputs, 30 VDC / 240 VAC, 4 A	•	•	$B0	-4 / --- / -4	3DO760.6	282
EX150	Remote I/O master	•			-5.5 / --- / -5.5	3EX150.60-1	103
EX250	Remote I/O slave, power supply insert				-1.5 / --- / -1.5	3EX250.60-1	109
EX282	ETHERNET Powerlink bus controller, 2 ETHERNET Powerlink interfaces, power supply module insert				-3.8 / --- / -3.8	3EX282.6	487
EX350	I/O Master Controller, power supply insert				-1.5 / --- / -1.5	3EX350.6	114
IF050	Interface module, 1 x RS232, 1 x RS485/RS422, 1 x RS232/TTY	•			-7 / --- / -7	3IF050.6	494
IF060	Interface module with insert slot for interface module inserts	•			-1 / --- / -1	3IF060.6	501
IF260	2005 CPU or progr. interface processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 insert slot for interface module inserts	•		$2A	-3.5 / --- / -3.5	3IF260.60-1	145
IF613	Interface module for insert slot, 3 x RS232				-1.2 / --- / -1.2	3IF613.9	503
IF621	Interface module for insert slot, 1 x RS485/RS422, 1 x CAN				-1.5 / --- / -1.5	3IF621.9	507

Table 24: Overview of B&R 2005 modules, sorted alphabetically according to product ID (cont.)

Name	Description	Main Backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
IF622	Interface module for insert slot, 1 x RS232, 2 x RS485/RS422				-1.8 / --- / -1.8	3IF622.9	511
IF661	Interface module for insert slot, 1 x RS485 RS485 (PROFIBUS DP slave)				-2 / --- / -2	3IF661.9	515
IF671	Interface module for insert slot, 1 x RS232, 1 x RS485/RS422, 1 x CAN				-2 / --- / -2	3IF671.9	519
IF672	Interface module for insert slot, 1 x RS232, 2 x CAN				-1.8 / --- / -1.8	3IF672.9	524
IF681.95	Interface module for insert slot, 1 x RS232, 1 x ETHERNET (10BASE2: CHEAPERNET BNC socket)				-2.4 / --- / -2.4	3IF681.95	528
IF681.96	Interface module for insert slot, 1 x RS232, 1 x ETHERNET (10BASE-T: twisted pair RJ45 socket)				-1.65 / --- / -1.65	3IF681.96	528
IF686	Interface module for insert slot, 1 ETHERNET Powerlink interface, manager or controller function				-1.76 / --- / -1.76	3IF686.9	532
IF772	aPCI interface module for aPCI insert, 1 x RS232, 2 x CAN				-2.1 / --- / -2.1	3IF772.9	537
IP161	2005 programmable I/O processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, max. 12 digital inputs 24 VDC, Sink, max. 12 digital outputs 24 VDC, 0.1 A, 6 analog inputs ±10 V, 14-bit, 6 analog outputs ±10 V, 12-bit, 2 outputs with +10 V and -10 V per terminal block. Order 3 x TB170 terminal blocks separately.	•		$34	-6.5 -11.5 incl. pot. volt. -18	3IP161.60-1	154
MASYS2 2005-0	B&R 2005 User's Manual, German					MASYS22005-0	610
MASYS2 2005 - E	B&R 2005 User's Manual, English					MASYS22005-E	610
MASYS2 2005-F	B&R 2005 User's Manual, French					MASYS22005-F	610
NC150	Counter module, 2 32-bit counters, 100 kHz, 2 voltage inputs ±10 V, 12-bit resolution	•	•		-1.5 / -3.5 / -5	3NC150.6	548
NC154	2005 axis controller, 3 axes. Each axis has the following data: Input frequency 150 kHz, incremental or absolute, 32-bit, encoder supply 5 VDC or 24 VDC, 5 digital inputs 24 VDC, sink, 1 relay output 24 VAC / 24 VDC, 1 A, 1 analog output +/- 10 V, 12-bit, 12-pin. Order 3 x TB162 terminal blocks separately.	•			-6 / --- / -6	3NC154.60-2	563
NC157	2005 positioning module, CAN bus interface for controlling up to 8 axes, 2 trigger inputs, 24 VDC, sink, 4-pin terminal block included in the delivery.	•			-6 / --- / -6	3NC157.60-1	572
NC352	B&R 2005 transducer module with 3 pulse interfaces, 3 digital inputs (24 V DC) (can be configured as event counter, for gate and frequency measurement and as A/B counter with external count frequency option) and also one digital output (24 V DC). Order TB708 terminal block separately.	•	•	$9A	-2.3 / -1.7 / -4	3NC352.6	581

Table 24: Overview of B&R 2005 modules, sorted alphabetically according to product ID (cont.)

Name	Description	Main Backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
NW150	PROFIBUS network module	•			-7 / --- / -7	3NW150.60-1	541
PS465	Power supply 24 VDC, 50 W, with expansion slot	•	•		+40 / +50 / +60	3PS465.9	100
PS477	Power supply 24 VDC, 50 W, with expansion slave	•	•		+40 / +50 / +58.5	3PS477.9	100
TB162	Single row terminal block, 12-pin, screw clamps					3TB162.9	608
TB170	Single row terminal block, 20-pin, screw clamps					3TB170.9	609
TB170	Single row terminal block, 20-pin, cage clamps					3TB170.91	609
TB170	20 single row terminal blocks, 20-pin, screw clamps					3TB170:90-02	609
TB170	20 single row terminal blocks, 20-pin, cage clamps					3TB170:91-02	609
UM161	2005 universal mixed module, 1x4 analog inputs ±10 V, 14-bit, 1x3 analog outputs ±10 V, 12-bit, 1x14 digital inputs 24 VDC, 1 ms, 1 digital output 24 VDC, 2 A, 500 µs, 1 digital output 24 VDC, 10 mA, 10 µs, both outputs can be used as inputs. Order 2 x TB718 terminal blocks separately!	•	•	$99	-2 -4 (-1.5 f. pot. volt.) -6	3UM161.6	468
XP152	2005 CPU, 118 KB SRAM, 512 KB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, insert for power supply modules			$11	-4 / --- / -4	3XP152.60-2	176

Table 24: Overview of B&R 2005 modules, sorted alphabetically according to product ID (cont.)

1) This CPU replaces the 3CP360.60-2. The 3CP360.60-1 has one additional USB interface.

1.2 According to Groups

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
	Module Rack						
BP150	Backplane with 15 slots					3BP150.4	90
BP150	Backplane with 15 slots, backup battery					3BP150.41	90
BP151	Backplane with 12 slots					3BP151.4	90
BP151	Backplane with 12 slots, backup battery					3BP151.41	90
BP152	Backplane with 9 slots					3BP152.4	90
BP152	Backplane with 9 slots, backup battery					3BP152.41	90
BP155	Backplane with 6 slots					3BP155.4	90
BP155	Backplane with 6 slots, backup battery					3BP155.41	90

Table 25: B&R 2005 module overview sorted according to group

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
	Power Supply Modules						
PS465	Power supply 24 VDC, 50 W, with expansion slot	•	•		+40 / +50 / +60	3PS465.9	100
PS477	Power supply 24 VDC, 50 W, with expansion slave	•	•		+40 / +50 / +58.5	3PS477.9	100
	Bus Controller Modules						
EX150	Remote I/O master	•			-5.5 / --- / -5.5	3EX150.60-1	103
EX250	Remote I/O slave, power supply insert				-1.5 / --- / -1.5	3EX250.60-1	109
EX350	I/O master controller, power supply insert				-1.5 / --- / -1.5	3EX350.6	114
	CPUs						
CP260	2005 CPU, 4 MB DRAM, 850 KB SRAM, 512 KB FlashPROM, 2 insert slots, 1 PCMCIA slot, 1 RS232 interface	•		$27	-5.7 / -2.3 / -8	3CP260.60-1	120
CP340	2005 CPU, x86 233 Intel compatible, 16 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-4.5 / -1 / -5.5	3CP340.60-1	129
CP360	2005 CPU, Pentium 266, 32 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.	•		---	-11 / -3 / -14	3CP360.60-1 1)	129
CP380	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert modules for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-13 / -3 / -16	3CP380.60-1	129
CP382	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 3 insert slots for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately	•		---	-13 / -4 / -17	3CP382.60-1	129
IF260	2005 CPU or progr. interface processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 insert slot for interface module inserts	•		$2A	-3.5 / --- / -3.5	3IF260.60-1	145
IP161	2005 programmable I/O processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, max. 12 digital inputs 24 VDC, Sink, max. 12 digital outputs 24 VDC, 0.1 A, 6 analog inputs ±10 V, 14-bit, 6 analog outputs ±10 V, 12-bit, 2 outputs with +10 V and -10 V per terminal block. Order 3 x TB170 terminal blocks separately.	•		$34	-6.5 -11.5 incl. pot. volt. -18	3IP161.60-1	154
XP152	2005 CPU, 118 KB SRAM, 512 KB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, insert for power supply modules			$11	-4 / --- / -4	3XP152.60-2	176

Table 25: B&R 2005 module overview sorted according to group (cont.)

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
	Programmable Modules						
DM455	8 digital inputs, 24 VDC, 2.5 µs, 8 transistor outputs, 0 - 50 VDC, 1 A	•	•	$20	-3.5 / --- / -3.5	3DM455.60-2	186
	Digital Input Modules						
DI450	16 digital inputs, 24 VDC, 4 counter inputs, gate/period measurement	•	•	$08	-2 / --- / -2	3DI450.60-9	203
DI475	16 digital inputs, 24 VDC, 10 ms switching delay	•	•	$01	-1.5 / --- / -1.5	3DI475.6	216
DI476	16 digital inputs, 24 VDC, 1 ms switching delay	•	•	$07	-1.5 / --- / -1.5	3DI476.6	216
DI477	32 digital inputs, 24 VDC, 1 ms switching delay, connection: DSUB connector	•	•	$05	-1.5 / --- / -1,5	3DI477.6	220
DI486	32 digital inputs, 24 VDC, 1 ms switching delay, connection: terminal	•	•	$09	-1.2 / --- / -1.2	3DI486.6	226
DI695	16 digital inputs, 120 / 230 VAC, 50 ms switching delay	•	•	$B2	-1,5 / --- / -1,5	3DI695.6	233
DI875	16 Namur inputs, 8.05 VDC, 1 ms switching delay	•	•	$B4	-1.3 / -4.8 / -6.1	3DI875.6	238
	Digital Output Modules						
DO479	16 transistor outputs, 24 VDC, 0.5 A	•	•	$40	-1 / --- / -1	3DO479.6	249
DO480	16 transistor outputs, 24 VDC, 2 A	•	•	$41	-1,5 / -1 / -2,5	3DO480.6	256
DO486	32 FET outputs, 24 VDC, 0.5 A	•	•	$42	-1.2 / --- / -1.2	3DO486.6	263
DO650	16 relay outputs, 24 VDC / 120 VAC, 2 A	•	•	$03	-0.7 / -3.3 / -4	3DO650.6	272
DO690	8 Triac outputs, 120 VAC, 1 A	•	•	$61	-1,5 / --- / -1,5	3DO690.6	277
DO750	8 relay outputs, 24 VDC / 230 VAC, 3 A	•	•	$04	-0.7 / -2.3 / -3	3DO750.6	272
DO760	8 relay outputs, 30 VDC / 240 VAC, 4 A	•	•	$B0	-4 / --- / -4	3DO760.6	282
	Digital Mixed Modules						
DM476	16 digital inputs, 24 VDC / 24 VAC, 1 ms, 16 transistor outputs, 24 VDC, 0.4 A	•	•	$62	-2,5 / --- / -2,5	3DM476.6	291
DM486	16 digital inputs, 24 VDC, 1 ms, 16 FET outputs, 24 VDC, 0.5 A	•	•	$63	-1.2 / --- / -1.2	3DM486.6	301
	Analog Input Modules						
AI350	8 voltage inputs ±10 V, 12-bit resolution	•	•	$82	-1 / -3,5 / -4,5	3AI350.6	313
AI375	8 voltage inputs 0 - 10 V, 12-bit resolution	•	•	$80	-1 / -3,5 / -4,5	3AI375.6	313
AI775	8 current inputs 0 - 20 mA, 12-bit resolution	•	•	$81	-1 / -3,5 / -4,5	3AI775.6	325
AI780	8 single channel isolated current inputs 0 - 20 mA, 16-bit resolution	•	•	$84	1,5 / --- / 1,5	3AI780.6	337

Table 25: B&R 2005 module overview sorted according to group (cont.)

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
	Analog Output Modules						
AO350	8 voltage outputs ±10 V, 12-bit resolution	•	•	$A0	-1 / -4 / -5	3AO350.6	361
AO360	8 voltage outputs ±10 V, 16-bit resolution	•	•	$A2	-1.1 / -4 / -5.1	3AO360.60-1	366
AO775	8 current outputs 0 - 20 mA, 11-bit resolution	•	•	$A1	-1 / -4,5 / -5,5	3AO775.6	370
	Analog Mixed Modules						
AM050	4 voltage inputs 0 - 10 V, 4 voltage outputs ±10 V, 12-bit resolution	•	•	$88	-1,5 / -5 / -6,5	3AM050.6	376
AM051	4 current inputs 0 - 20 mA, 4 current outputs 0 - 20 mA, 12-bit resolution	•	•	$89	-1,5 / -5 / -6,5	3AM051.6	389
AM055	5 voltage inputs 0 - 10 V, 3 voltage outputs ±10 V, 1 potentiometer voltage +10 V, 12-bit resolution	•	•	$97	-1,5 -5.5 incl. pot. volt. -7	3AM055.6	402
AM374	4 input 0 - 10 V / 0 - 20 mA, 4 outputs ±10 V / 0 - 20 mA, signal can be switched in 2 groups	•	•	$8A	-1,5 / -5 / -6,5	3AM374.6	416
	Temperature Modules						
AT350	4 inputs for PT100 sensors (3 line)	•	•	$93	-1 / -3 / -4	3AT350.6	438
AT450	4 inputs for PT100 sensors (4 line)	•	•	$92	-1 / -3 / -4	3AT450.6	438
AT660	8 inputs for FeCuNi sensors with type L + J, NiCrNi sensors with type K, raw value measurement	•	•	$95	-1.25 / -4.75 / -6	3AT660.6	451
	Other Modules						
UM161	2005 universal mixed module, 1x4 analog inputs ±10 V, 14-bit, 1x3 analog outputs ±10 V, 12-bit, 1x14 digital inputs 24 VDC, 1 ms, 1 digital output 24 VDC, 2 A, 500 µs, 1 digital output 24 VDC, 10 mA, 10 µs, both outputs can be used as inputs. Order 2 x TB718 terminal blocks separately!	•	•	$99	-2 -4 (-1.5 f. pot. volt.) -6	3UM161.6	468
	Communication Modules						
EX282	ETHERNET Powerlink bus controller, 2 ETHERNET Powerlink interfaces, power supply module insert				-3.8 / --- / -3.8	3EX282.6	487
IF050	Interface module, 1 x RS232, 1 x RS485/RS422, 1 x RS232/TTY	•			-7 / --- / -7	3IF050.6	494
IF060	Interface module with insert slot for interface module inserts	•			-1 / --- / -1	3IF060.6	501
IF613	Interface module for insert slot, 3 x RS232				-1.2 / --- / -1.2	3IF613.9	503
IF621	Interface module for insert slot, 1 x RS485/RS422, 1 x CAN				-1,5 / --- / -1,5	3IF621.9	507
IF622	Interface module for insert slot, 1 x RS232, 2 x RS485/RS422				-1.8 / --- / -1.8	3IF622.9	511
IF661	Interface module for insert slot, 1 x RS485 RS485 (PROFIBUS DP slave)				-2 / --- / -2	3IF661.9	515

Table 25: B&R 2005 module overview sorted according to group (cont.)

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
IF671	Interface module for insert slot, 1 x RS232, 1 x RS485/RS422, 1 x CAN				-2 / --- / -2	3IF671.9	519
IF672	Interface module for insert slot, 1 x RS232, 2 x CAN				-1.8 / --- / -1.8	3IF672.9	524
IF681.95	Interface module for insert slot, 1 x RS232, 1 x ETHERNET (10BASE2: CHEAPERNET BNC socket)				-2.4 / --- / -2.4	3IF681.95	528
IF681.96	Interface module for insert slot, 1 x RS232, 1 x ETHERNET (10BASE-T: twisted pair RJ45 socket)				-1.65 / --- / -1.65	3IF681.96	528
IF686	Interface module for insert slot, 1 ETHERNET Powerlink interface, manager or controller function				-1.76 / --- / -1.76	3IF686.9	532
IF772	aPCI interface module for aPCI insert, 1 x RS232, 2 x CAN				-2.1 / --- / -2.1	3IF772.9	537
NW150	PROFIBUS network module	•			-7 / --- / -7	3NW150.60-1	541
	Counter and Positioning Modules						
NC150	Counter module, 2 32-bit counter, 100 kHz, 2 voltage inputs ±10 V, 12-bit resolution	•	•		-1,5 / -3,5 / -5	3NC150.6	548
NC154	2005 Axis Controller, 3 axes. Each axis has the following data: Input frequency 150 kHz, incremental or absolute, 32-bit, encoder supply 5 VDC or 24 VDC, 5 digital inputs 24 VDC, sink, 1 relay output 24 VAC / 24 VDC, 1 A, 1 analog output +/- 10 V, 12-bit, 12-pin. Order 3 x TB162 terminal blocks separately.	•			-6 / --- / -6	3NC154.60-2	563
NC157	2005 positioning module, CAN bus interface for controlling up to 8 axes, 2 trigger inputs, 24 VDC, sink, 4-pin terminal block included in the delivery.	•			-6 / --- / -6	3NC157.60-1	572
NC352	B&R 2005 transducer module with 3 pulse interfaces, 3 digital inputs (24 V DC) (can be configured as event counter, for gate and frequency measurement and as A/B counter with external count frequency option) and also one digital output (24 V DC). Order TB708 terminal block separately.	•	•	$9A	-2.3 / -1.7 / -4	3NC352.6	581
	Accessories						
AC240	Battery module for two 9 V block cells, separate slot					0AC240.9	602
0G2001	2005 positioning accessory, cable for operating system download directly from the PC to the NC154					0G2001.00-090	606
BM150	Dummy module	•	•			3BM150.9	607
TB162	Single row terminal block, 12-pin, screw clamps					3TB162.9	608
TB170	Single row terminal block, 20-pin, screw clamps					3TB170.9	609
TB170	Single row terminal block, 20-pin, cage clamps					3TB170.91	609
TB170	20 single row terminal blocks, 20-pin, screw clamps					3TB170:90-02	609
TB170	20 single row terminal blocks, 20-pin, cage clamps					3TB170:91-02	609

Table 25: B&R 2005 module overview sorted according to group (cont.)

Name	Description	Main backplane	Exp. Backplane	B&R ID Code	Power [W] 5 V / 24 V / Total	Model No.	Page
	Manuals						
MASYS2 2005-0	B&R 2005 User's Manual, German					MASYS22005-0	610
MASYS2 2005-E	B&R 2005 User's Manual, English					MASYS22005-E	610
MASYS2 2005-F	B&R 2005 User's Manual, French					MASYS22005-F	610

Table 25: B&R 2005 module overview sorted according to group (cont.)

1) This CPU replaces the 3CP360.60-2. The 3CP360.60-1 has one additional USB interface.

2. Module Racks

2.1 BP15x

2.1.1 General Information

Backplane modules are installed on the mounting rail. They are used for installing controller components (CPU, I/O modules, power supply modules, system modules etc.). The I/O bus, system bus and the supply lines are provided on the backplanes. Backplanes are available with 6, 9, 12 or 15 slots for the B&R 2005.

It is recommended that the smallest possible backplane should be used to ensure that as few slots as possible remain free. Dummy modules must be installed in all free slots.

The backplane modules 3BP15x.41 are equipped with a lithium battery. The battery is used for central data buffering on the 2005 PLC (e.g. data and real-time clock for the XP152).

The **module address** is determined by the slot (slot coding). Module addressing begins with slot 3, which has address 1. For PLC systems with an operating system older than version 1.10, module addressing for system modules begins with address 0 (numbers are different for system modules and I/O modules).

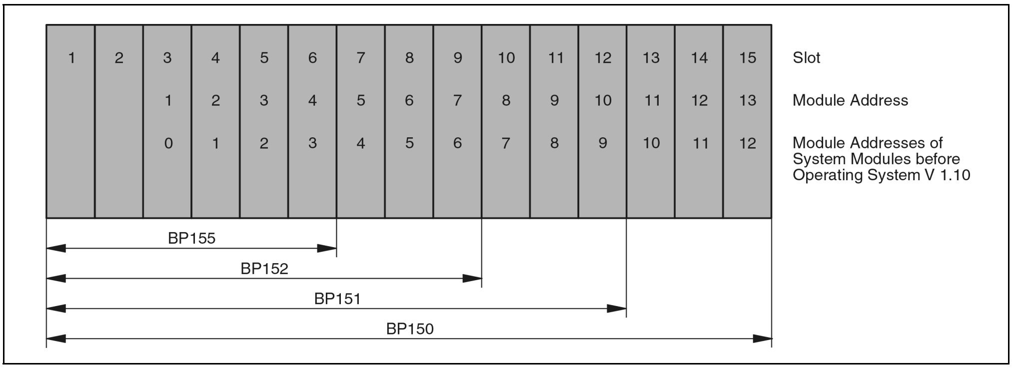


Figure 44: BP15x module address

The following modules can be used depending on whether the backplane is used as a main backplane or an expansion backplane:

Slot	Main Backplane	Expansion Backplane
1	Power supply with expansion slot or	Power Supply: With expansion slot
2	Any other power supply	With expansion slave
3	System or I/O module	I/O module
4		I/O module
5	System or I/O module	I/O module
6	System or I/O module	I/O module
:	:	:
:	:	:
15	System or I/O module	I/O module

Table 26: BP15x insert modules depending on backplane

2.1.2 Order Data

Model Number	Short Description	Image
	Module Rack	
3BP150.4	2005 backplane, 15 slots	
3BP151.4	2005 backplane, 12 slots	
3BP152.4	2005 backplane, 9 slots	
3BP155.4	2005 backplane, 6 slots	
3BP150.41	2005 backplane, 15 slots, with backup battery	
3BP151.41	2005 backplane, 12 slots, with backup battery	
3BP152.41	2005 backplane, 9 slots, with backup battery	
3BP155.41	2005 backplane, 6 slots, with backup battery	
	Accessories	
0AC201.9	Lithium batteries, 5 pcs., 3 V / 950 mAh, button cell	
Backup battery is included in the delivery.		

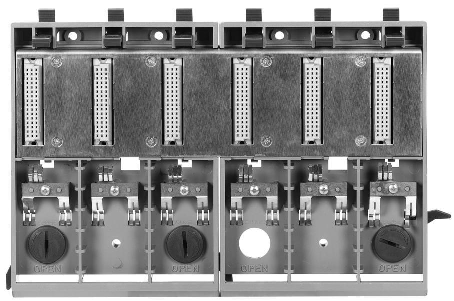


Table 27: BP15x order data

2.1.3 Technical Data

Product ID	BP150	BP151	BP152	BP155
C-UL-US Listed	Yes	Yes	Yes	Yes
Number of Slots	15	12	9	6
Number of Modules that can be Inserted On the Main Backplane 1 Power Supply + ... On Expansion Backplane 1 Power Supply + ...	13 system and I/O modules 13 I/O modules	10 system and I/O modules 10 I/O modules	7 system and I/O modules 7 I/O modules	4 system and I/O modules 4 I/O modules
Dimensions (H, W, D) [mm][1)]	165, 600, 23	165, 480, 23	165, 360, 23	165, 240, 23
Backup Battery Type Model Number Storage Time (not installed)	**Only** backplane modules with order number 3BP15x.**41** Lithium Battery - 3 V / 950 mAh 0AC201.9 - 5 lithium batteries Max. 3 years at 30° C			
Storage Temperature Backplane Module without Battery Backplane Module with Battery Battery (not installed)	-20 to +70° C -20 to +60° C -20 to +60° C			

Table 28: BP15x technical data

1) When installing the backplane, it is important to allow for 20 mm space on both sides of the backplane for the fastening lever.

2.1.4 Backup Battery

The backplane modules 3BP15x.41 are equipped with a lithium battery. The battery is used for central data buffering on the B&R SYSTEM 2005 (e.g. data and real-time clock for the XP152).

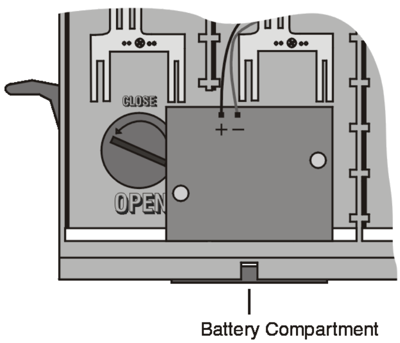


Figure 45: 3BP15x.41 backup battery

Buffer Battery Data

Lithium Battery	3 V / 950 mAh
Model Number	0AC201.9
Short Description	Lithium batteries, 5 pcs., 3 V / 950 mAh, button cell
Storage Temperature	-20 to +60° C
Storage Time	Max. 3 years at 30° C
Relative humidity	0 to 95% (non-condensing)

Table 29: 3BP15x.41 buffer battery data

Battery Change Interval

Batteries installed in the B&R 2005 backplane module should be changed according to the following change interval:

Change Interval: Every 4 years[1)]

Buffer Time

Buffer time is reduced when more processors e.g. IP161, XP152 or IF260 are operated from the same backplane module and when the rechargeable battery is already empty.

Reduction factor = Number of all processor modules on the backplane

2.1.5 Changing the Lithium Battery

The product design allows the battery to be changed with the PLC switched either on or off. In some countries, safety regulations do not allow batteries to be changed while the module is switched on. Therefore, B&R recommends the battery is switched when the power supply is switched off.

Data is lost when modules do not have their own buffer.

Procedure for Changing the Battery

1) Disconnect the power supply.
2) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.
3) Open the battery compartment using a screwdriver. The screwdriver should be placed in the slot and by levering it upwards, the compartment can be opened.

1) The change intervals refers to the average life span and operating conditions and are recommended by B&R. They do not correspond to the maximum buffer duration.

4) Remove the battery from the holder by pulling the battery compartment cover.

5) Remove the lithium battery (do not use insulated tools because of risk of short circuiting). The battery should not be held by its edges. **Insulated** tweezers may also be used for removing the battery.

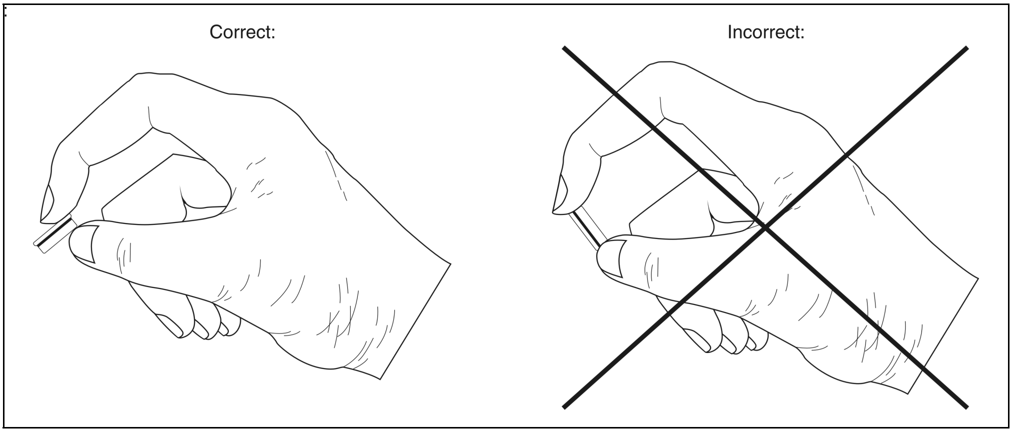


Figure 46: Holding the 3BP15x.41 battery correctly

6) Insert the new battery with correct polarity. The removal strip must be located underneath the battery as otherwise the battery can not be removed.

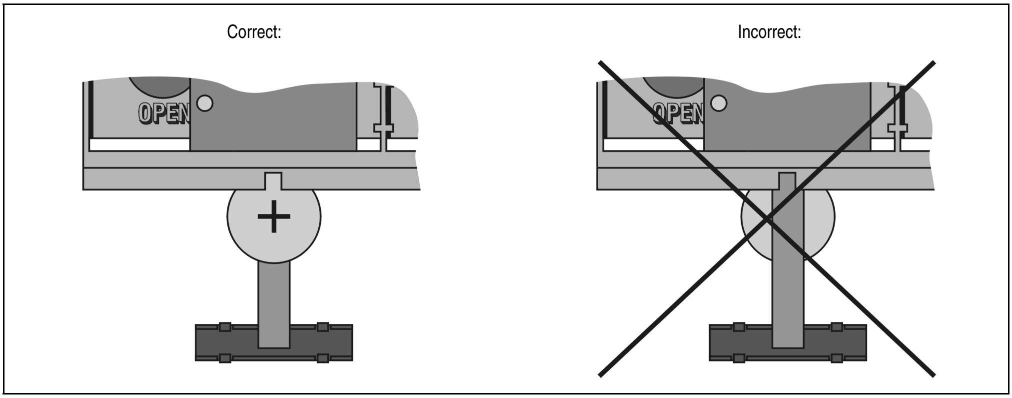


Figure 47: The removal strip must be located underneath the 3BP15x.41 battery

7) Close the cover for the lithium battery.

8) Connect the lines to the power supply.

Lithium batteries are considered hazardous waste! Used batteries should be disposed of accordingly.

3. Power Supply Modules

3.1 General Information

Power supply modules create the voltages required internally by the PLC from a 24 VDC input voltage. Each main and expansion unit requires its own power supply module. The power supply module always has to be operated in the far left slot of the backplane. All power supply modules require two slots.

3.1.1 Overview

Power Supply	Input Voltage	Output Power	Interface for System Expansions
PS465	24 VDC	Max. 60 W	Expansion slot
PS477	24 VDC	Max. 58.5 W	Expansion slave

Table 30: Power supply module overview

3.1.2 Slots

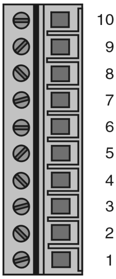
The power supply must always be located on the far left slot.

When configuring a system, make sure that the power consumption of all modules installed is not larger than the output power of the power supply module. If a power supply unit cannot provide the power required by the modules, install the I/O modules on an expansion backplane.

3.1.3 Current Limitation

Power supply modules are equipped with an internal current limit (short circuit protection) and have connections for an external buffer voltage (AC240 battery module). The current limitation is also activated if the modules require more power than the power supply can deliver. This causes a reset on the CPU without a power failure having occurred.

3.1.4 10-pin Terminal Block



Connection	Assignment
10	External buffer + [1]
9	External buffer - [1]
8	---
7	7 READY Contact
6 [2]	6 Normally Open Contact
5	+24V
4	---
3	---
2	GND
1	Ground

Table 31: Power supply modules 10-pin terminal blocks

1) For the PS477 power supply module, these connections are only meaningful when used in the main rack.
2) Contacts for the READY relay when the PLC is switched off.

3.1.5 LED Displays

Power supply modules have LED displays which indicate specific operational states:

LED Name	Function
DC1	Control LED for 5 V voltage supply.
DC2	Control LED for 24 V voltage supply.
DC3	Control LED for 11 V voltage supply.
	If one of the DCs LEDs is not lit, it means the internal voltage is not within the valid range. This can be caused by an overload or the input voltage has slipped under the required minimum range.
DC 24V	The connected 24 VDC input voltage is OK.

Table 32: Power supply modules operational states

3.1.6 READY Relay

If a reset occurs, the ready relay reacts to a loss in current by stopping the entire PLC through the programming system. It can be set or reset by the operating system. Errors that cause the relay to open are defined in the operating system.

It is also possible using software to define other errors that should cause a drop in the ready relay. The ready relay is coupled with the status LED "RUN" on the CPU.

The READY relay is controlled by the CPU. Therefore the pin assignments listed for the power supply PS477 are only valid for use in a main backplane.

Wiring the ready relay is carried out using the 10-pin terminal block. The ready relay contact can be integrated in the emergency stop circuit:

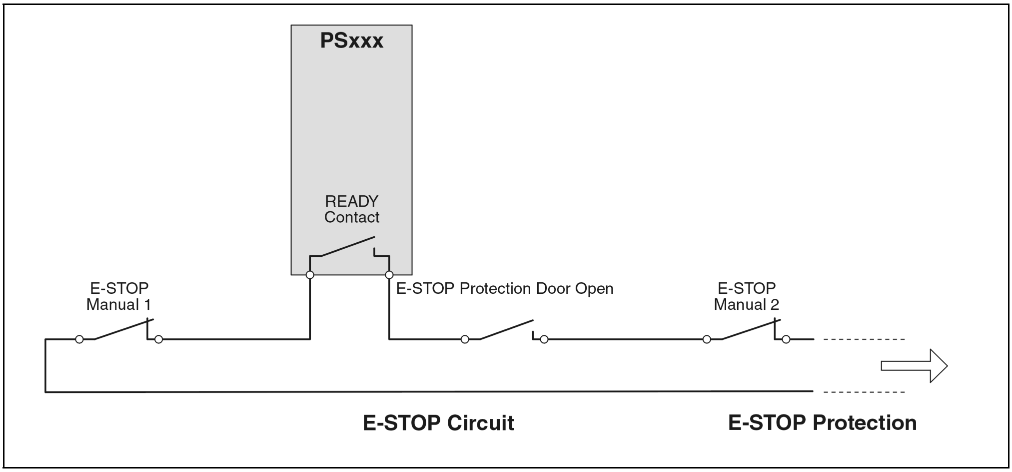


Figure 48: Power supply READY relay

3.1.7 Fuse

The power supply is equipped with a fuse which protects it from reverse polarity and overload. The compartment for the fuse is located behind the module door.

Glass fuse 5 * 20 mm: 6.3 A slow-blow / 250 V

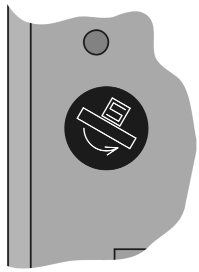


Figure 49: Fuses for the power supply modules

Before changing the fuse, the power supply must be disconnected.

Procedure when Changing a Fuse

1) Disconnect the power supply.
2) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.
3) Open the module door.
4) Loosen fuse holder by turning with a screwdriver in the direction shown by the arrow
5) Remove the fuse holder.
6) Remove the old fuse from the fuse holder.
7) Place the new fuse in the fuse holder.
8) Replace fuse holder in the power supply module.
9) Tighten fuse holder by turning with a screwdriver in the opposite direction as shown by the arrow
10) Close the module door.
11) Connect the lines to the power supply.

3.1.8 Expansion Slot

Power supply module PS465 has an expansion slot. The XP152 CPU e.g. can be placed in this expansion slot.

3.1.9 Expansion Slave (local expansion)

An expansion slave is integrated into the PS477 power supply module which allows another I/O bus segment to be started (see Chapter 2 "Installation", Section 2 "System Configuration and Power Supply", on page 54).

Interfaces for bus expansion are located behind the module door:

- Interface 1 (expansion slave IN) is connected with the EX350 I/O master controller or with interface 2 of a PS477 power supply module.
- Interface 2 (expansion slave OUT) is connected with interface 1 of another PS477 power supply module.

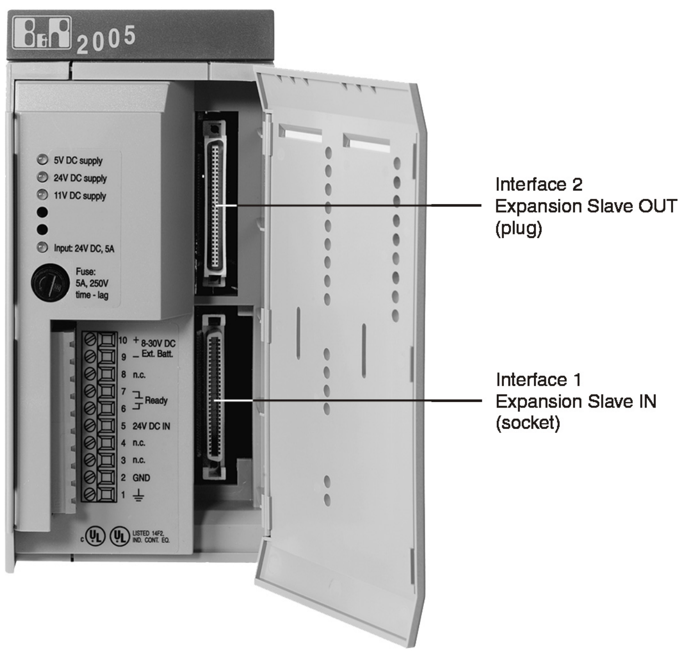


Figure 50: Power supply module interfaces for expansion slaves

3.1.10 Remote Slave (remote expansion)

The remote slave EX250 can be inserted in the expansion slot on power supply module PS465. The remote slave can be connected to the remote master bus cable on 2005 or 2010 systems.

With remote expansion (remote I/O), the expansion unit (remote slave) can be up to 1200 m away from the main unit (remote master). With a repeater, the network can be extended even further. Without a repeater, a maximum of 31 remote slaves can be connected to a remote master.

3.2 PS465 / PS477

3.2.1 Order Data

Model Number	Short Description	Image
	Power Supply Modules	
3PS465.9	2005 power supply module, 24 VDC, 50 W, with expansion slot	
3PS477.9	2005 power supply module, 24 VDC, 50 W, with expansion slave	
	Accessories	
0G0010.00-090	Cable I/O bus expansion, 1 m, bus expansion for B&R 2005 / B&R 2010	
0G0012.00-090	Cable I/O bus expansion, 2 m, bus expansion for B&R 2005 / B&R 2010	

Table 33: PS465 / PS477 order data

3.2.2 Technical Data

Product ID	PS465	PS477
C-UL-US Listed	Yes	
Input Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC	
External Backup Capacitor For Single-Phase Bridge For Three-Phase Bridge	 10000 µF 6000 µF	
Output Power 5 V 24 V Total	 Max. 40 W Max. 50 W Max. 60 W	 Max. 40 W Max. 50 W Max. 58.5 W
Current Requirements	Max. 3.5 A	
Input Capacitance	500 µF	

Table 34: PS465 / PS477 technical data

Product ID	PS465	PS477
Protection	6.3 A time lag / 250 V	
Expansion Slave	No	Yes
Expansion Slot	Yes	No
External RAM Buffering by Supplying	12 V (min. 8 V / max. 30 V)	
Contact for READY Relay Design Switching Voltage Switching Current Protection	 Normally open contact Max. 30 VDC Max. 3 A 370 V transient voltage protection diode to ground	
Dimensions	B&R 2005 double-width	

Table 34: PS465 / PS477 technical data (cont.)

4. Bus Controller Modules

4.1 Overview

Module	Description
EX150	2005 remote I/O master, electrically isolated RS485 interface for connection to a remote I/O bus
EX250	2005 remote I/O slave controller, electrically isolated RS485 interface for connection to a remote I/O bus, power supply module insert
EX350	2005 local I/O master controller, controls I/O modules on up to four expansion backplanes, power supply module insert

Table 35: Bus controller module overview

4.2 EX150

4.2.1 General Information

Remote Master

The remote master is a system module that can be used to connect I/O modules to the CPU over long distances. The remote master and up to 31 remote slaves are connected with a bus cable (see Chapter 2 "Installation", Section 2 "System Configuration and Power Supply", on page 54).

Remote Slave

A B&R SYSTEM 2005 is integrated into a remote I/O bus as a slave station with the EX250 bus controller. The EX250 bus controller is operated in an expansion slot on power supply module PS465.

4.2.2 Order Data

Model Number	Short Description	Image
	Remote I/O Master	
3EX150.60-1	2005 remote I/O master, electrically isolated RS485 interface for connection to a remote I/O bus	
	Accessories	
0G1000.00-090	Bus connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	

Table 36: EX150 order data

4.2.3 Technical Data

Product ID	EX150
C-UL-US Listed	Yes
B&R ID Code	$01
Serial Interface Design Electrical Isolation Baud Rates 100 kBit/s 181 kBit/s 500 kBit/s 1000 kBit/s 2000 kBit/s	RS485 9-pin DSUB socket Yes Depends on the distance Max. 1,200 m Max. 1,000 m Max. 400 m Max. 200 m Max. 100 m
Remote I/O Bus Access Procedure Maximum No. of Remote I/O Masters Number of Slaves Topology Connection to the Bus Transfer Media Terminating Resistance	 Master-slave principle 8 Max. 31 (without repeater) Physical bus Direct Shielded, twisted pair External
Power Consumption 5 V 24 V Total	 Max. 5.5 W --- Max. 5.5 W
Dimensions	B&R 2005 single-width

Table 37: EX150 technical data

4.2.4 Status LEDs

Image	LED	Description
	RUN	An I/O data transfer is running on the remote bus
	ERROR	The remote master has been reset
	Tx	Data is being sent
	Rx	Data is being received

Table 38: EX150 status LEDs

4.2.5 Operational and Connection Elements

The number switch for setting the slave address and the connection socket for the RS485 interface are located behind the module door.

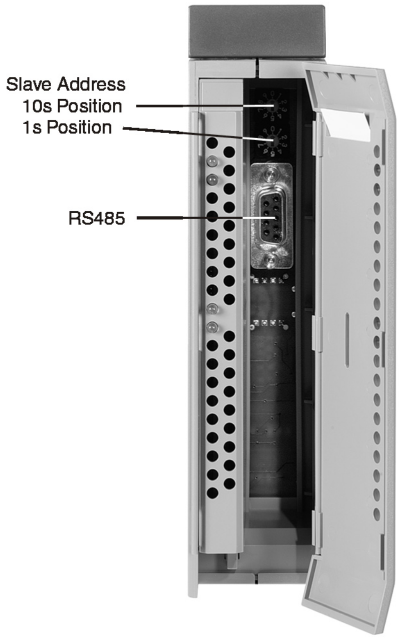


Table 39: EX150 operational and connection elements

4.2.6 RS485 Interface

The interface is electrically isolated. The status LEDs Rx and Tx are lit during data transfer via the RS485 interface.

Maximum Transfer Rate: 2 MBit/s
Max. Distance: 1,200 m

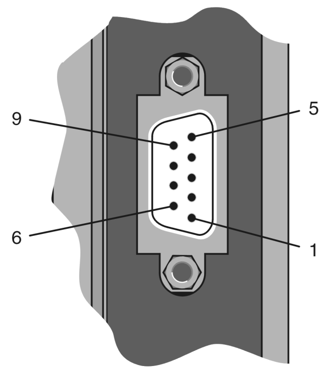


Figure 51: EX150 RS485 interface

Pin	Assignment	Function
1	Shield	
2		
3	DATA	Data
4	CTRL	Transmit enable
5	GND	Electrically isolated supply
6	5 V / 200 mA	Electrically isolated supply
7		
8	DATA\	Data\
9	CTRL\	Transmit Enable\

4.2.7 Cabling a Remote System

Information concerning specifications for the bus cable and cabling can be found in Chapter 2 "Installation", Section 2.1.3 "Remote I/O Bus", on page 58.

4.2.8 Intelligent Slave

An intelligent slave (ISL) is an RIO slave with its own CPU. The CPU on the ISL can make calculations or prepare data before it is sent back to the master. This data does not absolutely have to be inputs or outputs. ISL CPU internal variables are also possible.

Using ISLs can greatly reduce the load on the master's CPU. ISL CPUs are complete CPU modules (B&R SYSTEM 2005 or B&R SYSTEM 2010) with the same task class system. They can run nearly independent of the master CPU and send responses to the master when required.

Hardware: The RIO master remains unchanged (B&R SYSTEM 2005 or B&R SYSTEM 2010). The hardware configuration of the intelligent slave is the same as for the master: RIO master module (EX150), CPU and diverse I/O. Physically, it is a two master system. Cabling is carried out in the same way as on a "normal" master/slave system.

Number Switch: The setting for the slave address is made with both number switches. Addresses in the range from 1 to 98 are allowed. However, a maximum of 31 remote slaves can be connected to a remote master (without repeater). Dynamic addressing does not work on an ISL!

4.2.9 Commissioning a Remote System

Procedure when commissioning a remote system:

1) Cable the entire remote system (see Chapter 2 "Installation", Section 2 "System Configuration and Power Supply", on page 54).

2) Install the terminating resistors at the beginning and end of the remote buses (correct placement of bus terminators is very important when using high baud rates).

3) Set all slave addresses (no doubled addresses; 0 may not be used; dynamic addressing is activated using address 99, see Section 4.3 "EX250", on page 109).

4) Switch on all stations. The slaves automatically determine the baud rate of the master each time the system is switched on. Automatic baud rate recognition for remote slaves is described in Section 4.3 "EX250", on page 109. The start-up sequence is not important for function and boot procedure.

Setting the baud rate is made on the CPU using B&R Automation Studio™. The default setting is 500 kBaud.

4.3 EX250

4.3.1 General Information

A B&R SYSTEM 2005 is integrated into a remote I/O bus as slave station with the EX250 bus controller. A bus cable is used to connect the remote master station and up to 31 remote slave stations. Each B&R SYSTEM 2005 slave begins a new I/O bus which can be used to address a maximum of 13 modules.

The EX250 bus controller is operated in an expansion slot on power supply module PS465.

4.3.2 Order Data

Model Number	Short Description	Image
	Remote I/O Slave	
3EX250.60-1	2005 remote I/O slave controller, electrically isolated RS485 interface for connection to a remote I/O bus, power supply module insert	
	Accessories	
0G1000.00-090	Bus connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	

Table 40: EX250 order data

4.3.3 Technical Data

Product ID	EX250
C-UL-US Listed	In preparation
Slot	Insert for power supply PS465
Power Consumption 5 V 24 V Total	 Max. 1.5 W --- Max. 1.5 W
Peripherals	
Diagnosis LEDs	Yes
Number Switch	Used to set the slave address
Standard Communication interface	
Serial Interface Design Electrical Isolation Baud Rates 100 kBit/s 181 kBit/s 500 kBit/s 1000 kBit/s 2000 kBit/s	RS485 9-pin DSUB socket Yes Depends on the distance Max. 1,200 m Max. 1,000 m Max. 400 m Max. 200 m Max. 100 m
Remote I/O Bus Access Procedure Topology Connection to the Bus Transfer Media Terminating Resistance Baud Rate	 Master-slave principle Physical bus Direct Shielded, twisted pair External Automatic baud rate recognition

Table 41: EX250 technical data

4.3.4 Operational and Connection Elements

The module is equipped with status LEDs, two number switches for slave address settings and a connector for an RS485 interface.

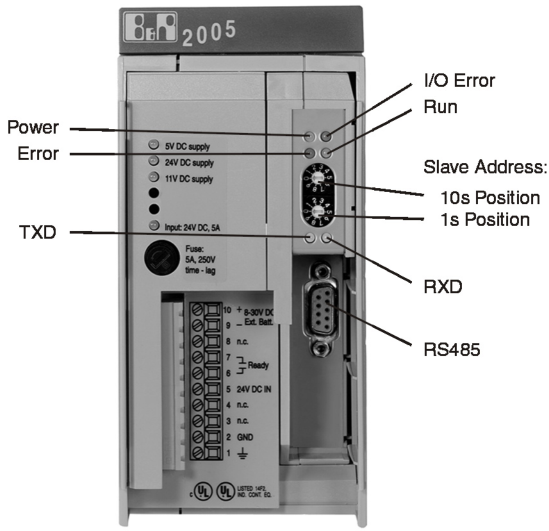


Table 42: EX250 operational and connection elements

4.3.5 Status LEDs

LED	Description
Power	Supplied by the power supply (5 V)
I/O Error	An I/O module on the expansion backplane can not be accessed. Cause: Incorrect, missing or defective I/O module. If the I/O Error and I/O Run LEDs are blinking alternately, the slave attempts to find out the baud rate of the master.
Error	Hardware error on the remote slave. In this case, please contact your technical advisor at B&R.
Run	I/O data transfer. If the I/O Error and I/O Run LEDs are blinking alternately, the slave attempts to find out the baud rate of the master.
TXD	Data is being sent
RXD	Data is being received

Table 43: EX250 status LEDs

4.3.6 Number Switch

The address of the remote slave station is set using number switches. Addresses in the range from 1 to 98 are allowed. However, a maximum of 31 remote slaves can be connected to a remote master (without repeater).

Dynamic addressing is activated using address 99. When this address is selected, the remote slave reads the address from the first I/O module (digital input module) of the remote station. The first eight digital inputs of the module are interpreted and set as a binary slave address.

4.3.7 RS485 Interface

The interface is electrically isolated. The status LEDs RXD and TXD light during data transfer via the RS485 interface.

Maximum Transfer Rate: 2 MBit/s
Max. Distance: 1,200 m

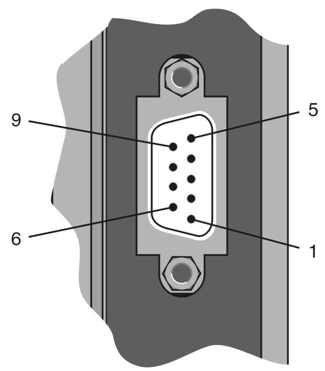


Figure 52: EX250 RS485 interface

Pin	Assignment	Function
1	Shield	
2		
3	DATA	Data
4	CTRL	Transmit enable
5	GND	Electrically isolated supply
6	5 V / 200 mA	Electrically isolated supply
7		
8	DATA\	Data\
9	CTRL\	Transmit Enable\

4.3.8 Automatic Baud Rate Recognition

The EX250 module is equipped with automatic baud rate recognition.

- If a remote slave is switched on (which is not connected to the remote bus), the I/O Run and I/O Error LEDs start to blink alternately. The slave indicates that it is attempting to define the baud rate of the master.
- If the slave is connected to the master via the bus cable, the Run and I/O Error LEDs go out as soon as the slave has recognized the baud rate of the master (to recognize the baud rate all telegrams on the remote bus are evaluated).
- If after approx. 15 seconds, the slave does not receive a directed telegram from the master, it switches automatically to baud rate recognition (responds after start-up).

4.3.9 Module Fastener

The EX250 module is equipped with a module fastener. The module fastener prevents the remote I/O bus controller from falling out of the power supply during transport.

A screwdriver is required to install the module. The screwdriver should be inserted between the power supply and EX250 at the same height as the sloped marking (see figure below). By simultaneously levering the screwdriver in the direction of the power supply and pulling the EX250, the I/O master controller is taken out from its bracing and can be removed from the power supply.

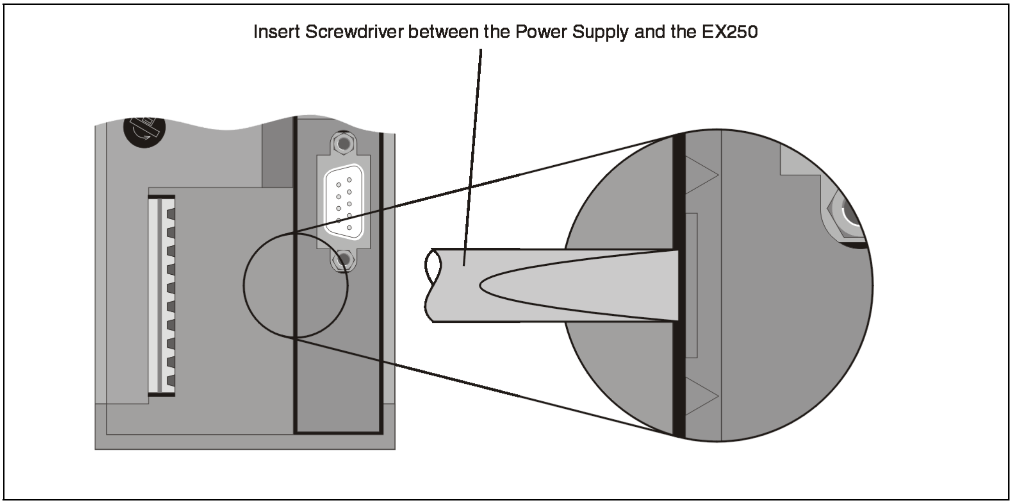


Figure 53: EX250 module fastener

4.4 EX350

4.4.1 General Information

Using the EX350 I/O master controller allows up to four expansion backplanes (including all I/O modules) to be operated with the CP260, CP360, IF260 and IP161 CPUs.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU during data processing of the I/O modules on the expansion base plates.

4.4.2 Order Data

Model Number	Short Description	Image
	Local I/O Master Controller	
3EX350.6	2005 local I/O master controller, controls I/O modules on up to four expansion backplanes, power supply module insert	
	Accessories	
0G0010.00-090	Cable I/O bus expansion, 1 m, bus expansion for B&R 2005 / B&R 2010	
0G0012.00-090	Cable I/O bus expansion, 2 m, bus expansion for B&R 2005 / B&R 2010	

Table 44: EX350 order data

4.4.3 Technical Data

Product ID	EX350
C-UL-US Listed	Yes
B&R ID Code	$02
Slot	Insert for power supply PS465
Communication Interface	Expansion master
Electrical Isolation	No
Access Procedure	B&R local I/O bus expansion (secure)
Data Buffering	Battery buffered via B&R 2005 backplane
Number of Expansion Backplanes	Max. 4
Number of I/O Data Points Digital Analog	Refers to B&R 2005 main and expansion systems 1024 inputs / 1024 outputs 512 inputs / 512 outputs
Power Consumption 5 V 24 V Total	 Max. 1.5 W --- Max. 1.5 W
Dimensions (H, W, D) [mm]	130, 28, 105

Table 45: EX350 technical data

4.4.4 Installation and Communication Interface

The I/O master controller is operated in the expansion slot of a PS465 power supply module.

A B&R System 2005 or 2010 expansion slave can be connected to I/O master controller interface (see Chapter 2 "Installation", Section 2 "System Configuration and Power Supply", on page 54).

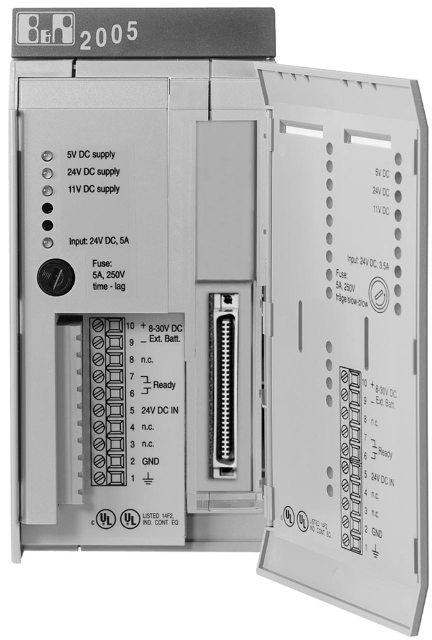


Figure 54: EX350 installation and communication interface

4.4.5 Module Fastener

The module is equipped with a module fastener (starting with revision 02.00). The module fastener prevents the I/O master controller from falling out of the power supply during transport.

A screwdriver is required to install the module. The screwdriver should be inserted between the power supply and EX350 at the same height as the sloped marking (see figure below). By simultaneously levering the screwdriver in the direction of the power supply and pulling the EX350, the I/O master controller is taken out from its bracing and can be removed from the power supply.

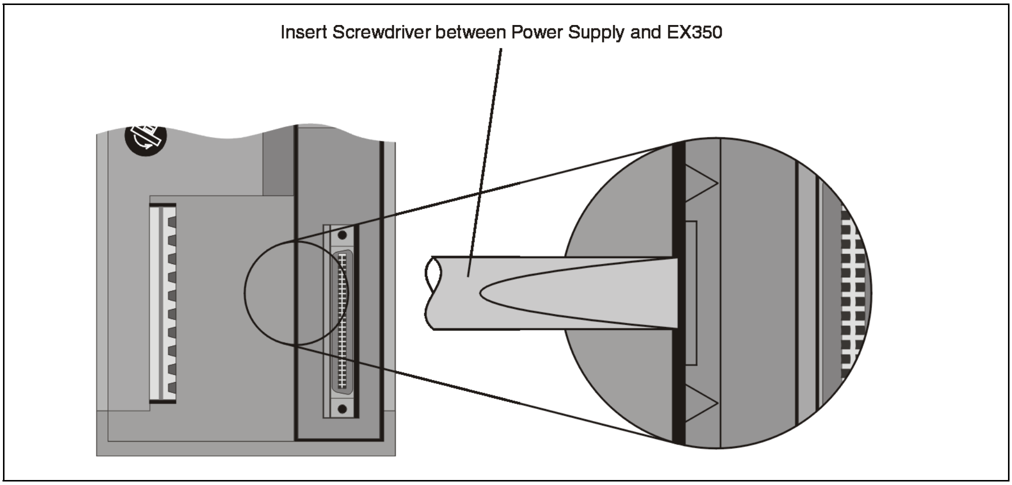


Figure 55: EX350 module fastener

5. CPUs

5.1 General Information

5.1.1 Programming

Programming is carried out using B&R Automation Studio™. Several programming languages are available:

- Automation Basic (previously PL2000)
- ANSI C
- IEC 1131 Ladder Diagram (LAD)
- IEC 1131 Sequential Function Chart (SFC)
- IEC 1131 Structured Text (ST)
- IEC 1131 Instruction List (IL)

For differences in data type abbreviations between B&R Automation Studio™ and PG2000, see Chapter 1 "General Information",Section 4.7 "Programming", on page 31.

5.1.2 Buffering

Buffering data and guaranteeing that the real-time clock operates during power failures are handled centrally by the backplane or the AC240 battery module.

The CP360 CPU is equipped with its own backup battery.

5.1.3 Programming the FlashPROM

Programming and deleting the built-in FlashPROM memory takes place using the programming system.

5.1.4 Overview

Module	Description
CP260	2005 CPU, 4 MB DRAM, 850 KB SRAM, 512 KB FlashPROM, 2 insert slots, 1 PCMCIA slot, 1 RS232 interface
CP340	2005 CPU, x86 233 Intel compatible, 16 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
CP360	2005 CPU, Pentium 266, 32 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
CP380	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
CP382	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 3 insert slots for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
IF260	2005 CPU or progr. interface processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 insert slot for interface module inserts
IP161	2005 programmable I/O processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, max. 12 digital inputs 24 VDC, Sink, max. 12 digital outputs 24 VDC, 0.1 A, 6 analog inputs ±10 V, 14-bit, 6 analog outputs ±10 V, 12-bit, 2 outputs with +10 V and -10 V per terminal block. Order 3 x TB170 terminal blocks separately.
XP152	2005 CPU, 118 KB SRAM, 512 KB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, insert for power supply modules

Table 46: CPU overview

5.2 CP260

5.2.1 General Information

The CPU is inserted in the main rack directly next to the power supply module. It requires two slots. Only the status LEDs can be seen with the module door closed. The CP260 module is equipped with two insert slots for interface modules and a PCMCIA interface for memory cards.

The possibility of combining interface modules allows various bus and network systems to be integrated into the B&R SYSTEM 2005.

A PCMCIA interface allows the memory size to be adjusted to suit different memory needs. Exchanging programs in the field can be carried out using the memory card.

5.2.2 Order Data

Model Number	Short Description	Image
	CPU	
3CP260.60-1	2005 CPU, 4 MB DRAM, 850 KB SRAM, 512 KB FlashPROM, 2 insert slots, 1 PCMCIA slot, 1 RS232 interface	
	Memory Cards	
0MC111.9	PCMCIA memory card, 2 MB FlashPROM	
0MC112.9	PCMCIA memory card, 4 MB FlashPROM	
0MC211.9	PCMCIA memory card, 2 MB SRAM	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	

Table 47: CP260 order data

5.2.3 Technical Data

Product ID	CP260
C-UL-US Listed	Yes
B&R ID Code	$27
Slot Main Rack Expansion Rack	 3 + 4 No
Power Consumption 5 V 24 V Total	 Max. 5.7 W Max. 2.3 W Max. 8 W, without memory cards and without interface modules
Controller	
Typical Instruction Cycle Time	0.2 µs
Data and Program Code Cache	2 x 256 bytes
Standard Memory for the CP260 RAM System RAM User RAM System PROM User PROM	 4 MB DRAM 174 KB SRAM 850 KB SRAM 512 KB FlashPROM 512 KB FlashPROM
NC-Synchronization	Yes
PCMCIA Interface Standard Card Height Card Type Memory Size SRAM FlashPROM	1 JEIDA V4.0 or PCMCIA Standard Release 2.0 Max. 3 mm Memory cards Max. 16 MB Max. 16 MB
Real-time Clock Resolution	Nonvolatile 1 s
Standard communication interface Application Interface (IF1) Electrical Isolation Design Max. Distance Max. Baud Rate	 RS232 No 9-pin DSUB plug 15 m / 19200 Baud 64 kBaud
Insert Slots	2 (for interface module inserts)
Reset Button	Yes
Status Display	LEDs
Data Buffering Backup Battery in 2005 Backplane Buffering with AC240 Battery Module Buffering with NiMH Rech. Battery Battery Monitoring	 At least 4 years At least 2.5 years At least 2 months Yes
Mechanical Characteristics	
Dimensions	B&R 2005 double-width

Table 48: CP260 technical data

Chapter 3
B&R 2005 Modules

5.2.4 Status LEDs

Image	LED	Description
	READY	CPU is active
	RUN	Application running
	MODE	Spool or programming function is active
	ERROR	SERVICE mode
	BAT	Battery and rechargeable battery empty

Table 49: CP260 status LEDs

5.2.5 Operational and Connection Elements

Operational and display elements, two insertion slots for interface modules, the PCMCIA interface and the RS232 interface are all located behind the module door.

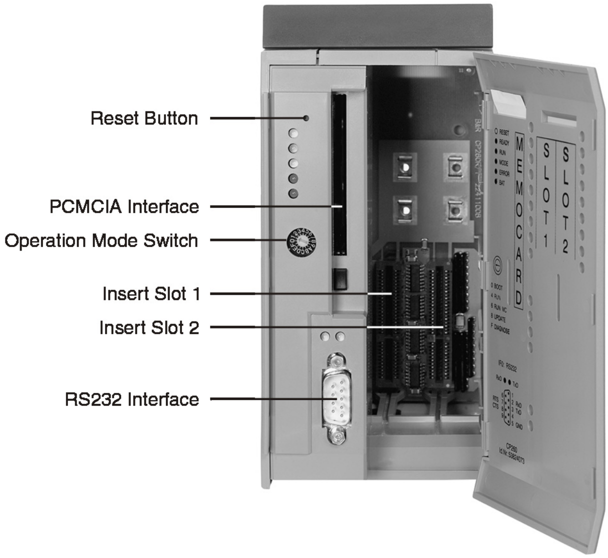


Figure 56: CP260 operational and connection elements

5.2.6 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Pressing the reset button triggers a hardware reset, which means:

- All application programs are stopped
- All outputs are set to zero

The PLC then goes into SERVICE mode.

5.2.7 Operating Mode Switch

The CP260 is equipped with a hex switch, which is used as an operating mode switch. Different operating modes are available depending on the PLC software version:

PLC Software ≤ V2.0

Switch Position	Operating Mode	Description
$0	Bootstrap Loader	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. Bootstrap loader mode is only required when PCCSW <2.0 is installed. The procedure is the same as described in Section 5.2.14 "Programming System Flash", on page 127. In an additional dialog box, only the baud rate and the interface, which are used to created a connection to the PLC, have to be set.
$1 - $E	Run with MC	The CPU boots and installs all modules from the internal User RAM and User FlashPROM. Apart from data modules, all other modules are additionally installed from the memory card. The code for all programs is then copied to DRAM. The program code is carried out in DRAM to increase the speed of the operation.
$F	Diagnostics	The CPU boots in Diagnostics mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostics mode, the CPU always boots with a cold restart.

Table 50: CP260 operating modes for PLC software ≤ V2.0

PLC Software > V2.0

Switch Position	Operating Mode	Description
$0	Bootstrap Loader	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. Bootstrap loader mode is only required when PCCSW <2.0 is installed. The procedure is the same as described in Section 5.2.14 "Programming System Flash", on page 127. In an additional dialog box, only the baud rate and the interface, which are used to created a connection to the PLC, have to be set.
$4	Run without MC	The CPU boots and installs all modules from the internal User RAM and User FlashPROM. The code for all programs is then copied to DRAM. The program code is carried out in DRAM to increase the speed of the operation. Any memory card found in the PCMCIA interface is ignored.
$6	Run with MC	The CPU boots and installs modules as described in switch position 4. Apart from data modules, all other modules are additionally installed from the memory card. They are also copied to DRAM.
$8	Update	In this switch position, the CPU checks if an update memory card is inserted. If not, the CPU goes into SERVICE mode. Otherwise the operating system, System ROM, User ROM and, if available, FIX RAM on the CP260 is deleted and reinstalled from the memory card. This operating mode is already supported by PLC software V2.0. If an error occurs during installation, the ERROR and BAT LEDs blink. When no errors have occurred during installation, the READY LED and RUN LEDs blink.
$F	Diagnostics	The CPU boots in Diagnostics mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostics mode, the CPU always boots with a cold restart.

Table 51: CP260 operating modes for PLC software > V2.0

5.2.8 RS232 Interface (IF1)

The RS232 interface is not electrically isolated. It can be used as an online interface for communicating with the programming device.

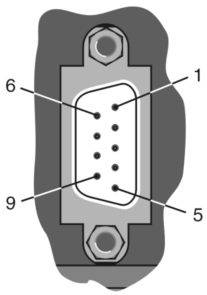
Interface	Description	Pin Assignments		
PG interface RS232  9-pin DSUB plug	The RS232 interface operates as an online interface. Online connection to the PG is achieved using a standard RS232 cable that is available from B&R: Product ID: RS232 cable Model Number: 0G0001.00-090 Max. Baud Rate: 64 kBaud Max. Cable Length: 15 m		**RS232**	
		1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	NC	
		5	GND	Ground
		6	NC	
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 52: CP260 RS232 Interface (IF1)

5.2.9 PCMCIA Interface

The CP260 is equipped with a PCMCIA interface. PCMCIA memory cards conforming to JEIDA V4.0 Type I or PCMCIA Standard Release 2.0 (max. 3 mm high) are supported.

The CP260 supports memory cards with up to 16 MB SRAM or with up to 16 MB FlashPROM. The following memory card can be ordered from B&R:

Model Number	Short Description	Power Consumption
0MC111.9	PCMCIA memory card, 2 MB FlashPROM	Max. 0.8 W
0MC112.9	PCMCIA memory card, 4 MB FlashPROM	Max. 0.8 W
0MC211.9	PCMCIA memory card, 2 MB SRAM	Max. 0.8 W

Table 53: CP260 PCMCIA memory cards

The memory cards are used by the CP260 as ROM Type "MEMCARD".

Limitations when using memory cards:

- Internal variables cannot be stored on the memory card.
- Memory cannot be allocated on the memory cards.
- The data format is not compatible to the B&R SYSTEM 2003 CPU CP476.

The SRAM and FlashPROM memory cards can only be written to by the CP260. Therefore, it is not possible to program system software or the application on a memory card directly on a PC with a PCMCIA interface.

5.2.10 Insert Slots

The CP260 CPU is equipped with two insert slots for interface modules.

The possibility of combining interface modules allows various bus and network systems to be integrated into the B&R SYSTEM 2005.

The following interface modules can be operated with the CP260:

Module	Description
3IF613.9	Interface module with three RS232 interfaces
3IF621.9	Interface module with one RS485/RS422 interface and one CAN interface
3IF622.9	Interface module with one RS232 interface and two RS485/RS422 interfaces
3IF661.9	Interface module with one RS485 interface (PROFIBUS DP slave)
3IF671.9	Interface module with one RS232 interface, one RS485/RS422 interface and one CAN interface
3IF672.9	Interface module with one RS232 interface and two CAN interfaces
3IF681.95	Interface module with one RS232 interface and one ETHERNET interface with 10 BASE2 connection (Cheapernet BNC-socket)
3IF681.96	Interface module with one RS232 interface and one ETHERNET interface with 10 BASE-T connection (Twisted Pair / RJ45-socket)
3IF686.9	2005 interface module, 1 ETHERNET Powerlink interface, manager or controller function, electrically isolated

Table 54: CP260 interface module inserts

5.2.11 Data/Real-time Buffering

The following areas are buffered:

- User RAM
- System RAM
- Real-time clock

Buffering is carried out with a NiMH rechargeable battery and with a battery in the following order:

1) NiMH rechargeable battery: The rechargeable battery is located in the CPU.

2) Backup battery: The backup battery is located either in the B&R 2005 rack or in the AC240 battery module

Battery Monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information "Battery OK" is available to the user from the SYS_lib function "SYS_battery".

Battery Change Interval

See section "Backup Battery" in sections 2 "Module Racks" and 17.2 "AC240" (battery module).

5.2.12 Local I/O Bus Expansion

Since the CP260 does not have its own expansion master, the EX350 I/O master controller is needed for local I/O bus expansion. By using this controller, up to four expansion racks with all I/O modules can be used with the CP260.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU by processing I/O module data on the expansion racks.

5.2.13 Axis Coupling over Multiple Modules

When coupling axes over multiple modules (gears, cams, CNC), the set positions of the master axes are sent to the NC154 modules with the slave axes in an interrupt routine running on the main CPU. The interrupt routine is not allowed to be stopped. These requirements are fulfilled by the following CPUs:

- CP260
- IF260 when it is used as a main CPU

5.2.14 Programming System Flash

General Information

CPUs are delivered with a runtime system. The operating mode switch is set to switch position 0 when delivered i.e. bootstrap loader mode is set.

A switch position must be set in order to boot the PLC in RUN mode (see Section 5.2.7 "Operating Mode Switch", on page 124). A runtime system update is only possible in RUN mode.

Runtime System Update

The runtime system can be updated using the programming system. When updating the runtime system (online runtime system update), the following procedure must be carried out:

1) An online runtime system update is only possible if the processor is in RUN mode. To do this, the operating mode switch must be turned to 4 or 6.

2) Switch on the supply voltage.

3) Establish online connection (online cable) between programming device (PC or Industrial PC) and the CP260. An online runtime update is possible using the serial RS232 onboard interface.

4) Start B&R Automation Studio™:

5) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

6) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   After pressing **Next >**, a dialog box appears where the user can set the CAN baud rate, CAN ID and the CAN node number (the CAN node number set here is only relevant if an interface module does not contain a CAN node number switch). Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

7) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

User Flash will be deleted.

8) When the update procedure is complete, the online connection is automatically established again.

9) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.

5.3 CP340, CP360, CP380 and CP382

5.3.1 General Information

The CP340, CP360, CP380 and CP382 are high-performance CPUs for the B&R SYSTEM 2005. The CPUs are operated in the main rack directly beside the power supply module. They require two or three slots.

It is equipped with one or three insert slots for aPCI interface modules, a Compact Flash interface for CF memory cards and a floating point unit. An RS232 programming interface, a USB interface and a 10/100 BASE-T ETHERNET interface are available.

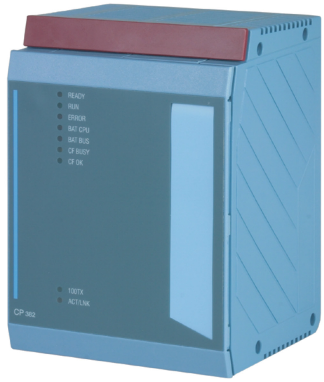
The aPCI insert slot for interface modules makes it possible to connect the CPUs to different bus and network systems.

The Compact Flash interface allows the size of the memory to be adjusted to suit different memory requirements of many diverse applications.

The CPUs are especially useful for applications where lower cycle times are required, very large amounts of data must be processed or for applications using the FPU.

5.3.2 Order Data

CP340, CP360, CP380



CP382

Model Number	Short Description
	CPU
3CP340.60-1	2005 CPU, x86 233 Intel-compatible, 16 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
3CP360.60-1 [1)]	2005 CPU, Pentium 266, 32 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
3CP380.60-1	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 1 insert slot for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
3CP382.60-1	2005 CPU, Pentium III 500, 64 MB DRAM, 512 KB SRAM, exchangeable application memory: Compact Flash, 3 insert slots for aPCI modules, 1 USB, 1 RS232 interface, 1 Ethernet interface 100 Base-T. Program memory must be ordered separately.
	Program Memory [2)]
5CFCRD.0032-01	Compact Flash 32 MB ATA/IDE SanDisk
5CFCRD.0064-01	Compact Flash 64 MB ATA/IDE SanDisk
5CFCRD.0128-01	Compact Flash 128 MB TrueIDE SanDisk
5CFCRD.0256-01	Compact Flash 256 MB ATA/IDE SanDisk
5CFCRD.0512-01	Compact Flash 512 MB ATA/IDE SanDisk
	Accessories
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable

Table 55: CP340, CP360, CP380 and CP382 order data

1) This CPU replaces the 3CP360.60-2. The 3CP360.60-1 has one additional USB interface.
2) Program memory is required to operate the CPUs. It is not included with the delivery of the CPUs, instead it must be ordered as an accessory.

5.3.3 Technical Data

Product ID	CP340	CP360	CP380	CP382
General Information				
C-UL-US Listed	Yes			
B&R ID Code	---			
Module Type	B&R 2005 CPU			
Slot Main Rack Expansion Rack	 3 + 4 No			 3 - 5 No
Power Consumption 5 V 24 V Total, without memory card and without interface module	 Max. 4.5 W Max. 1 W Max. 5.5 W	 Max. 11 W Max. 3 W Max. 14 W	 Max. 13 W Max. 3 W Max. 16 W	 Max. 13 W Max. 4 W Max. 17 W
Processor Section				
Clock Frequency	233 MHz	266 MHz	500 MHz	
Typical Instruction Cycle Time	0.038 µs	0.02 µs	0.012 µs	
Data and Program Code L1 Cache	16 KB	2 x 16 KB	2 x 16 KB	
L2 Cache	---	512 KB	256 KB	
Standard Memory RAM User RAM	 16 MB DRAM 496 KB SRAM	 32 MB DRAM 496 KB SRAM	 64 MB DRAM 496 KB SRAM	
Remanent Variables	32 KB	256 KB		
FPU	Yes			
Integrated I/O processor	Processes I/O data points in the background			
Data Buffering Lithium Battery Battery Monitoring	 At least 3 years Yes			
Peripheral				
Compact Flash Interface Connection Memory Size	1 ATA / True IDE 32 MB to 512 MB (as of 07/2003)			
Real-time Clock Resolution	Nonvolatile 1 s			
Reset Button	Yes			
Status Display	LEDs			
Insert slots for aPCI interface modules IF7xx	1			3

Table 56: CP340, CP360, CP380 and CP382 technical data

Product ID	CP340	CP360	CP380	CP382
Standard Communication Interfaces				
Application Interface IF1 Electrical Isolation Design Distance Baud Rate	RS232 No 9-pin DSUB plug Max. 15 m / 19200 Baud Max. 115.2 kBaud			
Application Interface IF2 Electrical Isolation Design Distance Baud Rate	ETHERNET Yes RJ45 socket Max. 100 m 10/100 MBaud			
Application Interface IF3	USB Rev. 1.1			
Mechanical Characteristics				
Dimensions	B&R 2005 double-width			B&R 2005 triple width

Table 56: CP340, CP360, CP380 and CP382 technical data (cont.)

5.3.4 Restrictions

Limitation	Replacement
NC Manager software for NC modules NC154 and NC157 are not supported. That means, these NC modules do not function with these CPUs. The NC150 can be used in applications with direct I/O access when the NC Manager is not used.	Direct control of ACOPOS via the CAN interface or ETHERNET Powerlink with the new NC Manager software.
The RIO-Master EX150 is not supported.	CAN IO, ETHERNET Powerlink
The PROFIBUS FMS module NW150 is not supported.	CAN IO, ETHERNET Powerlink
The IF050 communication module is not supported.	IF060
The IF681 interface module is not supported.	ETHERNET Onboard Interface

Table 57: CP340, CP360, CP380 and CP382 limitations

5.3.5 Status LEDs

Image	LED	Description
	READY	CPU is active
	RUN	Application running
	ERROR	SERVICE mode
	BAT CPU	CPU battery empty or not present
	BAT BUS	Bus battery empty or not present
	CF BUSY	Compact Flash BUSY
	CF OK	Compact Flash OK
	100TX	10/100 MBaud ETHERNET
	ACT/LNK	ETHERNET Activity/Link

Table 58: CP340, CP360, CP380 and CP382 Status LEDs

5.3.6 Operational and Connection Elements

The operational elements, display elements, one or three insert slots for aPCI interface modules, the slot for the program memory, the battery compartment and the connection plug for the RS232 interface are all found behind the module door. The RJ45 socket for the ETHERNET interface and the USB interface can be found on the bottom of the module.

CP340, CP360 and CP380

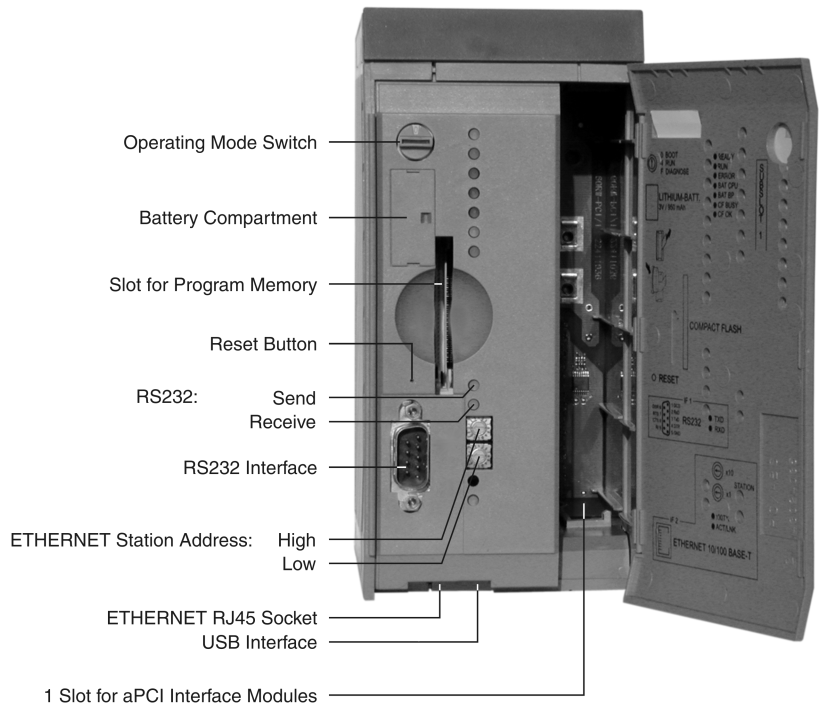


Figure 57: CP340, CP360 and CP380 operational and connection elements

CP382

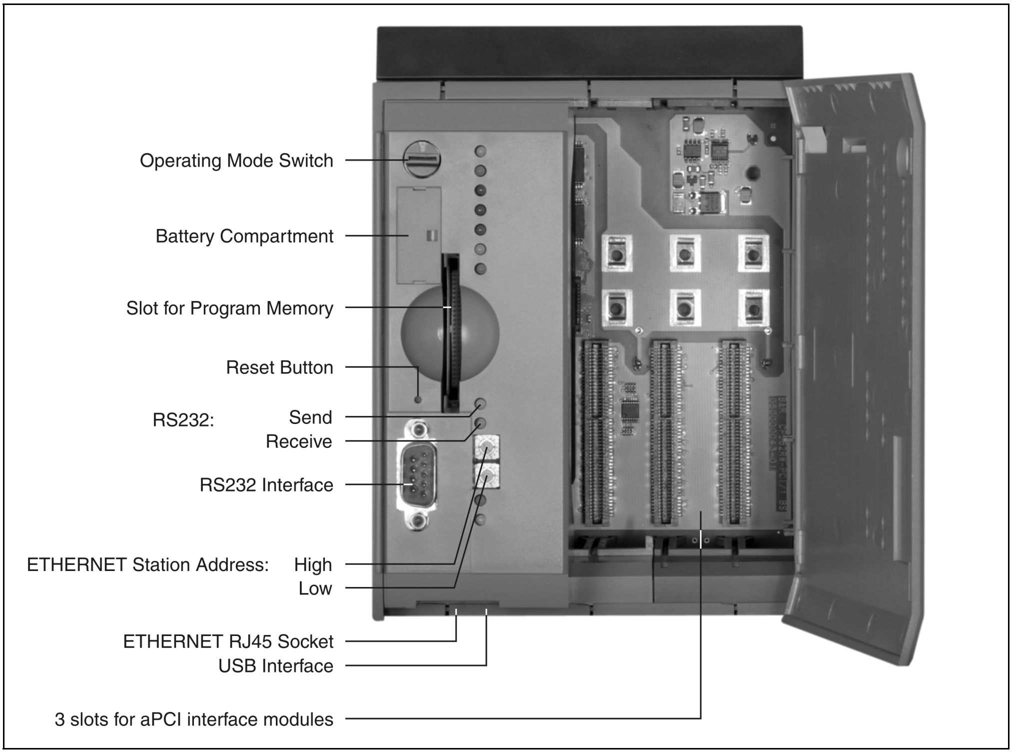


Figure 58: CP382 operational and connection elements

5.3.7 Slot for Program Memory

Program memory is required to operate the CPUs. The program memory is Compact Flash. It is not included with the delivery of the CPUs, instead it must be ordered as an accessory.

5.3.8 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Pressing the reset button triggers a hardware reset, which means:

- All application programs are stopped
- All outputs are set to zero

The PLC then goes into SERVICE mode.

5.3.9 Operating Mode Switch

The CPUs are equipped with a hex switch which acts as an operating mode switch.

Switch Position	Operating Mode	Description
$0	Boot	In this switch position the default B&R Automation Runtime™ (AR) is started, and the runtime system can be installed using the online interface (B&R Automation Studio™). User Flash is deleted after the download begins.
$4	Run	RUN Mode
$F	Diagnostics	The CPU boots in Diagnostics mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostics mode, the CPU always boots with a **warm restart**.

Table 59: CP340, CP360, CP380 and CP382 operating modes

5.3.10 RS232 Interface (IF1)

The RS232 interface is not electrically isolated. It can be used as an online interface for communicating with the programming device.

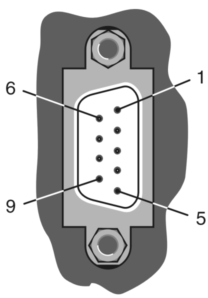
Interface	Description	Pin Assignments		
PG interface RS232  9-pin DSUB plug	The RS232 interface operates as an online interface. Online connection to the PG is achieved using a standard RS232 cable that is available from B&R: Module ID RS232 Cable Model No. 0G0001.00-090 Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m		RS232	
		1	DCD	Data Carrier Detect
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	RI	Ring Indicator

Table 60: CP340, CP360, CP380 and CP382 RS232 interface (IF1)

5.3.11 ETHERNET Interface (IF2):

IF2 is an ETHERNET interface. The connection is made using a 10/100 BASE-T Twisted Pair RJ45 socket on the bottom of the module.

The INA2000 station number for the ETHERNET interface is set with both hex switches.

Information:

The onboard ETHERNET interface is not suitable for ETHERNET Powerlink.

5.3.12 USB Interface (IF3)

The IF3 is a USB interface. The connection is made using a USB interface for Rev. 1.1 on the bottom of the module.

The USB interface can only be used for devices which have been released by B&R (e.g. floppy disk drive, DiskOnKey or dongle).

Information:

The USB interface (IF3) cannot be used as an online communication interface.

5.3.13 Insert Slot

The CPUs are equipped with one or three insert slots for aPCI interface modules.

The B&R SYSTEM 2005 can be connected to various bus or network systems using plug-in interface modules.

The following aPCI interface modules can be operated presently in the CPUs:

Module	Description
3IF761.9	aPCI interface module, 1 PROFIBUS DP interface, electrically isolated and network capable, 1 RS232 interface
3IF762.9	aPCI interface module, 1 PROFIBUS DP interface, electrically isolated and network capable, 1 RS422/RS485 interface, electrically isolated and network capable
3IF772.9	aPCI interface module with one RS232 interface and two CAN interfaces
3IF786.9	aPCI interface module, 1 ETHERNET Powerlink interface, manager or controller function, 1 RS232 interface
3IF787.9	aPCI interface module 1 ETHERNET Powerlink interface, manager or controller function, 1 CAN interface , max. 500 kbps, object buffer in send and receive direction, network capable, electrically isolated. Order TB704 terminal blocks separately.
3IF789.9	aPCI interface interface module, 1 ETHERNET Powerlink Schnittstelle, manager or controller function, 1 X2X Link Master interface, electrically isolated. Order TB704 terminal block separately.

Table 61: CP340, CP360, CP380 and CP382 aPCI interface module inserts

5.3.14 Data/Real-time Buffering

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Buffering is achieved using a lithium battery in the following order:

1) CPU battery: The battery is in the CPU

2) Bus battery: The backup battery is either in the B&R 2005 rack or in the AC240 battery module

Battery Monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available from the system library function "BatteryInfo".

Battery Change Interval

Battery	Change Interval
CPU Battery	The battery should be changed every 4 years. The change interval refers to the average life span and operating conditions and is recommended by B&R. This does not correspond to the maximum buffer duration.
Bus Battery	See the section "Backup Battery" in the sections 2 "Module Racks" and 17.2 "AC240" (Battery Module).

Table 62: CP340, CP360, CP380 and CP382 battery changing intervals

5.3.15 Changing the Lithium Battery

The CPUs are equipped with a lithium battery. The lithium battery is placed in a separate compartment and protected by a cover.

Buffer Battery Data

Lithium Battery	3 V / 950 mAh
Model Number	0AC201.9
Short Description	Lithium batteries, 5 pcs., 3 V / 950 mAh, button cell
Storage Temperature	-20 to +60° C
Storage Time	Max. 3 years at 30° C
Relative Humidity	0 to 95% (non-condensing)

Table 63: CP340, CP360, CP380 and CP382 data for the backup battery

The product design allows the battery to be changed with the PLC switched on or off. In some countries, safety regulations do not allow batteries to be changed while the module is switched on.

Information:

The data stored in the RAM of the CPU is not lost while power is not applied during a battery change, if the CPU is located in the module rack and the bus battery is functioning normally.

The bus battery is located either in the B&R 2005 rack or in the AC240 battery module

Procedure for Changing the Battery

1) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.

2) Remove the cover from the lithium battery holder using a screwdriver.

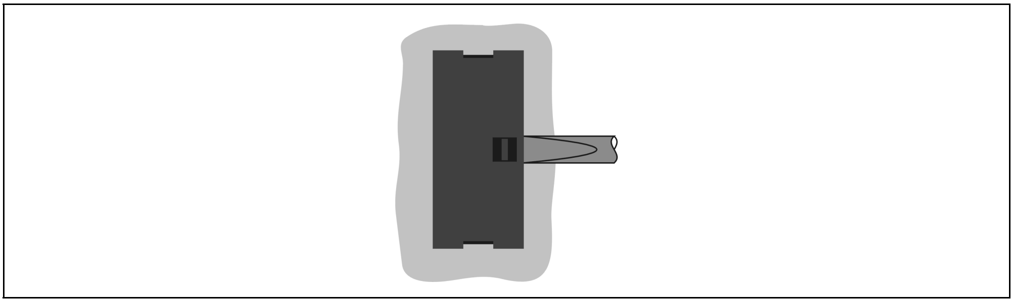


Figure 59: CP340, CP360, CP380 and CP382 - removing the cover for the lithium battery

3) Remove the battery from the holder by pulling the removal strip (don't use uninsulated tools because of risk of short circuiting). The battery should not be held by its edges. **Insulated** tweezers may also be used for removing the battery.

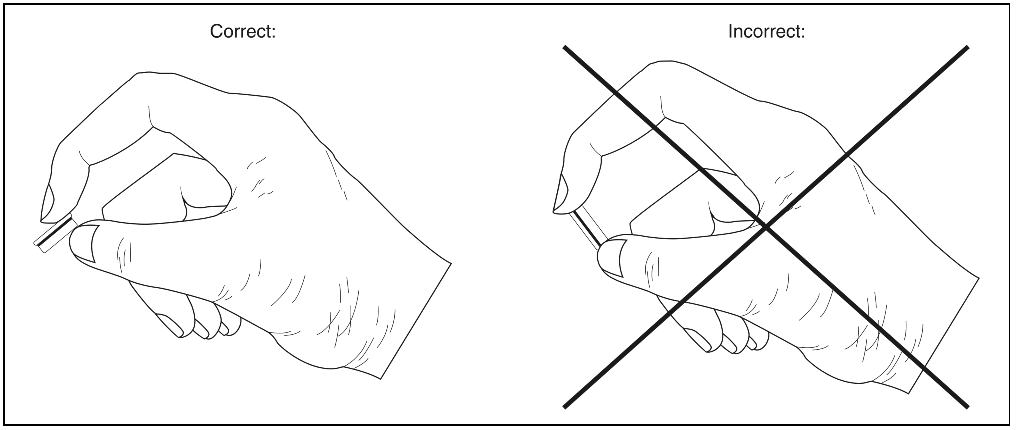


Figure 60: CP340, CP360, CP380 and CP382 - holding the battery correctly

4) Insert the new battery with correct polarity. The removal strip should be pulled to the right of the battery holder and the "+" side of the battery should be facing left. In order to be able to remove the battery again in future, the removal strip **must** be on the right side of the battery.

Figure 61: CP340, CP360, CP380 and CP382 - removal strip should be pulled to the right

5) Now wrap the end of the removal strip over the top of the battery and insert it underneath the battery so that it does not protrude from the battery holder.

6) Replace cover. Insert the lower edge of the cover in the battery holder opening. Press the upper end of the cover home firmly.

Information:

Lithium batteries are considered hazardous waste. Used batteries should be disposed of accordingly.

5.3.16 Local I/O Bus Expansion

Since the CPUs do not have their own expansion master, the EX350 I/O master controller is needed for local I/O bus expansion. By using this controller, up to four expansion racks with all I/O modules can be used with the CPUs.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU by processing I/O module data on the expansion racks.

5.3.17 Programming System Flash

General Information

The CPUs are delivered with a default B&R Automation Runtime™ (with limited functions) already installed. This runtime system is started in boot mode (operating mode switch position 0). It initializes and operates the serial RS232 onboard interface, allowing a runtime system download via INA2000 protocol.

This runtime system download is carried out during the commissioning of the CPU. The runtime system is stored in the program memory (Compact Flash) of the processor. A runtime system update can be carried out later.

A runtime system download or update is made using the programming system (starting with B&R Automation Studio™ V2.1).

Runtime System Download

When installing the runtime system (runtime system download) the following procedure must be carried out:

1) Turn off power to the PLC.
2) A runtime system download is only possible if the processor is in boot mode. To do this, the operating mode switch must be turned to 0.
3) Switch on the power supply again.
4) Establish an online connection between the programming device (PC or Industrial PC) and the CPU. A runtime system download is only possible using the serial RS232 onboard interface.
5) Start B&R Automation Studio™.
6) Start the download procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.
7) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system download. Otherwise, modules can also be downloaded using a later application download.

   Pressing **Next >** brings the user to a control box where the current settings are displayed.

8) The download procedure is started by pressing **Next >**. Download progress is shown in a message window.

Information:

The User Flash is cleared.

9) The operating mode switch must be turned to 4 when the download procedure is completed.

10) Turn PLC off and then on again.

11) The PLC is now ready for use.

Runtime System Update

When updating the runtime system (online runtime system update) the following procedure must be carried out:

1) An online runtime system update is only possible if the processor is in RUN mode. To do this, the operating mode switch must be turned to 4.

2) Switch on the supply voltage.

3) Establish online connection (online cable) between the programming device (PC or Industrial PC) and the CPU. An online runtime system update is only possible using the CPU interfaces.

4) Start B&R Automation Studio™.

5) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

6) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   Pressing **Next >** brings the user to a control box where the current settings are displayed.

7) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

Information:

The User Flash is cleared.

8) When the update procedure is complete, the online connection is automatically established again.

9) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.

5.4 IF260

5.4.1 General Information

The IF260 module can be used either as a CPU or as a programmable interface processor. The module recognizes the correct operating mode from the slot used (slot 3 -> CPU module). Usually, the module is used as an interface processor to relieve the strain on the CPU. The IF260 module is equipped with a CPU section and an insert slot for interface modules.

The programmable interface processor (like with intelligent I/O processors) also has a local processor core with RISC processor, local RAM and operating system. The DPR area ("PPdpr" library) is used as a communication interface between CPU PLC and IF260. A project must be created for each parallel processor in B&R Automation Studio™.

The PLC CPU and the local processor always have access to this data area, which guarantees data consistency for data type UINT. Larger data structures cannot be be used.

The insert slot for interface modules makes it possible to integrate different bus and network systems in the B&R SYSTEM 2005.

5.4.2 Order Data

Model Number	Short Description	Image
	CPU or Programmable Interface Processor	
3IF260.60-1	2005 CPU or progr. interface processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 insert slot for interface module inserts	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	

Table 64: IF260 order data

5.4.3 Technical Data

Product ID	IF260
C-UL-US Listed	Yes
B&R ID Code	$2A
Slot 3 ≥ 4	 CPU operation Programmable interface processor operation
Power Consumption 5 V 24 V Total	 Max. 3.5 W --- Max. 3.5 W
Processor	
Typical Instruction Cycle Time	0.4 µs
Memory Capacity System RAM User RAM System PROM User PROM	 174 KB SRAM 850 KB SRAM 512 KB FlashPROM 1536 KB FlashPROM

Table 65: IF260 technical data

Product ID	IF260
Real-time Clock Resolution	Nonvolatile 1 s
Insert Slots	1 (for interface module inserts)
Reset Button	Yes
Status Display	5 Status LEDs
NC-Synchronization	Yes
Data Buffering Backup Battery in 2005 Backplane Buffering with AC240 Battery Module Buffering with NiMH Rech. Battery Battery Monitoring	 At least 4 years At least 2.5 years At least 2 months Yes (when operated as main CPU)
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 65: IF260 technical data (cont.)

5.4.4 Status LEDs

Image	LED	Description
	READY	IF260 is active
	RUN	Application running
	MODE	Spool or programming function is active
	ERROR	SERVICE mode
	BAT	Battery and rechargeable battery empty

Table 66: IF260 status LEDs

5.4.5 Operational and Connection Elements

The operational elements, display elements and an insert slot for an interface module are behind the module door.

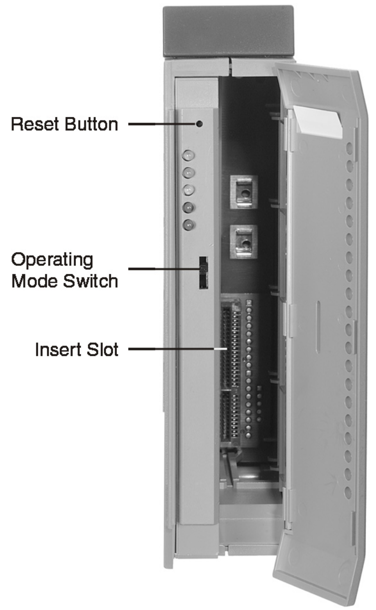


Figure 62: IF260 operational and connection elements

5.4.6 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Depending on the operating mode, pressing the reset buttons has different effects.

Operating Mode	Effects
Interface Processor	Local Reset - All IF260 application programs are stopped
CPU	Local reset and global bus reset - All application programs are stopped - All outputs are set to zero

Table 67: IF260 reset button

5.4.7 Operating Mode Switch

The IF260 module is equipped with a sliding switch, which can be used as an operating mode switch. The switch setting can be evaluated by the application program at any time. If the switch position is changed during operation, a warning can be generated. The operating system only interprets the switch position when switched on.

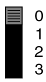
Operating Mode Switch	Switch Position	Function
	0	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. The bootstrap loader mode is only required when PCCSW <2.0 is installed. The procedure is the same as described in Section 5.4.13 "Programming System Flash", on page 152. In an additional dialog box, the baud rate and the interface must only be set, from which a connection to the PLC is created.
	1	Run mode, the application is running.
	2	Reserved
	3	diagnostics mode

Table 68: IF260 operating mode switch

5.4.8 Insert Slot

The programmable interface processor has an insert slot for interface modules.

The insert slot for interface modules makes it possible to integrate different bus and network systems in the B&R SYSTEM 2005.

The following interface modules can be operated in the IF260:

Module	Description
3IF613.9	Interface module with three RS232 interfaces
3IF621.9	Interface module with one RS485/RS422 interface and one CAN interface
3IF622.9	Interface module with one RS232 interface and two RS485/RS422 interfaces
3IF661.9	Interface module with one RS485 interface (PROFIBUS DP slave)
3IF671.9	Interface module with one RS232 interface, one RS485/RS422 interface and one CAN interface
3IF672.9	Interface module with one RS232 interface and two CAN interfaces
3IF681.95	Interface module with one RS232 interface and one ETHERNET interface with 10 BASE2 connection (Cheapernet BNC-socket)
3IF681.96	Interface module with one RS232 interface and one ETHERNET interface with 10 BASE-T connection (Twisted Pair / RJ45-socket)
3IF686.9	2005 interface module, 1 ETHERNET Powerlink interface, manager or controller function, electrically isolated

Table 69: IF260 interface module inserts

5.4.9 Data/Realtime Buffering

The following areas are buffered

- User RAM
- System RAM
- Real-time clock

Buffering is carried out with a NiMH rechargeable battery and with a battery in the following order:

1) NiMH Rechargeable Battery:	The rechargeable battery is located in the IF260.
2) Backup Battery:	The backup battery is located either in the B&R 2005 rack or in the AC240 battery module

Battery Monitoring

If the IF260 module is operated as the CPU, the interface processor carries out cyclical monitoring of the battery voltage. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available to the user from the SYS_lib function "SYS_battery".

Battery Change Interval

See section "Backup Battery" in sections 2 "Module Racks" and 17.2 "AC240" (battery module).

5.4.10 Local I/O Bus Expansion

Since the IF260 module does not have its own expansion master, the EX350 I/O master controller is needed for local I/O bus expansion. By using this controller, up to four expansion racks with all I/O modules can be used with the IF260.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU by processing I/O module data on the expansion racks.

5.4.11 Axis Coupling over Multiple Modules

When coupling axes over multiple modules (gears, cams, CNC), the set positions of the master axes are sent to the NC154 modules with the slave axes in an interrupt routine running on the main CPU. The interrupt routine is not allowed to be stopped. These requirements are fulfilled by the following CPUs:

- CP260
- IF260 when it is used as a main CPU

5.4.12 Online Connection

1) The online connection is established through an insertable interface module with an RS232 interface.

2) The IF260 module can be programmed via CAN in the same way as every other B&R CPU.

   One of the conditions required for programming using a CAN network is that an operating system must already have been installed. An RS232 connection is used to couple the programming system to a CPU module with a CAN interface. From here it is routed via CAN to the IF260 module.

3) When the programmable IF260 interface processor is used as the main CPU, the IF260 module can also be programmed by a peripheral processor through the backplane module. An XP152 module can be used as e.g. a peripheral processor.

   This is also possible in the opposite direction. The IF260 can also be programmed via the main CPU when it is used as a peripheral processor.

   One of the conditions required for programming using a backplane module is that an operating system must already have been installed. A PCCSW ≥V2.0 operating system must be installed on all processors.

4) Programming using the 3IF050.6 or 3IF060.6 interface modules is also possible. The connection is established using an RS232 or CAN interface. Programming can also be carried out using PROFIBUS-FMS. The NW150 PROFIBUS network module must have a revision number >14.04.

   One of the conditions required for programming is that an operating system must already have been installed. A corresponding FBASE module must be programmed in the IF260 memory. System modules e.g. FBASE modules, can also be programmed in system Flash starting with PCCSW V2.0. Therefore the connection via an IF050/IF060 or a PROFIBUS network remains intact in diagnostics mode.

5.4.13 Programming System Flash

General Information

CPUs are delivered with a runtime system. The operating mode switch is set to switch position 0 at delivery i.e. the bootstrap loader mode is set.

A switch position must be set in order to boot the PLC in RUN mode (see Section 5.4.7 "Operating Mode Switch", on page 149). A runtime system update is only possible in RUN mode.

Runtime System Update when Operated as a Parallel Processor

The runtime system can be updated using the programming system. When updating the runtime system (runtime system update) the following procedure must be carried out:

1) A runtime system update is only possible using the CPU interfaces. This means that updating the runtime system must take place using a CPU interface (also applies to parallel processors).
2) An online runtime system update is only possible if the CPU processor and the parallel processor are in RUN mode. The RUN mode can be set with the operating mode switch.
3) Switch on the supply voltage.
4) Establish online connection (online cable) between the programming device (PC or Industrial PC) and the CPU. An online runtime update is possible using the serial RS232 interface.
5) Start B&R Automation Studio™.
6) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

7) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   After pressing **Next >** a dialog box appears where the user can set the CAN baud rate, CAN ID and the CAN node number (the CAN node number set here is only relevant, if an interface module does not contain a CAN node number switch). Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

8) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

User Flash will be deleted.

9) When the update procedure is complete, the online connection is automatically established again.

10) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.

5.5 IP161

5.5.1 General Information

Programmable I/O processors are freely programmable I/O modules. Application programs and data modules can be created for all programmable I/O processors using the programming system.

The IP161 module has a CPU section, two interfaces, digital and analog I/O.

The IP161 module features interrupt capable digital inputs/outputs and the fast analog inputs which allow it to be used in both FIFO and comparator modes. The IP161 module can also be used both as a programmable I/O processor and a CPU. The module recognizes the correct operating mode from the slot used (slots 3+4 -> CPU module).

The module is usually used as an I/O processor to reduce the load on the CPU.

All programmable I/O processors have a local processor core with a RISC processor, local system RAM and operating system. The DPR area ("PPdpr" Library) is used as a communication interface between CPU PLC and the programmable I/O processor. A project must be created for each parallel processor in B&R Automation Studio™.

The PLC CPU and the local processor always have access to this data area, which guarantees data consistency for data type UINT. Larger data structures cannot be be used.

The system can be integrated in a CAN bus using the I/O processor's CAN interface. The IF1 RS232 interface is designed for the programming device's connection. The RS232 interface IF3 can be used e.g. for visualization by using the AC961 bus adapter. This ensures that the IF1 is kept free as the online interface.

5.5.2 Order Data

Model Number	Short Description	Image
	Programmable I/O Processor	
3IP161.60-1	2005 programmable I/O processor, 850 KB SRAM, 1.5 MB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, max. 12 digital inputs 24 VDC, Sink, max. 12 digital outputs 24 VDC, 0.1 A, 6 analog inputs ±10 V, 14-bit, 6 analog outputs ±10 V, 12-bit, 2 outputs with +10 V and -10 V per terminal block. Order 3 x TB170 terminal blocks separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
7AC911.9	Bus connector, CAN	
0AC912.9	Bus adapter, CAN, 1 CAN interface	
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable	
0AC961.9	Accessories, bus adapter (CAN, RS232)	

Table 70: IP161 order data

5.5.3 Technical Data

Product ID	IP161
C-UL-US Listed	Yes
B&R ID Code	$34
Module Type	B&R 2005 system module
Slot 3 ≥ 4	 CPU operation (slots 3+4 used) Programmable I/O processor operation
Power Consumption 5 V 24 V Total	 Max. 6.5 W Max. 11.5 W, including potentiometer supply (if used externally) Max. 18 W
Processor	
Typical Instruction Cycle Time	0.4 µs
Standard Memory System RAM User RAM System PROM User PROM	 174 KB SRAM 850 KB SRAM 512 KB FlashPROM 1.5 MB FlashPROM
Data Buffering Backup Battery in 2005 Backplane Buffering with AC240 Battery Module Battery Monitoring	 At least 4 years At least 2 years Yes, when operated as main CPU
Peripherals	
Real-time Clock Resolution	Nonvolatile during CPU operation (buffered externally) 1 s
Reset Button	Yes
Status display	4 status LEDs, 4 interface LEDs
Standard Communication Interfaces	
Application Interface IF1 Electrical Isolation Design Distance Baud Rate	RS232 No 9-pin DSUB plug Max. 15 m / 19200 Baud Max. 115.2 kBaud
Application Interface IF2 Electrical Isolation Design Station number Distance Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	CAN Yes 9-pin DSUB plug Can be set using two node number switches Max. 1,000 m 500 kBit/s 250 kBit/s 50 kBit/s
Application Interface IF3 Electrical Isolation Design Distance Baud Rate	RS232 No 9-pin DSUB plug, the AC961 bus adapter is required for operation Max. 15 m / 19200 Baud Max. 115.2 kBaud

Table 71: IP161 technical data

Product ID	IP161
Potentiometer Voltage Outputs	
Static Characteristics	
Number and Type of Potentiometer Voltages	2 outputs with +10 V and -10 V per terminal block
Electrical Isolation to PLC	Yes
Internal Reference Potential	AGND (analog ground for analog input circuit)
Output Current	±80 mA (simultaneously)
Short Circuit Current	Typ. ±100 mA
Continuous Short Circuit Protection	Yes
Basic Accuracy At 25° C At 0 - 60° C	 ±0.25% ±0.5%
Output Power	Max. 1.6 W
Analog Inputs	
Static Characteristics	
Input Type	Differential inputs for voltage measurement
Number of Inputs	6
Input Signal, Nominal	±10 V
Maximum Continuous Overload (without damage) Between +/- Connection Between Analog GND and + or -	 ±25 V ±30 V
Conversion Procedure	Successive approximation
Conversion Time	≤100 μs for all 6 channels (parameters can be set by LTX functions in cyclic operating mode)
Digital Converter Resolution	14-bit
Data Format in Application Program Value Range Raw Values from ADC According to standard software using FUB IP161AIx (x ... 1 - 6) Quantization	INT $8320 - $7CE0 (typically) $8000 - $7FFC 1.22 mV per LSB
Output of the Digital Value during Overload When range is exceeded (pos.) When range is exceeded (neg.)	 $7FFF $8000
Input Impedance in Signal Range Static Dynamic	 2 MΩ 3 kΩ/10 nF
Analog Input Measurement Error Maximum Error at 25° C Temperature Coefficient Offset Drift Gain Drift	 ±0.06% ±0.00122%/°C ±0.00061%/°C
Linearization Method	Scaling conversion using software
Common Mode Voltage	±5 V common mode voltage in contrast to other analog inputs

Table 71: IP161 technical data (cont.)

Product ID	IP161
Wiring	Differential or potentiometer input
External Power Consumption	None (except potentiometer)
Protection	Internal clamp diodes protect against voltage spikes
Dynamic Characteristics	
Input Filter Characteristic Frequency Limit	 Low pass 1st order 5 kHz
Total System Input Transfer Time	≤100 µs for all 6 channels (parameters can be set)
Scan Duration (including response time)	5 µs (response time on the multiplexer + sample time on the ADC)
Scan Repeat Time Minimum Typical	Parameters can be set by LTX functions depending on the operating mode (cyclic, applications driven) 85 µs (cyclic operation) 100 µs
Operating Characteristics	
Operating Modes Operating Mode 1 Operating Mode 2 Operating Mode 3	See Section 5.5.13 "Operating Modes", on page 172 Fast analog value registering Measurement values are recorded in FIFO memory Comparator
Isolations Voltage between Input and Bus Inputs	 ±50 V 0 V (no electrical isolation)
Installation Recommendations	Double-sided twisted cable with 2-pin twisted Cu wires, max. 10 m, Under **no circumstances** should inputs and outputs be mixed in a multi-wire cable
Typical Example for External Connections	Differential input (+/- connection) Potentiometer input (- input pin should be connected with AGND)
Consequences of Incorrect Connection to the Input Terminals	Mixing up the +/- connections: negative result Open inputs: Overrun to $7FFF
Cross-talk between Inputs	>40 dB (DC - 60 Hz)
Non-Linearity	±1 LSB (from ADC)
Continuity Without Missing Codes	No missing codes (in defined value range)
Calibrating or Testing for Maintaining the Accuracy Class	No calibration or testing required
Analog Outputs	
Static Characteristics	
Number of Outputs	6 voltage outputs ±10 V
Digital Converter Resolution	12-bit
Data Format in Application Program	INT ($8000 - $7FF0)
Quantization	1 LSB = 4.88 mV
Output Impedance in Signal Range	0.25 Ω (2.5 mV at load change of 0 to 10 mA at 10 V)
Load Impedance	≥1 kΩ

Table 71: IP161 technical data (cont.)

Product ID	IP161
Analog Output Measurement Error Alignment Precision at 25° C Offset Total Temperature Coefficient Offset Drift Gain Drift	 ±0.0366% ±0.4% ±0.00244%/°C ±0.00122%/°C
Dynamic Characteristics	
Response Time When Changing Using Whole Area	Max. 300 µs from 0.01% of end value (for resistive load)
Overshoot	For resistive load of 1 kΩ max. 3%
Output Response when Power Supply is Switched On/Off	An enable relay is switched on at a defined value of 0 V Default setting = short circuit on the output terminals using relay contact
Output Ripple Factor	≤250 mVpp
Operating Characteristics	
Operating Mode	Cyclic output with approx. 10 kHz
Isolation Voltages between Output and Bus	±50 V
Installation Recommendations	Double-sided twisted cable with 2-pin twisted Cu wires, max. 10 m, Under **no circumstances** should inputs and outputs be mixed in a multi-wire cable
Calibrating or Testing for Maintaining the Accuracy Class	No calibration or testing required
Permitted Load Types	Resistive, inductive
Maximum Capacitive Load	≤100 nF (larger capacity extends the response time)
Typical Example for External Connections	e.g. analog hydraulic valve
Consequences of Incorrect Connection to the Output Terminals	Depends on wiring and voltage size (in worst case scenario all 6 output circuits become defective)
Continuity	±0.5 LSB (DAC value)
Non-Linearity	Max. ±4 LSB (DAC value)
Repeat Precision at a Certain Temperature after a Specified Stabilizing Time	±2 LSB (noise at constant temperature in 24 hours)
Digital inputs	
Static Characteristics	
Number of Inputs	Up to 12 Configuration as input or output takes place in groups of two using software
Maximum Peak Voltage	+35 V
Rated Voltage	+24 VDC
Rated Frequency	Max. 200 kHz (symmetrical square wave)
Wiring	Sink
Limit Values 0-Signal UL 0-Signal IL 1-Signal UH 1-Signal IH	 ≤5 V ≤2 mA ≥11 V ≥5 mA

Table 71: IP161 technical data (cont.)

Product ID	IP161
Delay 0 to 1	≤2.5 µs
Delay 1 to 0	≤2.5 µs
Power Consumption (external) Per Group at 24 V (no load) Per Digital Input at 24 V	 ≤0.48 W 0.24 W
Additional Characteristics	
Status Display	No
Interrupt Capable	Yes Parameters can be set using LTX functions - each digital input can trigger an IRQ **WARNING:** Handling takes place using an exception task
Operating Characteristics	
Consequences of Incorrect Input Connections	At 24 V and COM exchange: internal reverse polarity diode For active inputs without supply: Output driver is not protected
Isolations Voltage between Input and Bus Inputs	 ±50 V Digital group <-> Digital group: ±50 V
Consequences of Removing/Inserting Input Modules with Voltage Applied	Must not be removed/inserted during operation (= system module)
Additional Exterior Load when Inputs and Outputs are Switched Together (if required)	No load required (push/pull)
Explanation of Signal Evaluation	Each digital input is assigned a TPU pin, different types of signal evaluation are possible (edges triggering, counter input) depending on the TPU function, several inputs can be combined (e.g. incremental encoder)
Recommended Length for Cable and Connections Depending on Cable Type and Electromagnetic Compatibility	The recommended cable length and cable type depends on the maximum frequency of use,Shielded cable are recommended for fast signals (>10 kHz)
Typical Example for External Connections	Only sink connection
Different Circuits Possible	Each group is electrically isolated
Digital Outputs	
Static Characteristics	
Number and Type of Outputs	Up to 12 transistor outputs (Push/Pull) Configuration as input or output takes place in groups of two using software
Maximum Switching Voltage	+35 V
Maximum Peak Voltage	+50 V
Rated Current (1-Signal)	±100 mA
Rated Voltage	+24 VDC
Switching Voltage Range	+12 VDC to +35 VDC
Rated Frequency	Max. 100 kHz
Current Range at 1-Signal (continuous at maximum voltage)	±100 mA

Table 71: IP161 technical data (cont.)

Product ID	IP161
Voltage Drop (1-Signal), Internal Resistance Protected and short circuit outputs	ΔU at 100 mA is ≤1 V I_K ≤300 mA, continuous
Short Circuit Current Turn-off delay Over-Temperature Cutoff	110 to 300 mA 100 µs ≥ 170° C
Wiring	Sink or source
Power Consumption per Group (external)	≤20 mA + load current for the outputs
Additional Characteristics	
Status Display	No
Protection Characteristics	
For Protected Outputs: Operating characteristics over 1.2 x I_e Including the Current Level, where the Protection Circuit Responds	Internal current limitation from ±110 mA to ±300 mA
For Short Circuit Proof Outputs: Information Concerning Replacement or Removal of the Prescribed Protective Measures	Internal thermal overload protection and internal current limitation
For Non-Protected Outputs: Information Concerning Required Protection Measures which must be Provided by the User	No prescribed protective circuit
Characteristics of the Output Circuit Protection Against Voltage Spikes when Turning Off Inductive Loads	Internal clamping diodes for group supply voltage Short term current of ±1 A, duration ≤10 ms
Type of External Protective Circuit	For inductive loads, clamping diodes can also be connected between the output and the group supply (24 VDC and GND)
Dynamic Characteristics	
Delay 0 to 1	≤2 µs for resistive loads
Delay 1 to 0	≤2 µs for resistive loads
Switch Frequency with Resistive Load	100 kHz with resistive load
Operating Characteristics	
Consequences when Outputs Incorrectly Connected	Depending on the error, the worst case scenario could cause destruction of digital group
Consequences of Multiple Overloads on Multi-Circuit Modules	The entire group is switched off due to internal thermal monitoring
Output Behavior when the Controller Falls Out During Voltage Dips, Interruptions and when the Unit is Switched On-or Off	Output switched to high resistance
Total Output Current	Max. 400 mA/group (static)
Isolation Voltages between Output and Bus	±50 V
Recommended Procedure when Changing Output Modules	Must not be removed/inserted during operation (= system module)

Table 71: IP161 technical data (cont.)

Product ID	IP161
Typical Example for External Connections	Sink or source wiring
Mechanical Characteristics	
Dimensions	B&R 2005 double-width
Pin Assignments	See sections 5.5.4 "Operational and Connection Elements" and 5.5.10 "I/O Connections"

Table 71: IP161 technical data (cont.)

5.5.4 Operational and Connection Elements

Three I/O groups, a reset button, status LEDs, two HEX number switches for the CAN bus station number and the connectors for two RS232 interfaces and a CAN interface are all located behind the module door.

If both RS232 interfaces are used, the AC961 bus adapter is required (see Section 5.5.8 "RS232 Interfaces (IF1 and IF3)", on page 164).

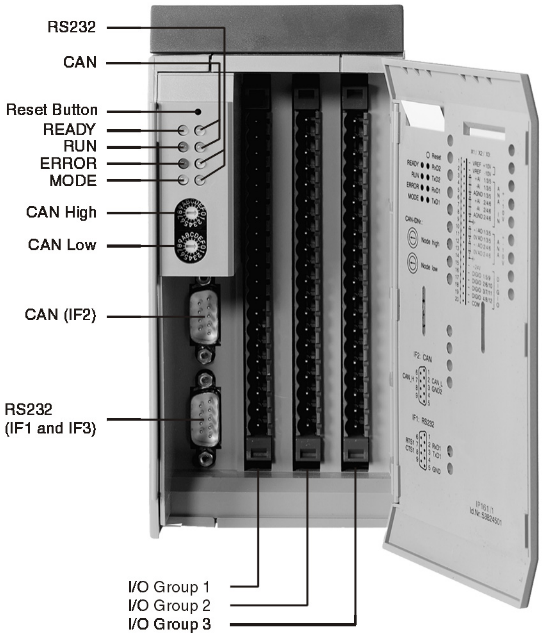


Figure 63: IP161 operational and connection elements

5.5.5 Status LEDs

LED	Description
READY	Lit in Service and diagnostics mode
RUN	Lit in Run, Service and diagnostics mode
ERROR	Lit if error occurs
MODE	Lit when programming FlashPROM
RXD1, TXD1	Lit during data exchange via either of the two RS232 interfaces
RXD2, TXD2	Lit during data exchange via the CAN interface

Table 72: IP161 status LEDs

The LEDs READY, RUN, ERROR and MODE are lit when the reset button is pressed.

5.5.6 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Depending on the operating mode, pressing the reset buttons has different effects.

Operating Mode	Effects
Programmable I/O Processor	Local Reset - All IP161 application programs are stopped - All IP161 outputs are set to zero
CPU	Local reset and global bus reset - All application programs are stopped - All outputs are set to zero

Table 73: IP161 reset button

5.5.7 CAN Node Number Switch

The CAN node number is set with the two hex switches. The switch setting can be evaluated by the application program at any time. If the switch position is changed during operation, a warning can be generated. The operating system only interprets the switch position when switched on.

The settings $00, and $FF are reserved for special functions.

Switch Position	Function
$00	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. The bootstrap loader mode is only required when PCCSW < 2.0 is installed. The procedure is the same as described in Section 5.5.14 "Programming System Flash", on page 174. In an additional dialog box, the baud rate and the interface must only be set, from which a connection to the PLC is created.
$FF	Diagnostics mode

Table 74: IP161 CAN node number switch

5.5.8 RS232 Interfaces (IF1 and IF3)

The IP161 programmable I/O processor is equipped with two RS232 interfaces. The signals are fed through together via a DSUB plug. The interfaces are not electrically isolated (shared GND connection).

The IF1 RS232 interface is designed to be used as an online interface. An AC961 bus adapter is needed to use the IF3. The IF3 can e.g. be used for visualization while the IF1 remains free as the online interface.

An RS232 cable is available from B&R for connecting programmable I/O processors with the PG software (PC).

Model No. 0G0001.00-090

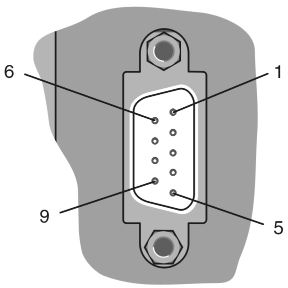
Interface	Description	Pin Assignments		
Application interface RS232	The RS232 interfaces are not electrically isolated.	**Pin**	**IF1**	**IF3**
	Status LEDs RXD1 and TXD1 are lit during data exchange via either of the two RS232 interfaces.	1		
	Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	2	RXD1	
		3	TXD1	
		4		TXD3
		5	GND	GND
		6		RXD3
		7	RTS1	
		8	CTS1	
9-pin DSUB plug		9		

Table 75: IP161 RS232 interfaces (IF1 and IF3)

AC961 Bus Adapter

An AC961 bus adapter is needed to use both RS232 interfaces. The bus adapter is connected to both DSUB plugs.

The (IF1) online interface is connected to the bus adapter with a 9-pin DSUB plug. Both the RS232 interface IF3 and the CAN interface are connected to one multipoint connector. One 120 Ω terminating resistor is included with the delivery of the AC961. If required, the resistor can be connected between the CAN_L and CAN_H.

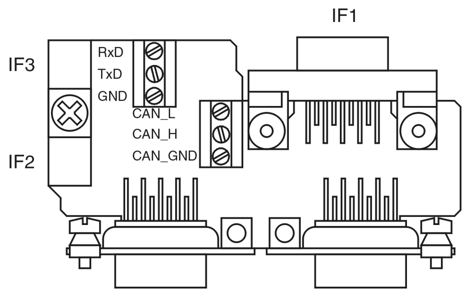


Figure 64: IP161 bus adapter for the AC961

5.5.9 CAN Interface (IF2)

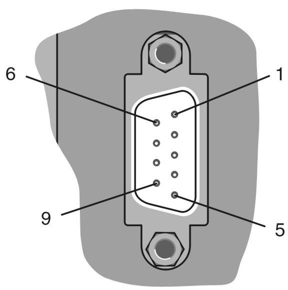
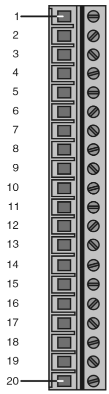
Interface	Description	Pin Assignments	
Application interface CAN  9-pin DSUB plug	The 82527 controller is used as the CAN controller. The interface is electrically isolated. The connection is made using a T-connector (7AC911.9). The status LEDs RXD2 and TXD2 are lit during data transfer via the CAN interface. Max. Baud Rate: 500 kBit/s Bus Length: ≤60 m 250 kBit/s Bus Length: ≤200 m 50 kBit/s Bus Length: ≤1,000 m	**Pin**	**CAN**
		1	
		2	CAN_L
		3	CAN_GND
		4	
		5	
		6	
		7	CAN_H
		8	
		9	

Table 76: IP161 CAN interface (IF2)

5.5.10 I/O Connections

The programmable I/O processor IP161 is equipped with three rows of terminals for analog and digital I/Os. The connection is made using the TB170 20-pin terminal block. The assignments for the three terminal blocks are the same. Only the channel numbers are different.



TB170

Connection	Assignment	Channel number for I/O Group		
		1	2	3
1	VREF +10 V			
2	VREF -10 V			
3	+ Analog input	1	3	5
4	- Analog input	1	3	5
5	Analog GND	1	3	5
6	+ Analog input	2	4	6
7	- Analog input	2	4	6
8	Analog GND	2	4	6
9	Shield analog inputs	1 + 2	3 + 4	5 + 6
10	± Analog output	1	3	5
11	0 V analog outputs	1	3	5
12	± analog output	2	4	6
13	0 V analog outputs	2	4	6
14	Shield Analog Outputs	1 + 2	3 + 4	5 + 6
15	+24 V 1)	1 - 4	5 - 8	9 - 12
16	Digital input / output 1	1	5	9
17	Digital input / output 1	2	6	10
18	Digital input / output 1	3	7	11
19	Digital input / output 1	4	8	12
20	COM 1)	1 - 4	5 - 8	9 - 12

Table 77: IP161 I/O connections

1) The digital inputs and digital outputs are arranged in three electrically isolated groups.

Analog Inputs

Signal Cable Connection

Shielded cables must be used for wiring the analog inputs. The shield is grounded on the module using the shield connections provided on the terminal block.

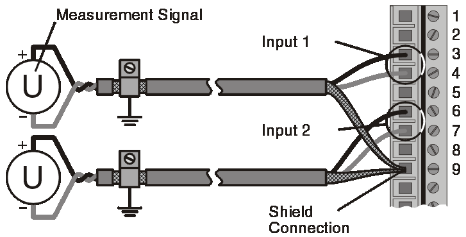


Figure 65: IP161 connections for analog inputs

The shielded connection (pin 9) is connected via an RC element with ground (⏚, i.e. spring contact and mounting rail).

R: 22 kΩ, C: 10 nF / 60 V

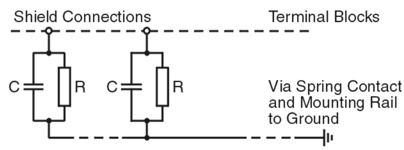


Figure 66: IP161 shielded connection

Potentiometer Connection

The module provides two potentiometer voltages (+10 V and -10 V). The sum of all currents from all three I/O groups amounts to +80 mA or -80 mA. The two voltages are short circuit proof.

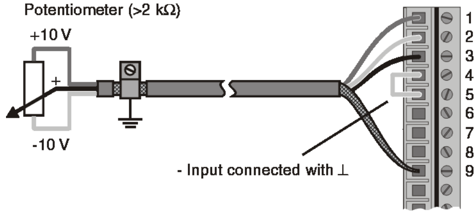


Figure 67: IP161 potentiometer connection

Analog Outputs

Signal Cable Connection

Shielded cables must be used for wiring the analog outputs. The shield is grounded on the module using the shield connections provided on the terminal block.

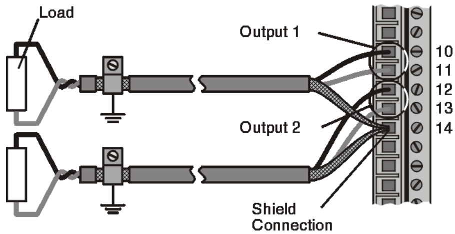


Figure 68: IP161 connection for analog outputs

The shielded connection (pin 14) is connected via an RC element with ground (⏚, i.e. spring contact and mounting rail)

R: 22 kΩ, C: 10 nF / 60 V.

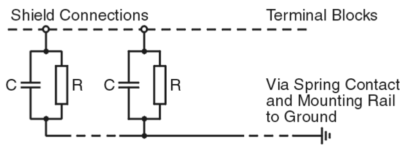


Figure 69: IP161 shielded connection

Digital I/O Group

Each digital I/O group has over four I/Os. As default, they are configured as digital inputs. They can be switched to digital outputs in two groups using software.

Each digital I/O group is supplied externally with +24 VDC (reverse polarity). The groups are electrically isolated by the system.

The digital inputs can be configured as interrupt inputs using the TPU Code Linker in the application program.

Connecting an I/O Group with Four Inputs

The inputs are wired as sink circuits.

Note: Although only inputs are used, the 24 V supply must also be connected to pin 15.

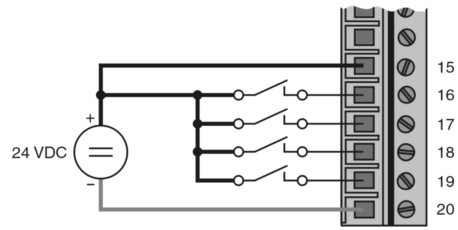


Figure 70: IP161 connecting an I/O group with four inputs

Connecting an I/O Group with Four Outputs

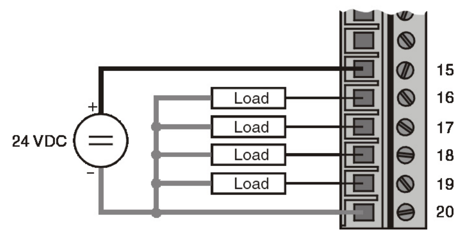


Figure 71: IP161 connecting an I/O group with four outputs

Connecting an I/O Group with Two Inputs and Two Outputs

The inputs are wired as sink circuits.

Note: The digital outputs are push/pull outputs. They can switch the load using a sink or source circuit.

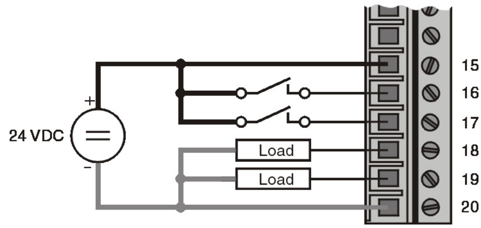


Figure 72: IP161 connecting an I/O group with two inputs and two outputs

5.5.11 Data/Real-time Buffering

The following areas are buffered

- User RAM
- System RAM
- Real-time clock

The backup battery is either in the B&R 2005 rack or in the AC240 battery module

Battery Monitoring

If the IP161 module is operated as the CPU, the I/O processor carries out cyclical monitoring of the battery voltage. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available to the user from the SYS_lib function "SYS_battery".

Battery Change Interval

See section "Backup Battery" in sections 2 "Module Racks" and 17.2 "AC240" (battery module).

5.5.12 Local I/O Bus Expansion

Since the IP161 module does not have its own expansion master, the EX350 I/O master controller is needed for local I/O bus expansion. By using this controller, up to four expansion racks with all I/O modules can be used with the IP161.

The I/O master controller is operated in the expansion slot of a PS465 power supply module. I/O modules on the main rack are handled by the CPU. The EX350 module supports the CPU by processing I/O module data on the expansion racks.

5.5.13 Operating Modes

Analog Inputs

The analog inputs are set in all operating modes using LTX functions.

1) Fast Analog Value Registering

a) Cyclic Mode

The six analog inputs are converted as quickly as possible. The conversion time for all six channels is less than 100 µs. When inputs are read with corresponding LTX functions from the application program, the values are a maximum of 100 µs old.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU cyclically using a specified frequency (max. 10 kHz).

2) Measurement Values are Recorded in FIFO Memory

a) Cyclic Mode

The six analog inputs are converted as quickly as possible. The converted analog values are stored in a FIFO memory. The FIFO memory must be allocated by the user.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU cyclically using a specified frequency (max. 10 kHz). The converted analog values are stored in a FIFO memory. The FIFO memory must be allocated by the user.

3) Comparator

a) Cyclic Mode

The six analog inputs are converted as quickly as possible and compared with a comparator value using hardware. The comparator value is evaluated by the TPU. The TPU can handle fast links to digital I/O or trigger an exception to the processor without loading the processor. Depending on the TPU, the reaction time ranges from 50 µs to 150 µs.

b) Triggered Mode

Conversion of the six analog inputs is started either by the application program or by the TPU using a specified frequency (max. 10 kHz). Analog values are compared with the comparator value using hardware. The comparator value is evaluated by the TPU. The TPU can handle fast links to digital I/O's or trigger an exception to the processor without loading the processor. Depending on the TPU, the reaction time ranges from 50 µs to 150 µs.

Analog Outputs

The six analog outputs are output cyclically with approximately 10 kHz.

Digital Inputs/Outputs

Digital I/O are set in all operating modes using LTX functions.

Application Example for Digital Inputs/Outputs

- Evaluating digital inputs using link function and exception generation
- Reading digital inputs using a time stamp
- Differential time measurements
- Period or pulse duration measurement using internal or external counter frequency
- Pulse width modulated outputs
- Controlling outputs using the link function
- Operating up to five incremental encoders using the comparator function
- Operating up to five SSI absolute value encoders
- Operating up to six 2 phase stepper motors using the external power supply

5.5.14 Programming System Flash

General Information

CPUs are delivered with a runtime system. The CAN node number switch is set to switch position 00 at delivery i.e. the bootstrap loader mode is set.

A switch position must be set in order to boot the PLC in RUN mode (see Section 5.5.7 "CAN Node Number Switch", on page 163). A runtime system update is only possible in RUN mode.

Runtime System Update when Operated as a Parallel Processor

The runtime system can be updated using the programming system. When updating the runtime system (runtime system update), the following procedure must be carried out:

1) A runtime system update is only possible using the CPU interfaces. This means that updating the runtime system must take place using a CPU interface (also applies to parallel processors).

2) An online runtime system update is only possible if the CPU processor and the parallel processor are in RUN mode. The RUN mode can be set with the operating mode switch.

3) Switch on the supply voltage.

4) Establish online connection (online cable) between programming device (PC or Industrial PC) and the CPU. An online runtime update is possible using the serial RS232 interface.

5) Start B&R Automation Studio™.

6) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

7) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   After pressing **Next >**, a dialog box appears where the user can set the CAN baud rate, CAN ID and the CAN node number (the CAN node number set here is only relevant, if an interface module does not contain a CAN node number switch). Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

8) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

User Flash will be deleted.

9) When the update procedure is complete, the online connection is automatically established again.

10) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.

5.6 XP152

5.6.1 General Information

The XP152 module is a CPU insert for power supply modules. This means that the CPU does not require its own slot.

Optionally, the XP152 module can be operated as intelligent CAN bus processor together with a CPU (e.g. CP260). With this type of operation, the XP152 cannot access local modules on the 2005 unit. It is controlled by the CPU, collects data from the CAN stations (e.g. I/O) and provides this data to the CPU.

5.6.2 Order Data

Model Number	Short Description	Image
	CPU	
3XP152.60-2	2005 CPU, 118 KB SRAM, 512 KB FlashPROM, 1 RS232 interface, 1 CAN interface, CAN: electrically isolated, network capable, insert for power supply modules	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
7AC911.9	Bus connector, CAN	
0AC912.9	Bus adapter, CAN, 1 CAN interface	
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable	

Table 78: XP152 order data

5.6.3 Technical Data

Product ID	**XP152**
General Information	
C-UL-US Listed	Yes
B&R ID Code	$11
Slot	Insert for power supply PS465
Power Consumption 5 V 24 V Total	 Max. 4 W --- Max. 4 W
Processor	
Typical Instruction Cycle Time	0.8 µs
SRAM User RAM / DPR System RAM	 118 KB 138 KB
FlashPROM User PROM System PROM	 512 KB 512 KB
Data Buffering Backup Battery in 2005 Backplane with Battery Module AC240 Battery Monitoring	 At least 4 years At least 2 years Yes, when operated as main CPU (starting with Rev. 12.00)
Peripherals	
Real-time Clock Resolution	Nonvolatile (external buffering) 1 s
Reset Button	Yes
Status Display	LEDs
Standard Communication Interfaces	
Application Interface IF1 Design Electrical Isolation Max. Distance Max. Baud Rate	RS232 9-pin DSUB plug No 15 m / 19200 Baud 64 baud
Application Interface IF2 Design Electrical Isolation Max. Distance Max. Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	CAN 9-pin DSUB plug Yes 1,000 m 500 kBits/s 250 kBits/s 50 kBits/s
Mechanical Characteristics	
Dimensions (H, W, D) [mm]	130, 28, 105

Table 79: XP152 technical data

5.6.4 Operational and Connection Elements

On the module, there is a Reset key, status LEDs, two HEX number dials for the CAN bus station number and the connector for a RS232 and a CAN interface.

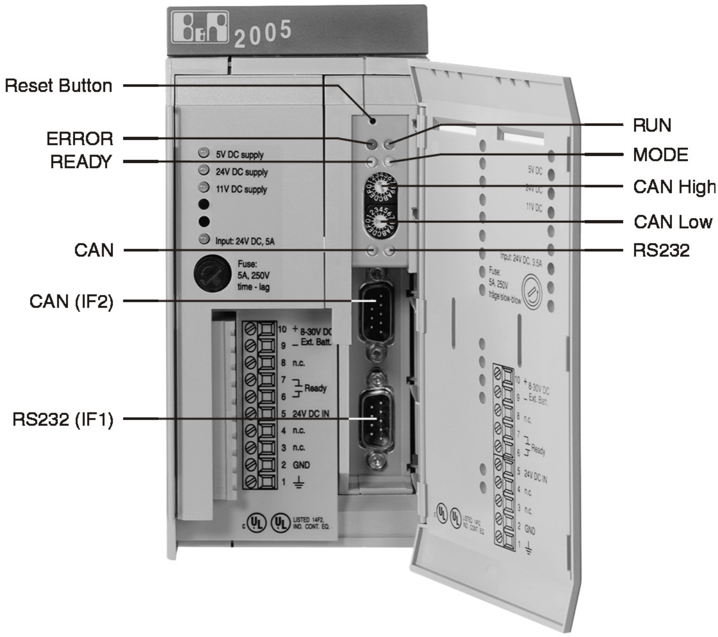


Figure 73: XP152 operational and connection elements

5.6.5 Status LEDs

LED	Description
ERROR	Lit in Service and diagnostics mode
RUN	Lit in Run, Service and diagnostics mode
READY	Lit in Service and diagnostics mode
MODE	Lit when programming FlashPROM
CAN	Lit during data exchange via the CAN interface
RS232	Lit during data exchange via the RS232 interface

Table 80: XP152 status LEDs

All LEDs are lit when the reset button is pressed. They are still lit for another 0.4 s after being released.

5.6.6 Reset Button

The reset button can be pressed with any small pointed object (e.g. paper clip). The reset button is protected by the module door. Depending on the operating mode, pressing the reset buttons has different effects.

Operating Mode	Effects
CAN Bus Processor	Local Reset - All XP152 application programs are stopped
CPU	Local reset and global bus reset - All application programs are stopped - All outputs are set to zero

Table 81: XP152 reset button

5.6.7 CAN Node Number Switch

The CAN node number is set with the two hex switches. The switch setting can be evaluated by the application program at any time. If the switch position is changed during operation, a warning can be generated. The operating system only interprets the switch position when switched on.

The settings $00, and $FF are reserved for special functions.

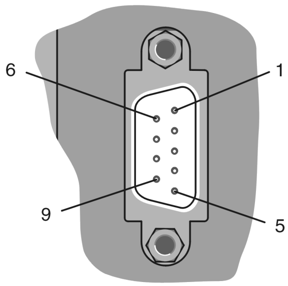
Switch Position	Function
$00	In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. The bootstrap loader mode is only required when PCCSW < 2.0 is installed. The procedure is the same as described in Section 5.6.12 "Programming System Flash", on page 182. In an additional dialog box, the baud rate and the interface must only be set, from which a connection to the PLC is created.
$FF	diagnostics mode

Table 82: XP152 CAN node number switch

5.6.8 RS232 Interface (IF1)

An RS232 cable is available from B&R for connecting the CPU and PG (PC).

Model No. 0G0001.00-090

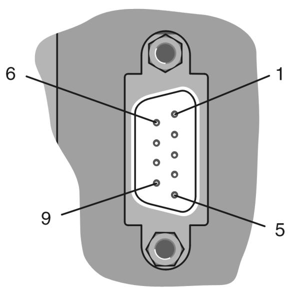
<table>
<tr><th>Interface</th><th>Description</th><th colspan="2">Pin Assignments</th></tr>
<tr><td rowspan="10">Application interface
RS232

9-pin DSUB plug</td><td rowspan="10">The RS232 interface is not electrically isolated.

The RS232 status LED is lit when data is transferred via the RS232 interface.

Max. Baud Rate: 64 kBaud
Max. Cable Length: 15 m</td><th>Pin</th><th>RS232</th></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td>RXD</td></tr>
<tr><td>3</td><td>TXD</td></tr>
<tr><td>4</td><td></td></tr>
<tr><td>5</td><td>GND</td></tr>
<tr><td>6</td><td></td></tr>
<tr><td>7</td><td>RTS</td></tr>
<tr><td>8</td><td>CTS</td></tr>
<tr><td>9</td><td></td></tr>
</table>

Table 83: XP152 RS232 Interface (IF1)

5.6.9 CAN Interface (IF2)

<table>
<tr><th>Interface</th><th>Description</th><th colspan="2">Pin Assignments</th></tr>
<tr><td rowspan="10">Application interface
CAN

9-pin DSUB plug</td><td rowspan="10">The 82527 processor is used as the CAN controller.

The interface is electrically isolated. The connection is made using a T-connector (7AC911.9).

The CAN status LED is lit when data is transferred via the CAN interface.

Max. Baud Rate:

500 kBit/s Bus Length: ≤60 m
250 kBit/s Bus Length: ≤200 m
50 kBit/s Bus Length: ≤1,000 m</td><th>Pin</th><th>CAN</th></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td>CAN_L</td></tr>
<tr><td>3</td><td>CAN_GND</td></tr>
<tr><td>4</td><td></td></tr>
<tr><td>5</td><td></td></tr>
<tr><td>6</td><td>res.</td></tr>
<tr><td>7</td><td>CAN_H</td></tr>
<tr><td>8</td><td></td></tr>
<tr><td>9</td><td></td></tr>
</table>

Table 84: XP152 CAN interface (IF2)

5.6.10 Data/Real-time Buffering

The following areas are buffered

- User RAM
- System RAM
- Real-time clock

The backup battery is either in the B&R 2005 rack or in the AC240 battery module Data can also buffered be by module with a rechargeable battery such as e.g. CP260.

Battery Monitoring

If the XP152 is operated as the CPU, it carries out cyclical monitoring of the battery voltage. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available to the user from the SYS_lib function "SYS_battery".

Battery Change Interval

See section "Backup Battery" in sections 2 "Module Racks" and 17.2 "AC240" (battery module).

5.6.11 Module Fastener

The XP152 is equipped with a module fastener starting from revision 12.00. The module fastener prevents the power supply from falling out of the CPU during transport.

A screwdriver is required to install the module. The screwdriver should be inserted between the power supply and XP152 at the same height as the sloped marking (see figure below). By simultaneously levering the screwdriver in the direction of the power supply and pulling the XP152, the CPU is taken out from its bracing and can be removed from the power supply.

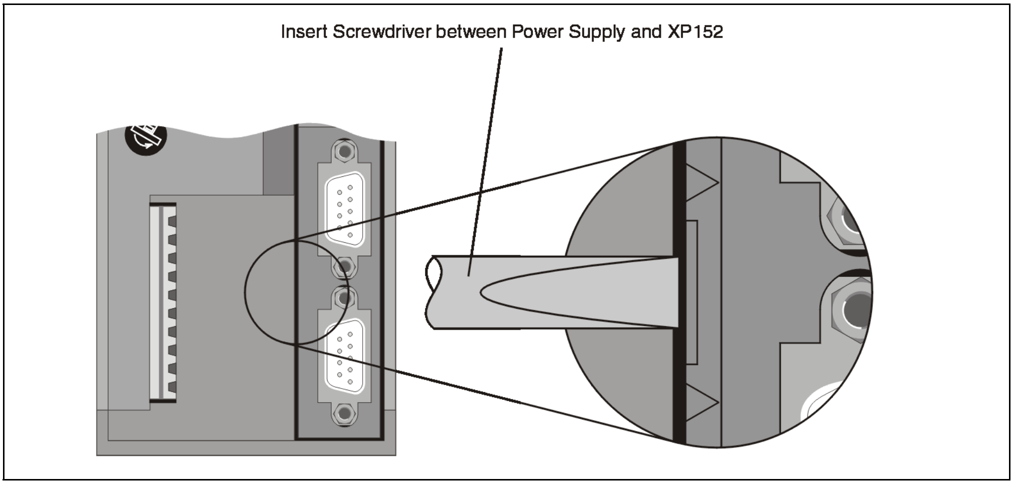


Figure 74: XP152 module fastener

5.6.12 Programming System Flash

General Information

CPUs are delivered with a runtime system. The CAN node number switch is set to switch position 00 at delivery i.e. the bootstrap loader mode is set.

A switch position must be set in order to boot the PLC in RUN mode (see Section 5.6.7 "CAN Node Number Switch", on page 179). A runtime system update is only possible in RUN mode.

Runtime System Update

The runtime system can be updated using the programming system. When updating the runtime system (online runtime system update), the following procedure must be carried out:

1) An online runtime system update is only possible, if the processor is in RUN mode.

2) Switch on the supply voltage.

3) Establish online connection (online cable) between programming device (PC or Industrial PC) and the XP152. An online runtime update is possible using the serial RS232 onboard interface.

4) Start B&R Automation Studio™.

5) Start the update procedure by calling the **Services** command from the **Project** menu. Select **Transfer Operating System...** from the menu shown. Follow the instructions from B&R Automation Studio™.

6) A dialog box is displayed for configuring the runtime system version. The runtime system version is already preselected by the user's project settings. Using the drop-down menu, the runtime system versions stored in the project can be selected. Clicking on the **Browse** button allows the selected runtime system version to be loaded from the hard drive or from the CD.

   Pressing **Next >** opens a pop-up window, which allows the user to select whether the modules should be downloaded with SYSTEM ROM target memory using the following runtime system update. Otherwise, modules can also be downloaded using a later application download.

   After pressing **Next >** a dialog box appears where the user can set the CAN baud rate, CAN ID and the CAN node number (the CAN node number set here is only relevant if an interface module does not contain a CAN node number switch). Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

7) The update procedure is started by pressing **Next >**. The update progress is shown in a message window.

User Flash will be deleted.

8) When the update procedure is complete, the online connection is automatically established again.

9) The PLC is now ready for use.

An operating system update is not only possible through an online connection, but also through a CAN network, serial network (INA2000 protocol) or an ETHERNET network, depending on the system configuration.

6. Programmable Modules

6.1 Overview

Module	Description
DM455	2005 digital mixed module, 8 inputs, 24 VDC, 2.5 µs, sink, 8 transistor outputs, 0 to 50 VDC, 1 A. Order terminal blocks separately.

Table 85: Programmable module overview

6.2 DM455

6.2.1 General Information

The DM455 is equipped with a powerful processor. The functionality (DM455 operating system) is transferred via a coupling memory from the CPU into the DM455. Therefore, it is possible to provide functions such as stepper motor control, PWM positioning, connection of an asymmetrical incremental encoder, gear measuring, etc.

6.2.2 Order Data

<table>
<tr><th>Model Number</th><th>Short Description</th><th>Image</th></tr>
<tr><td>3DM455.60-2</td><td>2005 digital mixed module, 8 inputs, 24 VDC, 2.5 µs, sink, 8 transistor outputs, 0 to 50 VDC, 1 A. Order terminal blocks separately.</td><td rowspan="6">


</td></tr>
<tr><td>3TB170.9</td><td>2005 terminal block, 20-pin, screw clamps</td></tr>
<tr><td>3TB170.91</td><td>2005 terminal block, 20-pin, cage clamps</td></tr>
<tr><td>3TB170:90-02</td><td>2005 terminal block, 20-pin, 20 pcs., screw clamps</td></tr>
<tr><td>3TB170:91-02</td><td>2005 terminal block, 20-pin, 20 pcs., cage clamps</td></tr>
<tr><td colspan="2">Terminal blocks not included in the delivery (see "Accessories").</td></tr>
</table>

Table 86: DM455 order data

6.2.3 Technical Data

Product ID	DM455
C-UL-US Listed	Yes
B&R ID Code	$20
Status LEDs Inputs Outputs ERROR RUN	 8 (green) 8 (yellow) Red Green
Inputs	
Number of Inputs	8
Input Connections	Sink
Electrical Isolation Input - PLC Input - Output	 Yes (optocoupler) Yes (optocoupler)
Input Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC
Input Voltage to Ground	Max. ±70 VDC
Input Current at Nominal Voltage	Approx. 5 mA
Input Resistance	4.4 kΩ
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Applications	Encoder evaluation, signal measurement, high-speed signal processing
Input Frequency	Max. 100 kHz, decisively limited by the software
Input Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Max. 2.5 µs Max. 2.5 µs
Outputs	
Number of Outputs	8
Design	Transistor
Electrical Isolation Output - PLC Output - Input	 Yes (optocoupler) Yes (optocoupler)
Supply Voltage	0 -50 VDC
Supply Voltage Range + to ground - to ground	 Max. +70 VDC Max. -70 VDC
Continuous Current per Output Push, Pull or Push/Pull Operation Motor Operation	 Max. 1 A See Section 6.2.11 "Maximum Permitted Load on the Motor Windings", on page 198

Table 87: DM455 technical data

Product ID	DM455
Current Threshold Offset Error Amplification Error Digital Value -> Analog Value Minimum Permitted Setting Maximum Setting	 Max. ±40 mA Max. 8% 1 LSB = 1 mA 0.1 A 2.55 A
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Max. 7 µs Max. 7 µs
Switching Frequency (resistive load)	Max. 100 kHz, decisively limited by the software
Short Circuit Protection	Yes
Switching On after Short Circuit Cutoff	Using software
Short Circuit Current	2.55 A ±15%
Protective Circuit Internal External	 Yes Generally required (fuse)
Power Consumption 5 V 24 V Total	 Max. 3.5 W --- Max. 3.5 W
Dimensions	B&R 2005 single-width

Table 87: DM455 technical data (cont.)

6.2.4 Status LEDs

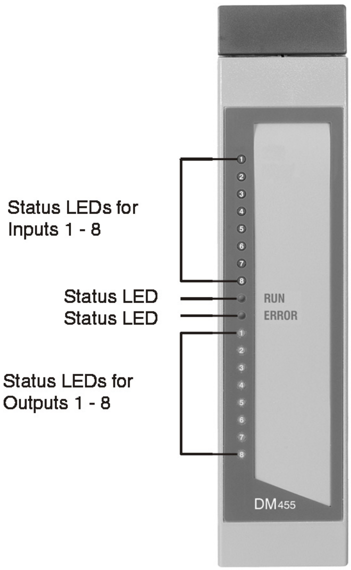
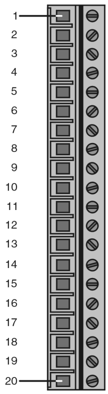
Image	LED	Description
	1 -8, green	The 8 green status LEDs indicate the relevant logical status of the corresponding inputs. The LED is lit if the operating system sets the corresponding LED because of the input information.
	RUN	LED blinks ......the DM455 is not initialized LED not lit ....the DM455 is initialized
	ERROR	LED blinks ......LED blinks during the boot phase LED lit ....module error
	1 -8, yellow	The 8 yellow status LEDs indicate the relevant logical status of the corresponding outputs.

Table 88: DM455 Status LEDs

6.2.5 Pin Assignments



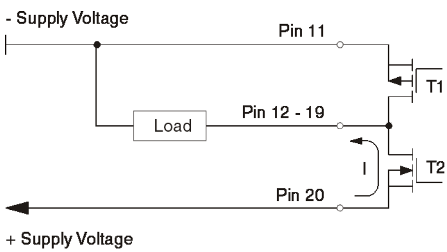
TB170

Connection	Assignment
1	COM (Inputs 1 - 8)
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Input 7
9	Input 8
10	Shield
11	COM (Outputs 1 - 8)
12	Output 1
13	Output 2
14	Output 3
15	Output 4
16	Output 5
17	Output 6
18	Output 7
19	Output 8
20	Supply of Outputs

Table 89: DM455 pin assignments

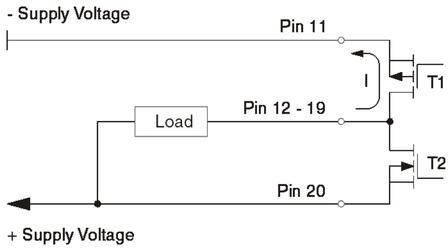
6.2.6 Connection Example

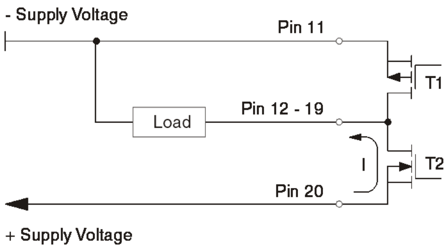
1) Push Operation

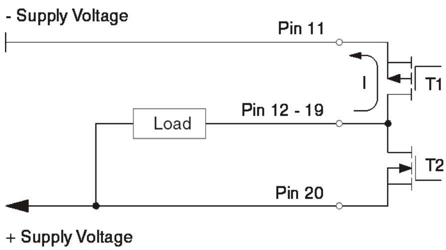


Output	IN	OUT
T1	Off	Off
T2	On	Off

Table 90: DM455 connection examples

<table>
<tr><td>2) Pull Operation</td><td>


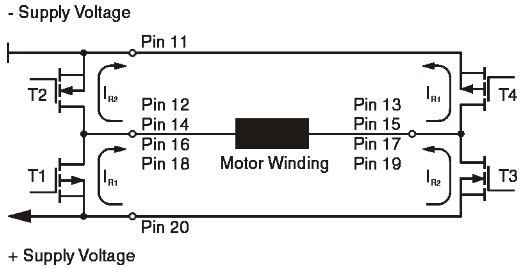
<table>
<tr><th>Output</th><th>IN</th><th>OUT</th></tr>
<tr><td>T1</td><td>On</td><td>Off</td></tr>
<tr><td>T2</td><td>Off</td><td>Off</td></tr>
</table>
</td></tr>
<tr><td>3) Push/Pull Operation</td><td>


Current flow, if output = IN
<table>
<tr><th>Output</th><th>IN</th><th>OUT</th></tr>
<tr><td>T1</td><td>Off</td><td>On</td></tr>
<tr><td>T2</td><td>On</td><td>Off</td></tr>
</table>


Current flow, if output = OUT
</td></tr>
</table>

Table 90: DM455 connection examples (cont.)

4) Motor Operation



Output	Direction 1	Direction 2
T1	On	Off
T2	Off	On
T3	Off	On
T4	On	Off

Table 90: DM455 connection examples (cont.)

6.2.7 Installation Notes

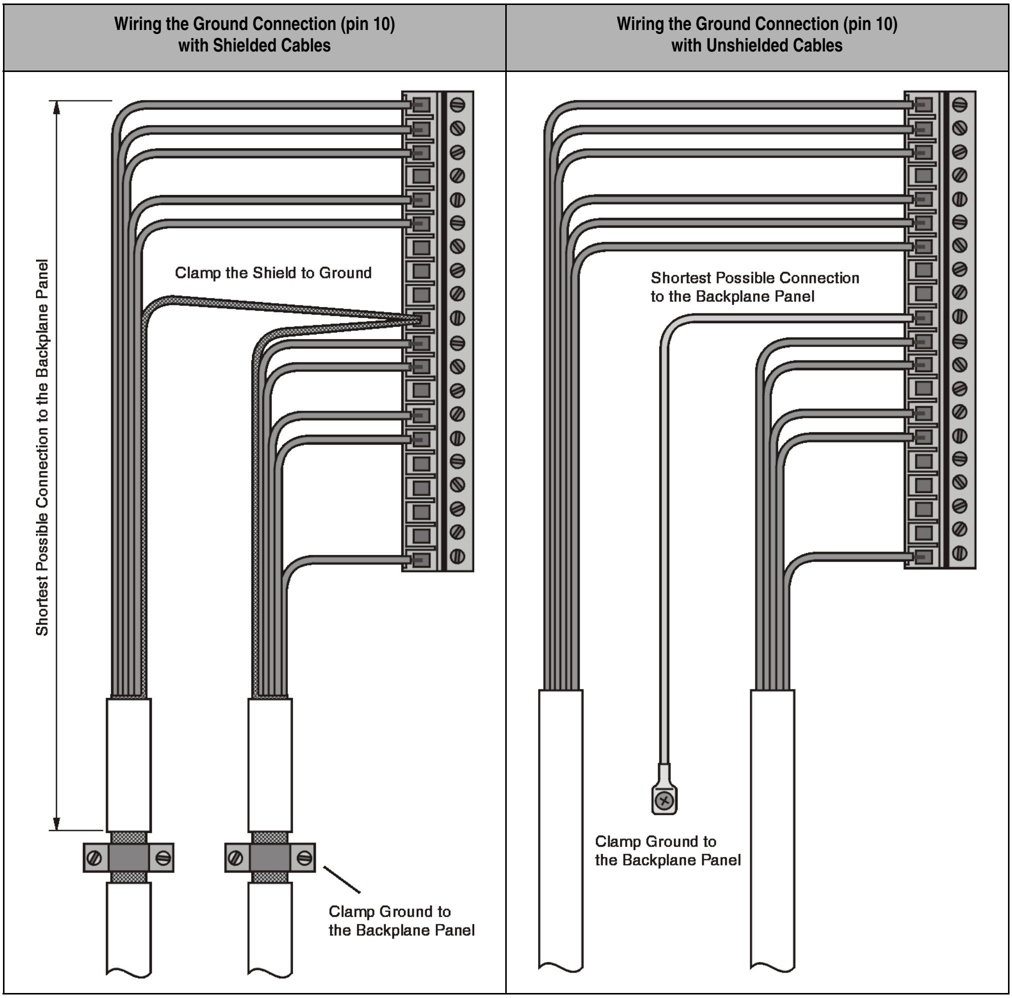


Figure 75: DM455 installation guidelines

6.2.8 Input Circuit Diagram

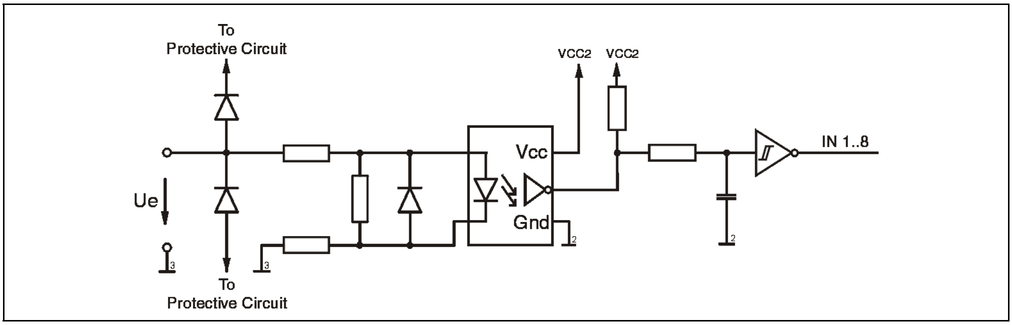


Figure 76: DM455 input circuit diagram

6.2.9 Output Circuit Diagram

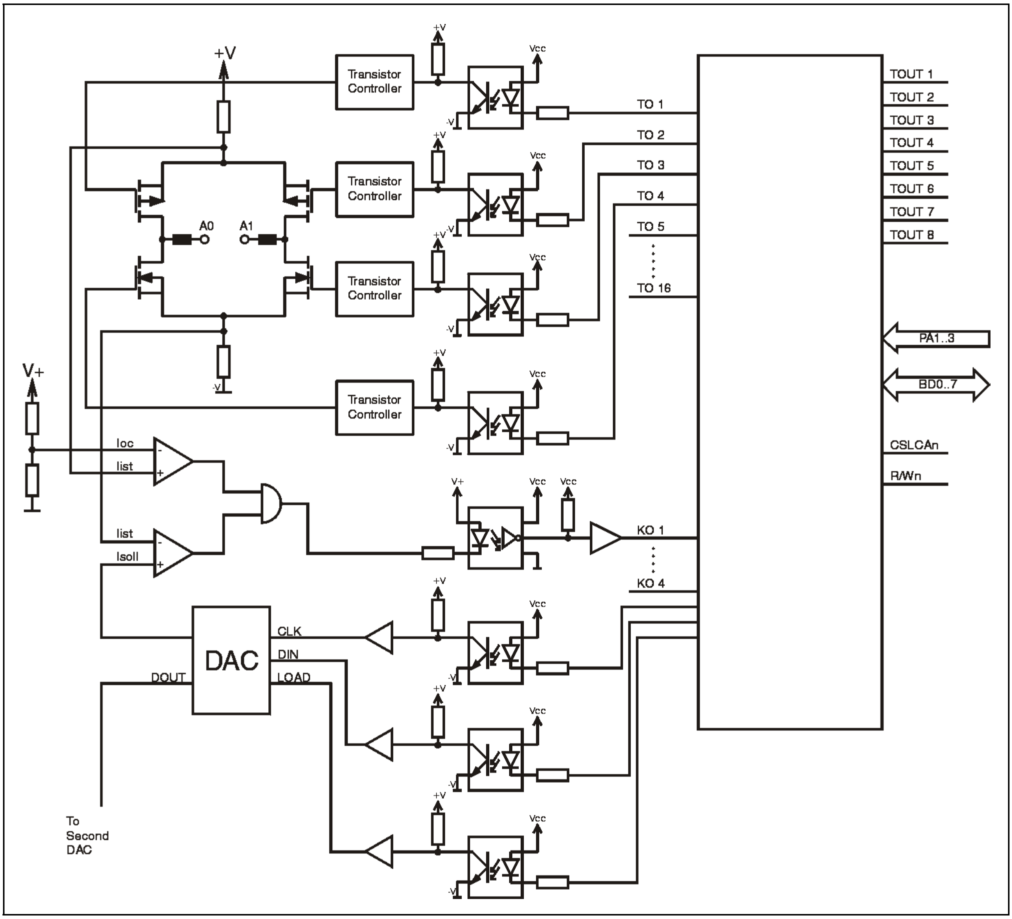


Figure 77: DM455 output circuit diagram

6.2.10 Detailed Description of Outputs

The DM455 is equipped with eight outputs. Two outputs are grouped together into one pair:

Pair	Outputs
1	1 + 2
2	3 + 4
3	5 + 6
4	7 + 8

Table 91: DM455 outputs

Operating Modes

The DM455 provides four operating modes which can be configured by the user using software.

Operating Mode	Description
Push	Switched to plus
Pull	Switched to GND
Push/Pull	Switched to plus and GND
Motor	Full-bridge

Table 92: DM455 operating modes

The first three operating modes are defined in pairs.

Example:

Pair	Outputs	Operating Mode
1	1 + 2	Push
2	3 + 4	Push
3	5 + 6	Pull
4	7 + 8	Push/Pull

Motor Operation

Up to two motors can be controlled using the DM455.

Motor	Outputs
1	1 - 4
2	5 - 8

Two outputs are required per motor windings.

Motor	Motor Windings	Outputs
1	1	1 + 2
	2	3 + 4
2	1	5 + 6
	2	7 + 8

A set current value can be given by the software for each motor.

Motor	Set Value
1	1
2	2

Configuration examples for motor operation.

Example 1:

Operating Mode	Outputs
Motor	1 - 4
Push	5 + 6
Pull	7 + 8

Example 2:

Operating Mode	Outputs
Push	1 + 2
Push/Pull	3 + 4
Motor	5 - 8

Example 3:

Operating Mode	Outputs
Motor 1	1 - 4
Motor 2	5 - 8

6.2.11 Maximum Permitted Load on the Motor Windings

The following diagram displays the maximum load on the motor windings depending on the power supply voltage and the switch off time.

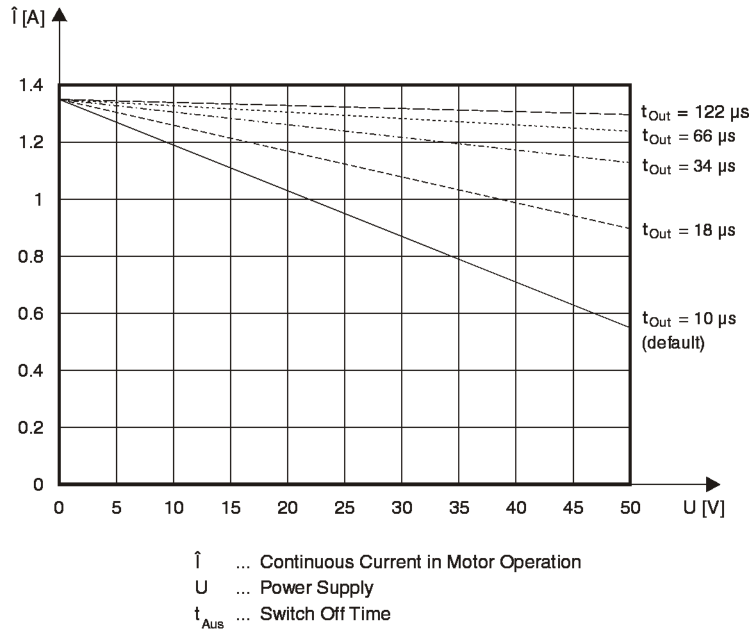


Figure 78: DM455 maximum permitted load on the motor windings

6.2.12 Current Surge Cutoffs

Push, Pull or Push/Pull Operation

Current surge cutoff occurs at 2.55 A (±15%).

Operation as a Motor Bridge Circuit

Each of the four motor bridge circuits monitors the current for the plus and minus supply. A short circuit message is given if the current exceeds 2.55 A (±15%).

6.2.13 Communication Memory

The communication memory can be freely defined by the user.

Division

USINT
USINT
USINT
USINT
UINT
UINT
UDINT
UDINT

7. Digital Input Modules

7.1 General Information

Digital input modules convert binary process signals into the internal signal level required by the PLC. The states of the digital inputs are shown with status LEDs.

The distinguishing features relevant for the input modules are:

- Number of Inputs
- Input voltage
- Input delay (filter)
- Special functions (e.g. counter inputs)

7.1.1 Input Filter

An input filter is available for each input. The input delay is shown in the technical data sections. Disturbance pulses which are shorter than input delay are suppressed by the input filter.

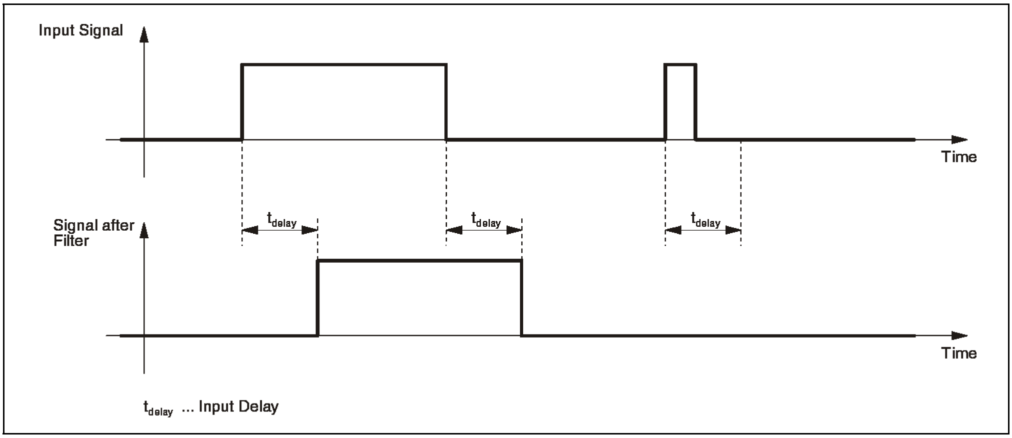


Figure 79: Input filter for digital input modules

7.1.2 Sink/Source Wiring

Most 24 VDC B&R SYSTEM 2005 input modules can be either wired as sink or source circuits. The inputs on a module are normally separated in electrically isolated groups of four inputs. Therefore individual group can also be wired differently.

- In a sink circuit (current consumer for the sensor), the COM connection for an input group is connected to signal ground and the inputs are connected to sensors that switch to 24 VDC.
- For source wiring (current supplier from the sensor's point of view), the COM connection of an input group is connected to +24 VDC, and the inputs are connected to GND switching sensors.

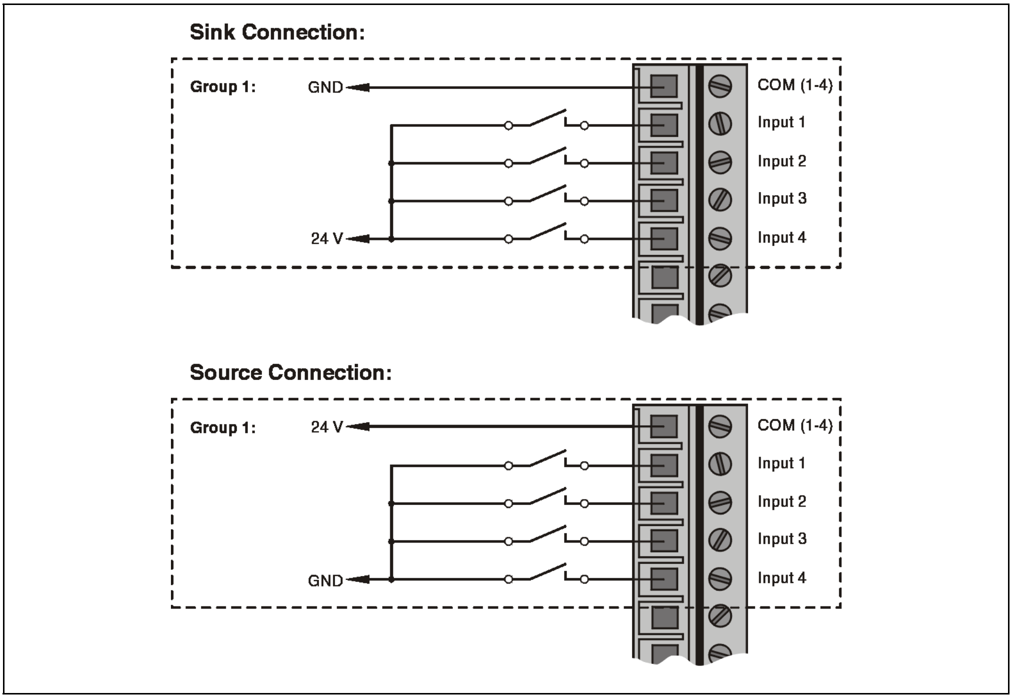


Figure 80: Digital input modules sink/source connections

7.1.3 Overview

Module	DI450	DI475	DI476	DI477	DI486	DI695
Number of Inputs	16	16	16	32	32	16
Input Voltage	24 VDC	24 VDC	24 VDC	24 VDC	24 VDC	120 / 230 VAC
Input Delay	1 ms (inputs 1 - 8) 10 ms (inputs 9 -16)	10 ms	1 ms	1 ms	1 ms	50 ms
Remarks	Input 1 - 4: Counter Inputs Input 5 - 6: Gate Measurement			Connection: DSUB connector	Connection: Terminal	

Table 93: Digital input module overview

Module	DI875
Number of Inputs	16 Namur inputs
Input Voltage	8.05 VDC
Switching Threshold Switching range Hysteresis	 1.2 mA to 2.1 mA Typ. ±100 µA
Input Delay	1 ms

Table 94: Digital input module overview (cont.)

7.1.4 Programming

The digital inputs are accessed directly in the application program using a variable name. The relationship between the input channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

7.2 DI450

7.2.1 General Information

The DI450 is equipped with the following functions:

- Standard digital inputs
- 4 Counter inputs
- 2 Channels for gate or period measurement

7.2.2 Order Data

Model Number	Short Description	Figure
3DI450.60-9	2005 digital input module, 16 inputs 24 VDC, 1 ms / 10 ms, sink or sink/source, 4 electrically isolated input groups, 4 counter inputs, 100 kHz, gate or period measurement. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 95: DI450 order data

7.2.3 Technical Data

Product ID	DI450
C-UL-US Listed	Yes
B&R ID Code	$08

Table 96: DI450 technical data

Product ID	DI450
Number of Inputs Total in 4 Groups of	 16 4
Type of Inputs Channels 1 -4 Channels 5 -6 Channels 7 - 16	 8-bit counter Gate, period measurement (starting with Rev. 30.00) Digital input
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes (optocoupler) Yes (optocoupler) No
Wiring Groups 1 + 2 (input 1 - 8) Groups 3 +4 (input 9 -16)	 Sink Sink or source
Input Voltage Nominal Maximum	 24 VDC 30 VDC
Input current at 24 VDC at 30 VDC	 Approx. 8 mA Approx. 10 mA
Input Resistance	2.8 kΩ
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Input Delay for inputs 1 - 8 Typical Max. for inputs 9 -16 Typical Max.	 1 ms 1.2 ms 10 ms 12 ms
Counter Inputs Inputs Counter Size Count Frequency	 1 - 4 8-bit (individual) 1) Max. 100 kHz
Gate Measurement Channels Gate Frequency Gate Pause	 5 and 6 Max. 10 kHz > 50 µs
Period Measurement (Rev. 30.00 and up) Channels Input Frequency	 5 and 6 Max. 10 kHz
Maximum Peak Voltage	500 V for 50 µs max. every 100 ms
Power Consumption 5 V 24 V Total	 Max. 2 W --- Max. 2 W
Dimensions	B&R 2005 single-width

Table 96: DI450 technical data (cont.)

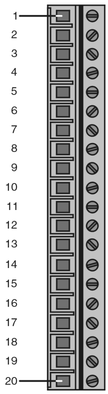
1) Counter inputs 1 and 2 as well as 3 and 4 can be linked together as a 16-bit counter.

7.2.4 Status LEDs

Figure	LED	Description
	1 - 16	The status LEDs indicate the logical status of the corresponding inputs. Regardless of the type connection (sink or source connection), the LED is lit if the input is logical 1, i.e. when the current flows through the optocoupler.

Table 97: DI450 status LEDs

7.2.5 Pin Assignments



TB170

Connection	Assignment			
1	COM (1-4)			
2	Input 1	Counter 1: 8-bit		
3	Input 2	Counter 2: 8-bit	Counter 1 and 2: 16-bit	Group 1
4	Input 3	Counter 3: 8-bit		
5	Input 4	Counter 4: 8-bit	Counter 3 and 4: 16-bit	
6	Input 5	Gate/Period Measurement Channel 2: 16-bit		
7	Input 6	Gate/Period Measurement Channel 4: 16-bit		
8	Input 7			Group 2
9	Input 8			
10	COM (5-8)			
11	COM (9-12)			
12	Input 9			
13	Input 10			Group 3
14	Input 11			
15	Input 12			
16	Input 13			
17	Input 14			
18	Input 15			Group 4
19	Input 16			
20	COM (13-16)			

Table 98: DI450 pin assignment

7.2.6 Pulse Measurement

Channels 1 to 4 can be used as 8-bit counter inputs (input frequency max. 100 kHz). Channel pairs 1 and 2 as well as 3 and 4 can be linked together as 16-bit counters. In this case, the counter inputs for the channel are 2 or 4.

The counters run continually. This means an overflow is not recognized. The application program can read the counter states and e.g. use the previous cycle value for the differential peak.

Reset / Enable

All counters are automatically reset and and then enabled with a hardware reset. The counter status is increased with every negative edge (change from logical 1 to logical 0) of the respective input.

A reset causes one or more counters to be set to zero. Counting begins after the counter is enabled again. Since the status out byte is only written to at the end of a task cycle, the reset and enable must be carried out in two different task cycles.

To avoid pulses from the configuration process, a reset of the effected counter is necessary after counter configuration.

Connection Examples for Pulse Measurement

Example 1: 8-bit counter for inputs 1 - 4

Configuration Register: $00

Pin Assignments:

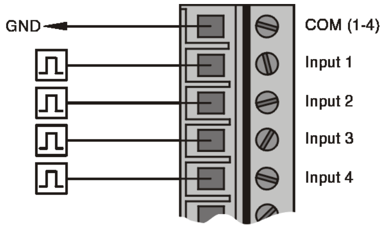


Figure 81: DI450 connection example 1 for pulse measurement

Example 2: 16-bit counter for inputs 2 and 4

Configuration Register: $03

Pin Assignments:

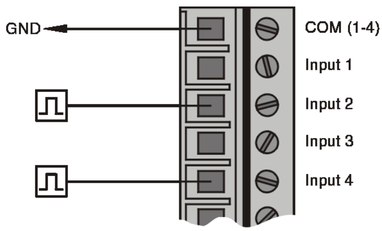


Figure 82: DI450 connection example 2 for pulse measurement

7.2.7 Gate Measurement

A signal connected to channel 5 or 6 can be evaluated using gate measurement. The resolution is 16-bit. The frequency of the signal to be measured can be a maximum of 10 kHz. The signal to be measured is also called the gate frequency. The pause between two gate measurements must be larger than 50 µs.

An internal or external counter frequency can be selected for the measurement. The setting is made with the configuration register.

- Internal counter frequency (31250 Hz or 4 MHz)
- External counter frequency (max. 100 kHz)

The external counter frequency is connected to inputs 2 (for counters 1/2) and 4 (for counters 3/4).

Gate Measurement Principle

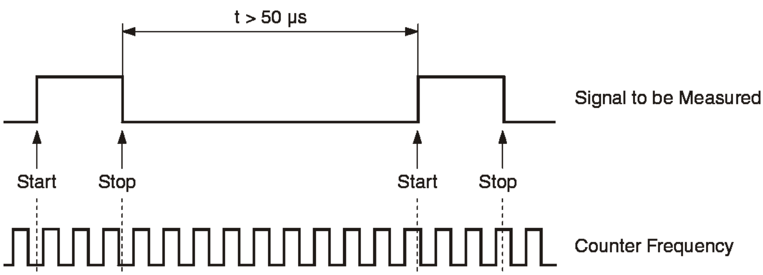


Figure 83: DI450 gate measurement principle

Pulse counting is started by a rising edge on the gate and stopped by a falling edge. The count is placed in a temporary register when the falling edge occurs. The counter is started again by the next rising edge.

During gate measurement, the count stored last (the gate) can be read by the active application program. The value in the temporary register is only updated after at the end of the active measurement (falling edge).

Mixed operation between pulse measurement and gate measurement is possible (see connection example 2).

Connection Example for Gate Measurement

Example 1: Gate measurement on channels 5 and 6.

An external frequency is used for measurement:

Channel 2: 100 kHz

Channel 4: 20 kHz

Configuration Register:

7							0	
0	0	1	0	1	0	1	1	= $2B

Pin Assignments

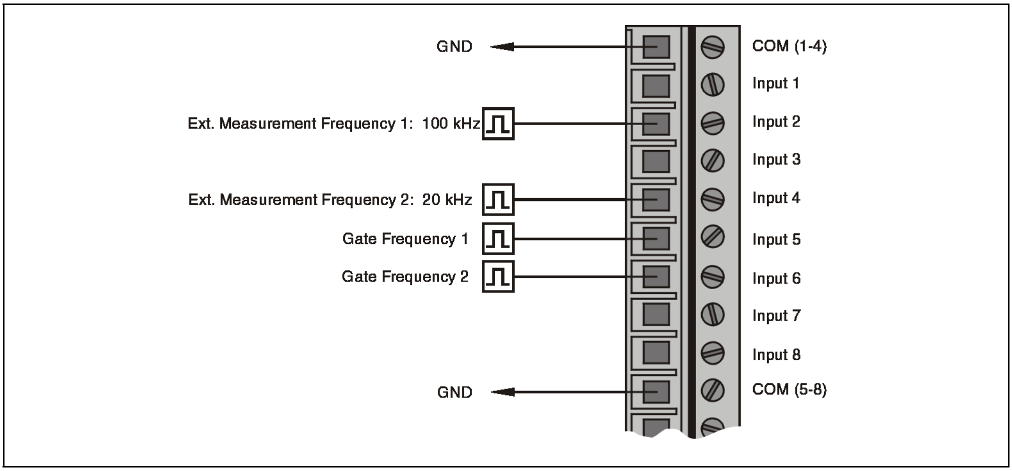


Figure 84: DI450 connection example 1 for gate measurement

Example 2: Pulse measurement with counters 1/2 (16-bit resolution).

Gate measurement on channel 6.

An external frequency is used for measurement (channel 4): 15 kHz

Configuration Register:

0	0	1	0	0	0	1	1	= $23
7							0	

Connection Example:

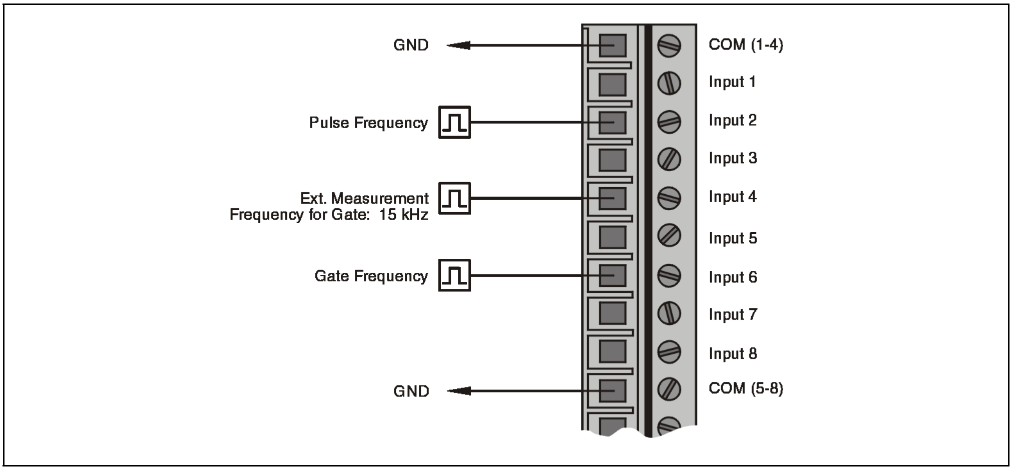


Figure 85: DI450 connection example 2 for gate measurement

7.2.8 Period Measurement

The period can be measured from a signal connected to channel 5, 6 or 7. The resolution is 16-bit. The frequency of the signal to be measured can be a maximum of 10 kHz.

An internal or external counter frequency can be selected for the measurement. The setting is made with the configuration register.

- Internal counter frequency (31250 Hz or 4 MHz)
- External counter frequency (max. 100 kHz)

The external counter frequency is connected to inputs 2 (for counters 1/2) and 4 (for counters 3/4).

Period Measurement Principle

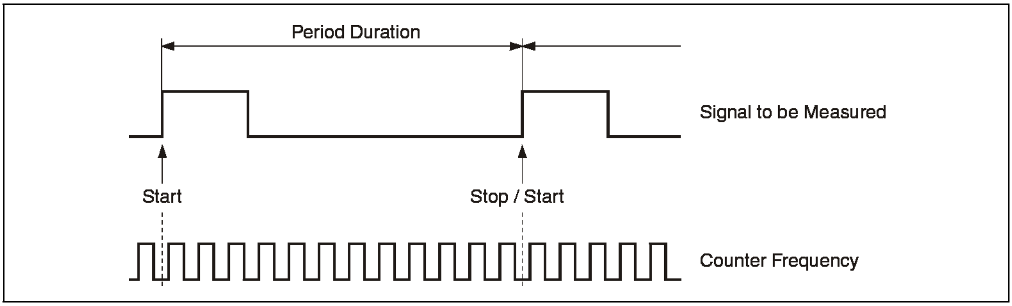


Figure 86: DI450 period measurement principle

Pulse counting is started by a high edge on the input and stopped by the next rising edge. The count is placed in a temporary register. The counter is started again by the same rising edge.

During period measurement, the count stored last (the period) can be read by the active application program. The value in the temporary register is only updated at the end of the active measurement.

Connection Example for Period Measurement

Period measurement on channels 5 and 6.

An external frequency is used for measurement:

Channel 2: 100 kHz

Channel 4: 20 kHz

Configuration Register:

1	0	1	0	1	0	1	1	= $AB
7							0	

Pin Assignments:

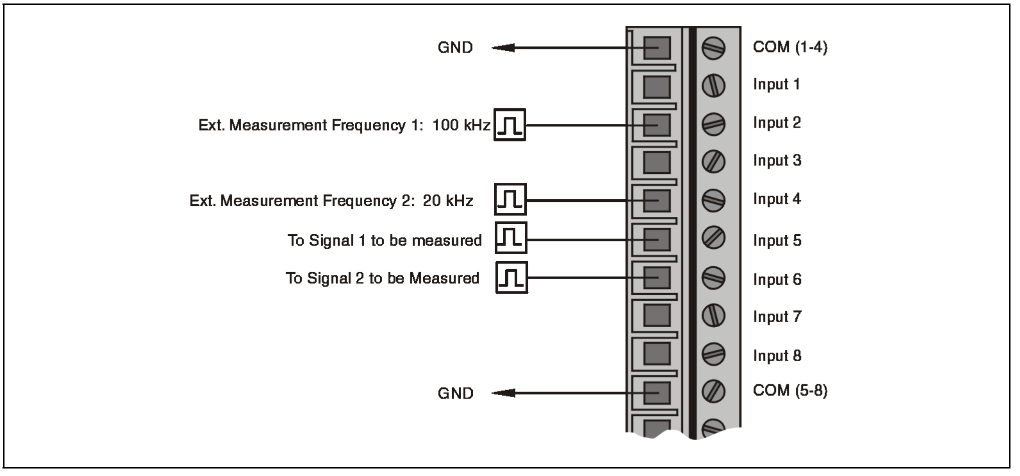


Figure 87: DI450 connection example for period measurement

7.2.9 Input Circuit Diagram

Inputs 1 - 6 (counter and gate inputs)

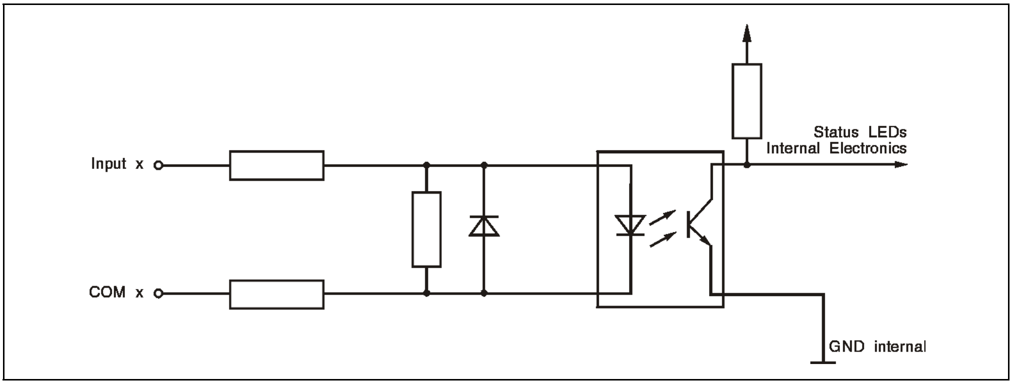


Figure 88: DI450 input circuit diagram for inputs 1 - 6 (counter and gate inputs)

Inputs 7 -16

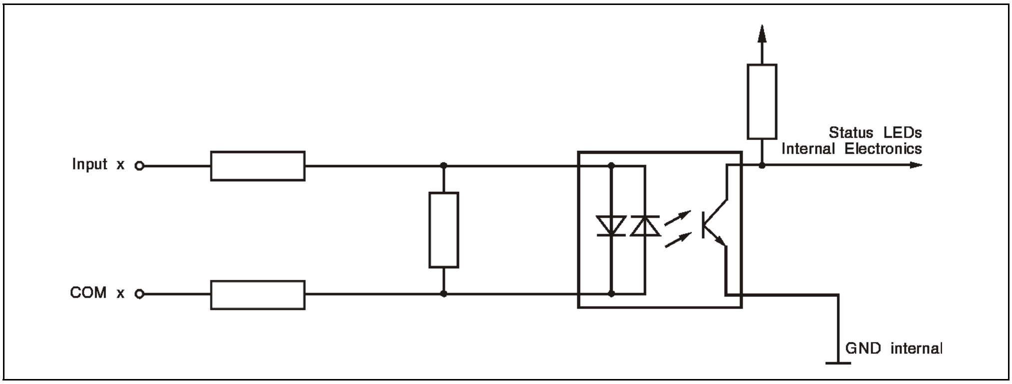


Figure 89: DI450 input circuit diagram for inputs 7 - 16

7.2.10 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function		Variable Declarations				
		Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)		tc_global	BOOL	1	Digit. In	1 ... 16
Read 8-bit counter (input 1 to 4):	Input 1	tc_global	USINT	1	Transp. In	4
	Input 2	tc_global	USINT	1	Transp. In	5
	Input 3	tc_global	USINT	1	Transp. In	6
	Input 4	tc_global	USINT	1	Transp. In	7
Read 16-bit counter (input 2 and 4):	Input 2[1)]	tc_global	UINT	1	Transp. In	4
	Input 4[1)]	tc_global	UINT	1	Transp. In	6
Resetting one or more counters by writing with $7F:	All counters	tc_global	USINT	1	Status Out	1
	Counters 1 and 2	tc_global	USINT	1	Status Out	2
	Counters 3 and 4	tc_global	USINT	1	Status Out	3
	Counter 1	tc_global	USINT	1	Status Out	4
	Counter 2	tc_global	USINT	1	Status Out	5
	Counter 3	tc_global	USINT	1	Status Out	6
	Counter 4	tc_global	USINT	1	Status Out	7
Enabling one or more counters by writing with $FF:	All counters	tc_global	USINT	1	Status Out	1
	Counters 1 and 2	tc_global	USINT	1	Status Out	2
	Counters 3 and 4	tc_global	USINT	1	Status Out	3
	Counter 1	tc_global	USINT	1	Status Out	4
	Counter 2	tc_global	USINT	1	Status Out	5
	Counter 3	tc_global	USINT	1	Status Out	6
	Counter 4	tc_global	USINT	1	Status Out	7
Counter configuration (see section "Configuration Register")		tc_global	USINT	1	Status Out	0

Table 99: DI450 variable declaration

1) If input 2/4 is used as a 16-bit counter, it is not possible to simultaneously use input 1/3 as an 8-bit counter.

All digital inputs can be read at any time regardless if an input is used as a counter.

Configuration Register

Configuration Reg.	Bit	Description	
	7	Period	- Period measurement
	6	Int C4	- Internal frequency for channel 4
	5	Gate C4	- Gate measurement for channel 4
	4	Int C2	- Internal frequency for channel 2
	3	Gate C2	- Gate measurement for channel 2
	2	4 MHz	- Internal 4 MHz
	1	Z1/2 16-bit	- Counter 1 and counter 2 16-bit resolution
	0	Z1/4 16-bit	- Counter 3 and counter 4 16-bit resolution

7 0

Period
0 ...... Pulse measurement and gate measurement
1 ...... Period measurement

Int C4
0 ...... External frequency for channel 4
1 ...... Internal frequency for channel 4

Gate C4
0 ...... Pulse measurement for channel 4
1 ...... Gate measurement or period measurement for channel 4

Int C2
0 ...... External frequency for channel 2
1 ...... Internal frequency for channel 2

Gate C2
0 ...... Pulse measurement for channel 2
1 ...... Gate measurement or period measurement for channel 2

4 MHz
0 ...... Internal 31250 Hz
1 ...... Internal 4 MHz

Z1/2 16-bit
0 ...... counter 1 and 2: 8-bit
1 ...... counter 1 and 2: 16-bit

Z3/4 16-bit
0 ...... counter 3 and 4: 8-bit
1 ...... counter 3 and 4: 16-bit

7.3 DI475 / DI476

7.3.1 General Information

The DI475 and DI476 are standard digital input modules.

7.3.2 Order Data

Model Number	Short Description	Figure
3DI475.6	2005 digital input module, 16 inputs 24 VDC, 10 ms, sink/source, 4 electrically isolated input groups. Order TB170 terminal blocks separately.	
3DI476.6	2005 digital input module, 16 inputs 24 VDC, 1 ms, sink/source, 4 electrically isolated input groups. Order TB170 terminal blocks separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 100: DI475 / DI476 order data

7.3.3 Technical Data

Product ID	DI475	DI476
C-UL-US Listed	Yes	Yes
B&R ID Code	$01	$07
Number of Inputs Total in 4 Groups of	 16 4	
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes (optocoupler) Yes (optocoupler) No	
Wiring	Sink or source	

Table 101: DI475 / DI476 technical data

Product ID	DI475	DI476
Input Voltage Nominal Maximum	 24 VDC 30 VDC	
Input Resistance	4.8 kΩ	
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V	
Input Delay Typical Maximum	 10 ms 12 ms	 1 ms 1.2 ms
Input Current at Nominal Voltage	Approx. 5 mA	
Maximum Peak Voltage	500 V for 50 µs max. every 100 ms	
Power Consumption 5 V 24 V Total	 Max. 1.5 W --- Max. 1.5 W	
Dimensions	B&R 2005 single-width	

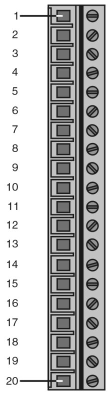
Table 101: DI475 / DI476 technical data (cont.)

7.3.4 Status LEDs

Figure	LED	Description
	1 - 16	The status LEDs indicate the logical status of the corresponding inputs. Regardless of the type connection (sink or source connection) the LED is lit, if the input is logical 1, i.e. when the current flows through the optocoupler.

Table 102: DI475 / DI476 status LEDs

7.3.5 Pin Assignments



TB170

Connection	Assignment	
1	COM (1-4)	Group 1
2	Input 1	
3	Input 2	
4	Input 3	
5	Input 4	
6	Input 5	Group 2
7	Input 6	
8	Input 7	
9	Input 8	
10	COM (5-8)	
11	COM (9-12)	Group 3
12	Input 9	
13	Input 10	
14	Input 11	
15	Input 12	
16	Input 13	Group 4
17	Input 14	
18	Input 15	
19	Input 16	
20	COM (13-16)	

Table 103: DI475 / DI476 pin assignments

7.3.6 Input Circuit Diagram

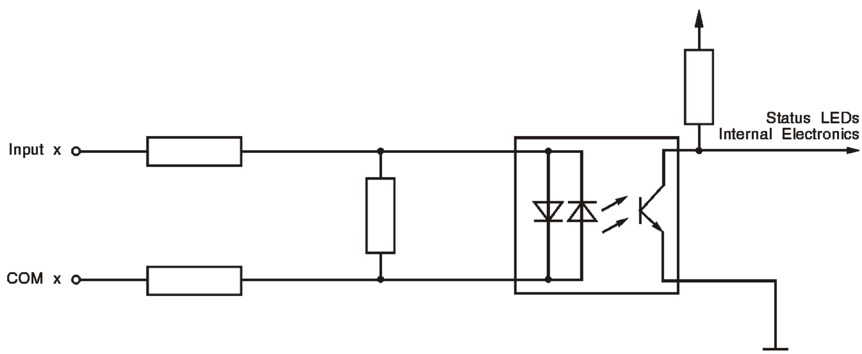


Figure 90: DI475 / DI476 input circuit diagram

7.3.7 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 16

Table 104: DI475 / DI476 variable declaration

7.4 DI477

7.4.1 General Information

The DI477 is a standard digital input module.

7.4.2 Order Data

Model Number	Short Description	Figure
3DI477.6	2005 digital input module, 32 inputs 24 VDC, 1 ms, sink/source, 8 electrically isolated input groups	
Connection made using DSUB connector.		

Table 105: DI477 order data

7.4.3 Technical Data

Product ID	DI477
C-UL-US Listed	Yes
B&R ID Code	$05
Number of Inputs Total in 8 Groups of	 32 4
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes (optocoupler) Yes (optocoupler) No
Wiring	Sink or source

Table 106: DI477 technical data

Product ID	DI477
Input Voltage Nominal Maximum	 24 VDC 30 VDC
Input Resistance	4.8 kΩ
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Input Delay Typical Maximum	 1 ms 1.2 ms
Input Current at Nominal Voltage	Approx. 5 mA
Maximum Peak Voltage	500 V for 50 µs max. every 100 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W --- Max. 1.5 W
Dimensions	B&R 2005 single-width

Table 106: DI477 technical data (cont.)

7.4.4 Status LEDs

Figure	LED	Description
	1 - 32	The status LEDs indicate the logical status of the corresponding inputs. Regardless of the type connection (sink or source connection), the LED is lit if the input is logical 1, i.e. when the current flows through the optocoupler.

Table 107: DI477 status LEDs

7.4.5 Connection Elements

Since the DI477 module has 32 digital inputs and B&R 2005 controller terminal blocks are only 20-pin, two 25-pin DSUB sockets are built into the module.

The connection for the DSUB socket is made using two 25-pin DSUB connectors. Due to space restrictions it is necessary to use crimp connectors and rolled ribbon cable for the connection.

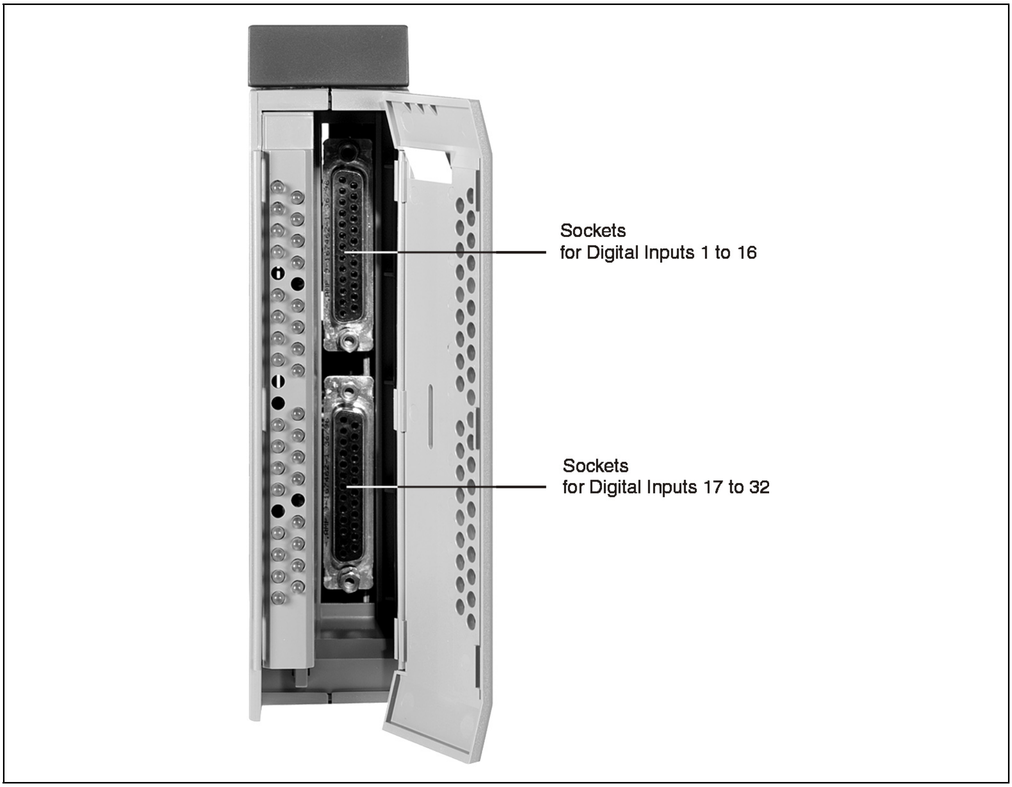
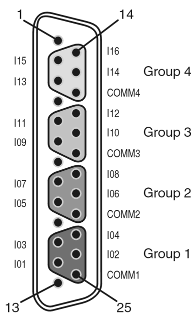


Figure 91: DI477 connection elements

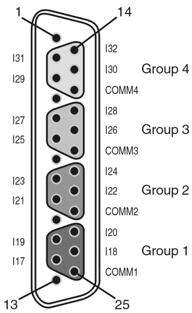
7.4.6 Pin Assignments for DSUB Sockets

With these pin assignments, a COM line and the lines for the four inputs that belong to it are located beside each other for this ribbon cable. Therefore, it is possible to split the ribbon cable and run electrically isolated groups for external connection. For an external contact, terminal blocks can be used with a 1:1 conversion DSUB ↔ connector (e.g. from Phoenix).



Upper 25-pin DSUB Socket	Pin	Assignment	Group
	1	---	
	2	Input 15	4
	3	Input 13	4
	4	---	
	5	Input 11	3
	6	Input 9	3
	7	---	
	8	Input 7	2
	9	Input 5	2
	10	---	
	11	Input 3	1
	12	Input 1	1
	13	---	
	14	Input 16	4
	15	Input 14	4
	16	COM (13-16)	4
	17	Input 12	3
	18	Input 10	3
	19	COM (9-12)	3
	20	Input 8	2
	21	Input 6	2
	22	COM (5-8)	2
	23	Input 4	1
	24	Input 2	1
	25	COM (1-4)	1

Table 108: DI477 pin connections for the upper 25-pin DSUB socket



Lower 25-pin DSUB Socket	Pin	Assignment	Group
	1	---	
	2	Input 31	4
	3	Input 29	4
	4	---	
	5	Input 27	3
	6	Input 25	3
	7	---	
	8	Input 23	2
	9	Input 21	2
	10	---	
	11	Input 19	1
	12	Input 17	1
	13	---	
	14	Input 32	4
	15	Input 30	4
	16	COM (29-32)	4
	17	Input 28	3
	18	Input 26	3
	19	COM (25-28)	3
	20	Input 24	2
	21	Input 22	2
	22	COM (21-24)	2
	23	Input 20	1
	24	Input 18	1
	25	COM (17-20)	1

Table 109: DI477 pin connections for the lower 25-pin DSUB socket

7.4.7 Input Circuit Diagram

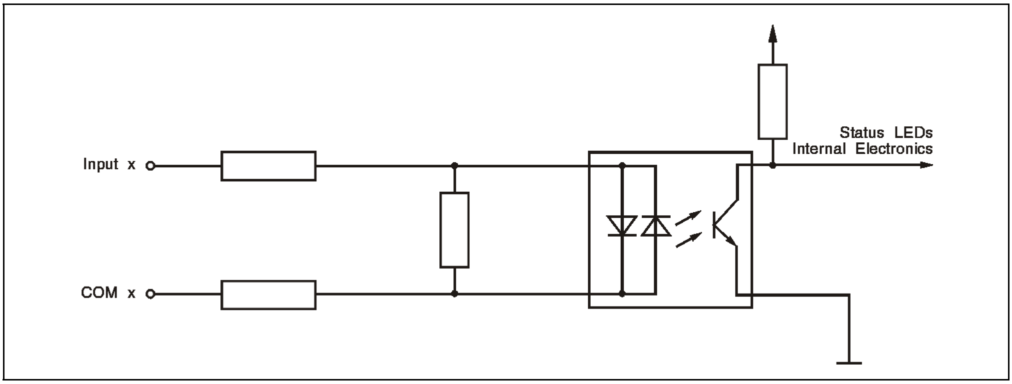


Figure 92: DI477 input circuit diagram

7.4.8 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 32

Table 110: DI477 variable declaration

7.5 DI486

7.5.1 General Information

The DI486 is a standard digital input module. It offers very high component density using standard 3.5 mm terminal blocks.

7.5.2 Order Data

Model Number	Short Description	Figure
3DI486.6	2005 digital input module, 32 inputs 24 VDC, 1 ms, sink/source, 2 electrically isolated input groups. Order 2 x TB718 terminal blocks separately!	
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	
Terminal blocks are not included in the delivery (see "General Accessories").		

Table 111: DI486 order data

7.5.3 Technical Data

Product ID	DI486
C-UL-US Listed	Yes
B&R ID Code	$09
Number of Inputs Total in 2 Groups of	 32 16
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes (optocoupler) Yes (optocoupler) No
Wiring	Sink or source
Input Voltage Nominal Maximum	 24 VDC 30 VDC
Input Resistance	6 kΩ
Switching Threshold LOW Range Switching Range HIGH Range	 < 5 V 5 to 15 V > 15 V
Input Delay Typical Maximum	 0.5 ms 1 ms
Input Current at Nominal Voltage	Approx. 4 mA
Maximum Peak Voltage	500 V for 50 μs max. every 100 ms
Power Consumption 5 V 24 V Total	 Max. 1.2 W --- Max. 1.2 W
Dimensions	B&R 2005 single-width

Table 112: DI486 technical data

7.5.4 Status LEDs

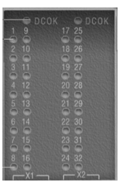
Figure	LED	Description
	DCOK	The DCOK LED is controlled by the respective input supply and is lit if the supply voltage is over +18 VDC.
	1 - 32	Input state of the corresponding digital inputs.

Table 113: DI486 status LEDs

7.5.5 Connection Elements

Two 18-pin terminal blocks are located next to each other in the lower part of the housing so that all signals can be connected using terminal blocks.

The TB718 terminal blocks are available with screw and cage clamps.

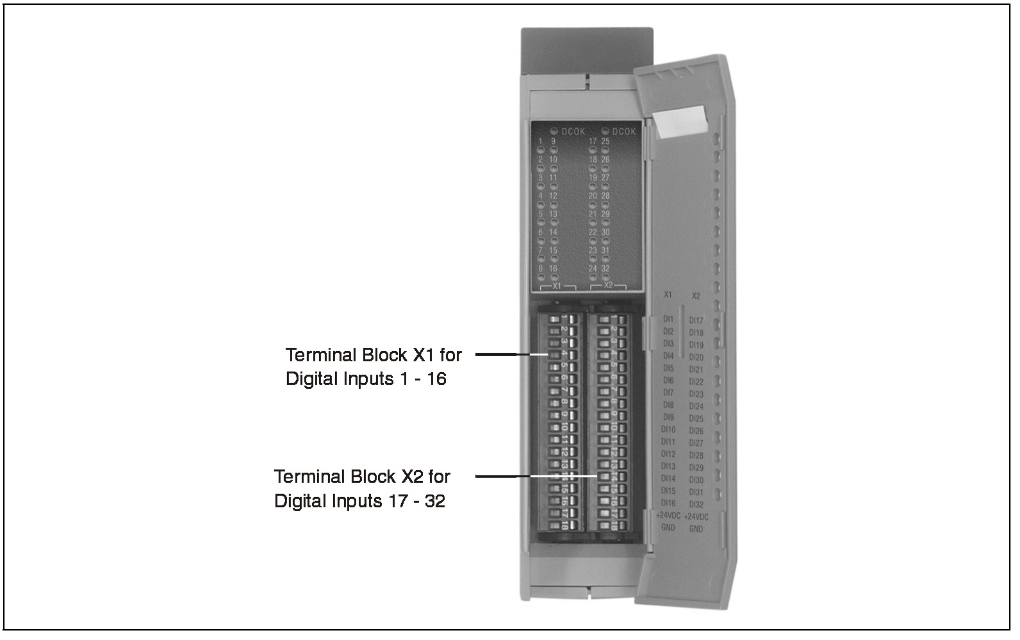


Figure 93: DI486 Connection Elements

7.5.6 Pin Assignments

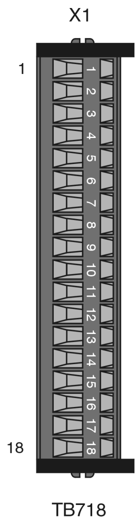
Left 18-pin Terminal Block	Connection	Assignment	Group
	1	Input 1	1
	2	Input 2	
	3	Input 3	
	4	Input 4	
	5	Input 5	
	6	Input 6	
	7	Input 7	
	8	Input 8	
	9	Input 9	
	10	Input 10	
	11	Input 11	
	12	Input 12	
	13	Input 13	
	14	Input 14	
	15	Input 15	
	16	Input 16	
	17	COMs (+24 VDC in sink operation)	
	18	COM (GND in sink operation)	

Table 114: DI486 pin assignment for terminal block X1

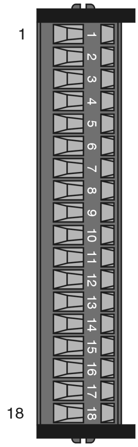
Right 18-pin Terminal Block	Connection	Assignment	Group
X2  TB718	1	Input 17	2
	2	Input 18	
	3	Input 19	
	4	Input 20	
	5	Input 21	
	6	Input 22	
	7	Input 23	
	8	Input 24	
	9	Input 25	
	10	Input 26	
	11	Input 27	
	12	Input 28	
	13	Input 29	
	14	Input 30	
	15	Input 31	
	16	Input 32	
	17	COMs (+24 VDC in sink operation)	
	18	COM (GND in sink operation)	

Table 115: DI486 pin assignment for terminal block X2

7.5.7 Input Circuit Diagram

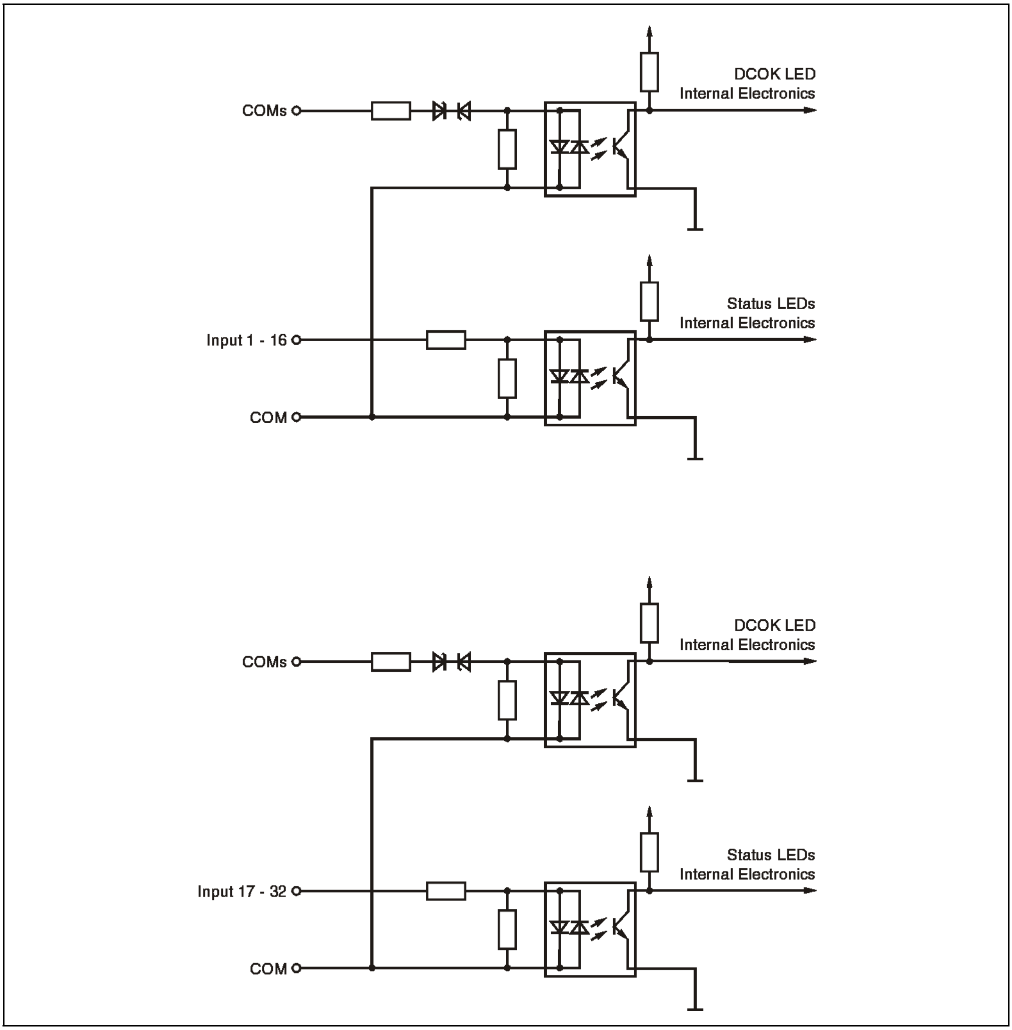


Figure 94: DI486 input circuit diagram

7.5.8 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 32
Status Register	tc_global	USINT	1	Status In	0

Table 116: DI486 variable declaration

Status Register

Status Register	Bit	Description
	7	DCOK - Supply voltage in the valid range
	6	x
	5	x
	4	x
	3	x
	2	x
	1	x
	0	x

| x | x | x | x | x | x | x

7 0

DCOK 0...... No supply voltage or supply voltage too low for digital inputs
1...... Supply voltage in the valid range

7.6 DI695

7.6.1 General Information

The DI695 is a standard digital input module.

7.6.2 Order Data

Model Number	Short Description	Figure
3DI695.6	2005 digital input module, 16 inputs 120/230 VAC, 50 ms, 2 electrically isolated input groups, Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 117: DI695 order data

7.6.3 Technical Data

Product ID	DI695
General Information	
C-UL-US Listed	Yes
B&R ID Code	$B2
Can be Installed on Main Rack Expansion Rack	 Yes Yes

Table 118: DI695 technical data

Product ID	DI695
Static Characteristics	
Module Type	B&R 2005 I/O module
Number of Inputs	16
Maximum Peak Voltage	264 VAC
Rated Voltage	120 / 230 VAC
Rated Frequency	50 / 60 Hz
Connections (Sink/Source)	--- (AC input module)
Limit Values 0-Signal UL 0-Signal IL 1-Signal UH 1-Signal IH	 Max. 40 VAC Max. 15 mA Min. 79 VAC Min. 2 mA
Delay 0 to 1	Max. 50 ms
Delay 1 to 0	Max. 50 ms
Power Consumption Internal 5 V 24 V Total external	 Max. 1.5 W --- Max. 1.5 W Max. 4 W
Additional Characteristics	
Status Displays for Inputs	1 green LED per channel
Operating Characteristics	
Consequences of Incorrect Input Connections	No effects on the module
Isolation Voltage under Normal Operating Conditions between Channel and Bus Group 1 - Group 2	 2500 VAC 500 VAC
Tapping Point and Binary Status of Visual Displays	PLC in logic part
Consequences of Removing/Inserting Input Modules with Voltage Applied	No effects on the module
Additional Exterior Load when Inputs and Outputs are Switched Together (if required)	Additional load depending on leakage current for the corresponding outputs
Explanation of Signal Evaluation	AC voltage travels to the optocoupler via an RC combination. Evaluation is carried out every second with a comparator using a filter circuit. Further signal processing in the digital section.
Typical Example for External Connections	COM connection to neutral, input to switch phase
Different Circuits Possible	Yes (but not different phases)
Mechanical characteristics	
Dimensions	B&R 2005 single-width
Terminal Layout	See Section 7.6.5 "Pin Assignments", on page 236

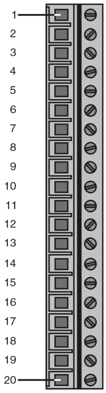
Table 118: DI695 technical data (cont.)

7.6.4 Status LEDs

Figure	LED	Description
	1 - 16	The status LEDs indicate the logical status of the corresponding inputs. The LED is lit when the input is log. 1, i.e. when the current flows through the optocoupler.

Table 119: DI695 status LEDs

7.6.5 Pin Assignments



TB170

Connection	Assignment	
1	---	Group 1
2	Input 1	
3	Input 2	
4	Input 3	
5	Input 4	
6	Input 5	
7	Input 6	
8	Input 7	
9	Input 8	
10	COM (1-8)	
11	COM (9-16)	Group 2
12	Input 9	
13	Input 10	
14	Input 11	
15	Input 12	
16	Input 13	
17	Input 14	
18	Input 15	
19	Input 16	
20	---	

Table 120: DI695 pin assignment

The connections COM (1 - 8) and COM (9 - 16) are not permitted to be used with the different phases (L1, L2, L3).

7.6.6 Input Circuit Diagram

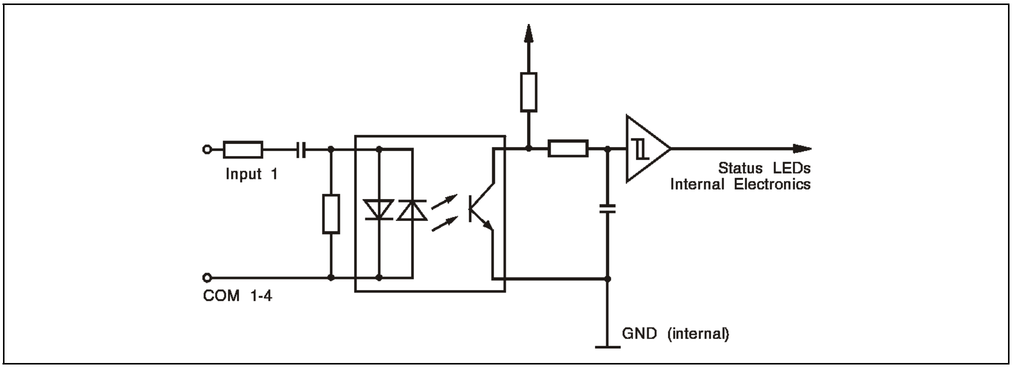


Figure 95: DI695 input circuit diagram

7.6.7 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 16

Table 121: DI695 variable declaration

7.7 DI875

7.7.1 General Information

The DI875 module is used to transfer digital signals from Namur encoders according to EN 60947-5-6.

In addition to Namur encoders normal switches can also be used.

7.7.2 Examples of Possible Encoders

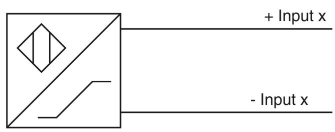
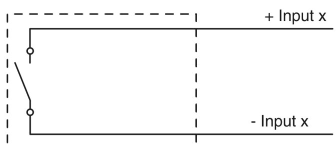
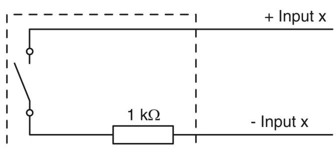
Proximity Switch	
Switch according to EN 60947-5-6 (Namur)	
Mechanical Contacts (instead of Namur encoders)	
Without open line recognition and without short circuit recognition	
Without open line recognition and with short circuit recognition	

Table 122: DI875 Examples of possible encoders

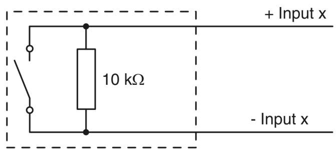
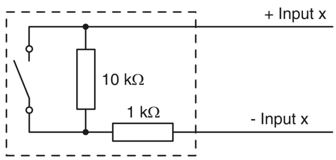
Mechanical Contacts (instead of Namur encoders)	
With open line recognition and without short circuit recognition	
With open line recognition and with short circuit recognition	

Table 122: DI875 Examples of possible encoders (cont.)

7.7.3 Order Data

Model Number	Short Description	Figure
3DI875.6	2005 digital input module, 16 Namur inputs, 8.05 VDC, 2 electrically isolated input groups. Order 2 x TB718 terminal blocks separately.	

Table 123: DI875 order data

7.7.4 Technical Data

Product ID	DI875
General Information	
C-UL-US Listed	In preparation
B&R ID Code	$B4
Can be Installed on Main Rack Expansion Rack	 Yes Yes
Static Characteristics	
Module Type	B&R 2005 I/O module
Number of Inputs Total in 2 Groups of	 16 8
No Load Voltage	8.05 V ±5%
Internal Resistance	Approx. 1 kΩ
Open Line Detection	<200 µA
Short Circuit Recognition	> 7 mA
Maximum short circuit current	< 9 mA
Switching Threshold Switching range Hysteresis	 1.2 mA to 2.1 mA Typ. ±100 µA
Delay 0 to 1	Max. 1 ms
Delay 1 to 0	Max. 1 ms
Power Consumption 5 V 24 V Total	 Max. 1.3 W Max. 4.8 W Max. 6.1 W
Operating Characteristics	
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes Yes No
Mechanical Characteristics	
Dimensions	B&R 2005 single-width
Terminal Layout	See 7.7.7 "Pin Assignments", on page 242

Table 124: DI875 technical data

7.7.5 Status LEDs

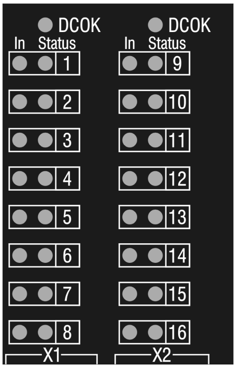
Figure	LED	Description
	2 x DCOK	The orange DCOK LED is lit when there is a Namur supply voltage of 8 VDC (supply for Namur encoder).
	16 x green	Input state of the corresponding digital inputs.
	16 x Dual LED	Operating status for the corresponding digital inputs.
		Status — **Description**
		Not lit — Normal Operation
		Red blinking — Open line recognition for the respective input
		Red lit — Short circuit recognition for the respective input

Table 125: DI875 status LEDs

7.7.6 Connection Elements

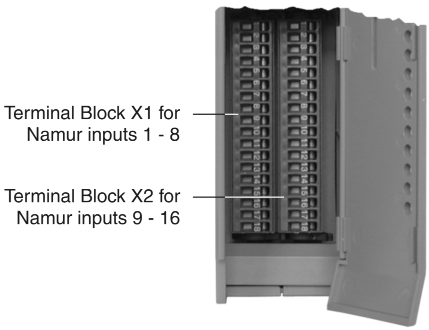


Figure 96: DI875 connection elements

7.7.7 Pin Assignments

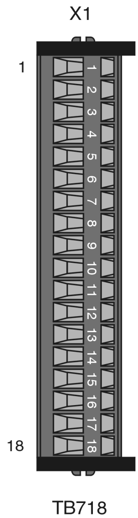
Left 18-pin Terminal Block	Pin	Assignment	Group
	1	+ Input 1	1
	2	- Input 1	
	3	+ input 2	
	4	- Input 2	
	5	+ Input 3	
	6	- Input 3	
	7	+ Input 4	
	8	- Input 4	
	9	+ Input 5	
	10	- Input 5	
	11	+ Input 6	
	12	- Input 6	
	13	+ Input 7	
	14	- Input 7	
	15	+ Input 8	
	16	- Input 8	
	17	NC	
	18	NC	

Table 126: DI875 pin assignments for terminal block X1

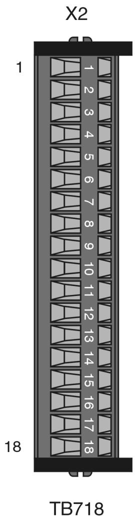
Right 18-pin Terminal Block	Pin	Assignment	Group
	1	+ Input 9	2
	2	- Input 9	
	3	+ input 10	
	4	- Input 10	
	5	+ Input 11	
	6	- Input 11	
	7	+ Input 12	
	8	- Input 12	
	9	+ Input 13	
	10	- Input 13	
	11	+ Input 14	
	12	- Input 14	
	13	+ Input 15	
	14	- Input 15	
	15	+ Input 16	
	16	- Input 16	
	17	NC	
	18	NC	

Table 127: DI875 pin assignment for terminal block X2

7.7.8 Input Circuit Diagram

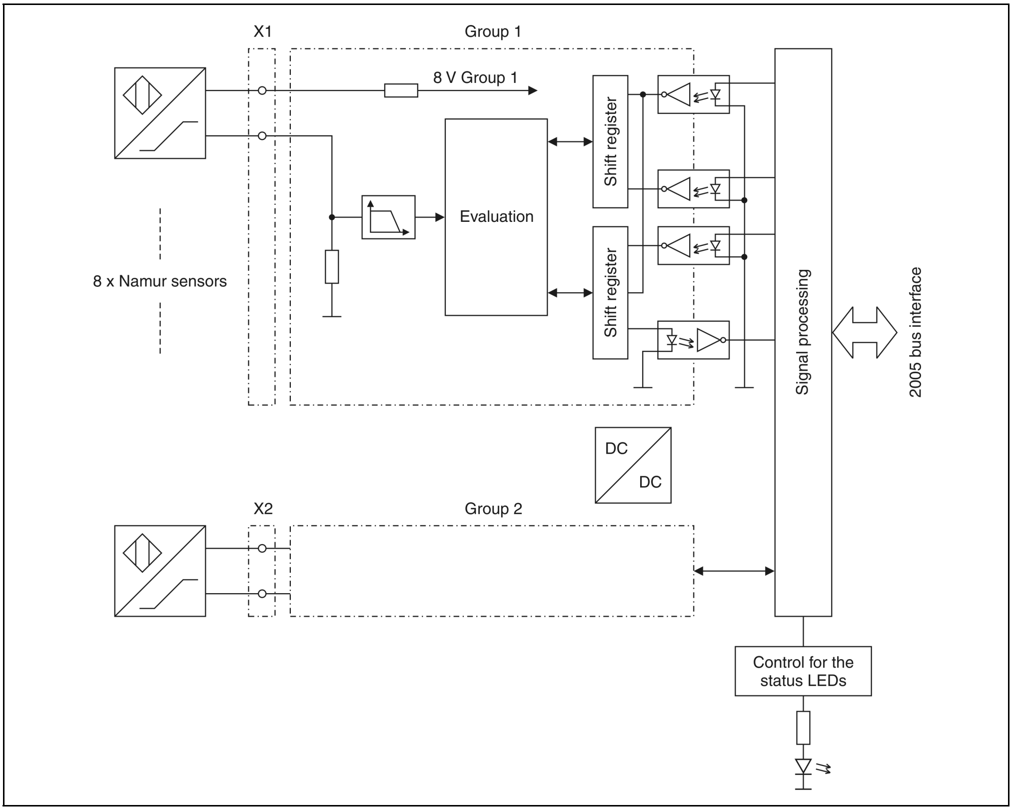


Figure 97: DI875 input circuit diagram

7.7.9 Variable Declarations

B&R Automation Studio™ Support: See B&R Automation Studio™ Help starting with V1.40.

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 16
Read open line registers 1 - 8	tc_global	USINT	1	Status In	0
Read open line registers 9 -16	tc_global	USINT	1	Status In	1
Read short circuit registers 1 - 8	tc_global	USINT	1	Status In	2
Read short circuit registers 9 -16	tc_global	USINT	1	Status In	3

Table 128: DI875 variable declaration

Open Line Register (read)

Legend: No ..... No open line
Yes ... Open line

Bit	Chan.	Status	Description
0	1	0	No
		1	Yes
1	2	0	No
		1	Yes
2	3	0	No
		1	Yes
3	4	0	No
		1	Yes
4	5	0	No
		1	Yes
5	6	0	No
		1	Yes
6	7	0	No
		1	Yes
7	8	0	No
		1	Yes
8	9	0	No
		1	Yes
9	10	0	No
		1	Yes
10	11	0	No
		1	Yes
11	12	0	No
		1	Yes
12	13	0	No
		1	Yes
13	14	0	No
		1	Yes
14	15	0	No
		1	Yes
15	16	0	No
		1	Yes

Table 129: DI875 open line register (read)

Short Circuit Register (read)

Legend: No ..... No short circuit
Yes ... Short circuit

Bit	Chan.	Status	Description
0	1	0	No
		1	Yes
1	2	0	No
		1	Yes
2	3	0	No
		1	Yes
3	4	0	No
		1	Yes
4	5	0	No
		1	Yes
5	6	0	No
		1	Yes
6	7	0	No
		1	Yes
7	8	0	No
		1	Yes
8	9	0	No
		1	Yes
9	10	0	No
		1	Yes
10	11	0	No
		1	Yes
11	12	0	No
		1	Yes
12	13	0	No
		1	Yes
13	14	0	No
		1	Yes
14	15	0	No
		1	Yes
15	16	0	No
		1	Yes

Table 130: DI875 short circuit register (read)

8. Digital Output Modules

8.1 General Information

Digital output modules are used to control external loads (relays, motors, solenoids). The states of the digital outputs are indicated by status LEDs.

The distinguishing features relevant for output modules are:

- Number of Outputs
- Type (relays, transistors, triacs)
- Switching Voltage
- Continuous Current

8.1.1 Protective Circuit

The transistor output modules DO479 and DO480 have overload protection and an internal protective circuit for overload peaks or reverse polarity. The braking voltage allows fast switching of inductive loads without external inverse diodes.

Relays and triac output modules have external overload protection (fuse).

8.1.2 Overview

Module	DO479	DO480	DO486	
Number of Outputs	16	16	32	
Design	Transistor	Transistor	FET positive switching	
Switching Voltage Minimum Nominal Maximum	 19.5 VDC 24 VDC 30 VDC	 0 VDC 24 VDC 48 VDC	 18 VDC 24 VDC 30 VDC	
Continuous Current per Output Group Module	 Max. 0.5 A Max. 4 A Max. 8 A	 Max. 2 A Max. 12 A Max. 24 A	Rev. <E0 Max. 0.5 A Max. 6 A Max. 12 A	Rev. ≥E0 Max. 0.5 A Max. 8 A Max. 16 A

Table 131: Overview of digital output modules

Module	DO650	DO690	DO750	DO760
Number of Outputs	16	8	8	8
Design	Relay	Triac	Relay	Relay
Switching Voltage Minimum Nominal Maximum	 120 VAC / 24 VDC 144 VAC / 30 VDC	 30 VAC 120 VAC 144 VAC	 230 VAC / 24 VDC 250 VAC / 30 VDC	 30 VDC / 240 VAC 125 VDC / 264 VAC
Continuous Current per Output Group Module	 Max. 2 A Max. 8 A Max. 32 A	 Max. 1 A Max. 2 A Max. 4 A	 Max. 3 A Max. 8 A Max. 16 A	 Max. 4 A Max. 32 A

Table 132: Overview of digital output modules

8.1.3 Programming

The digital outputs are accessed directly in the application program using a variable name. The relationship between the output channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

8.2 DO479

8.2.1 General Information

The DO479 is a standard digital output module.

8.2.2 Order Data

Model Number	Short Description	Image
3DO479.6	2005 digital output module, 16 transistor outputs 24 VDC, 0.5 A, 2 electrically isolated output groups. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 133: DO479 order data

8.2.3 Technical Data

Product ID	DO479
C-UL-US Listed	Yes
B&R ID Code	$40
Number of Outputs Total in 2 Groups of	 16 8
Design	Transistor

Table 134: DO479 technical data

Product ID	DO479
Electrical Isolation Output - PLC Group - Group Output - Output	 Yes Yes No
Switching Voltage Minimum Nominal Maximum	 19.5 VDC 24 VDC 30 VDC
Continuous Current per Output Group Module	 Max. 0.5 A Max. 4 A Max. 8 A
Leakage Current when Switched Off	0.3 mA
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Typ. 5 µs / max. 110 µs Typ. 60 µs / max. 100 µs
Switching Frequency (resistive load)	Max. 500 Hz
Overload Protection	Yes
Switching On after Overload Cutoff	Automatically after approx. 5 s
Short Circuit Current	0.75 to 1.5 A
Protective Circuit Internal External	 Yes Only if necessary (surge)
Braking Voltage when Switching Off Inductive Loads	45 to 55 V
Power Consumption Internal 5 V 24 V Total Terminal Side at 24 V	 Max. 1 W --- Max. 1 W Max. 2 W per Group
Dimensions	B&R 2005 single-width

Table 134: DO479 technical data (cont.)

8.2.4 Status LEDs

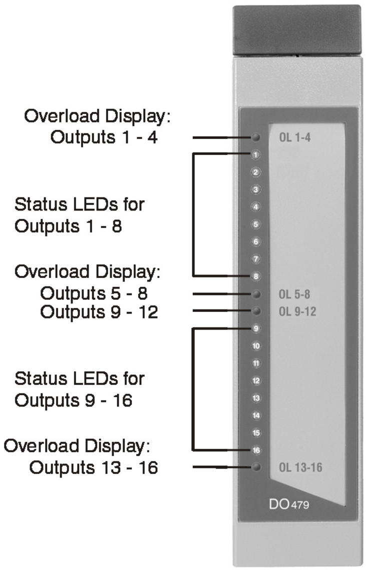
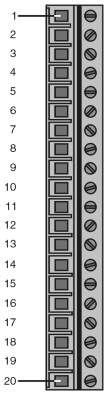
Image	LED	Description
	1 - 16	The status LEDs indicate the logical status of the corresponding outputs.
	OL x-y	The LEDs OL x-y (overload) indicate that the overload or short circuit cutoff has been activated for the respective LED group. If e. g. the OL 1-4 LED is lit, it means that a transistor (output 1, 2, 3 or 4) has been switched off (for more information see Section 8.2.7 "Overload Protection", on page 254).

Table 135: DO479 status LEDs

8.2.5 Pin Assignments



TB170

Connection	Assignment	
1	+24 V supply for inputs 1 - 8	Group 1
2	Output 1	
3	Output 2	
4	Output 3	
5	Output 4	
6	Output 5	
7	Output 6	
8	Output 7	
9	Output 8	
10	GND for output 1 - 8	
11	GND for output 9 -16	Group 2
12	Output 9	
13	Output 10	
14	Output 11	
15	Output 12	
16	Output 13	
17	Output 14	
18	Output 15	
19	Output 16	
20	+24 V supply for inputs 9 -16	

Table 136: DO479 pin assignment

When connecting the terminal block, it is important to ensure that any potential difference does not exceed 50 V. This is valid for:

Potential Difference <50 V
Group ↔ Group
+24 V connection ↔ PLC ground
+24 V connection ↔ ground

Table 137: DO479 the potential difference must be smaller than 50 V

Both electrically isolated groups can also be supplied by 2 separate 24 V sources.

Connection Example

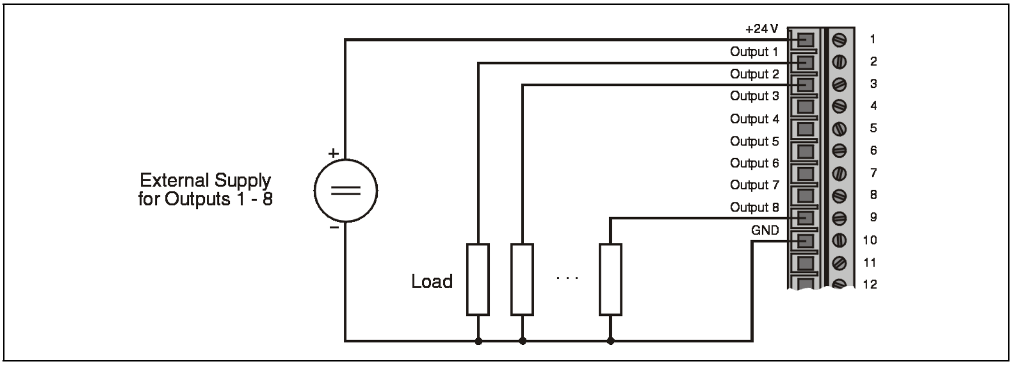


Figure 98: DO479 connection example

8.2.6 Output Circuit Diagram

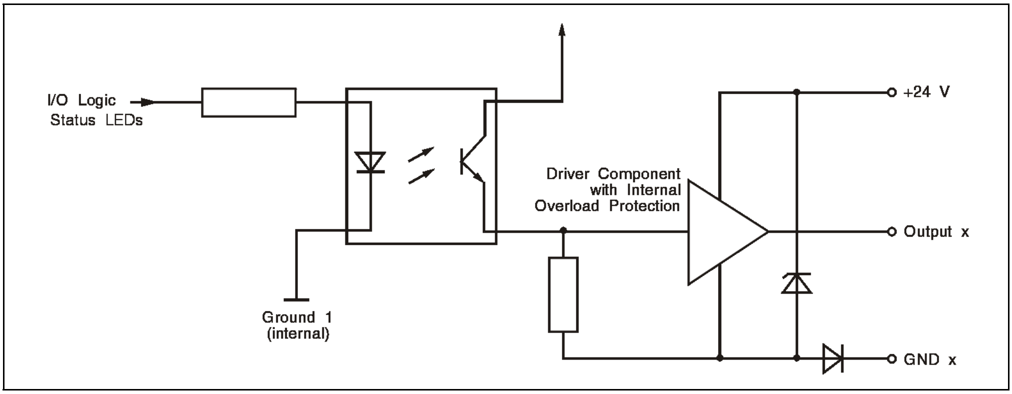


Figure 99: DO479 output circuit diagram

8.2.7 Overload Protection

The overload protection is activated in the following cases:

- Junction temperature for transistors exceeds the limit value (typ. 150° C, min. 135° C, max. 175° C). Causes: Short circuit, overload or environmental temperature is too high.
- The 24 V supply voltage (terminal side) is smaller than typ. 13 V (min. 10 V, max. 14.5 V).

The affected output remains switched off until ...

... the junction temperature is again within the limit value (hysteresis typ. 20° C). The time until it is switched on again is within seconds.

... the voltage supply is again within the valid range (typ. >14.5 V).

8.2.8 Switching Inductive Loads

Transistors are suitable for switching inductive loads off quickly and safely. Inverse diodes are not necessary on inductive loads. It should be noted that the maximum switching frequency at a given inductance is limited by a set braking voltage of 45 V to 55 V.

Braking Voltage: is a negative voltage on the switching element (e.g. valve). If the switching element is unable to operate with a negative voltage, an external inverse diode must be installed to limit the voltage to approx. -0.6 V.

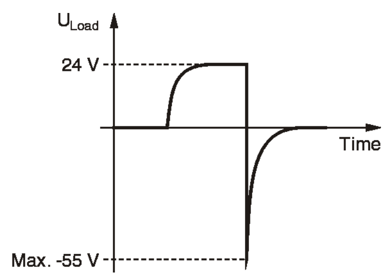


Figure 100: DO479 schematic representation for braking voltage

The maximum switching frequency decreases as the inductance increases. A coil with an inductivity of 0.5 H can be easily switched with 0.5 Hz at 24 V / 0.5 A and 60° C environmental temperature.

The maximum switching frequency in relation to a given inductance can be seen from the following diagram.

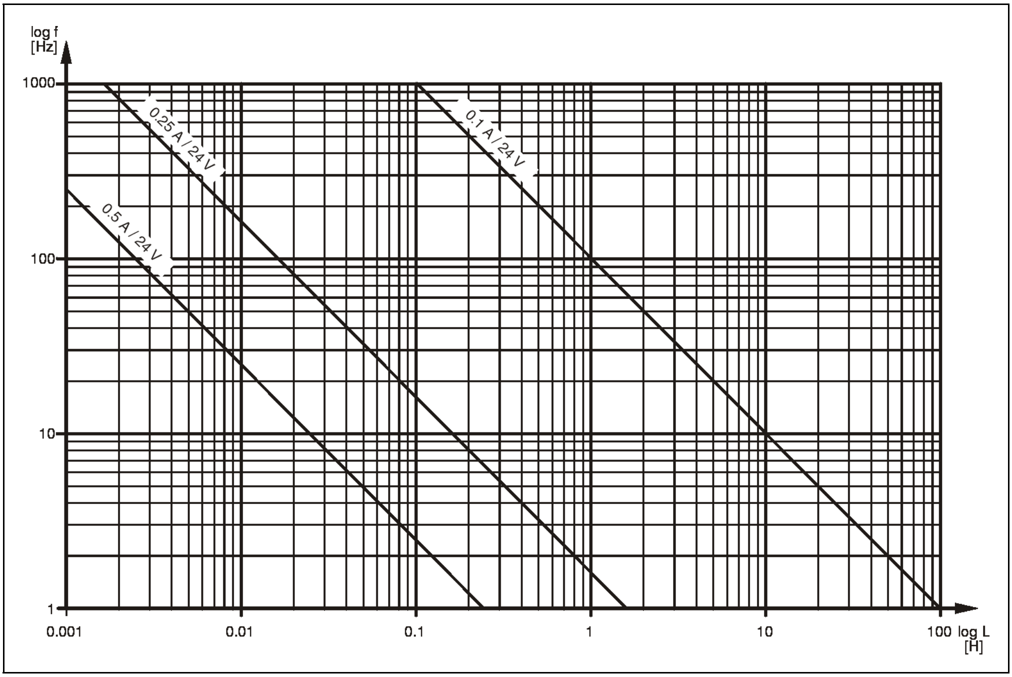


Figure 101: DO479 switching frequency in relation to a given inductance

8.2.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 16

Table 138: DO479 variable declaration

8.3 DO480

8.3.1 General Information

The DO480 is a standard digital output module.

8.3.2 Order Data

Model Number	Short Description	Image
3DO480.6	2005 digital output module, 16 transistor outputs 24 VDC, 2 A, 2 electrically isolated output groups. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 139: DO480 order data

8.3.3 Technical Data

Product ID	DO480
C-UL-US Listed	Yes
B&R ID Code	$41
Number of Outputs Total in 2 Groups of	 16 8
Design	Transistor
Electrical Isolation Output - PLC Group - Group Output - Output	 Yes Yes No

Table 140: DO480 technical data

Product ID	DO480
Switching Voltage Minimum Nominal Maximum	 0 VDC 24 VDC 48 VDC
Continuous Current per Output Group Module	 Max. 2 A Max. 12 A 1) Max. 24 A
Switching Capacity of Filament Lamps	15 W / 24 V
Leakage Current when Switched Off	0.1 mA
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Typ. 4 µs / max. 120 µs Typ. 100 µs / max. 120 µs
Switching Frequency (resistive load)	Max. 500 Hz
Overload Protection	Yes
Switching On after Overload Cutoff	Automatically after approx. 1 s
Short Circuit Current	Max. 90 A
Protective Circuit Internal External	 Yes Only if necessary (surge)
Residual Voltage of Transistors	Max. 0.3 V (at 2 A)
Braking Voltage when Switching Off Inductive Loads	Typ. 56 V
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 1 W Max. 2.5 W
Dimensions	B&R 2005 single-width

Table 140: DO480 technical data (cont.)

1) Simultaneousness factor = 75%, maximum 12 of the 16 outputs can be fully loaded at the same time.

8.3.4 Status LEDs

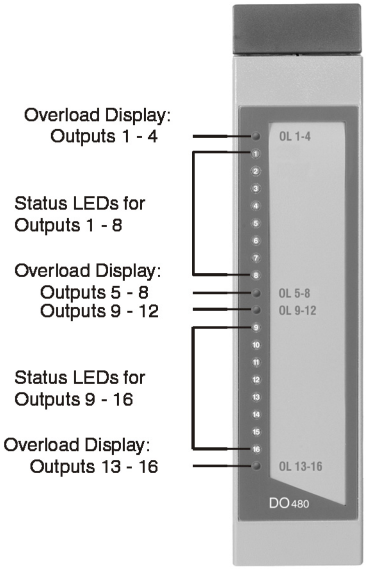
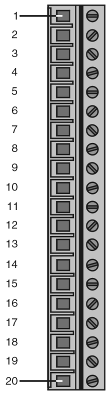
Image	LED	Description
	1 - 16	The status LEDs indicate the logical status of the corresponding outputs.
	OL x-y	The LEDs OL x-y (overload) indicate that the overload or short circuit cutoff has been activated for the respective LED group. If e.g. the OL 1-4 LED is lit, it means that a transistor pair (output 1/2 or 3/4) has been switched off (for more information see Section 8.3.7 "Overload Protection", on page 261).

Table 141: DO480 status LEDs

8.3.5 Pin Assignments



TB170

Connection	Assignment	
1	+24 V supply for inputs 1 - 8	Group 1
2	Output 1	
3	Output 2	
4	Output 3	
5	Output 4	
6	Output 5	
7	Output 6	
8	Output 7	
9	Output 8	
10	--- 1)	
11	--- 1)	Group 2
12	Output 9	
13	Output 10	
14	Output 11	
15	Output 12	
16	Output 13	
17	Output 14	
18	Output 15	
19	Output 16	
20	+24 V supply for inputs 9 -16	

Table 142: DO480 pin assignment

1) For technical reasons it is recommended to connect these pins to ground to enable the DO480 to be replaced by the DO479 at a future point in time. This step also avoids any rewiring.

When connecting the terminal block, it is important to ensure that any potential difference does not exceed 50 V. This is valid for:

Potential Difference <50 V
Group ↔ Group
+24 V connection ↔ PLC ground
+24 V connection ↔ ground

Table 143: DO480 the potential difference must be smaller than 50 V

Both electrically isolated groups can also be supplied by 2 separate 24 V sources.

Connection Example

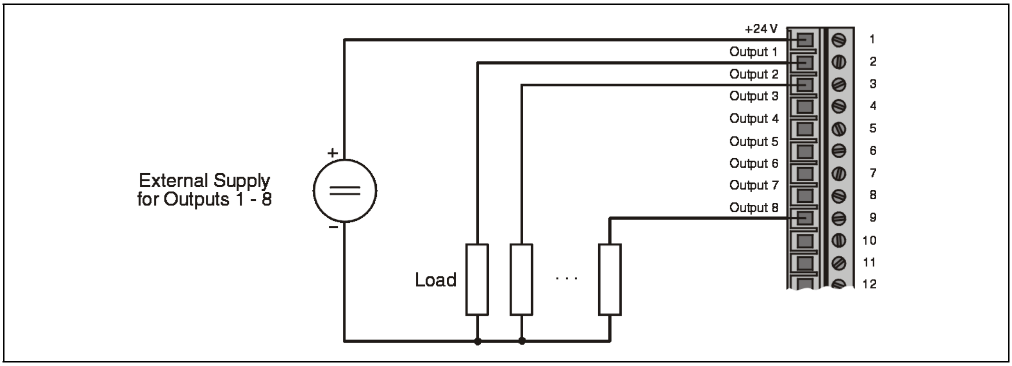


Table 144: DO480 connection example

8.3.6 Output Circuit Diagram

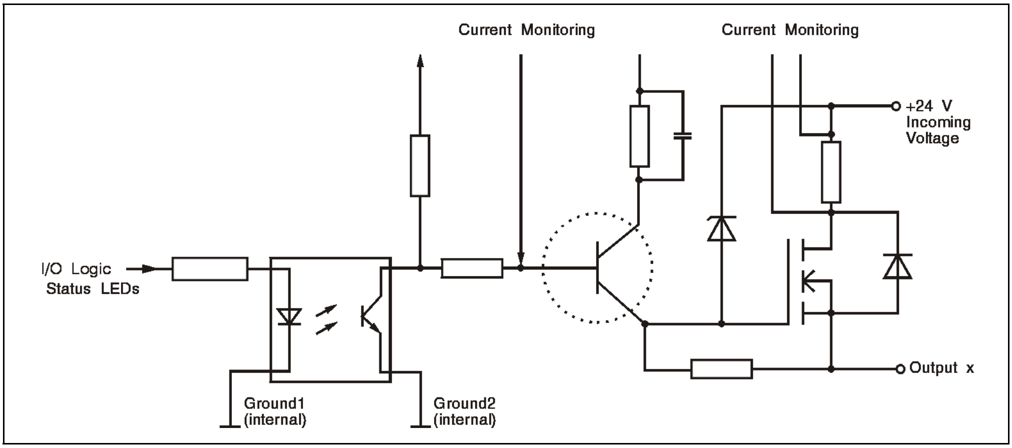


Figure 102: DO480 output circuit diagram

8.3.7 Overload Protection

The overload protection is activated in the following cases:

- The sum of all currents from output pairs (1/2, 3/4, 5/6, etc.) is greater than 4.4 A (at 60° C environmental temperature). The cutoff delay is typically 5 ms. The more the 4.4 A limit is exceeded, the faster the cutoff.
  When switching loads with high starting current (e.g. lamps) this switch-off functionality must be taken into consideration.
- If the total current (output pair) reaches approximately 15 A the cutoff takes place without delay.

When an output pair is turned off because of an overload (overload LED lit), an attempt to restart is made after approximately 1 s. If the overload still exists, this causes a continual switching on and off until the respective output is turned off by the application program or the overload no longer exists.

8.3.8 Switching Inductive Loads

The transistors are suited for fast and secure switching of inductive loads using Zener diodes. The transistors are switched on at a voltage of >56 V (⇒ braking voltage) and provide protection from large voltage spikes. For this reason, inverse diodes are not necessary on inductive loads.

Braking Voltage: is a negative voltage on the switching element (e.g. valve). If the switching element is **unable** to operate with a negative voltage, an external inverse diode must be installed to limit the voltage to approx. -0.6 V.

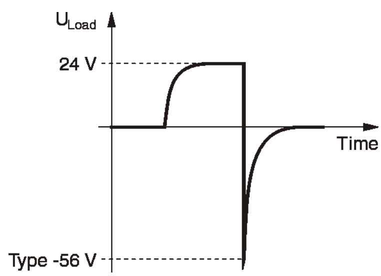


Figure 103: DO480 schematic representation for braking voltage

The protective switch reduces the maximum switching frequency as inductivity increases. A coil with an inductivity of 1 H can be easily switched with 5 Hz at 48 V / 0.5 A and 60° C environmental temperature.

The maximum switching frequency in relation to a given inductance can be seen from the following diagram.

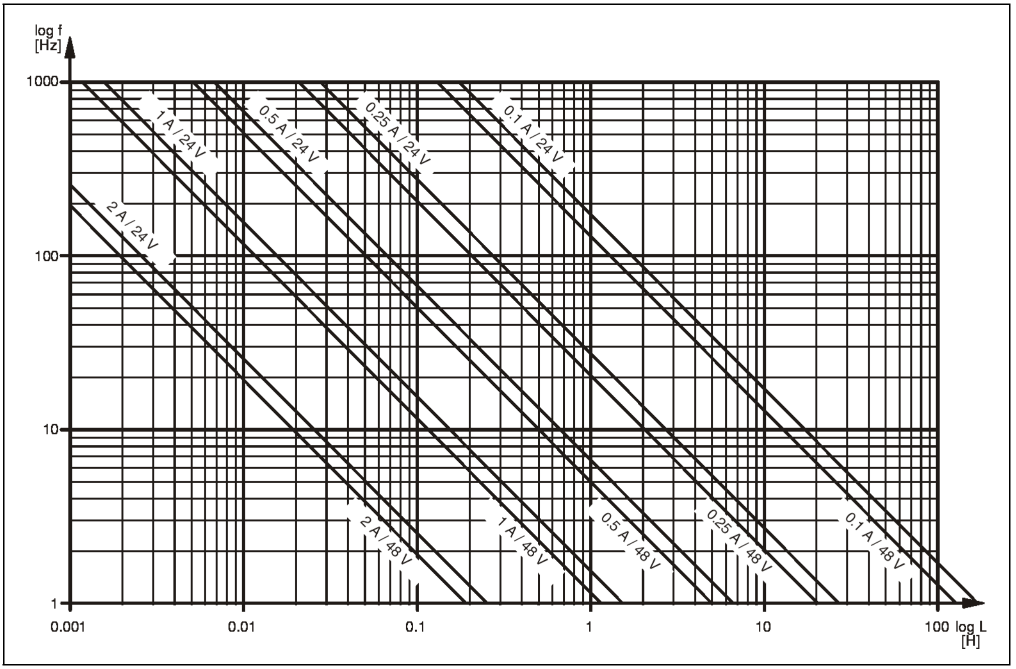


Figure 104: DO480 switching frequency in relation to a given inductance

8.3.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 16

Table 145: DO480 variable declaration

8.4 DO486

8.4.1 General Information

The DO486 is a standard digital output module. For output monitoring, the status of each individual channel can be read.

The DO486 offers very high component density using standard 3.5 mm terminal blocks.

8.4.2 Order Data

Model Number	Short Description	Image
3DO486.6	2005 digital output module, 32 transistor outputs 24 VDC, 0.5 A, 2 electrically isolated output groups. Order 2 x TB718 terminal block separately.	
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	
Terminal blocks are not included in the delivery.		

Table 146: DO486 order data

8.4.3 Technical Data

Product ID	DO486	
General Information		
C-UL-US Listed	Yes	
B&R ID Code	$42	
Module Type	B&R 2005 I/O module	
Can be Installed on Main Rack Expansion Rack	 Yes Yes	
Static Characteristics		
Number of Outputs Total in 2 Groups of	 32 16	
Design	FET positive switching	
Electrical Isolation Output - PLC Group - Group Output - Output	 Yes Yes No	
Diagnosis Status Voltage monitoring Output Monitoring	 Supply voltage <18 VDC Output Status	
Switching Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC	
Continuous Current per Output Group Module	Rev. <E0 Max. 0.5 A Max. 6 A Max. 12 A	Rev. ≥E0 Max. 0.5 A Max. 8 A Max. 16 A
	To increase the output current, outputs can be switched in parallel.	
Leakage Current when Switched Off	<120 µA	
Residual Voltage	<200 mV @ 0.5 A	
Short Circuit - Peak Current	<13 A	
Switching On after Overload Cutoff	Automatically within seconds depending on the module temperature	
Power Consumption Internal 5 V 24 V Total External 24 VDC	 Max. 1.2 W --- Max. 1.2 W Max. 4.4 W	
Protection	Thermal cutoff for over-current and short circuit Integrated protection for switching inductances Reverse polarity protection	
Additional Characteristics		
Status Display	32 yellow output LEDs 2 yellow DCOK LEDs 2 red ERROR LEDs	

Table 147: DO486 technical data

Product ID	DO486	
Dynamic Characteristics		
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	Rev. <E0 < 475 µs < 550 µs	Rev. ≥E0 < 225 µs < 330 µs
Switching Frequency Resistive Load Inductive Load	Max. 100 Hz See Section 8.4.10 "Switching Inductive Loads", on page 270 (with 90% duty cycle)	
Braking Voltage when Switching Off Inductive Loads	50 VDC	
Mechanical Characteristics		
Dimensions	B&R 2005 single-width	

Table 147: DO486 technical data (cont.)

8.4.4 Status LEDs

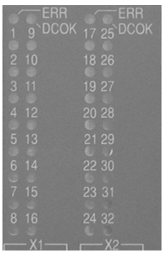
Image	LED	Description
	ERR	The ERR LED is an accumulative indication for all high-side drivers in an output group. This LED is lit if an output which is being controlled has a short circuit or over-temperature or if the module voltage sinks below 18 VDC.
	DCOK	The DCOK LED is controlled by the respective output supply and is lit if the supply voltage is over +18 VDC.
	1 - 32	Control status of the corresponding digital output.

Table 148: DO486 Status LEDs

8.4.5 Connection Elements

Two 18-pin terminal blocks are located next to each other in the lower part of the housing so that all signals can be connected using terminal blocks.

The TB718 terminal blocks are available with screw and cage clamps.

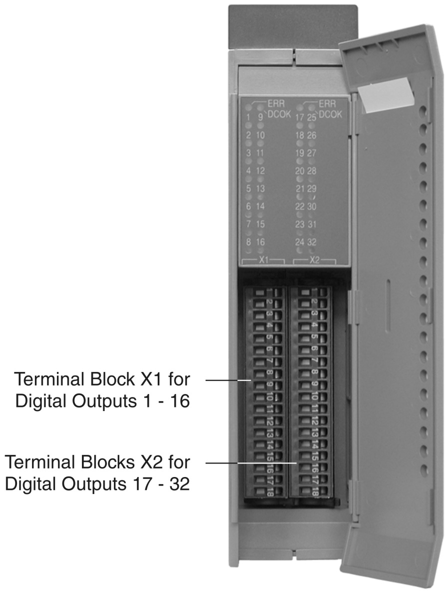


Figure 105: DO486 connection elements

8.4.6 Pin Assignments

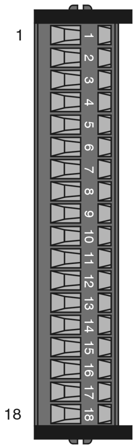
Left 18-pin Terminal Block	Connection	Assignment
X1  TB718	1	Output 1
	2	Output 2
	3	Output 3
	4	Output 4
	5	Output 5
	6	Output 6
	7	Output 7
	8	Output 8
	9	Output 9
	10	Output 10
	11	Output 11
	12	Output 12
	13	Output 13
	14	Output 14
	15	Output 15
	16	Output 16
	17	+24 VDC
	18	GND

Table 149: DO486 pin assignments for terminal block X1

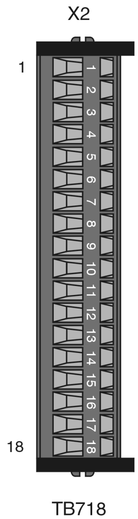
Right 18-pin Terminal Block	Connection	Assignment
	1	Output 17
	2	Output 18
	3	Output 19
	4	Output 20
	5	Output 21
	6	Output 22
	7	Output 23
	8	Output 24
	9	Output 25
	10	Output 26
	11	Output 27
	12	Output 28
	13	Output 29
	14	Output 30
	15	Output 31
	16	Output 32
	17	+24 VDC
	18	GND

Table 150: DO486 pin assignments for terminal block X2

8.4.7 Connection Example

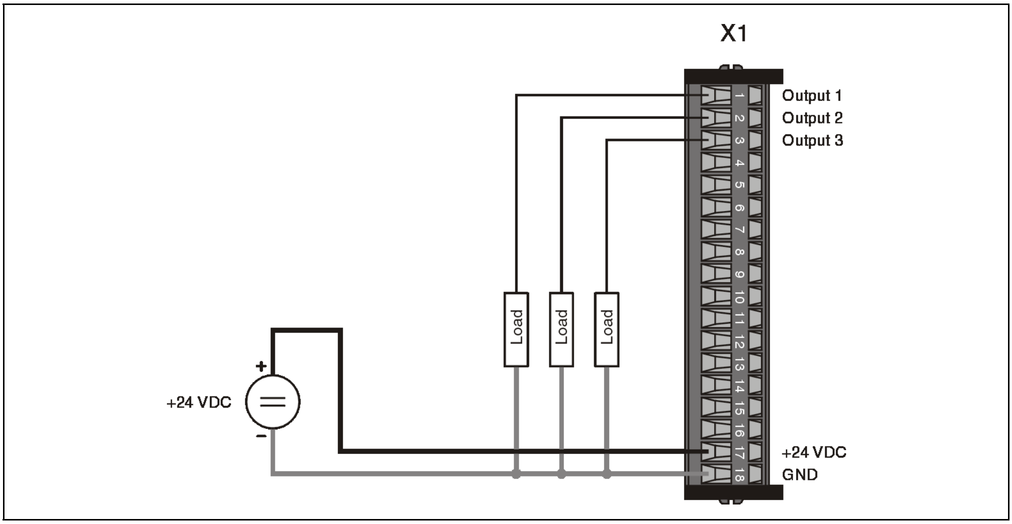


Figure 106: DO486 connection example

8.4.8 Output Circuit Diagram

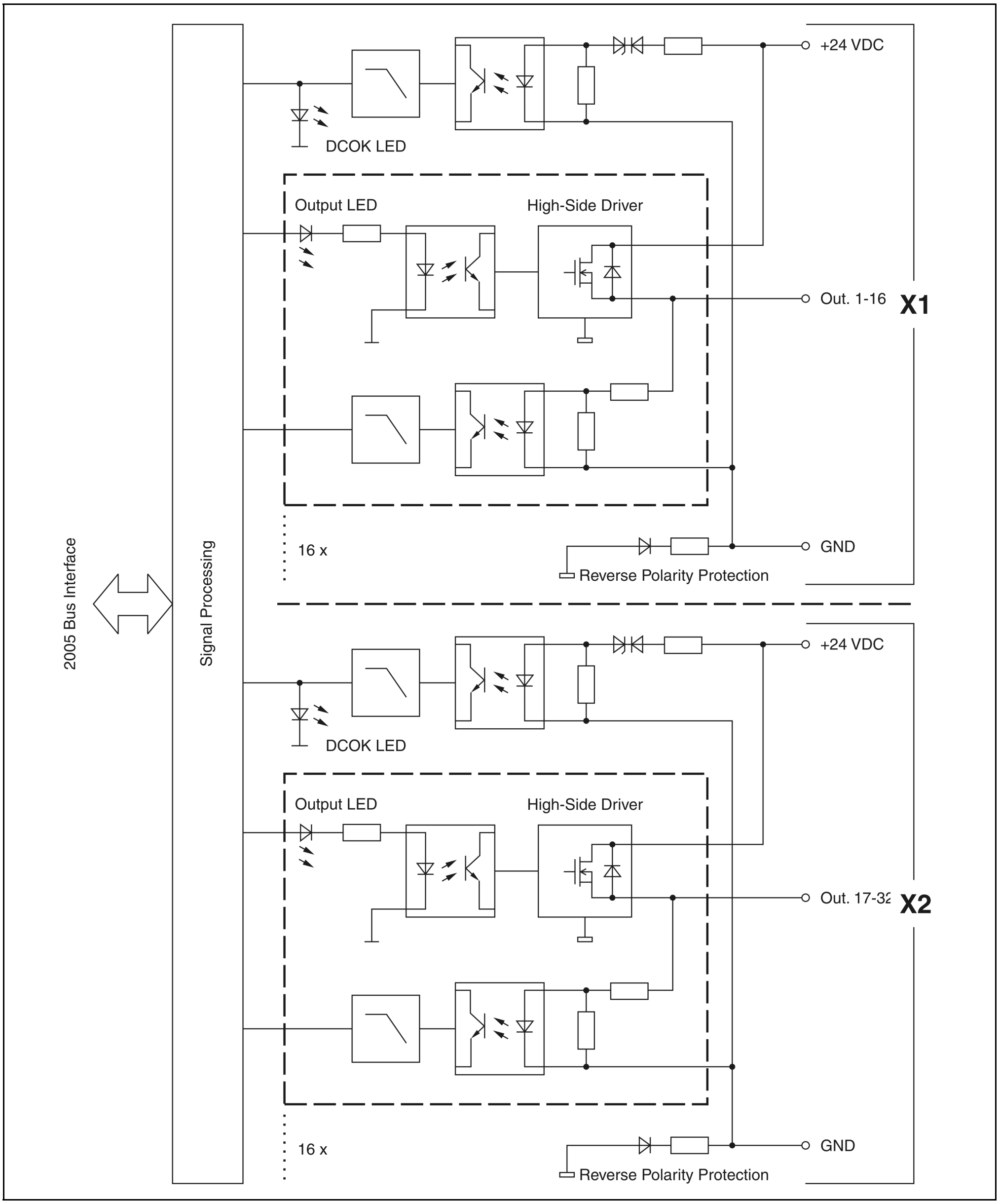


Figure 107: DO486 output circuit diagram

8.4.9 Output Monitoring

The output states are compared to the set values on the module. The output driver is used to control desired states. Output monitoring is only active if the supply voltage for the group is in the valid range.

The status of each individual channel can be read using a register. Additionally, an accumulative bit for output monitoring is created. The status of the supply voltage can also be read.

8.4.10 Switching Inductive Loads

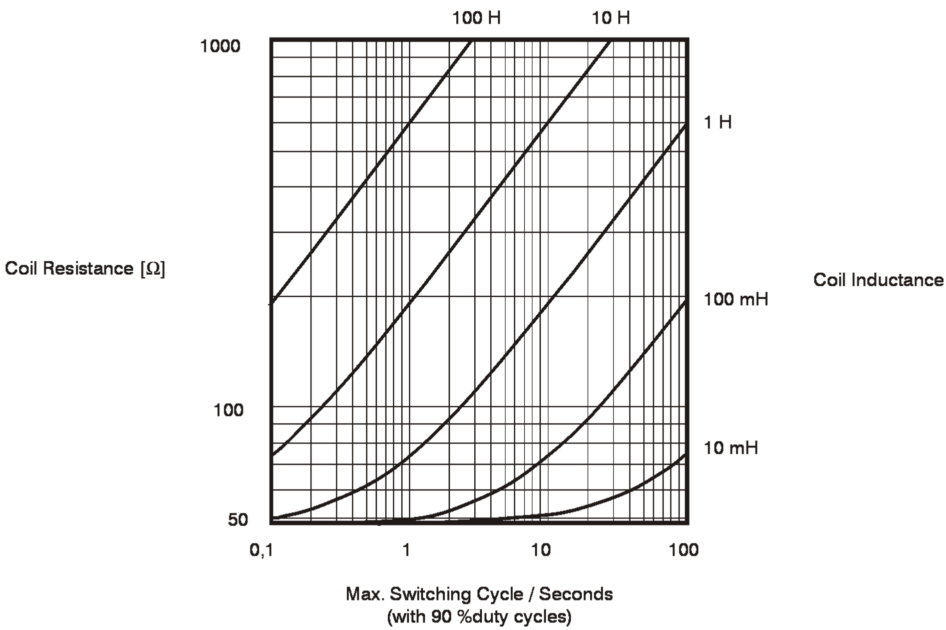


Figure 108: DO486 switching inductive loads

8.4.11 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 32
Single output status (channel x)	tc_global	BOOL	1	Digit. In	65 ... 96
Status register	tc_global	USINT	1	Status In	0

Table 151: DO486 variable declaration

Status Register

Status Register	Bit	Description
	7	DCOK_2 - Supply voltage for output group 2 in the valid range
	6	DCOK_1 - Supply voltage for output group 1 in the valid range
	5	ERR_2 - Error occurred in output group 2
	4	ERR_1 - Error occurred in output group 1
	3	x
	2	x
	1	x
	0	x

7							0
				x	x	x	x

ERR_1
- 0...... Outputs for group 1 working correctly
- 1...... A controlled output for group 1 has short circuited or has an over-temperature status, or the module voltage has dropped below 18 VDC

ERR_2
- 0...... Outputs for group 2 working correctly
- 1...... A controlled output for group 2 has short circuited or has an over-temperature status, or the module voltage has dropped below 18 VDC

DCOK_1
- 0...... No supply voltage or supply voltage too low for output group 1
- 1...... Supply voltage for output group 1 in the valid range

DCOK_2
- 0...... No supply voltage or supply voltage too low for output group 2
- 1...... Supply voltage for output group 2 in the valid range

8.5 DO650 / DO750

8.5.1 General Information

The DO650 and DO750 are standard digital output modules.

8.5.2 Order Data

Model Number	Short Description	Image
3DO650.6	2005 digital output module, 16 relay outputs 120 VAC / 24 VDC, 2 A, 4 electrically isolated output groups. Order TB170 terminal block separately.	
3DO750.6	2005 digital output module, 8 relay outputs 230 VAC / 24 VDC, 3 A, 2 electrically isolated output groups. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 152: DO650 / DO750 order data

8.5.3 Technical Data

Product ID	DO650	DO750
C-UL-US Listed	Yes	Yes
B&R ID Code	$03	$04
Number of Outputs Total in 4/2 Groups of	 16 4	 8 4
Design	Relay / N.O.	
Electrical Isolation Output - PLC Group - Group Output - Output	 Yes / max. 144 VAC Yes / max. 250 VAC No	 Yes / max. 250 VAC Yes / max. 430 VAC No
Switching Voltage Nominal Maximum	 120 VAC / 24 VDC 144 VAC / 30 VDC	 230 VAC / 24 VDC 250 VAC / 30 VDC

Table 153: DO650 / DO750 technical data

Product ID	DO650	DO750
Continuous Current per Output Group Module	 Max. 2 A Max. 8 A Max. 32 A	 Max. 3 A Max. 8 A Max. 16 A
Starting Current	Max. 12 A / Channel	Max. 12 A / Channel
Switching Capacity Minimum Maximum	 0.1 mA / 0.1 VDC 300 VA / 90 W	 10 mA / 5 VDC 500 VA / 150 W
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Typ. 5.6 ms / max. 10 ms Typ. 2.5 ms / max. 5 ms	 Typ. 4 ms / max. 6 ms Typ. 6 ms / max. 8 ms
Short Circuit Protection (external)	Fuse 8 A time lag per group (on COM connection)	
External Protective Circuit	Generally required	
Voltage Limitations on the Relay Contacts (internal)	400 V_{SS}	
Contact Resistance at Maximum Load	100 mΩ	
Switching Frequency (nominal load)	Max. 10 Hz	
Operating Cycles Mechanical Electrical (nominal load) Per Hour (nominal load)	 $>2 \times 10^7$ $>1 \times 10^5$ Max. 600	
Dielectric Strength Contact Contact - Coil	 280 VAC (due to voltage limitations) 2000 VAC / 1 min	
Power Consumption 5 V 24 V Total	 Max. 0.7 W Max. 3.3 W Max. 4 W	 Max. 0.7 W Max. 2.3 W Max. 3 W
Dimensions	B&R 2005 single-width	

Table 153: DO650 / DO750 technical data (cont.)

8.5.4 Status LEDs

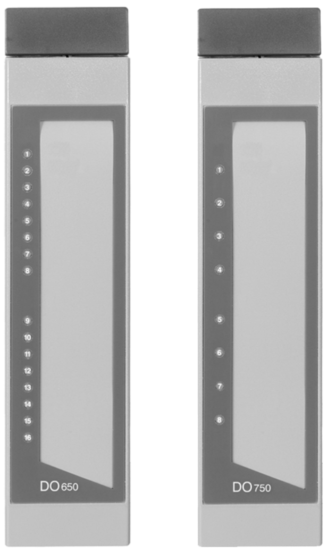
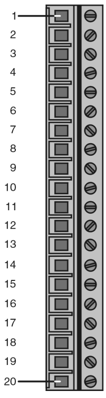
Image	LED	Description
	1 - 16 / 1 - 8	Status LEDs indicate the logic status of the corresponding output, also when the terminal block is not connected and there is no voltage to the terminal block. The LED is lit when the relay contact is closed.

Table 154: DO650 / DO750 status LEDs

8.5.5 Pin Assignments



TB170

Connection	DO650	Group	DO750	Group
1	COM for Output 1 -4	1	COM for Output 1 -4	1
2	Output 1		---	
3	Output 2		Output 1	
4	Output 3		---	
5	Output 4		Output 2	
6	Output 5	2	---	
7	Output 6		Output 3	
8	Output 7		---	
9	Output 8		Output 4	
10	COM for Output 5 - 8		---	
11	COM for Output 9 -12	3	---	2
12	Output 9		Output 5	
13	Output 10		---	
14	Output 11		Output 6	
15	Output 12		---	
16	Output 13	4	Output 7	
17	Output 14		---	
18	Output 15		Output 8	
19	Output 16		---	
20	COM for Output 13 -16		COM for Output 5 - 8	

Table 155: DO650 / DO750 pin assignments

For the connection of the terminal block, it is important to ensure that any potential difference does not exceed 50 V. This is valid for:

Potential Difference Between	DO650	DO750
Group ↔ Group	250 VAC	430 VAC
COM x ↔ PLC Ground	144 VAC	250 VAC
COM x ↔ Ground	144 VAC	250 VAC

Table 156: DO650 / DO750 maximum potential difference not exceeded

8.5.6 Output Circuit Diagram

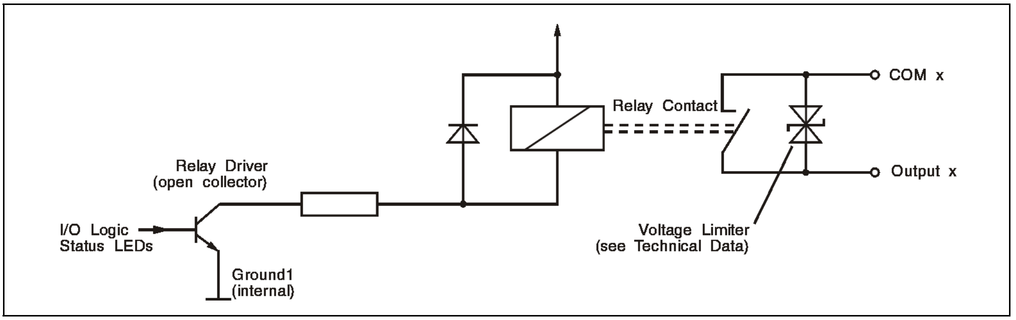


Figure 109: DO650 / DO750 output circuit diagram

8.5.7 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 8/16

Table 157: DO650 / DO750 variable declaration

8.6 DO690

8.6.1 General Information

The DO690 is a standard digital output module. Outputs are triac outputs.

8.6.2 Order Data

Model Number	Short Description	Image
3DO690.6	2005 digital output module, 8 triac outputs 120 VAC, 1 A, 2 electrically isolated output groups. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 158: DO690 order data

8.6.3 Technical Data

Product ID	DO690	
C-UL-US Listed	Yes	
B&R ID Code	$61	
Number of Outputs Total in 2 Groups of	 8 4	
Design	Triac	
Electrical Isolation Output - PLC Group - Group Output - Output	 Yes (optotriac) Yes (optotriac) No	
Switching Voltage Minimum Nominal Maximum	 30 VAC 120 VAC 144 VAC	
Switching Voltage Frequency	45 to 63 Hz	
Continuous Current per Output Group Module	 Max. 1 A Max. 2 A (simultaneousness factor = 50%) 1) Max. 4 A	
Leakage Current	4 mA (resistive load)	
Minimum Holding Current At 0° C At 60° C	 3 mA 3 mA	
Switching Delay Switching Voltage Frequency Log. 0 - Log. 1 Log. 1 - Log. 0	 At 50 Hz 10 ms 10 ms	 At 60 Hz 8.5 ms 8.5 ms
Switching Frequency (resistive load)	Max. 100 Hz	
Overload Protection Internal External	 Yes By user	
Protective Circuit Internal External	 Yes Generally required (fuse)	
Power Consumption Internal 5 V 24 V Total External	 Max. 1.5 W --- Max. 1.5 W Max. 6 W (simultaneousness factor = 50%) 1)	
Dimensions	B&R 2005 single-width	

Table 159: DO690 technical data

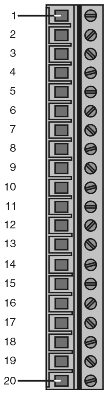
1) Simultaneous factor = 50%: A maximum 4 of 8 outputs are allowed to be fully loaded at the same time.

8.6.4 Status LEDs

Image	LED	Description
	1 - 8	The status LEDs indicate the logical status of the corresponding outputs.

Table 160: DO690 status LEDs

8.6.5 Pin Assignments



TB170

Connection	Assignment	
1	COM for Output 1 -4	Group 1
2	---	
3	Output 1	
4	---	
5	Output 2	
6	---	
7	Output 3	
8	---	
9	Output 4	
10	---	
11	---	Group 2
12	Output 5	
13	---	
14	Output 6	
15	---	
16	Output 7	
17	---	
18	Output 8	
19	---	
20	COM for Output 5 - 8	

Table 161: DO690 pin assignment

8.6.6 Output Circuit Diagram

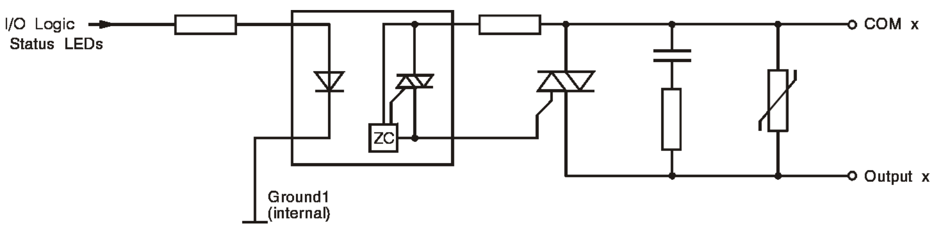


Figure 110: DO690 output circuit diagram

8.6.7 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 8

Table 162: DO690 variable declaration

8.7 DO760

8.7.1 General Information

The DO760 is a standard digital output module. The outputs are single channel isolated.

8.7.2 Order Data

Model Number	Short Description	Image
3DO760.6	2005 Digital Output Module, 8 relay outputs 240 VAC / 30 VDC, 4 A, outputs electrically isolated. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 163: DO760 order data

8.7.3 Technical Data

Product ID	DO760
General Information	
C-UL-US Listed	Yes
B&R ID Code	$B0
Can be Installed on Main Rack Expansion Rack	 Yes Yes
Static Characteristics	
Module Type	B&R 2005 I/O module
Number and Type of Outputs	4 change over contacts 4 normally open contacts The outputs are single channel isolated.
Maximum Switching Voltage	125 VDC / 264 VAC
Maximum Peak Voltage	Externally limited to a maximum of 460 V
Rated Voltage	30 VDC / 240 VAC
Switching Voltage Range	min. 5 VDC @ 1 mA
Rated Frequency	DC or 45 - 63 Hz
Rated Current (1-Signal)I_e	4 A (resistive load)
Current Range at 1-Signal (continuous at maximum voltage) DC AC	 1 mA - 4 A (resistive load) 100 mA -8 A (resistive load)
Switching Capacity	2000 VA; 120 W @ 30 VDC (resistive load)
Contact Resistance (DC)	Max. 100 mΩ @ 6 VDC / 100 mA
Power Loss on Contact (AC)	Typical 1 W (max. 5 W)
Fuse	External Fuse
Wiring	4 change-over contacts / 4 normally open contacts
Power Consumption Internal 5 V 24 V Total External	 Max. 4 W --- Max. 4 W Max. 4 W
Additional Characteristics	
Status Display	1 yellow LED per channel
Protection Characteristics	
Type of Protection Short Circuit Protection AC DC Overvoltage Protection for Contacts DC Connection	 Fuse 8 A time lag (required externally) Fuse 4 A time lag (required externally) Limited to 460 V (required externally) Spark protection as required (to be connected externally)

Table 164: DO760 technical data

Product ID	DO760
Dynamic Characteristics	
Output Delay for Signal Changes from log 0 - log 1 log 1 - log 0	 Max. 13 ms (including chatter time) Max. 16 ms (including chatter time)
Operating Characteristics	
Consequences when Outputs Incorrectly Connected	No effects on the module
Output Behavior when the Controller Falls Out During Voltage Dips, Interruptions and when the Unit is Switched On-or Off	The outputs are reset in the event of malfunction (normally closed)
Relay Contact Lifespan	See Section 8.7.8 "Switching Cycles", on page 289
Total Output Current Following Condition must be Fulfilled Wire Cross Section	Max. 32 A $\Sigma I_n^2 \leq 200$ See alsoSection 8.7.7 "Total Output Current Allowed", on page 288 2.5 mm², for currents≥4 A or if a recommended value is reached
Isolation Voltage under Normal Operating Conditions between Channel and Bus Other Channels Supply Interfaces	 1 Minute 2800 VAC or 4 kV @ 1.2 x 50 µs pulse 1 Minute 1000 VAC or 1.4 kV @ 1.2 x 50 µs pulse ---
Isolation Strength between Open Relay Contacts	1 Minute 1000 VAC or 1.4 kV @ 1.2 x 50 µs pulse
Different Phases Possible	Yes, but only for 110 VAC
Point at which the LED for Each Channel is Switched On	When a relay coil signal is received
Method of Operation	Latches are written using the bus, which are switched via the relay's transistor driver
Typical Example for External Connections	Standard N.O. and changeover circuit, Sink and source connection possible
Mechanical Characteristics	
Dimensions	B&R 2005 single-width
Pin Assignments	See Section 8.7.5 "Pin Assignments", on page 286

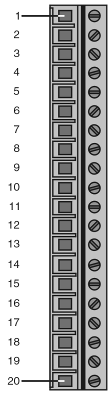
Table 164: DO760 technical data (cont.)

8.7.4 Status LEDs

Image	LED	Description
	1 - 8	Status LEDs indicate the logic status of the corresponding output, also when the terminal block is not connected and there is no voltage to the terminal block. The LED is lit if the relay contact is made (N.O. contact closes, N.C. contact opens).

Table 165: DO760 status LEDs

8.7.5 Pin Assignments



TB170

Connection	Assignment		
1	Output 1	COM	Group 1
2	Output 1	N.O.	
3	Output 1	N.C.	
4	Output 2	COM	
5	Output 2	N.O.	
6	Output 3	COM	
7	Output 3	N.O.	
8	Output 4	N.C.	
9	Output 4	N.O.	
10	Output 4	COM	
11	Output 5	COM	Group 2
12	Output 5	N.O.	
13	Output 5	N.C.	
14	Output 6	COM	
15	Output 6	N.O.	
16	Output 7	COM	
17	Output 7	N.O.	
18	Output 8	N.C.	
19	Output 8	N.O.	
20	Output 8	COM	

Table 166: DO760 pin assignment

For the connection of the terminal block, it is important to ensure that any potential difference does not exceed 50 V. This is valid for:

Potential Difference Between	Voltage
COM x ↔ PLC Ground	250 VAC
COM ↔ Ground	250 VAC

Table 167: DO760 maximum potential difference not exceeded

8.7.6 Output Circuit Diagram

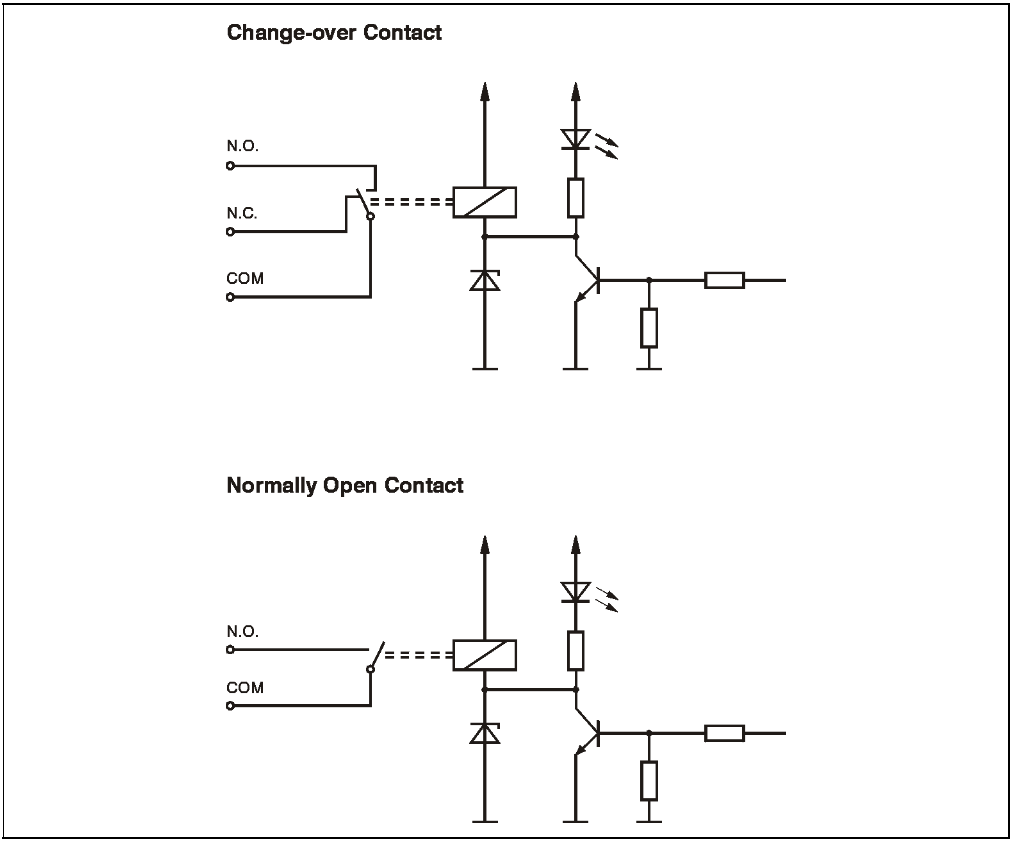


Figure 111: DO760 output circuit diagram

8.7.7 Total Output Current Allowed

The DO760 digital output module is set up for a total output current of 32 A. The following conditions must be fulfilled to protect against the module overheating:

$$\Sigma I_n \leq 32\text{ A} \quad \text{and} \quad \Sigma I_n^2 \leq 200$$

n ... Channel number 1 to 8

Wire Cross Section

For currents of ≥4 A or when one of the above recommended values has been reached, wires with a cross section of 2.5 mm² are required.

Calculation Example

Example 1

Each of the eight channels is loaded with 4 A.

1) Recommended Value 1: Total current ≤ 32 A
   I_{total} = 8 x 4 A = 32 A -> condition fulfilled

2) Recommended Value 2: $\Sigma I_n^2 \leq 200$
   $\Sigma I_n^2 = 8 \times 4^2 = 128$ -> condition fulfilled

Both conditions have been fulfilled. The load is therefore permitted. Wires with a cross section of 2.5 mm² are required.

Example 2

Three channels are supplied with a maximum current of 8 A.

1) Recommended Value 1: Total current ≤ 32 A
   I_{total} = 3 x 8 A = 24 A -> condition fulfilled

2) Recommended Value 2: $\Sigma I_n^2 \leq 200$
   $\Sigma I_n^2 = 3 \times 8^2 = 192$

Both conditions have been fulfilled. The load is therefore permitted. Wires with a cross section of 2.5 mm² are required.

8.7.8 Switching Cycles

Mechanical Load

The relay contacts are set up for 5 x 10^6 switching cycles.

Electrical Load

The following table contains an overview of switching cycles that can be carried out by the DO760 with various electromagnetic loads.

Valid for each specification:

- Maximum 30 switching cycles per minute
- Entries for N.O. and N.C., but not for change over contact. That means only N.O. or N.C. contacts are connected, but not both.

Load	Operating Cycles
Nominal load 8 A, 230 VAC, resistive	1 x 10^5
Motor load 230 VAC (starting current 12 A, cos φ 0.5, nominal current 1.8 A)	4 x 10^5
Valve load 0.1 A, 230 VAC	1 x 10^6
Hydraulic valve 2 A, 24 VDC (with external spark protection)	1 x 10^6
8 A, 30 VDC, resistive	>1000
1 A, 24 VDC	2 x 10^5

Table 168: DO760 electrical load

8.7.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 8

Table 169: DO760 variable declaration

9. Digital Mixed Modules

9.1 General Information

Digital mixed modules are a combination of digital input and output modules. The states of the digital inputs or outputs are shown by the status LEDs.

9.1.1 Overview

Module	DM476	DM486
Digital Inputs		
Number of Inputs	16	16
Nominal Input Voltage	24 VDC	24 VDC
Input Delay	1 ms	1 ms
Digital Outputs		
Number of Outputs	16	16
Nominal Switching Voltage	24 VDC	24 VDC
Continuous Current	0.4 A	0.5 A
Connection		
Connection via	DSUB connector	Terminal Block

Table 170: Digital Mixed Module Overview

9.1.2 Programming

The digital inputs and outputs are accessed directly in the application program using a variable name. The relationship between an input or output channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

9.2 DM476

9.2.1 General Information

The DM476 is a standard digital mixed module.

9.2.2 Order Data

Model Number	Short Description	Image
3DM476.6	2005 digital mixed module, 16 inputs, 24 VDC / 24 VAC, 1 ms, DC: Sink/Source, 4 electrically isolated input groups, 16 transistor outputs, 24 VDC, 0.4 A	
Connection made using DSUB connector.		

Table 171: DM476 order data

9.2.3 Technical Data

Product ID	DM476
C-UL-US Listed	Yes
B&R ID Code	$62
Inputs	**25-pin DSUB socket (upper)**
Number of Inputs Total in 4 Groups of	 16 4
Input Connections	Sink or source

Table 172: DM476 technical data

Product ID	DM476
Electrical Isolation Input - PLC Group - Group Input - Input (same group)	 Yes (optocoupler) Yes (optocoupler) No
Input Voltage Nominal Maximum	 24 VDC / 24 VAC 30 VDC / 30 VAC
Input Resistance	4.8 kΩ
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Input Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Max. 1 ms Max. 1 ms
Input Current at Nominal Voltage	Approx. 5 mA
Maximum Peak Voltage	500 V for 50 µs max. every 100 ms
Outputs	**25-pin DSUB plug (lower)**
Number of Outputs	16
Design	Transistor
Electrical Isolation Output - PLC Output - Output	 Yes No
Switching Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC
Continuous Current per Output Module	 Max. 0.4 A Max. 4.8 A[1)]
Leakage Current when Switched Off	0.3 mA
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	 Max. 100 µs Max. 100 µs
Switching Frequency (resistive load)	Max. 500 Hz
Overload Protection	Yes
Switching On after Overload Cutoff	Automatically within seconds (depends on the module temperature)
Short Circuit Current	0.75 to 1.5 A
Protective Circuit Internal External	 Yes Only if necessary (surge)
Braking Voltage when Switching Off Inductive Loads	45 to 55 V

Table 172: DM476 technical data (cont.)

Product ID	DM476
Power Consumption Internal 5 V 24 V Total Terminal Side at 24 V	 Max. 2.5 W --- Max. 2.5 W Max. 2 W
Dimensions	B&R 2005 single-width

Table 172: DM476 technical data (cont.)

1) Simultaneousness factor = 75%: A maximum 12 of 16 outputs are allowed to be fully loaded at the same time.

9.2.4 Status LEDs

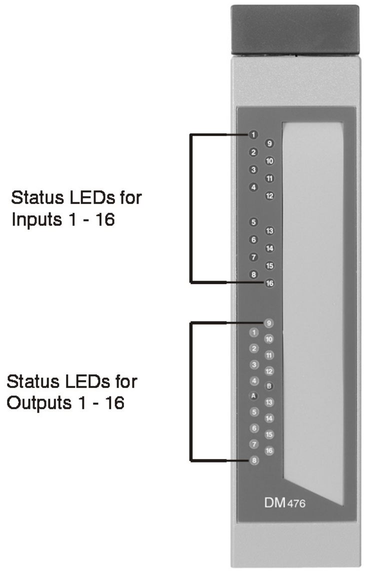
<table>
<tr><th>Image</th><th>LED</th><th>Description</th></tr>
<tr><td rowspan="3">
</td><td>1 - 16, green</td><td>The 16 green status LEDs indicate the logical status of the corresponding inputs. Regardless of the type connection (sink or source connection) the LED is lit if the input is logical 1, i.e. when the current flows through the optocoupler.</td></tr>
<tr><td>1 - 16, yellow</td><td>The 16 yellow status LEDs indicate the logical status of the corresponding outputs.</td></tr>
<tr><td>A, B</td><td>LEDs A and B indicate the operating status.
<table>
<tr><th>B</th><th>A</th><th>Description</th></tr>
<tr><td>OFF</td><td>OFF</td><td>Outputs work normally.</td></tr>
<tr><td>OFF</td><td>ON</td><td>A short circuit or over temperature has occurred with at least one of the outputs (see also Section 9.2.10 "Overload Protection", on page 298).</td></tr>
<tr><td>ON</td><td>OFF</td><td>An output is switched on, even though no load is connected.</td></tr>
<tr><td>ON</td><td>ON</td><td>The supply voltage for the output driver has sunk to <12 V.</td></tr>
</table></td></tr>
</table>

Table 173: DM476 Status LEDs

9.2.5 Connection Elements

The DM476 module is supplied with 16 digital inputs and 16 digital outputs. However, the terminal block for B&R 2005 controllers is only 20-pin. The connection elements are made up of a 25-pin DSUB sockets and a 25-pin DSUB plug.

Due to space restrictions, it is necessary to use press connectors and rolled ribbon cable for the connection.

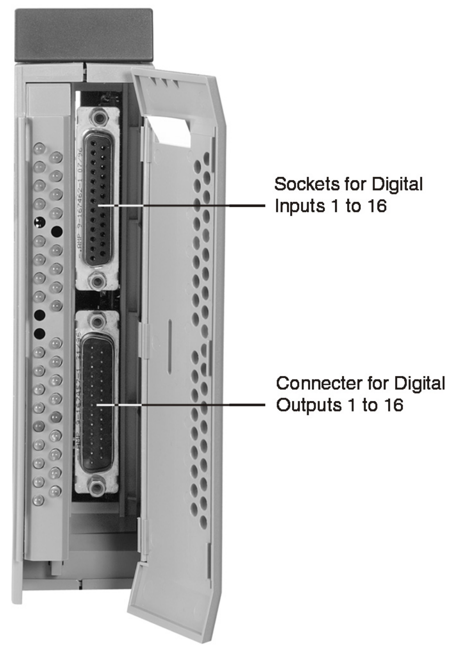


Figure 112: DM476 connection elements

9.2.6 Pin Assignments

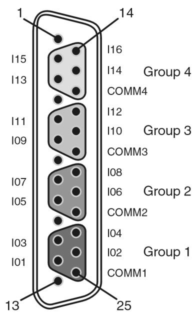
Upper 25-pin DSUB socket	Pin	Assignment	Group
	1	---	
	2	Input 15	4
	3	Input 13	4
	4	---	
	5	Input 11	3
	6	Input 9	3
	7	---	
	8	Input 7	2
	9	Input 5	2
	10	---	
	11	Input 3	1
	12	Input 1	1
	13	---	
	14	Input 16	4
	15	Input 14	4
	16	COM (13-16)	4
	17	Input 12	3
	18	Input 10	3
	19	COM (9-12)	3
	20	Input 8	2
	21	Input 6	2
	22	COM (5-8)	2
	23	Input 4	1
	24	Input 2	1
	25	COM (1-4)	1

Table 174: DM476 pin connections for the upper 25-pin DSUB socket

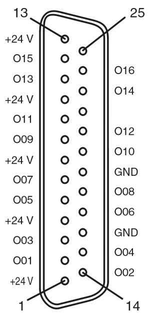
Lower 25-pin DSUB plug	Pin	Assignment
	1	+24 V
	2	Output 1
	3	Output 3
	4	+24 V
	5	Output 5
	6	Output 7
	7	+24 V
	8	Output 9
	9	Output 11
	10	+24 V
	11	Output 13
	12	Output 15
	13	+24 V
	14	Output 2
	15	Output 4
	16	GND
	17	Output 6
	18	Output 8
	19	GND
	20	Output 10
	21	Output 12
	22	---
	23	Output 14
	24	Output 16
	25	---

Table 175: DM476 pin assignments for the lower 25-pin DSUB plug

9.2.7 Connection Example for Digital Outputs

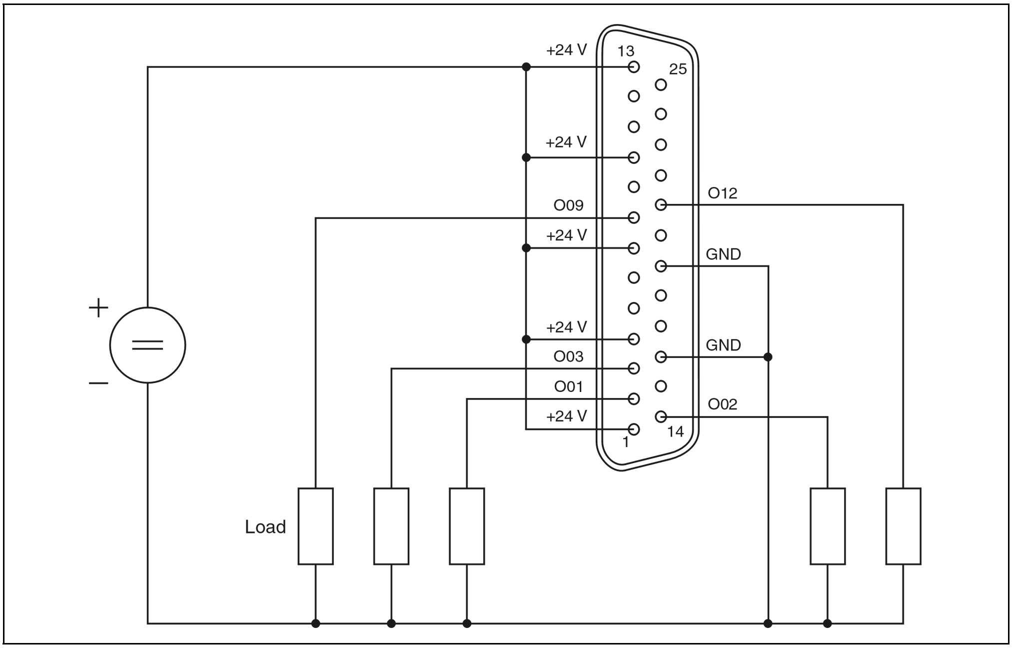


Figure 113: DM476 connection example for digital outputs

9.2.8 Input Circuit Diagram

The inputs can be connected with a 24 VDC or a nominal 24 VAC. For DC input voltages, sink or source circuits are allowed within a group of four. The logical status of each input is indicated by a green LED.

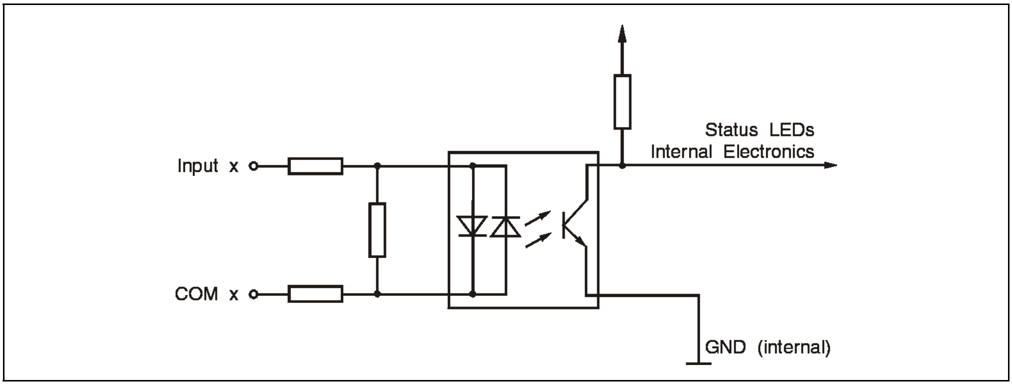


Figure 114: DM476 input circuit diagram

9.2.9 Output Circuit Diagram

The output driver requires an external supply, which is divided into five socket contacts because of the high current requirement (approximately 410 mA/channel).

The logical status of each output is indicated by a yellow LED. The operational status is indicated with LEDs A and B (see also Section 9.2.4 "Status LEDs", on page 293).

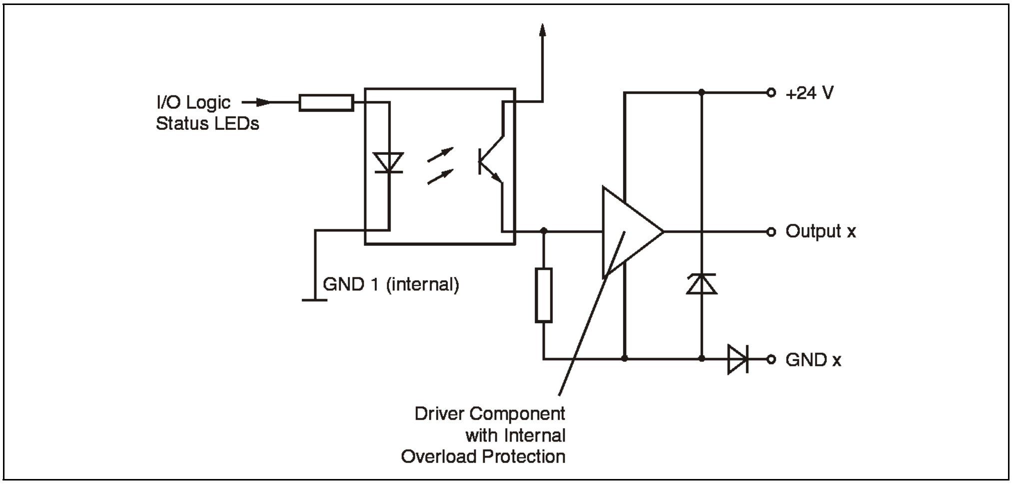


Figure 115: DM476 output circuit diagram

9.2.10 Overload Protection

The overload protection is activated in the following cases:

- Junction temperature for transistors exceeds the limit value (typ. 150° C, min. 135° C, max. 175° C). Causes: Short circuit, overload or environmental temperature is too high
- The 24 V supply voltage (terminal side) is smaller than typ. 12 V (min. 10 V, max. 14.5 V).

The affected output remains switched off until ...

... the junction temperature is again within the limit value (hysteresis typ. 20° C). The time until it is switched on again is within seconds.

... the voltage supply is again within the valid range (typ. >14.5 V).

9.2.11 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single digital input (channel x)	tc_global	BOOL	1	Digit. In	1 ... 16
Read digital inputs I01 - I08 Bit 0 ... I01 Bit 7 ... I08	tc_global	USINT	1	Transp. In	0
Read digital inputs I09 - I16 Bit 0 ... I09 Bit 7 ... I16	tc_global	USINT	1	Transp. In	1
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 16
Digital Outputs O01 - O08 Bit 0 ... O01 Bit 7 ... O08	tc_global	USINT	1	Transp. Out	0
Digital Outputs O09 - O16 Bit 0 ... O09 Bit 7 ... A16	tc_global	USINT	1	Transp. Out	1
Read Status Register	tc_global	USINT	1	Status In	0

Table 176: DM476 variable declaration

Status Register

Status Register	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	Status - 24 V on the output
	1	Diag1 - Diagnostics bit 1
	0	Diag2 - Diagnostics bit 2

7							0
x	x	x	x	x			

Output	Status	Diag1	Diag2	Information
0	0	1	1	Outputs work normally.
1	1	1	1	
0	0	1	1	An output is switched on even though no load is connected.
1	1	0	1	
0	0	1	0	A short circuit or over temperature has occurred with at least one of the outputs.
1	0	1	0	
0	0	0	0	The supply voltage for the output driver has sunk to <12 V.
1	0	0	0	

Table 177: DM476 status register states

9.3 DM486

9.3.1 General Information

The DM486 is a standard digital mixed module. The properties are the same as the DI486 and DO486.

The DM486 supplements the DI486/DO486 and likewise offers very high component density using standard 3.5 mm terminal blocks.

9.3.2 Order Data

Model Number	Short Description	Image
3DM486.6	2005 digital mixed module, 16 inputs 24 VDC, 1 ms, sink/source, 16 transistor outputs 24 VDC, 0.5 A, electrically isolated input and output groups. Order 2 x TB718 terminal blocks separately!	
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	
Terminal blocks are not included in the delivery.		

Table 178: DM486 order data

9.3.3 Technical Data

Product ID	DM486
General Information	
C-UL-US Listed	Yes
B&R ID Code	$63
Module Type	B&R 2005 I/O module
Can be Installed on Main Rack Expansion Rack	 Yes Yes
Power Consumption Internal 5 V 24 V Total External 24 VDC (DO)	 Max. 1.2 W --- Max. 1.2 W Max. 2.2 W
Static Characteristics for Inputs	
Number of Inputs	16
Design	IEC1131 - Type 1
Electrical Isolation Input - PLC Input Groups – Output Groups Input - Input	 Yes Yes No
Wiring	Sink or source
Diagnosis Status Voltage monitoring Input Monitoring	 Supply voltage <18 VDC Input State
Maximum Peak Voltage	500 V for 50 µs max. every 100 ms
Rated Voltage Nominal Maximum	 +24 VDC +30 VDC
Input Current at Nominal Voltage	Approx. 4 mA
Input Resistance	6 kΩ
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Isolation Voltage between Input and Bus	±50 V
Additional Characteristics for Inputs	
Status Display	16 green Input LEDs 1 yellow DCOK LED
Dynamic Characteristics for Inputs	
Input Delay Typical Maximum	 0.5 ms 1 ms

Table 179: DM486 technical data

Product ID	DM486	
Static Characteristics for Outputs		
Number of Outputs	16	
Design	FET positive switching	
Electrical Isolation Output - PLC Output Groups – Input Groups Output - Output	 Yes Yes No	
Diagnosis Status Voltage monitoring Output Monitoring	 Supply voltage <18 VDC Output Status	
Switching Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC	
Continuous Current per Output Module	Rev. <E0 Max. 0.5 A Max. 6 A	Rev. ≥E0 Max. 0.5 A Max. 8 A
	To increase the output current, outputs can be switched in parallel.	
Leakage Current when Switched Off	<120 µA	
Residual Voltage	<200 mV @ 0.5 A	
Short Circuit - Peak Current	<13 A	
Switching On after Overload Cutoff	Automatically within seconds depending on the module temperature	
Protection	Thermal cutoff for over-current and short circuit Integrated protection for switching inductances Reverse Polarity Protection	
Additional Characteristics for Outputs		
Status Display	16 yellow output LEDs 1 yellow DCOK LED 1 red ERROR LED	
Dynamic Characteristics for Outputs		
Switching Delay Log. 0 - Log. 1 Log. 1 - Log. 0	Rev. <E0 < 475 µs < 550 µs	Rev. ≥E0 < 225 µs < 330 µs
Switching Frequency Resistive Load Inductive Load	 Max. 100 Hz See Section 9.3.11 "Switching Inductive Loads", on page 310 (with 90% duty cycle)	
Braking Voltage when Switching Off Inductive Loads	50 VDC	
Mechanical Characteristics		
Dimensions	B&R 2005 single-width	

Table 179: DM486 technical data (cont.)

9.3.4 Status LEDs

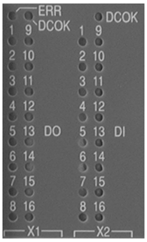
Image	LED	Description
	ERR	The ERR LED is an accumulative indication for all high-side drivers. The LED is lit if an output which is being controlled has a short circuit or over-temperature or if the module voltage sinks below 18 VDC.
	DCOK	The DCOK LED is controlled by the respective supply and is lit if the supply voltage is over +18 VDC.
	1 - 16, yellow	Control status of the corresponding digital output.
	1 - 16, green	Input state of the corresponding digital inputs.

Table 180: DM486 Status LEDs

9.3.5 Connection Elements

Two 18-pin terminal blocks are located next to each other in the lower part of the housing so that all signals can be connected using terminal blocks.

The TB718 terminal blocks are available with screw and cage clamps.

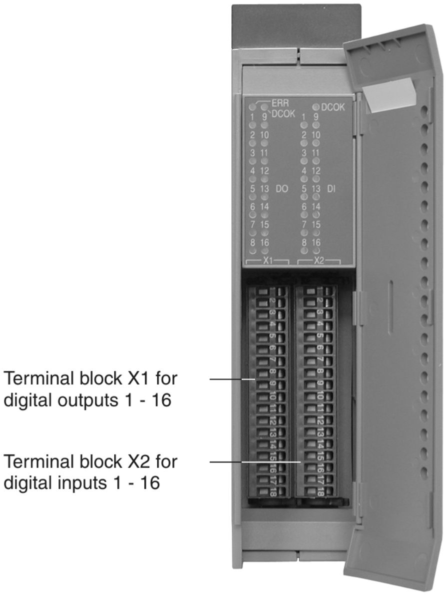


Figure 116: DM486 connection elements

9.3.6 Pin Assignments

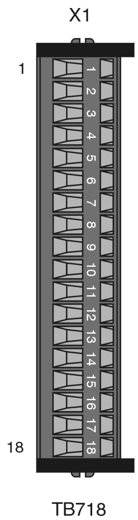
Left 18-pin Terminal Block	Connection	Assignment
	1	Output 1
	2	Output 2
	3	Output 3
	4	Output 4
	5	Output 5
	6	Output 6
	7	Output 7
	8	Output 8
	9	Output 9
	10	Output 10
	11	Output 11
	12	Output 12
	13	Output 13
	14	Output 14
	15	Output 15
	16	Output 16
	17	+24 VDC
	18	GND

Table 181: DM486 pin assignments for terminal block X1

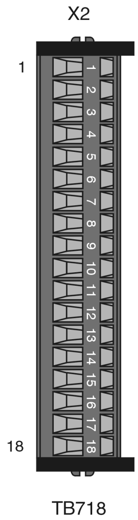
Right 18-pin Terminal Block	Connection	Assignment
	1	Input 1
	2	Input 2
	3	Input 3
	4	Input 4
	5	Input 5
	6	Input 6
	7	Input 7
	8	Input 8
	9	Input 9
	10	Input 10
	11	Input 11
	12	Input 12
	13	Input 13
	14	Input 14
	15	Input 15
	16	Input 16
	17	COMs (+24 VDC in sink operation)
	18	COM (GND in sink operation)

Table 182: DM486 pin assignments for terminal block X2

9.3.7 Connection Example

Digital Outputs

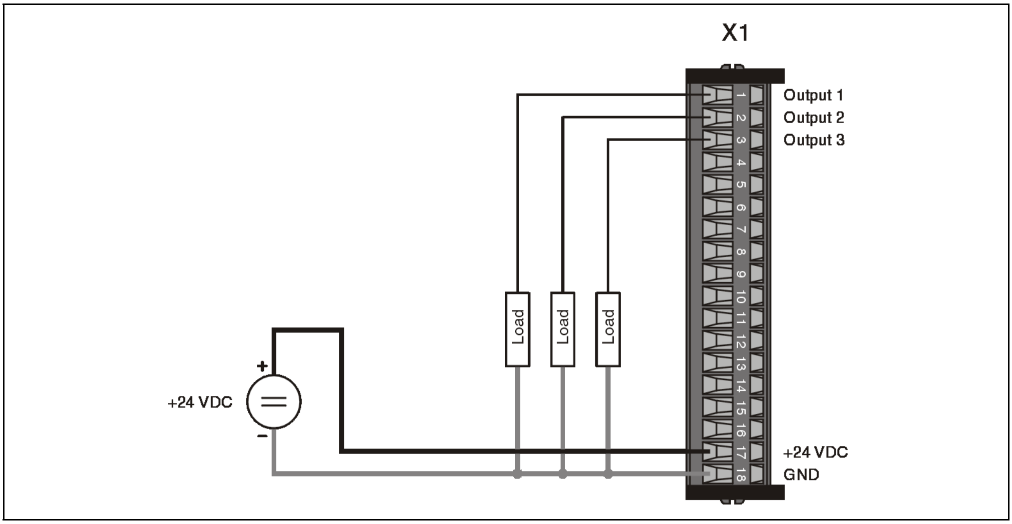


Figure 117: DM486 digital output connection example

Digital Inputs

Sink Connection

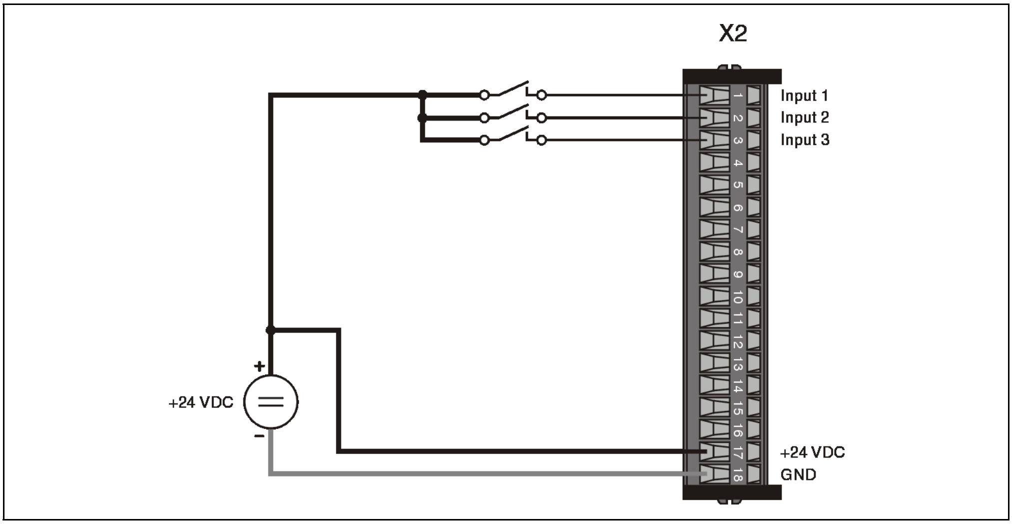


Figure 118: DM486 digital input connection examples (sink)

Source Connection

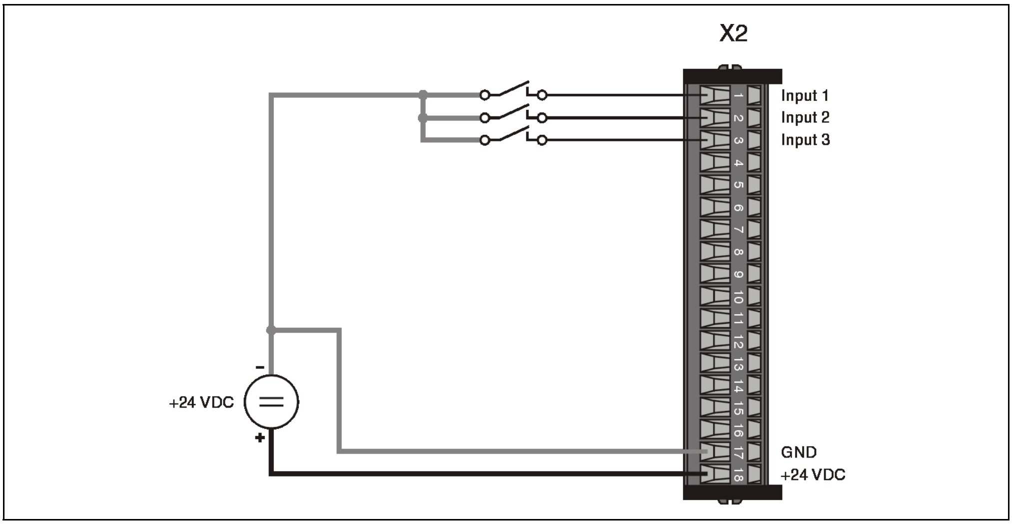


Figure 119: DM486 digital inputs connection examples (source)

9.3.8 Input Circuit Diagram

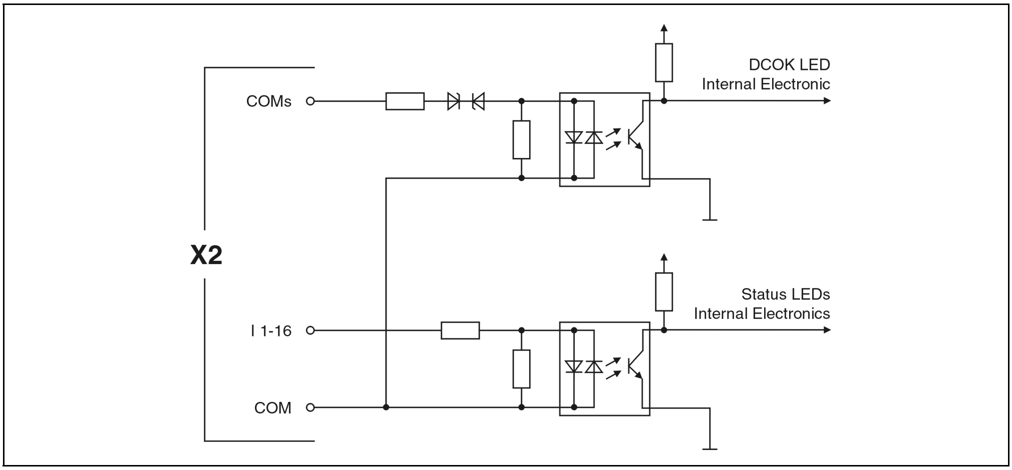


Figure 120: DM486 input circuit diagram

9.3.9 Output Circuit Diagram

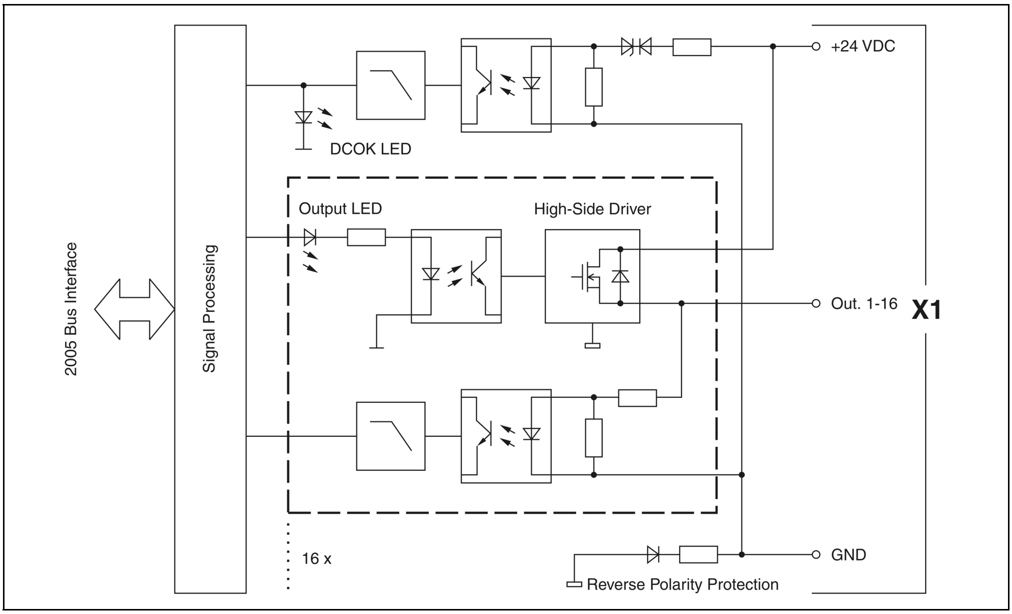


Figure 121: DM486 output circuit diagram

9.3.10 Output Monitoring

The output states are compared to the set values on the module. The output driver is used to control desired states. Output monitoring is only active if the supply voltage for the group is in the valid range.

The status of each individual channel can be read using a register. Additionally, an accumulative bit for output monitoring is created. The status of the supply voltage can also be read.

9.3.11 Switching Inductive Loads

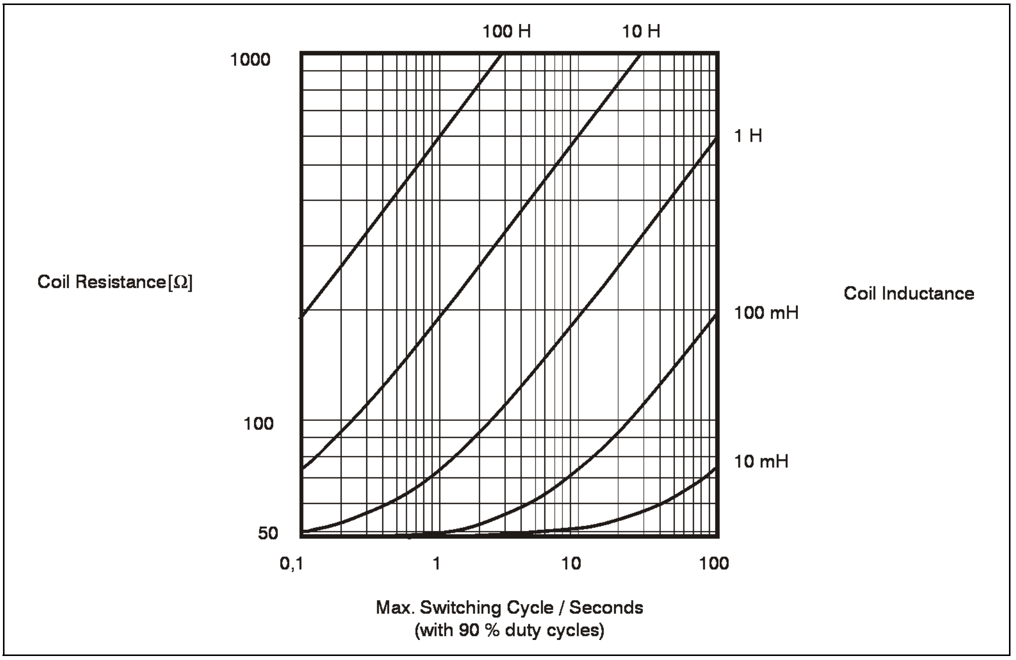


Figure 122: DM486 switching inductive loads

9.3.12 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	1 ... 16
Single digital input (Channel x)	tc_global	BOOL	1	Digit. In	1 ... 16
Single output status (channel x)	tc_global	BOOL	1	Digit. In	65 ... 80
Status register	tc_global	USINT	1	Status In	0

Table 183: DM486 variable declaration

Status Register

Status Register	Bit	Description
	7	DCOK_DI - Supply voltage for inputs in the valid range
	6	DCOK_DO - Supply voltage for outputs in the valid range
	5	x
	4	ERR_2 - Error occurred in output group
	3	x
	2	x
	1	x
	0	x

7							0
		x		x	x	x	x

ERR
0...... Outputs working correctly
1...... A controlled output has short circuited or has an over-temperature status or the module voltage has dropped below 18 VDC

DCOK_DO
0...... No supply voltage or supply voltage too low for outputs
1...... Supply voltage for outputs in the valid range

DCOK_DI
0...... No supply voltage or supply voltage too low for inputs
1...... Supply voltage for inputs in the valid range

10. Analog Input Modules

10.1 General information

Measured values (voltages, currents) are converted into numerical values which can be processed by the PLC using analog input modules.

In the PLC, analog data is always in 16-bit 2s complement regardless of the resolution. Therefore, the resolution of the module used does not have to be taken into consideration when creating an application program.

All analog input modules have a status LED labeled "RUN" which indicates that the A/D converter is active.

10.1.1 Overview

Module	AI350	AI375	AI775	AI780
Number of Channels	8	8	8	8
Input Signal	±10 V	0 to 10 V	0 to 20 mA	0 to 20 mA
Digital Converter Resolution	12-bit	12-bit	12-bit	16-bit

Table 184: Analog Input Module Overview

10.1.2 Programming

The analog data points are accessed directly in the application program using a variable name. The relationship between the channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

10.2 AI350 / AI375

10.2.1 General information

The AI350 and AI375 are standard analog input modules.

10.2.2 Order Data

Model Number	Short Description	Image
3AI350.6	2005 analog input module, 8 inputs, +/- 10 V, 12-bit. Order terminal block separately.	
3AI375.6	2005 Analog Input Module, 8 inputs, 0 to 10 V, 12-bit. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 185: AI350 / AI375 order data

10.2.3 Technical Data

Product ID	AI350	AI375
C-UL-US Listed	Yes	Yes
B&R ID Code	$82	$80
Number of Inputs	8 differential inputs	
Electrical Isolation Input - PLC Input - Input	 Yes No	
Input signal Nominal Min./Max.	 -10 to +10 V -20 to +20 V	 0 to +10 V -20 to +20 V

Table 186: AI350 / AI375 technical data

Product ID	AI350	AI375
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs	
Digital Converter Resolution	12-bit	12-bit
Non-Linearity	±1 LSB	
Output Format	INT $8000 - $7FF0 1 LSB = $0010 = 4.883 mV	INT $0000 - $7FF8 1 LSB = $0008 = 2.441 mV
Conversion Procedure	Successive approximation	
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms	
Differential Input Resistance	2 MΩ	
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz	
Basic Accuracy at 25° C	±0.1% 1)	
Offset Drift	Max. ±0.0037% /° C 1)	
Gain Drift	Max. ±0.0075% /° C 2)	
Repeat Precision	±0.025% 1)	
Cross-Talk between Channels	-66 dB	
Common-Mode Rejection DC 50 Hz	 50 dB 45 dB	
Maximum Modulation Compared to Ground Potential	±50 V	
Common Mode Modulation Capability between Two Channels	±5 V	±10 V
Power Consumption 5 V 24 V Total	 Max. 1 W Max. 3.5 W Max. 4.5 W	
Dimensions	B&R 2005 single-width	

Table 186: AI350 / AI375 technical data (cont.)

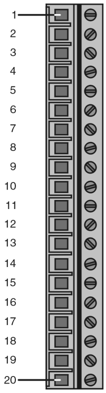
1) Refers to the measurement range.
2) Refers to the current measurement value.

10.2.4 Status LEDs

Image	LED	Description
	RUN	The RUN LED indicates that the analog/digital converter is running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 187: AI350 / AI375 status LEDs

10.2.5 Pin Assignments



TB170

Connection	Assignment
1	+ Input 1
2	- Input 1
3	+ Input 2
4	- Input 2
5	+ Input 3
6	- Input 3
7	+ Input 4
8	- Input 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Input 5
14	- Input 5
15	+ Input 6
16	- Input 6
17	+ Input 7
18	- Input 7
19	+ Input 8
20	- Input 8

Table 188: AI350 / AI375 pin assignments

Signal Cable Connection

Shielded cables must be used with analog input modules. The ground connection for the shield is made on one of the terminal block shield connections provided for the two inputs.

For EMC reasons, it is recommended to short circuit the inputs which are not used.

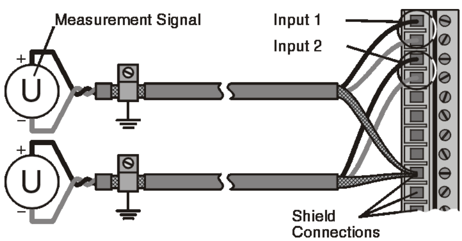


Figure 123: AI350 / AI375 signal cable connection

The four shielded connections are of the same value and each connected via 100 Ω resistors with ground (⏚, that means: a spring contact and a mounting rail).

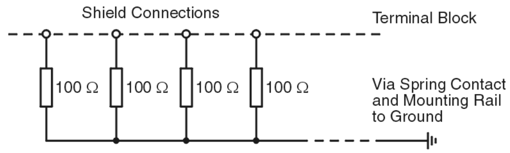


Figure 124: AI350 / AI375 shielded connection

10.2.6 Input Circuit Diagram

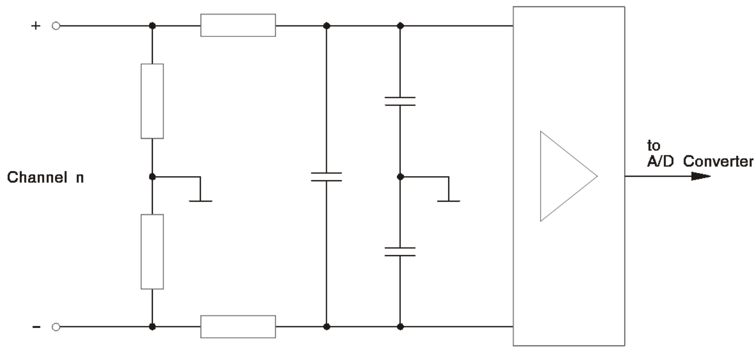


Figure 125: AI350 / AI375 input circuit diagram

10.2.7 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after power-on.

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms due to the higher computing time needed.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value : %00010000

With this type of operation, the measurement cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse). Conversion of all eight channels is carried out without responding to further start pulses. The end of the cycles is registered by setting bit 7 in the status register 2.

Application example: Data acquisition (without jitter) in high-speed task classes (e.g. for a controller).

Mode Register 8	Analog Input Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Start measurement channel 1	t_c1 = t_0 + 128 to 130 µs
	Start measurement channel 2	t_c1 + 1 * 85 µs
	Start measurement channel 3	t_c1 +2 * 85 µs
	Start measurement channel 4	t_c1 +3 * 85 µs
	Start measurement channel 5	t_c1 +4 * 85 µs
	Start measurement channel 6	t_c1 +5 * 85 µs
	Start measurement channel 7	t_c1 +6 * 85 µs
	Start measurement channel 8	t_c1 +7 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 189: AI350 / AI375 special operating mode 1: Direct software timing

1) Writing the measurement value in the Dual Ported RAM (DPR) can be interrupted by accessing the module using the bus. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

Mode register 2 must be set to the following value : %00110000

The procedure is similar to special operating mode 1. However, in special operating mode 2 there is the option to set the time when the next measurement should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles. The conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for default times: 2000 to 65535 µs

Application example: equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1 . At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Input Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Start measurement channel 1	t_c1 = t_St + 128 to 130 µs
	Start measurement channel 2	t_c1 + 1 * 85 µs
	Start measurement channel 3	t_c1 +2 * 85 µs
	Start measurement channel 4	t_c1 +3 * 85 µs
	Start measurement channel 5	t_c1 +4 * 85 µs
	Start measurement channel 6	t_c1 +5 * 85 µs
	Start measurement channel 7	t_c1 +6 * 85 µs
	Start measurement channel 8	t_c1 +7 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in status register 2 = 1(cycle end)	t_pre - 100 µs

Table 190: AI350 / AI375 special operating mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Input Module	Time
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 190: AI350 / AI375 special operating mode 2: Software timing using default time (cont.)

1) Writing the measurement value in the Dual Ported RAM (DPR) can be interrupted by accessing the module using the bus. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

10.2.8 Relationship between Input Voltage and Converter Value

AI350

The converter value (INT format) changes in increments of 16 (0, 16, 32, etc.).

Voltage	Converter Value	
	Hexadecimal	Decimal
≤-10 V	8000	-32768
-4.883 mV	FFF0	-16
0 V	0000	0
4.883 mV	0010	16
≥10 V	7FF0	32752

Table 191: AI350 Relationship between input voltage and converter value

AI375

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Voltage	Converter Value	
	Hexadecimal	Decimal
≤0 V	0000	0
2.441 mV	0008	8
≥10 V	7FF8	32760

Table 192: AI375 Relationship between input voltage and converter value

10.2.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 8

Table 193: AI350 / AI375 variable declaration

Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1

Table 193: AI350 / AI375 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

0	0	0	0	0	0		0

7 0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive final value when averaging is switched on is $7FEF with the AI350 instead of $7FF0 and $7FF7 instead of $7FF8 with the AI375.

Mode Register 2

Bits 0 and -3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description	
	7	0	
	6	0	
	5	SWT_TIM	- Software timing using default time
	4	SWT_DIR	- Direct software timing
	3	0	
	2	0	
	1	0	
	0	0	

7							0
0	0			0	0	0	0

SWT_DIR
0 ...... Normal operation (default setting)
1 ...... Special operating mode 1 (Direct Software Timing)

SWT_TIM
SWT_TIM is only active if SWT_DIR is set to 1!
0 ...... Operating mode dependent on SWT_DIR (default setting)
1 ...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The measurement of the eight channels must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

	0	0	0	0	0	0	0
7							0

TRIGn	TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0) A write access using TRIGn = 0 triggers the immediate measurement of all eight channels. A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

7							0
x	x	x	x	x	x		

I_ERR 0 ..... Data values in the dual ported RAM (DPR) correspond to definitions
1 ..... An internal error exists. That means that the data values in the Dual Ported RAM (DPR) do not correspond to the definitions. Please contact B&R if this occurs.

MW Averaging in normal operation is active (mode register 1 settings are repeated)

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

7							0
	x			x	x	x	x

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0 ...... Measurement or waiting loop is running
1 ...... The last cycle is completed

10.3 AI775

10.3.1 General information

The AI775 is a standard analog input module.

10.3.2 Order Data

Model Number	Short Description	Image
3AI775.6	2005 analog input module, 8 inputs, 0 to 20 mA, 12-bit. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 194: AI775 order data

10.3.3 Technical Data

Product ID	AI775
C-UL-US Listed	Yes
B&R ID Code	$81
Number of Inputs	8 differential inputs
Electrical Isolation Input - PLC Input - Input	 Yes No
Input signal Nominal Min./Max.	 0 to 20 mA -50 to +50 mA
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs

Table 195: AI775 technical data

Product ID	AI775
Digital Converter Resolution	12-bit
Non-Linearity	±1 LSB
Output Format	INT $0000 - $7FF8 1 LSB = $0008 = 4.883 µA
Conversion Procedure	Successive approximation
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Load	50 Ω
Voltage Drop at 20 mA	1 V
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz
Basic Accuracy at 25° C	±0.1% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.01% /° C 2)
Repeat Precision	±0.05% 1)
Cross-Talk between Channels	-66 dB
Common-Mode Rejection DC 50 Hz	 55 dB 50 dB
Maximum Modulation Compared to Ground Potential	±50 V
Common Mode Modulation Capability between Two Channels	±15 V
Power Consumption 5 V 24 V Total	 Max. 1 W Max. 3.5 W Max. 4.5 W
Dimensions	B&R 2005 single-width

Table 195: AI775 technical data

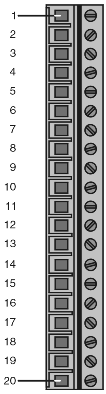
1) Refers to the measurement range.
2) Referring to the current measurement value.

10.3.4 Status LEDs

Image	LED	Description
	RUN	The RUN LED indicates that the analog/digital converter is running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 196: AI775 status LEDs

10.3.5 Pin Assignments



TB170

Connection	Assignment
1	+ Input 1
2	- Input 1
3	+ Input 2
4	- Input 2
5	+ Input 3
6	- Input 3
7	+ Input 4
8	- Input 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Input 5
14	- Input 5
15	+ Input 6
16	- Input 6
17	+ Input 7
18	- Input 7
19	+ Input 8
20	- Input 8

Table 197: AI775 pin assignment

Signal Cable Connection

Shielded cables must be used with analog input modules. The ground connection for the shield is made on one of the terminal block shield connections provided for the two inputs.

For EMC reasons, it is recommended to short circuit the inputs which are not used.

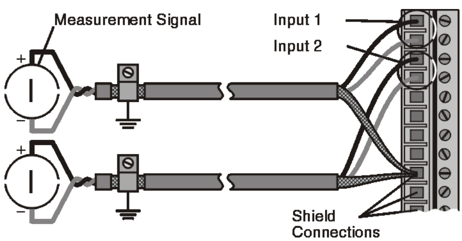


Figure 126: AI775 signal cable connection

The four shielded connections are of the same value and each connected via 100 Ω resistors with ground (⏚, that means: a spring contact and a mounting rail).

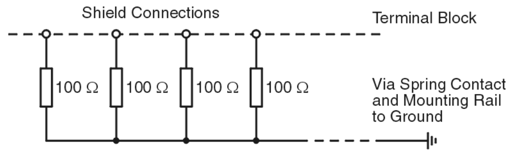


Figure 127: AI775 shielded connection

10.3.6 Input Circuit Diagram

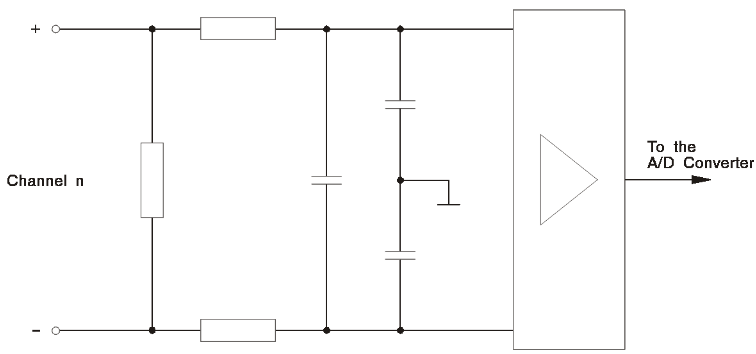


Figure 128: AI775 input circuit diagram

10.3.7 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However, changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after power-on.

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms, due to the higher computing time needed.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value : %00010000

With this type of operation, the measurement cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse). Conversion of all eight channels is carried out, without responding to further start pulses. The end of the cycles is registered by setting bit 7 in the status register 2.

Application example: Data acquisition (without jitter) in high-speed task classes (e.g. for a controller).

Mode Register 8	Analog Input Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in status register 2 = 0	t_0 + 20 to 40 µs
	Start measurement channel 1	t_c1 = t_0 + 128 to 130 µs
	Start measurement channel 2	t_c1 + 1 * 85 µs
	Start measurement channel 3	t_c1 +2 * 85 µs
	Start measurement channel 4	t_c1 +3 * 85 µs
	Start measurement channel 5	t_c1 +4 * 85 µs
	Start measurement channel 6	t_c1 +5 * 85 µs
	Start measurement channel 7	t_c1 +6 * 85 µs
	Start measurement channel 8	t_c1 +7 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 198: AI775 Special Operating Mode 1: Direct software timing

1) Writing the measurement value in the Dual Ported RAM (DPR) can be interrupted by accessing the module using the bus. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

Mode register 2 must be set to the following value : %00110000

The procedure is similar to special operating mode 1. However in special operating mode 2 there is the option to set the time when the next measurement should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles. The conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1. At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Input Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Start measurement channel 1	t_c1 = t_St + 128 to 130 µs
	Start measurement channel 2	t_c1 + 1 * 85 µs
	Start measurement channel 3	t_c1 +2 * 85 µs
	Start measurement channel 4	t_c1 +3 * 85 µs
	Start measurement channel 5	t_c1 +4 * 85 µs
	Start measurement channel 6	t_c1 +5 * 85 µs
	Start measurement channel 7	t_c1 +6 * 85 µs
	Start measurement channel 8	t_c1 +7 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in status register 2 = 1(cycle end)	t_pre - 100 µs

Table 199: AI775 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Input Module	Time
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 199: AI775 Special Operating Mode 2: Software timing using default time (cont.)

1) Writing the measurement value in the Dual Ported RAM (DPR) can be interrupted by accessing the module using the bus. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

10.3.8 Relationship between Input Current and Converter Value

The converter value (INT format) changes in increments of 8 (0, 8, 16, ...).

Current	Converter Value	
	Hexadecimal	Decimal
≤0 A	0000	0
4.883 µA	0008	8
≥20 mA	7FF8	32760

Table 200: AI775 Relationship between input current and converter value

10.3.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 8
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1

Table 201: AI775 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

0	0	0	0	0	0		0

7 0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive limit for averaging is $7FF7 instead of $7FF8.

Mode Register 2

Bits 0 and -3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

7							0
0	0			0	0	0	0

SWT_DIR	0 ...... Normal operation (default setting) 1 ...... Special operating mode 1 (Direct Software Timing)
SWT_TIM	SWT_TIM is only active if SWT_DIR is set to 1! 0 ...... Operating mode dependent on SWT_DIR (default setting) 1 ...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The measurement of the eight channels must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

7							0
	0	0	0	0	0	0	0

TRIGn	TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0) A write access using TRIGn = 0 triggers the immediate measurement of all eight channels. A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

7							0
x	x	x	x	x	x		

I_ERR 0 ......Data values in the dual ported RAM (DPR) correspond to definitions.
1 ......An internal error exists. That means that the data values in the Dual Ported RAM (DPR) do not correspond to the definitions. Please contact B&R if this occurs.

MW Averaging in normal operation is active (mode register 1 settings are repeated).

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

7							0
	x			x	x	x	x

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0 ......Measurement or waiting loop is running
1 ......The last cycle is completed

10.4 AI780

10.4.1 General Information

The AI780 is an 8-channel analog input module. The channels are single channel isolated. An individual analog/digital converter is used for each channel.

An electrically isolated encoder supply is created for each channel from a 24 VDC module supply.

10.4.2 Order Data

Model Number	Short Description	Figure
3AI780.6	2005 analog input module, 8 inputs, 0 to 20 mA, 16-bit, 24 VDC encoder supply, single channel isolation and encoder supply. Order 2 x TB718 terminal blocks separately.	

Table 202: AI780 order data

10.4.3 Technical Data

Product ID	AI780
General Information	
C-UL-US Listed	In preparation
B&R ID Code	$84
Can be Installed on Main Rack Expansion Rack	 Yes Yes

Table 203: AI780 technical data

Product ID	AI780
Static Characteristics	
Module Type	B&R 2005 I/O module
Input Type	Current Signal 0 - 25 mA
Number of Inputs	8
Module Supply	24 VDC ±10% (21.6 - 26.4 VDC)
Encoder Supply General Information	An electrically isolated encoder supply is created from the module supply for each channel.
Encoder Supply Voltage Current	 Module supply -15% / +25% Max. 30 mA
Common Potential between Channels	None (single channel isolation)
Protection of all Channels against Incoming Voltage and Reverse Polarity	Up to 30 VDC
Overload Display	LED
Output of the Digital Value during Overload Limits Exceeded Limits not Reached	Depends on module configuration $7FFF $8001
Digital Converter Resolution	16-bit
Data Format Delivered to the Application Program Default setting 0 mA 20 mA	INT $0000 $7FFF
Conversion Method	Sigma Delta
Conversion Time for all Channels Continuous Mode 50 Hz 60 Hz Trigger Mode 50 Hz 60 Hz	 20 ms 16.67 ms 60 ms 50 ms
Input Impedance in Signal Range	Max. 400 Ω
Zero Error at 25° C	±0.005% 1)
Basic Accuracy at 25° C	±0.05% 1)
Offset Drift	±0.001%/°C1)
Gain Drift	±0.007%/°C2)
Common Mode Range	±300 VAC/VDC
Noise (Peak to Peak)	±0.001% 1)
Cross-talk between Channels for DC Voltage, 50 Hz, 60 Hz and up to 300 VAC/VDC	<1 LSB
Linearization Method	Electronic compensation on the module Measurement value adjustment can be made by the user using application software

Table 203: AI780 technical data (cont.)

Product ID	AI780
Measurement Ranges	0 - 25 mA @ converter resolution 16-bit
Wiring	See 10.4.7 "Connection Examples", on page 342
Power Consumption internal 5 V 24 V Total Module Supply	 Max. 1.5 W --- Max. 1.5 W Max. 14 W
Dynamic Characteristics	
Total System Input Transfer Time	System dependent, cyclic in task class intervals
Analog filter Cut-off Frequency Attenuation Step-response	 80 Hz 20 dB/Decade 63% in 2 ms
Digital filter for first notch frequency of 50 Hz and 60 Hz	>120 dB
Maximum short term deviation during every defined electrical disturbance check	±1%
Operating Characteristics	
Operating Voltage Channel to Ground Channel to Channel	 Max. 300 V_{eff} Max. 600 V_{eff}
Pulse Dielectric Strength at 2000 m above Sea Level Channel to Ground Channel to Channel	 4000 V 4000 V
Operating Modes Operating Mode 1 Operating Mode 2	For a more detailed explanation see section 10.4.10 "Operating Modes", on page 345 continuous mode (Standard Mode) Trigger mode
Calibrating or Testing for Maintaining the Accuracy Class	None
Non-Linearity	<0.003% 1)
Operational conditions	
Environmental temperature during operation	0 to +60° C (see also section 10.4.9 "Derating", on page 345)
Relative humidity during operation	5 to 95%, non-condensing
Mechanical characteristics	
Dimensions	B&R 2005 single-width
Terminal Layout	See 10.4.6 "Pin Assignments", on page 341

Table 203: AI780 technical data (cont.)

1) Refers to the measurement range (0 - 25 mA)
2) Refers to the current measurement value

10.4.4 Status LEDs

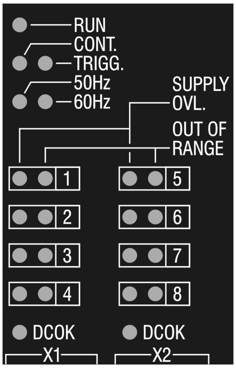
<table>
<tr><th>Figure</th><th>LED</th><th colspan="2">Description</th></tr>
<tr><td rowspan="16">
</td><td>RUN</td><td colspan="2">Indicates that the analog/digital converter is running and is being accessed on the module via the I/O bus.</td></tr>
<tr><td>CONT.</td><td colspan="2">Continuous mode is set (standard mode).</td></tr>
<tr><td>TRIGG.</td><td colspan="2">Trigger mode is set. The LED is lit when a measurement cycle is started by a trigger pulse for all eight channels.</td></tr>
<tr><td>50Hz</td><td colspan="2">The filter time is 20 ms.</td></tr>
<tr><td>60 Hz</td><td colspan="2">The filter time is 16.67 ms.</td></tr>
<tr><td rowspan="4">Supply Overload 1 - 8</td><td colspan="2">Status display for encoder supply. Each channel is assigned one LED.</td></tr>
<tr><td>Status</td><td>Description</td></tr>
<tr><td>Constant light</td><td>An over-current or a short circuit has occurred in the respective channel supply.</td></tr>
<tr><td>Blink signal</td><td>A converter error exists or the module supply is too low.</td></tr>
<tr><td rowspan="5">Out of Range 1 - 8</td><td colspan="2">Status display for input range and converter function. Each channel is assigned one LED.</td></tr>
<tr><td>Status</td><td>Description</td></tr>
<tr><td>Constant light</td><td>The input signal for the channel is outside the valid range.</td></tr>
<tr><td>Blink signal</td><td>When the Out of Range LED is blinking, then the converter for this channel is out of service.</td></tr>
<tr><td>Double pulse</td><td>When the LED Out of Range blinks as a double pulse, then the input signal for the channel is outside the valid range and converter for this channel is out of service.</td></tr>
<tr><td>DCOK</td><td colspan="2">The DCOK LED is controlled by the respective module supply and is lit if the supply voltage is over 18 VDC.</td></tr>
</table>

Table 204: AI780 status LEDs

10.4.5 Connection Elements

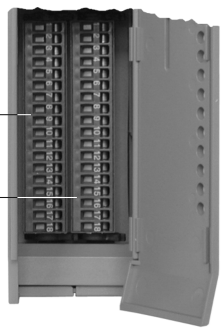


Figure 129: AI780 connection elements

10.4.6 Pin Assignments

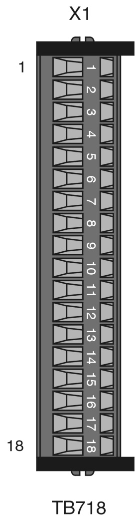
Left 18-pin Terminal Block	Pin	Assignment
	1	+ Encoder supply 1
	2	+ Current input 1
	3	- Current input 1
	4	Free
	5	+ Encoder supply 2
	6	+ Current input 2
	7	- Current input 2
	8	Free
	9	+ Encoder supply 3
	10	+ Current input 3
	11	- Current input 3
	12	Free
	13	+ Encoder supply 4
	14	+ Current input 4
	15	- Current input 4
	16	Free
	17	+24 VDC
	18	GND

Table 205: AI780 pin assignments for terminal block X1

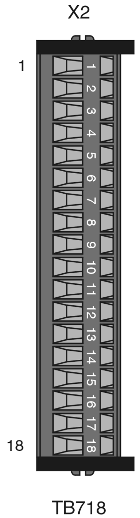
Right 18-pin Terminal Block	Pin	Assignment
	1	+ Encoder supply 5
	2	+ Current input 5
	3	- Current input 5
	4	Free
	5	+ Encoder supply 6
	6	+ Current input 6
	7	- Current input 6
	8	Free
	9	+ Encoder supply 7
	10	+ Current input 7
	11	- Current input 7
	12	Free
	13	+ Encoder supply 8
	14	+ Current input 8
	15	- Current input 8
	16	Free
	17	+24 VDC
	18	GND

Table 206: AI780 pin assignment for terminal block X2

10.4.7 Connection Examples

Encoder Connection with External Supply

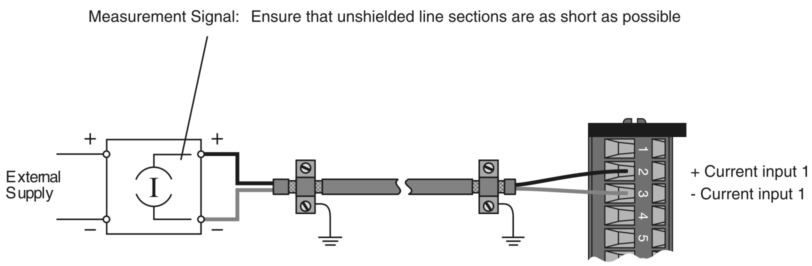


Figure 130: AI780 encoder connection with external supply

Encoder Connection with Internal Supply

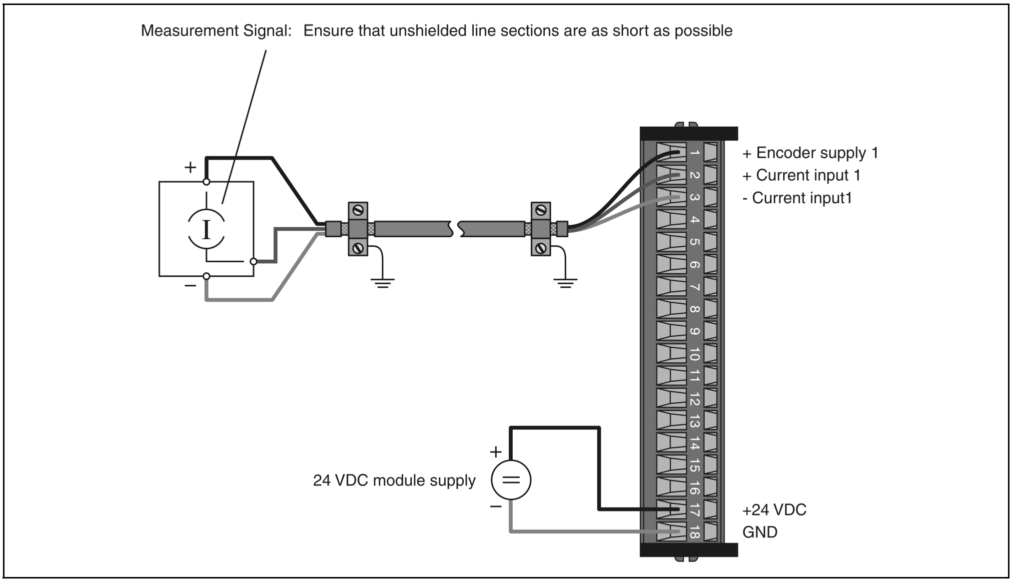


Figure 131: AI780 encoder connection with internal supply

Two Wire Connection with Supply via AI780

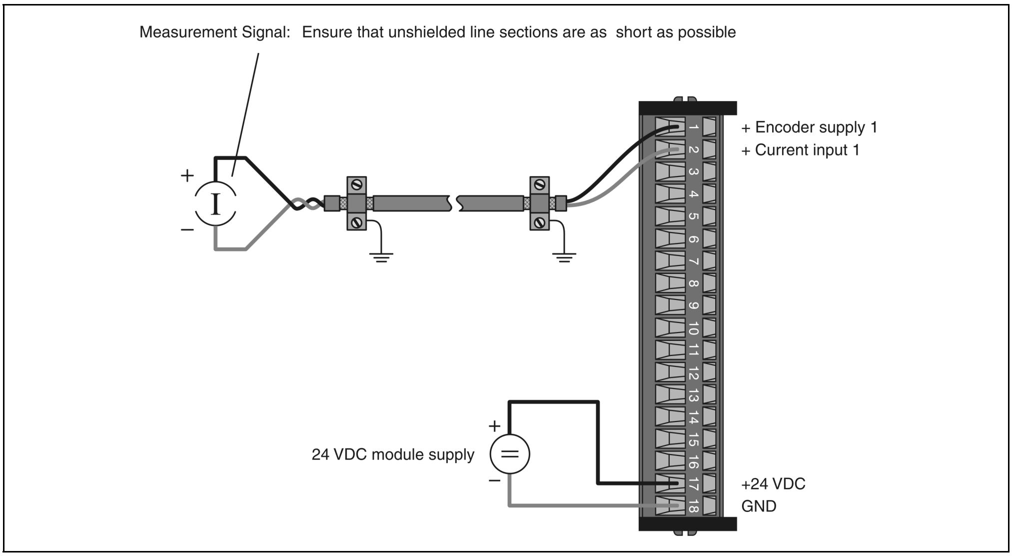


Figure 132: AI780 two wire connection with supply via AI780

10.4.8 Input Circuit Diagram

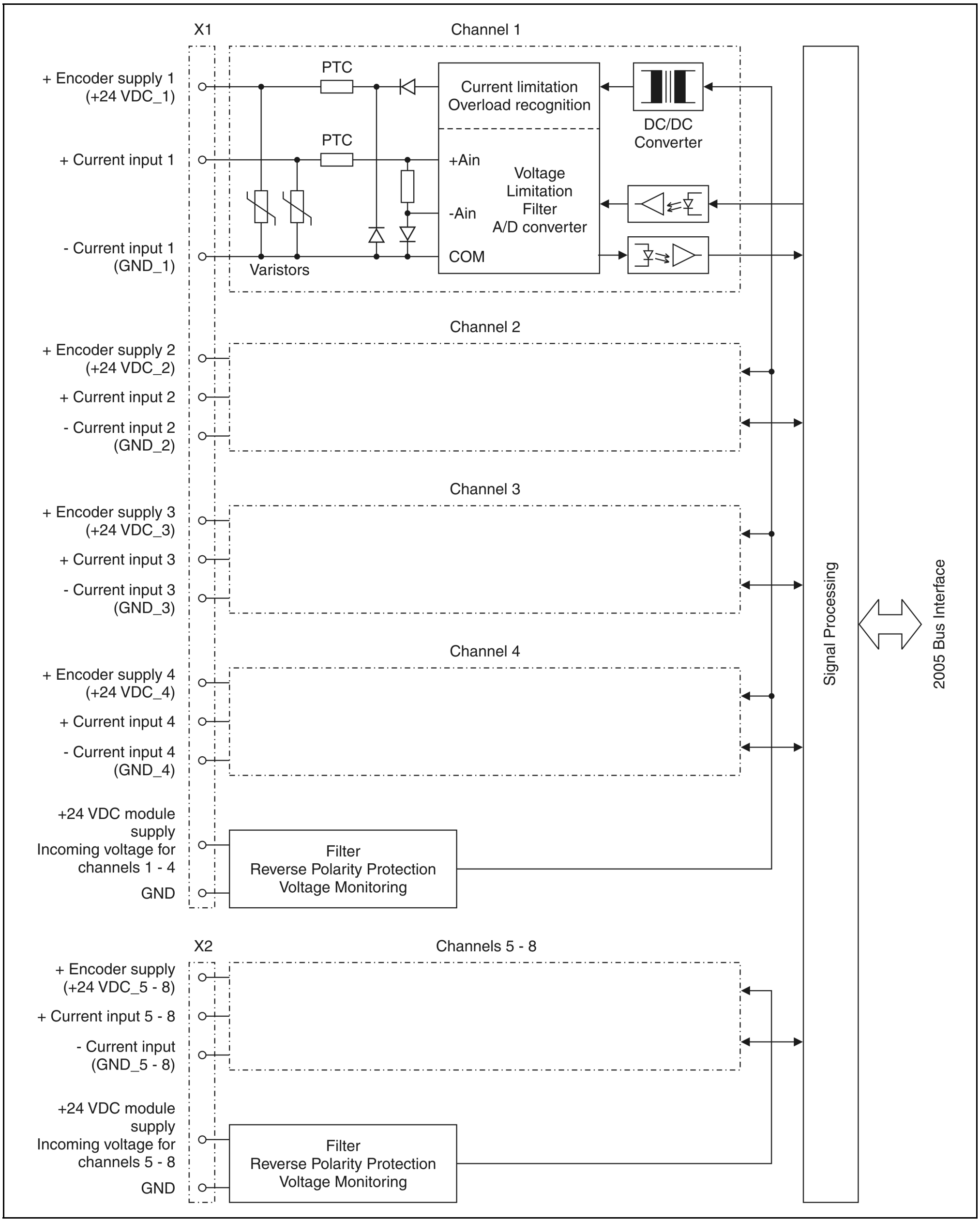


Figure 133: AI780 input circuit diagram

10.4.9 Derating

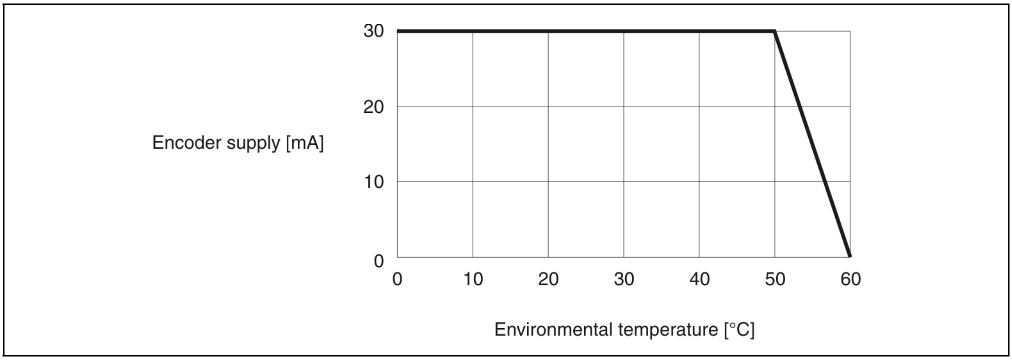


Figure 134: AI780 derating

10.4.10 Operating Modes

Two operating modes can be configured for the AI780. The configured operating mode is valid for all eight channels.

Continuous Mode

The continuous mode is also known as the standard mode. In this mode, the AI780 is found after power-on. The analog/digital converters run asynchronous to one another and convert the respective channel as fast as possible.

Trigger Mode

The trigger mode is configured by setting bit 0 in the configuration register. The analog/digital converter for a measurement cycle are activated using a trigger pulse. For the remainder of the time, they are stopped.

10.4.11 Standardization

The input signal is converted to a raw value by the analog/digital converter. A measurement value is calculated from this raw value, which is then made available to the user for his program.

The operating system for the AI780 offers the possibility of standardization. Therefore the measurement value is calculated in a defined physical unit by the user.

10.4.12 Variable Declarations

B&R Automation Studio™ Support: See B&R Automation Studio™ Help starting with V1.40

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Read single analog input (channel x) Depending on the configuation, the measurement value or the standardized measurement value is read.	tc_global	INT	1	Analog In	1 ... 8
Lower limit values were exceeded	tc_global	USINT	1	Status In	0
Upper limit values exceeded	tc_global	USINT	1	Status In	1
Read converter function register	tc_global	USINT	1	Status In	2
Read supply overload register	tc_global	USINT	1	Status In	3
Read module status	tc_global	USINT	1	Status In	6
Sends trigger pulse by setting bit 7	tc_global	USINT	1	Transparent Out	0
Configure module	tc_global	USINT	1	Transparent Out	1
Switches standardization on or off. The following settings are accepted using the positive edge when switching on the standardization: • All settings in the data module (see section "Data for the Standardization", on page 353) • The variable "Standardization using Coordinates or Slope and Offset" • The variable "Standardization absolute/relative"	tc_global	USINT	1	Transparent Out	3
Standardization using two coordinates (x0/y0) and (x1/y1) or using slope k and offset d.	tc_global	USINT	1	Transparent Out	4
Standardization absolute/relative (see section "Absolute or relative standardization", on page 354).	tc_global	USINT	1	Transparent Out	5

Table 207: AI780 variable declaration Data Area

Lower Limit Values were Exceeded (read)

Lower limit values are defined in the data module (default: $8001). The data module is described in section "Data for the Standardization", on page 353.

Bit	Description
0	0 ... signal from channel 1 is in the valid range 1 ... Signal from channel 1 is below the limit value
1	0 ... signal from channel 2 is in the valid range 1 ... Signal from channel 2 is below the limit value
2	0 ... Signal from channel 3 is in the valid range 1 ... Signal from channel 3 is below the limit value
3	0 ... signal from channel 4 is in the valid range 1 ... Signal from channel 4 is below the limit value
4	0 ... Signal from channel 5 is in the valid range 1 ... Signal from channel 5 is below the limit value
5	0 ... signal from channel 6 is in the valid range 1 ... Signal from channel 6 is below the limit value
6	0 ... Signal from channel 7 is in the valid range 1 ... Signal from channel 7 is below the limit value
7	0 ... signal from channel 8 is in the valid range 1 ... Signal from channel 8 is below the limit value

Upper Limit Values Exceeded (read)

The upper limit value is defined in the data module (default: $7FFF). The data module is described in section "Data for the Standardization", on page 353.

Bit	Description
0	0 ... signal from channel 1 is in the valid range 1 ... Signal from channel 1 is above the limit value
1	0 ... signal from channel 2 is in the valid range 1 ... Signal from channel 2 is above the limit value
2	0 ... Signal from channel 3 is in the valid range 1 ... Signal from channel 3 is above the limit value
3	0 ... signal from channel 4 is in the valid range 1 ... Signal from channel 4 is above the limit value
4	0 ... Signal from channel 5 is in the valid range 1 ... Signal from channel 5 is above the limit value
5	0 ... signal from channel 6 is in the valid range 1 ... Signal from channel 6 is above the limit value
6	0 ... Signal from channel 7 is in the valid range 1 ... Signal from channel 7 is above the limit value
7	0 ... signal from channel 8 is in the valid range 1 ... Signal from channel 8 is above the limit value

Converter Function Register (read)

Bit	Description
0	0 ... Converter for channel 1 is running 1 ... Converter for channel 1 is out of service 1)
1	0 ... Converter for channel 2 is running 1 ... Converter for channel 2 is out of service 1)
2	0 ... Converter for channel 3 is running 1 ... Converter for channel 3 is out of service 1)
3	0 ... Converter for channel 4 is running 1 ... Converter for channel 4 is out of service 1)
4	0 ... Converter for channel 5 is running 1 ... Converter for channel 5 is out of service 1)
5	0 ... converter for channel 6 is running 1 ... Converter for channel 6 is out of service 1)
6	0 ... Converter for channel 7 is running 1 ... Converter for channel 7 is out of service 1)
7	0 ... Converter for channel 8 is running 1 ... Converter for channel 8 is out of service 1)

1) The converter can be out of service either because of a disturbance or because the 24 VDC industrial voltage to terminal blocks X1 and X2 is missing (Pin 17 and 18).

Supply Overload Register (read)

Bit	Description
0	0 ... Encoder supply for channel 1 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 1.
1	0 ... encoder supply for channel 2 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 2.
2	0 ... Encoder supply for channel 3 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 3.
3	0 ... encoder supply for channel 4 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 4.
4	0 ... Encoder supply for channel 5 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 5.
5	0 ... encoder supply for channel 6 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 6.
6	0 ... Encoder supply for channel 7 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 7.
7	0 ... encoder supply for channel 8 is in the valid range 1 ...An over-current or a short circuit has occurred in the encoder supply for channel 8.

Status Register (read)

Bit	Description
0	0 ... Continuous Mode 1 ... Trigger Mode
1	0
2	0 ... Filter 50 Hz (20 ms measurement cycle) 1 ... Filter 60 Hz (16.67 ms measurement cycle)
3	0
4	0 ... The errors are displayed in the status registers and also in the measurement value. $7FFF ... Overflow $8001 .... Underflow $8000 .... Converter is out of service 1 ... The errors are only displayed in the corresponding status register (overflow, underflow, converter is out of service)
5	This bit has only one function, if bit 4 is set in the configuration register (errors are only displayed in the corresponding status register). 0 ... The measurement values are not limited 1 ... The measurement values are limited downwards with the lower limit value and upwards with the upper limit value.
6	0 ... The measurement values correspond to the definitions. 1 ... A system error exists. This means that the measurement values do not correspond to the definitions. Please contact B&R if this occurs.
7	0 ... Measurement is running 1 ... Measurement completed. The bit is set differently depending on the operating mode: Continuous Mode ... after the first measurement Trigger Mode .... after each measurement

Trigger Pulse (write)

Bit	Description
0 - 6	0
7	0 ... Measurement is not triggered 1 ... Measurement is triggered

Configuration Register (write)

Bit	Description
0	0 ... Continuous Mode (default setting) 1 ... Trigger Mode
1	0
2	0 ... Filter 50 Hz (20 ms measurement cycle) (default setting) 1 ... Filter 60 Hz (16.67 ms measurement cycle)
3	0
4	0 ... The errors are additionally displayed in the status registers also in the measurement value (default setting). $7FFF ... Overflow $8001 .... Underflow $8000 .... Converter is out of service 1 ... The errors are only displayed in the corresponding status register (overflow, underflow, converter is out of service)
5	This bit has only one function, if bit 4 is set in the configuration register (errors are only displayed in the corresponding status register). 0 ... The measurement values are not limited (default setting) 1 ... The measurement values are limited downwards with the lower limit value and upwards with the upper limit value.
6 - 7	0

Switches Standardization On / Off (write)

Bit	Description
0	0 ... Channel 1 is not standardized 1 ... Channel 1 is standardized
1	0 ... Channel 2 is not standardized 1 ... Channel 2 is standardized
2	0 ... Channel 3 is not standardized 1 ... Channel 3 is standardized
3	0 ... Channel 4 is not standardized 1 ... Channel 4 is standardized
4	0 ... Channel 5 is not standardized 1 ... Channel 5 is standardized
5	0 ... Channel 6 is not standardized 1 ... Channel 6 is standardized
6	0 ... Channel 7 is not standardized 1 ... Channel 7 is standardized
7	0 ... Channel 8 is not standardized 1 ... Channel 8 is standardized

Standardization using Two Coordinates or using Slope and Offset (write)

Bit	Description
0	0 ... Channel 1: Standardization using two coordinates 1 ... Channel 1: Standardization using slope and offset
1	0 ... Channel 2: Standardization using two coordinates 1 ... Channel 2: Standardization using slope and offset
2	0 ... Channel 3: Standardization using two coordinates 1 ... Channel 3: Standardization using slope and offset
3	0 ... Channel 4: Standardization using two coordinates 1 ... Channel 4: Standardization using slope and offset
4	0 ... Channel 5: Standardization using two coordinates 1 ... Channel 5: Standardization using slope and offset
5	0 ... Channel 6: Standardization using two coordinates 1 ... Channel 6: Standardization using slope and offset
6	0 ... Channel 7: Standardization using two coordinates 1 ... Channel 7: Standardization using slope and offset
7	0 ... Channel 8: Standardization using two coordinates 1 ... Channel 8: Standardization using slope and offset

Standardization Absolute/Relative (write)

Bit	Description
0	0 ... Channel 1: Absolute standardization 1 ... Channel 1: Relative standardization
1	0 ... Channel 2: Absolute standardization 1 ... Channel 2: Relative standardization
2	0 ... Channel 3: Absolute standardization 1 ... Channel 3: Relative standardization
3	0 ... Channel 4: Absolute standardization 1 ... Channel 4: Relative standardization
4	0 ... Channel 5: Absolute standardization 1 ... Channel 5: Relative standardization
5	0 ... Channel 6: Absolute standardization 1 ... Channel 6: Relative standardization
6	0 ... Channel 7: Absolute standardization 1 ... Channel 7: Relative standardization
7	0 ... Channel 8: Absolute standardization 1 ... Channel 8: Relative standardization

10.4.13 Standardization

General Information

Through standardization, the measurement value is assigned a value corresponding to the physical unit. The conversion takes place along a standardization line:

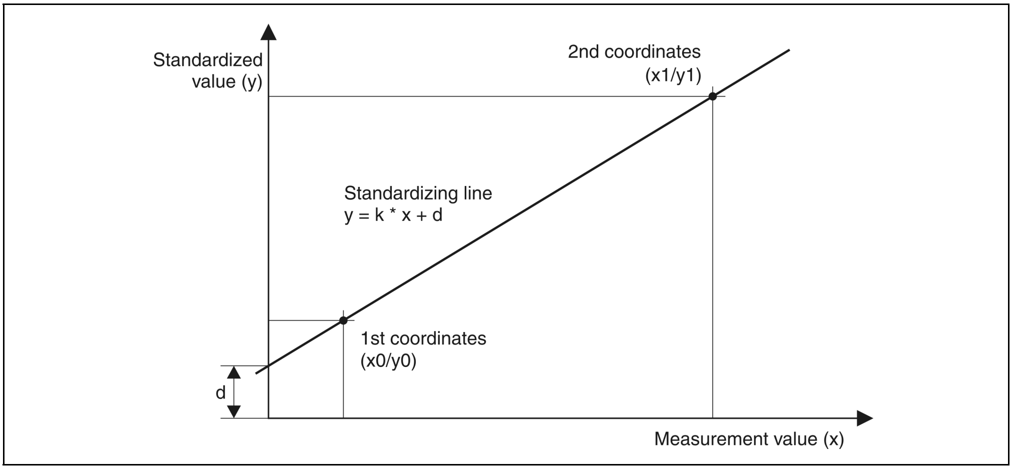


Figure 135: AI780 standardization

The line equation is: $y = k * x + d$

y ..... standardized value
k ..... slope
x ..... measurement value
d ..... y, if x = 0 (offset)

Definition for the Standardizing Line

The definition can be made in two ways:

- Using two coordinates
- Using slope k and offset d

Definition for Equations using Two Coordinates

If the slope and the offset for the line equation is unknown, then the standardization line must be defined using two coordinates (x0/y0) and (x1/y1).

Standard setting: 0 mA $0000
20 mA ... $7FFF

Defining the Coordinates

The coordinates are defined using corresponding values y0 and y1 for the physical units and using the corresponding values x0 and x1 for the measurement values. The values for y0 and y1 (set value) are known. x0 and x1 (actual value) are defined as follows:

No.	Command to be Executed
1	Create conditions which correspond to the first coordinates (x0/y0) (weight, load etc.). The setting corresponds to the encoder minimum value.
2	Read the measurement value and save.
3	Create conditions which correspond to the second coordinates (x1/y1). The setting corresponds to the encoder maximum value.
4	Read the measurement value and save.

Table 208: Defining the Coordinates

Data for the Standardization

The various configuration data is created in the form of a data module, which is transferred to the module using the Spooler library. The variable "Switching Standardization On/Off" must be set to 0 and then to 1 for the data to be accepted. The data is accepted using the positive edges. The text at the beginning of the data module is used for identification of the module and is not allowed to be changed or moved.

The data module is created/configured using B&R Automation Studio™ in offline mode and then transferred to the PLC.

The library DataObj is available for manipulation during the operation of the system. Value changes can be made e.g. using the visualization device.

In section 10.4.15 "Configuration Examples" two data modules are listed.

Definition of the Straight Lines using Slope and Offset

If the slope k and the offset d for the line equation is known, then the definition for the standardizing lines can be made using these two parameters.

Standard setting: 0 mA $00000000
20 mA ... $00010000

Number Format

The number format for k and d is DINT. The 2 high-order bytes are the integer part and the 2 low-order bytes are the decimal places. To ensure the correct processing, both values must be multiplied by 65536.

Example: k = 2.4 and d = 0.5

Slope = k x 65536 = 2.4 x 65536 = 157286 = $00026666
Offset = d x 65536 = 0.5 x 65536 = 32768 = $00008000

Special Functions

- Other standardization parameters can be configured for each channel
- Standardization can be switched on or off separately for each channel
- Standardization can be made absolute or relative for each channel

Absolute or relative standardization

1) Absolute standardization

Normally, absolute standardization is used. The slope k and the offset d are taken directly from the operating system for the AI780 and calculated from the coordinates provided.

2) Relative standardization

The relative standardization can e.g. be used during commissioning or for matching a line equation to modified operating conditions.

With relative standardization, the AI780 records the current values for the slope and the offset when switching off. The parameters for k and d transferred during the boot phase are not directly accepted, rather used as factor. The new slope and the new offset are calculated using these factors:

$k_{new} = k_{old} \times k_{factor}$

$d_{new} = d_{old} \times k_{factor} + d_{factor}$

10.4.14 Commissioning

1) Creating the data module. The data module is created offline using B&R Automation Studio™ and in the operation using the library DataObj. The following data is defined:

   - Lower/upper limit value
   - Coordinates
   - Slope k and Offset d

   If the data module was created using B&R Automation Studio™, then the data module must be transferred to the PLC.

2) Spool the data module onto the AI780 using the Spooler library.

3) Define whether standardization should be made using two coordinates or using slope k and offset d.

4) Define whether standardization is made absolute or relative.

5) Switch standardization on/off. Switching on standardization is interpreted as the start signal for the converters. Converters are operated differently, depending on the operating mode:

Continuous Mode:	Converters are started
Trigger Mode:	Converters can be started using a trigger pulse for one measurement cycle at a time

10.4.15 Configuration Examples

Example 1 - Standard setting

The standard settings are described in the following example. The measurement values are standardized to 0 - 20 mA. Settings for the lower and upper limit values correspond to the respective maximum value.

- Setting the lower limit to $8001
- Setting the upper limit to $7FFF
- All coordinates are 0/0, which means that the x/y calculation is deactivated

<u>Data Module</u>

```
"6098_cfg",0,0,0,0,0,   ; text is not allowed to be changed
$0100,                  ; Version code AI780 configuration structure

$8001,        ; Lower limit channel 1
$8001,        ; Lower limit channel 2
$8001,        ; Lower limit channel 3
$8001,        ; Lower limit channel 4
$8001,        ; Lower limit channel 5
```

```
$8001,        ; Lower limit channel 6
$8001,        ; Lower limit channel 7
$8001,        ; Lower limit channel 8

$7FFF,        ; Upper limit channel 1
$7FFF,        ; Upper limit channel 2
$7FFF,        ; Upper limit channel 3
$7FFF,        ; Upper limit channel 4
$7FFF,        ; Upper limit channel 5
$7FFF,        ; Upper limit channel 6
$7FFF,        ; Upper limit channel 7
$7FFF,        ; Upper limit channel 8

00000,        ; x0 channel 1
00000,        ; x0 channel 2
00000,        ; x0 channel 3
00000,        ; x0 channel 4
00000,        ; x0 channel 5
00000,        ; x0 channel 6
00000,        ; x0 channel 7
00000,        ; x0 channel 8

00000,        ; x1 channel 1
00000,        ; x1 channel 2
00000,        ; x1 channel 3
00000,        ; x1 channel 4
00000,        ; x1 channel 5
00000,        ; x1 channel 6
00000,        ; x1 channel 7
00000,        ; x1 channel 8

00000,        ; y0 channel 1
00000,        ; y0 channel 2
00000,        ; y0 channel 3
00000,        ; y0 channel 4
00000,        ; y0 channel 5
00000,        ; y0 channel 6
00000,        ; y0 channel 7
00000,        ; y0 channel 8

00000,        ; y1 channel 1
00000,        ; y1 channel 2
00000,        ; y1 channel 3
00000,        ; y1 channel 4
00000,        ; y1 channel 5
00000,        ; y1 channel 6
00000,        ; y1 channel 7
00000,        ; y1 channel 8

$00010000,    ; k * 65536 channel 1
$00010000,    ; k * 65536 channel 2
$00010000,    ; k * 65536 channel 3
```

```
$00010000,    ; k * 65536 channel 4
$00010000,    ; k * 65536 channel 5
$00010000,    ; k * 65536 channel 6
$00010000,    ; k * 65536 channel 7
$00010000,    ; k * 65536 channel 8

$00000000,    ; d * 65536 channel 1
$00000000,    ; d * 65536 channel 2
$00000000,    ; d * 65536 channel 3
$00000000,    ; d * 65536 channel 4
$00000000,    ; d * 65536 channel 5
$00000000,    ; d * 65536 channel 6
$00000000,    ; d * 65536 channel 7
$00000000,    ; d * 65536 channel 8
```

Example 2

The measurement values are standardized to auf 4 - 20 mA in the following example. Additionally, the data for the lower and upper limit values were changed.

- Setting the lower limit to 0
- Setting the upper limit to $7FF0
- The x/y coordinates correspond to measurement value standardization to 4 - 20 mA
- The k/d coordinates correspond to measurement value standardization to 4 - 20 mA

Data Module

```
"6098_cfg",0,0,0,0,0,   ; text is not allowed to be changed
$0100,                  ; Version code AI780 configuration structure

$0000,        ; Lower limit channel 1
$0000,        ; Lower limit channel 2
$0000,        ; Lower limit channel 3
$0000,        ; Lower limit channel 4
$0000,        ; Lower limit channel 5
$0000,        ; Lower limit channel 6
$0000,        ; Lower limit channel 7
$0000,        ; Lower limit channel 8

$7FF0,        ; Upper limit channel 1
$7FF0,        ; Upper limit channel 2
$7FF0,        ; Upper limit channel 3
$7FF0,        ; Upper limit channel 4
$7FF0,        ; Upper limit channel 5
$7FF0,        ; Upper limit channel 6
$7FF0,        ; Upper limit channel 7
$7FF0,        ; Upper limit channel 8

$1999,        ; x0 channel 1
```

```
$1999,         ; x0 channel 2
$1999,         ; x0 channel 3
$1999,         ; x0 channel 4
$1999,         ; x0 channel 5
$1999,         ; x0 channel 6
$1999,         ; x0 channel 7
$1999,         ; x0 channel 8

$7FFF,         ; x1 channel 1
$7FFF,         ; x1 channel 2
$7FFF,         ; x1 channel 3
$7FFF,         ; x1 channel 4
$7FFF,         ; x1 channel 5
$7FFF,         ; x1 channel 6
$7FFF,         ; x1 channel 7
$7FFF,         ; x1 channel 8

$0000,         ; y0 channel 1
$0000,         ; y0 channel 2
$0000,         ; y0 channel 3
$0000,         ; y0 channel 4
$0000,         ; y0 channel 5
$0000,         ; y0 channel 6
$0000,         ; y0 channel 7
$0000,         ; y0 channel 8

$7FFF,         ; y1 channel 1
$7FFF,         ; y1 channel 2
$7FFF,         ; y1 channel 3
$7FFF,         ; y1 channel 4
$7FFF,         ; y1 channel 5
$7FFF,         ; y1 channel 6
$7FFF,         ; y1 channel 7
$7FFF,         ; y1 channel 8

$00014000,     ; k * 65536 channel 1
$00014000,     ; k * 65536 channel 2
$00014000,     ; k * 65536 channel 3
$00014000,     ; k * 65536 channel 4
$00014000,     ; k * 65536 channel 5
$00014000,     ; k * 65536 channel 6
$00014000,     ; k * 65536 channel 7
$00014000,     ; k * 65536 channel 8

$E0004000,     ; d * 65536 channel 1
$E0004000,     ; d * 65536 channel 2
$E0004000,     ; d * 65536 channel 3
$E0004000,     ; d * 65536 channel 4
$E0004000,     ; d * 65536 channel 5
$E0004000,     ; d * 65536 channel 6
$E0004000,     ; d * 65536 channel 7
$E0004000,     ; d * 65536 channel 8
```

Program Example

This program example describes a possible variant for spooling the data module to the AI780. For more details, please consult the online help for the Spooler library in B&R Automation Studio.

```
if (enable_cfg)                      /* Spool configuration to AI780? */
{
  if (DldDataM.enable == 0)          /* first cycle? */
  {
    DldDataM.io_type    = 1;         /* 2005 IO */
    DldDataM.master_no  = 1;         /* always 1 */
    DldDataM.slave_no   = 0;         /* always 0 */
    DldDataM.module_adr = 4;         /* Slot for the AI780 */
    DldDataM.mode       = 0x00;      /* always 0 */
    DldDataM.pName      = (UDINT)"6098_cfg";  /* Name of the configuration module
*/
    DldDataM.enable     = 1;         /* was first cycle */
  }
  SPDownModule(&DldDataM);           /* Calls function block cyclically */
  if (DldDataM.status != 6666)
  {
    Status = DldDataM.status;  /* FBK ready with or without error, see status */
    DldDataM.enable = enable_cfg = 0;
  }
}
```

After the data module has been spooled to the AI780, the variable "Switching Standardization On/Off" must be set to 0 and then to 1 for the data to be accepted. The data is accepted using the positive edges.

11. Analog Output Modules

11.1 General information

Analog output modules convert PLC internal numerical values into voltages or currents. The numbers to be converted must be in 16-bit 2s complement. The conversion takes place independent of the resolution of the output module used.

All analog output modules have a status LED labeled "RUN" which indicates that the D/A converter is active.

11.1.1 Overview

Module	AO350	AO360	AO775
Number of Outputs	8	8	8
Output Signal	±10 V	±10 V	0 to 20 mA
Digital Converter Resolution	12-bit	16-bit	11-bit

Table 209: Analog output module overview

11.1.2 Programming

The analog data points are accessed directly in the application program using a variable name. The relationship between the channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

11.2 AO350

11.2.1 General Information

The AO350 is a standard analog output module.

11.2.2 Order Data

Model Number	Short Description	Image
3AO350.6	2005 analog output module, 8 outputs, +/- 10 V, 12-bit. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 210: AO350 order data

11.2.3 Technical Data

Product ID	AO350
C-UL-US Listed	Yes
B&R ID Code	$A0
Number of Outputs	8 voltage outputs
Electrical Isolation Output - PLC Output - Output	 Yes No
Output Signal	-10 to +10 V
Digital Converter Resolution	12-bit
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz
Conversion Time for all Channels	250 µs

Table 211: AO350 technical data

Product ID	AO350
Load per Output	Max. ±10 mA (load ≥ 1 kΩ)
Short Circuit Protection (current limit)	±15 mA
Precision Basic Accuracy (at 20° C) Precision (0 to 60° C)	 ±0.25% ±0.5%
Power Consumption 5 V 24 V Total	 Max. 1 W Max. 4 W Max. 5 W
Dimensions	B&R 2005 single-width

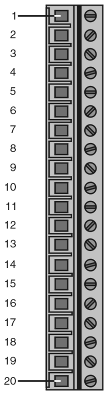
Table 211: AO350 technical data (cont.)

11.2.4 Status LEDs

Image	LED	Description
	RUN	The RUN LED indicates that the digital/analog converter is running.

Table 212: AO350 status LEDs

11.2.5 Pin Assignments



TB170

Connection	Assignment
1	+ Output 1
2	- Output 1
3	+ Output 2
4	- Output 2
5	+ Output 3
6	- Output 3
7	+ Output 4
8	- Output 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Output 5
14	- Output 5
15	+ Output 6
16	- Output 6
17	+ Output 7
18	- Output 7
19	+ Output 8
20	- Output 8

Table 213: AO350 pin assignment

Signal Cable Connection

Shielded cables must be used with analog output modules. The ground connection for the shield is made on one of the terminal block shield connections provided for the two outputs.

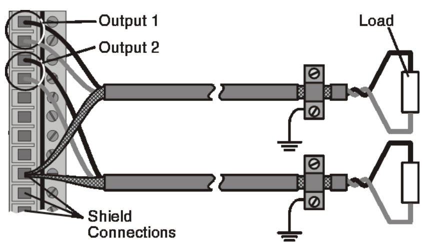


Figure 136: AO350 signal cable connection

The four shielded connections are of the equal value and each connected via RC elements with ground (⏚, i.e.: a spring contact and a mounting rail).

R: 22 kΩ, C: 10 nF / 60 V.

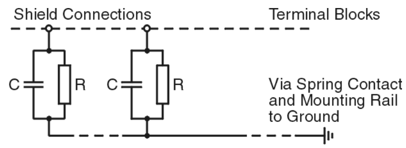


Figure 137: AO350 shielded connection

11.2.6 Output Circuit Diagram

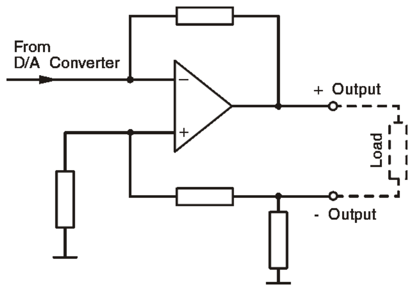


Figure 138: AO350 output circuit diagram

11.2.7 Relationship between Numerical Value and Output Voltage

Numerical Value		Output Voltage
Hexadecimal	Decimal	
8000	-32768	-10 V
C000	-16384	-5 V
FFF0	-16	-4.88 mV
0000	0	0 V
0010	16	4.88 mV
4000	16384	5 V
7FF0	32752	10 V

Table 214: AO350 relationship between numerical value and output voltage

11.2.8 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 8

Table 215: AO350 variable declaration

11.3 AO360

11.3.1 General Information

The AO360 is a standard analog output module.

11.3.2 Order Data

Model Number	Short Description	Image
3AO360.60-1	2005 analog output module, 8 outputs, +/- 10 V, 16-bit. Order TB718 terminal block separately.	
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	
Terminal blocks not included in the delivery (see "Accessories").		

Table 216: AO360 order data

11.3.3 Technical Data

Product ID	AO360
General information	
C-UL-US Listed	Yes
B&R ID Code	$A2
Can be Installed on Main Rack Expansion Rack	 Yes Yes
Static Characteristics	
Module Type	B&R 2005 I/O module
Number of Outputs	8 voltage outputs
Output Signal	-10 V to +10 V

Table 217: AO360 technical data

Product ID	AO360
Digital Converter Resolution	16-bit
Output Filter	Low pass 1st order / cut-off frequency: 8 kHz
Basic Accuracy (at 24° C)	±0.011% 1) ±700 µV
Temperature Drift Offset Gain	 ±100 µV /° C ±25 ppm /° C 1)
Maximum Load per Output	±10 mA (load ≥1 kΩ)
Continuous Short Circuit Protection	Yes
Power Consumption 5 V 24 V Total	 Max. 1.1 W Max. 4 W Max. 5.1 W
Operating Characteristics	
Conversion Time for all Channels	192 µs
Switch On/Off Behavior	Internal enable relay Default Setting: 10 kΩ between output + and output -
Electrical Isolation Output - PLC Output - Output	 Yes No
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 217: AO360 technical data (cont.)

1) Referring to the current output value.

11.3.4 Status LEDs

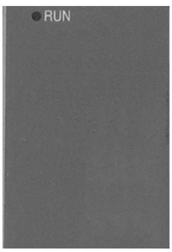
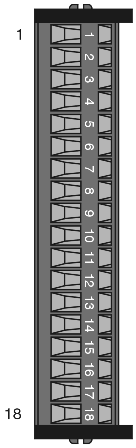
Image	LED	Description
	RUN	Indicates that the module is in operation.

Figure 139: AO360 status LEDs

11.3.5 Pin Assignments



TB718

Connection	Assignment
1	Shield
2	Shield
3	+ Output 1
4	- Output 1
5	+ Output 2
6	- Output 2
7	+ Output 3
8	- Output 3
9	+ Output 4
10	- Output 4
11	+ Output 5
12	- Output 5
13	+ Output 6
14	- Output 6
15	+ Output 7
16	- Output 7
17	+ Output 8
18	- Output 8

Table 218: AO360 pin assignments

Signal Cable Connection

Shielded cables must be used with analog output modules. The ground connection for the shield is made on one of the terminal block shield connections provided for the four outputs.

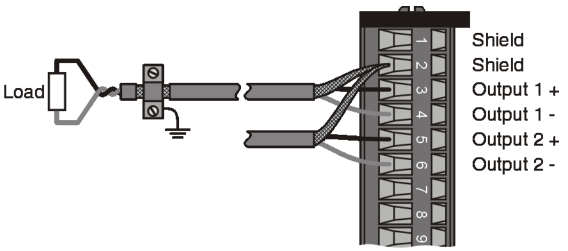


Figure 140: AO360 signal cable connection

11.3.6 Output Circuit Diagram

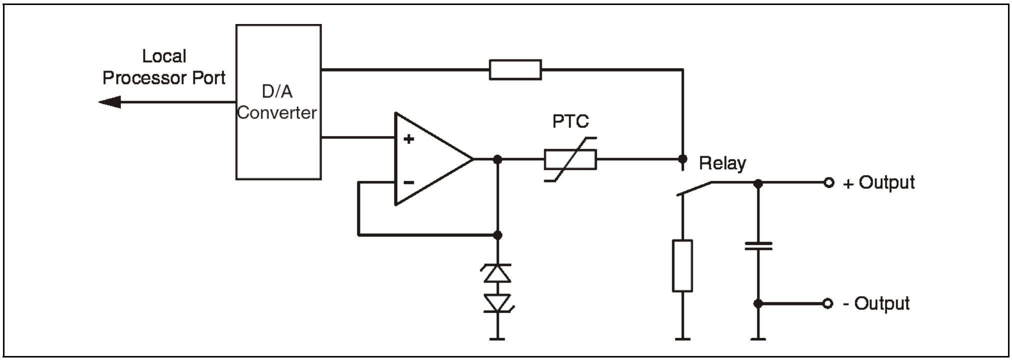


Figure 141: AO360 output circuit diagram

11.3.7 Relationship between Numerical Value and Output Voltage

Numerical Value		Output Voltage
Hexadecimal	Decimal	
8000	-32768	-10.0003 V
8001	-32767	-10 V
C001	-16383	-5 V
FFFF	-1	-305 µV
0000	0	0 V
0001	1	305 µV
3FFF	16383	5 V
7FFF	32767	10 V

Table 219: AO360 relationship between numerical value and output voltage

11.3.8 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 8

Table 220: AO360 variable declaration

11.4 AO775

11.4.1 General Information

The AO775 is a standard analog output module.

11.4.2 Order Data

Model Number	Short Description	Image
3AO775.6	2005 analog output module, 8 outputs, 0 to 20 mA, 11-bit. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 221: AO775 order data

11.4.3 Technical Data

Product ID	AO775
C-UL-US Listed	Yes
B&R ID Code	$A1
Number of Outputs	8 current outputs
Electrical Isolation Output - PLC Output - Output	 Yes No
Output Signal	0 to 20 mA
Digital Converter Resolution	11-bit
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz
Conversion Time for all Channels	250 µs

Table 222: AO775 technical data

Product ID	AO775
Load	Max. 600 Ω
Precision Basic Accuracy (at 20° C) Precision (0 to 60° C)	 ±0.5% ±0.75%
Power Consumption 5 V 24 V Total	 Max. 1 W Max. 4.5 W Max. 5.5 W
Dimensions	B&R 2005 single-width

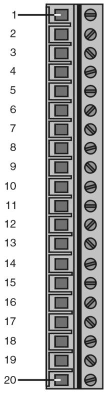
Table 222: AO775 technical data (cont.)

11.4.4 Status LEDs

Image	LED	Description
	RUN	The RUN LED indicates that the digital/analog converter is running.

Table 223: AO775 status LEDs

11.4.5 Pin Assignments



TB170

Connection	Assignment
1	+ Output 1
2	- Output 1
3	+ Output 2
4	- Output 2
5	+ Output 3
6	- Output 3
7	+ Output 4
8	- Output 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Output 5
14	- Output 5
15	+ Output 6
16	- Output 6
17	+ Output 7
18	- Output 7
19	+ Output 8
20	- Output 8

Table 224: AO775 pin assignment

Signal Cable Connection

Shielded cables must be used with analog output modules. The ground connection for the shield is made on one of the terminal block shield connections provided for the two outputs.

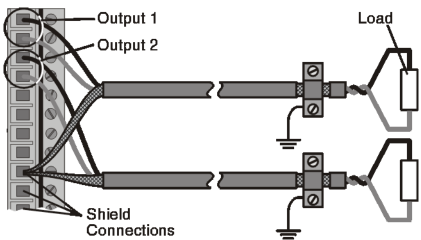


Figure 142: AO775 signal cable connection

The four shielded connections are of the equal value and each connected via RC elements with ground (⏚, i.e.: a spring contact and a mounting rail).

R: 22 kΩ, C: 10 nF / 60 V

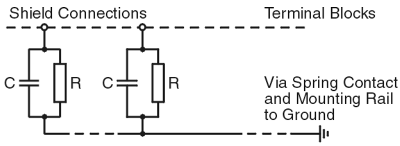


Figure 143: AO775 shielded connection

11.4.6 Output Circuit Diagram

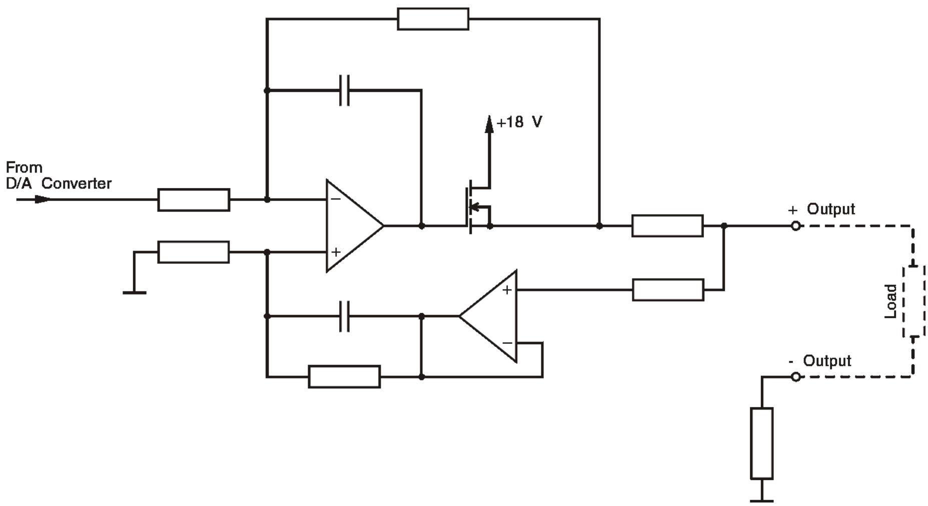


Figure 144: AO775 output circuit diagram

11.4.7 Relationship between Numerical Value and Output Current

Numerical Value		Output Current
Hexadecimal	Decimal	
0000	0	0 mA
0010	16	9.77 µA
4000	16384	10 mA
7FF0	32752	20 mA

Table 225: AO775 relationship between numerical value and output current

11.4.8 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 8

Table 226: AO775 variable declaration

12. Analog Mixed Modules

12.1 General Information

Analog mixed modules are a combination of analog input and output modules.

All analog mixed modules have a status LED labeled "RUN" which indicates that the D/A and A/D converters are active.

12.1.1 Overview

Module	AM050	AM051	AM055	AM374
Number of Inputs	4	4	5	4
Input signal	0 to 10 V	0 to 20 mA	0 to 10 V	0 - 10 V / 0 - 20 mA [1)]
Number of Outputs	4	4	3	4
Output signal	±10 V	0 to 20 mA	±10 V	±10 V / 0 - 20 mA [1)]
Digital Converter Resolution	12-bit	12-bit	12-bit	12-bit

Table 227: Analog Mixed Module Overview

1) Can be switched in groups of 2

12.1.2 Programming

The analog data points are accessed directly in the application program using a variable name. The relationship between the channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

12.2 AM050

12.2.1 General Information

The AM050 is a standard analog mixed module.

12.2.2 Order Data

Model Number	Short Description	Image
3AM050.6	2005 analog mixed module, 4 inputs, 0 to 10 V, 12-bit, 4 outputs, +/- 10 V, 12-bit. Order terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 228: AM050 order data

12.2.3 Technical Data

Product ID	AM050
General information	
C-UL-US Listed	Yes
B&R ID Code	$88
Slot Main Rack Expansion Rack	 Yes Yes
Inputs Input Signal	4 0 -10 V
Outputs Output Signal	4 ±10 V

Table 229: AM050 technical data

Product ID	AM050
Electrical Isolation Channel - PLC Channel - Channel	 Yes No
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 5 W Max. 6.5 W
Analog Inputs	
Input Signal Nominal Min./Max.	 0 to +10 V -20 to +20 V
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FF8 (1 LSB = $0008 = 2.441 mV)
Non-Linearity	±1 LSB
Differential Input Resistance	2 MΩ
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz
Basic Accuracy at 25° C	±0.1% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.0075% /° C 2)
Repeat Precision	±0.025% 1)
Cross-Talk between Channels	-66 dB
Common-Mode Rejection DC 50 Hz	 50 dB 45 dB
Maximum Modulation Compared to Ground Potential	±50 VDC
Common Mode Modulation Capability between Two Channels	±10 VDC
Analog Outputs	
Output signal	±10 V
Digital Converter Resolution	12-bit
Output Format	INT $8080 - $7F80 (1 LSB = $0010 = 4.90 mV)
Non-Linearity	±1 LSB
Load	Min. 1 kΩ

Table 229: AM050 technical data (cont.)

Product ID	AM050
Short-circuit-proof	Current limit -15 mA to -30 mA / +15 mA to +30 mA
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz
Basic Accuracy at 25° C Offset Total	 ±0.025% 1) ±0.15% 1)
Offset Drift	Max. ±0.0015% /° C 1)
Gain Drift	Max. ±0.0050% /° C 2)
Error caused by Load Change	Max. 0.013% (from 10 MΩ -> 1 kΩ, resistive)
Repeat Precision	±0.025% 1)
Switch On/Off Behavior	Internal enable relay, default setting: Short circuit
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 229: AM050 technical data (cont.)

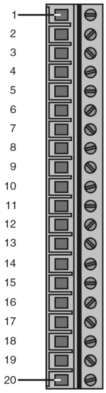
1) Refers to the measurement range.
2) Refers to the current measurement value.

12.2.4 Status LEDs

Image	LED	Description
	RUN	A lit RUN LED indicates the analog/digital converter and digital/analog converter are running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 230: AM050 status LEDs

12.2.5 Pin Assignments



TB170

Connection	Assignment
1	+ Input 1
2	- Input 1
3	+ Input 2
4	- Input 2
5	+ Input 3
6	- Input 3
7	+ Input 4
8	- Input 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Output 1
14	- Output 1
15	+ Output 2
16	- Output 2
17	+ Output 3
18	- Output 3
19	+ Output 4
20	- Output 4

Table 231: AM050 pin assignment

Signal Cable Connection

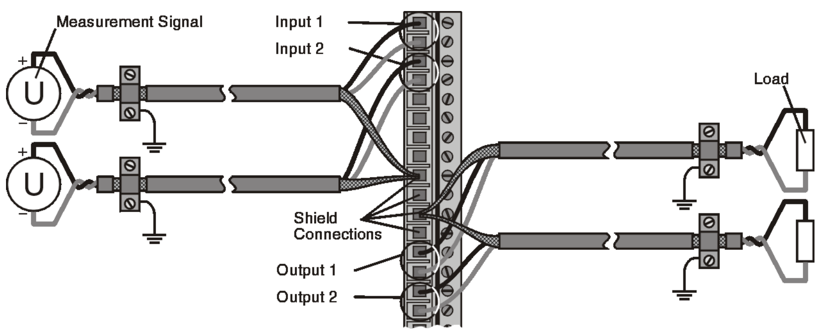


Figure 145: AM050 signal cable connection

Shielded cabling should be used for the mixed module's analog input and output signal cables. The shield is grounded for two inputs/outputs using one of the terminal block shield connections provided.

For EMC reasons, it is recommended to short circuit the inputs which are not used.

Minus connections for the analog outputs are switched over 22 Ω to the internal ground. A floating connection is recommended for large cable lengths. The potential displacement between minus connections is allowed to be a maximum of 4 V.

The four shielded connections are of the same value and each connected via 100 Ω resistors with ground (⏚, that means: a spring contact and a mounting rail).

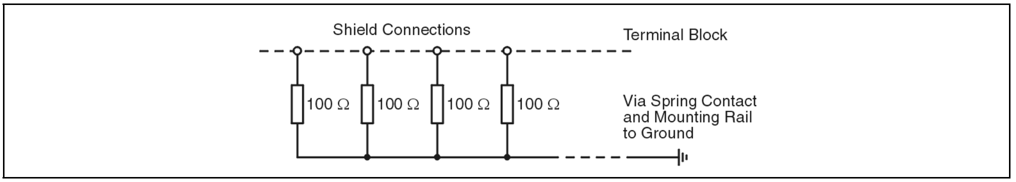


Figure 146: AM050 shielded connection

12.2.6 Input Circuit Diagram

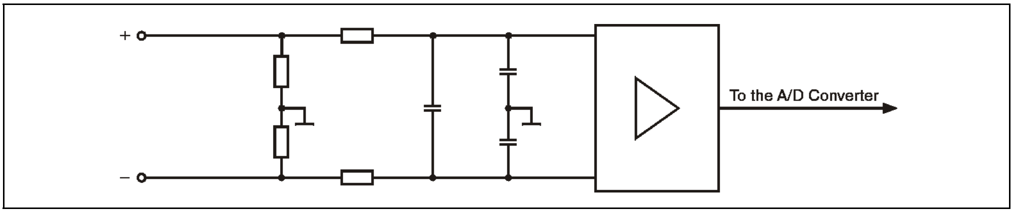


Figure 147: AM050 input circuit diagram

12.2.7 Output Circuit Diagram

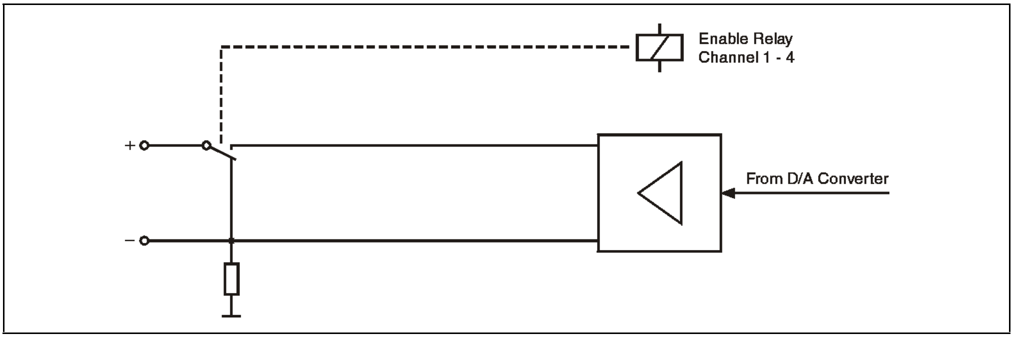


Figure 148: AM050 output circuit diagram

12.2.8 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset. The enable relay releases the outputs approximately 300 ms after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after power-on.

Analog Inputs

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms, due to the higher computing time needed.

Analog Outputs

All values are read, and written on the analog output channels. The update time for the analog outputs should be considered in the above listed conversion times for the analog inputs.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value : %00010000

In this operating mode, the conversion cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse).

All analog output values are then immediately read and written on the output channels. Finally, the conversion of all four input channels is carried out so that it does not react to another start pulse. The end of the cycles is registered by setting bit 7 in the status register 2.

Application example: Data acquisition (without jitter) in high-speed task classes (e.g. for a controller).

Mode Register 8	Analog Mixed Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_0 + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 232: AM050 Special Operating Mode 1: Direct software timing

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

Mode register 2 must be set to the following value : %00110000

The procedure is similar to special operating mode 1. However, in special operating mode 2 there is the option to set the time when the next conversion cycle should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles.

The reading of analog output values and the conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1. At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Mixed Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_St + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)

Table 233: AM050 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Mixed Module	Time
	Bit 7 in the status register 2 = 1(cycle end)	t_pre - 100 µs
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 233: AM050 Special Operating Mode 2: Software timing using default time (cont.)

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

12.2.9 Relationship between Converter Value and Input / Output Signals

Input Voltage 0 - 10 V

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Voltage	Converter Value	
	Hexadecimal	Decimal
Error Status	$8000	-32768
≤0 V	$0000	0
2.441 mV	$0008	8
9.997 V	$7FF0	32752
≥10 V	$7FF8	32760

Table 234: AM050 Relationship between input voltage and converter value

12.2.10 Output Voltage ±10 V

The converter value (INT format) changes in increments of 16 (..., -32, -16, 0, 16, 32, etc.).

Converter Value		Output Voltage
Hexadecimal	Decimal	
≤$8080	-32640	-10 V
$FFF0	-16	-4.901 mV
$0000	0	0 V
$0010	16	4.901 mV
≥$7F80	32640	10 V

Table 235: AM050 Relationship between output voltage and converter value

12.2.11 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single analog input (Channel x)	tc_global	INT	1	Analog In	1 ... 4
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 4
Mode register 1	tc_global	USINT	1	Status Out	0
Mode register 2	tc_global	USINT	1	Status Out	1
Mode registers 7 + 8 Special operating mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status register 1	tc_global	USINT	1	Status In	0
Status register 2	tc_global	USINT	1	Status In	1

Table 236: AM050 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

0	0	0	0	0	0		0
7							0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive limit for averaging is $7FF7 instead $7FF8.

Mode Register 2

Bits 0 and -3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

7							0
0	0			0	0	0	0

SWT_DIR 0 ..... Normal operation (default setting)
1 ..... Special operating mode 1 (Direct Software Timing)

SWT_TIM SWT_TIM is only active if SWT_DIR is set to 1!
0 ..... Operating mode dependent on SWT_DIR (default setting)
1 ..... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The conversion cycle of all analog inputs and analog outputs must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

7							0
	0	0	0	0	0	0	0

TRIGn — TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0)
A write access with TRIGn = 0 triggers a conversion cycle.
A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

x	x	x	x	x	x		
7							0

I_ERR 0...... Data values in the dual ported RAM (DPR) correspond to definitions
1...... An internal error exists. Please contact B&R.

MW Averaging in normal operation is active (mode register 1 settings are repeated)

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

	x			x	x	x	x
7							0

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0 ......Measurement or waiting loop is running
1 ......The last cycle is completed

12.3 AM051

12.3.1 General Information

The AM051 is a standard analog mixed module.

12.3.2 Order Data

Model Number	Short Description	Image
3AM051.6	2005 analog mixed module, 4 inputs, 0 to 20 mA, 12-bit, 4 outputs, 0 to 20 mA, 12-bit. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 237: AM051 order data

12.3.3 Technical Data

Product ID	AM051
General information	
C-UL-US Listed	Yes
B&R ID Code	$89
Slot Main Rack Expansion Rack	 Yes Yes
Inputs Input Signal	4 0 - 20 mA
Outputs Output Signal	4 0 - 20 mA

Table 238: AM051 technical data

Product ID	AM051
Electrical Isolation Channel - PLC Channel - Channel	 Yes No
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 5 W Max. 6.5 W
Analog Inputs	
Input Signal Nominal Min./Max.	 0 to 20 mA -50 to +50 mA
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FF8 (1 LSB = $0008 = 4.883 µA)
Non-Linearity	±1 LSB
Load	50 Ω
Voltage Drop at 20 mA	1 V
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz
Basic Accuracy at 25° C	±0.1% [1)]
Offset Drift	Max. ±0.0025% /° C [1)]
Gain Drift	Max. ±0.01% /° C [2)]
Repeat Precision	±0.05% [1)]
Cross-Talk between Channels	-66 dB
Common-Mode Rejection DC 50 Hz	 55 dB 50 dB
Maximum Modulation Compared to Ground Potential	±50 VDC
Common Mode Modulation Capability between Two Channels	±15 VDC
Analog Outputs	
Output Signal	0 - 20 mA
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7F80 (1 LSB = $0080 = 4.90 µA)
Non-Linearity	±1 LSB

Table 238: AM051 technical data (cont.)

Product ID	AM051
Load	Max. 600 Ω
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz
Basic Accuracy at 25° C Offset Total	 -0.013% to +0.039% 1) ±0.15% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.008%/°C 2))
Error caused by Load Change	Max. 0.075% (from 1 Ω -> 600 kΩ, resistive)
Repeat Precision	±0.025% 1)
Switch On/Off Behavior	Internal enable relay, default setting: Short circuit
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 238: AM051 technical data (cont.)

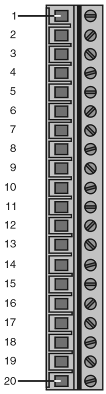
1) Refers to the measurement range.
2) Referring to the current measurement value

12.3.4 Status LEDs

Image	LED	Description
	RUN	A lit RUN LED indicates the analog/digital converter and digital/analog converter are running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 239: AM051 status LEDs

12.3.5 Pin Assignments



TB170

Connection	Assignment
1	+ Input 1
2	- Input 1
3	+ Input 2
4	- Input 2
5	+ Input 3
6	- Input 3
7	+ Input 4
8	- Input 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Output 1
14	- Output 1
15	+ Output 2
16	- Output 2
17	+ Output 3
18	- Output 3
19	+ Output 4
20	- Output 4

Table 240: AM051 pin assignment

Signal Cable Connection

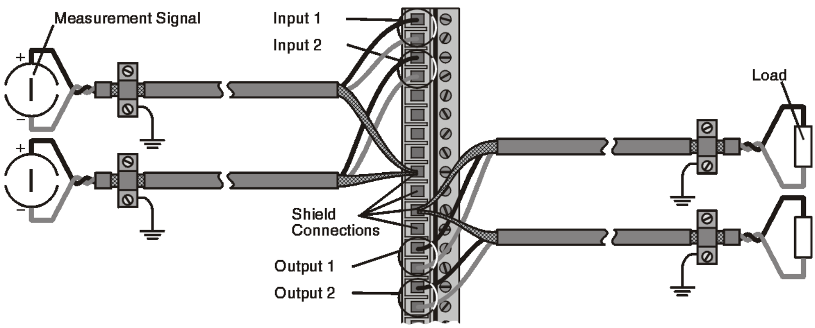


Figure 149: AM051 signal cable connection

Shielded cabling should be used for the mixed module's analog input and output signal cables. The shield is grounded for two inputs/outputs using one of the terminal block shield connections provided.

For EMC reasons, it is recommended to short circuit the inputs which are not used.

Minus connections for the analog outputs are switched over 22 Ω to the internal ground. A floating connection is recommended for large cable lengths. The potential displacement between minus connections is allowed to be a maximum of 4 V.

The four shielded connections are of the same value and each connected via 100 Ω resistors with ground (⏚, that means: a spring contact and a mounting rail).

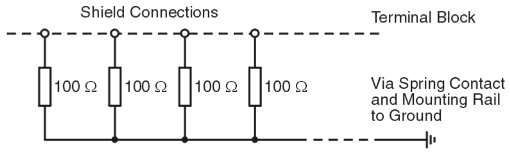


Figure 150: AM051 shielded connection

12.3.6 Input Circuit Diagram

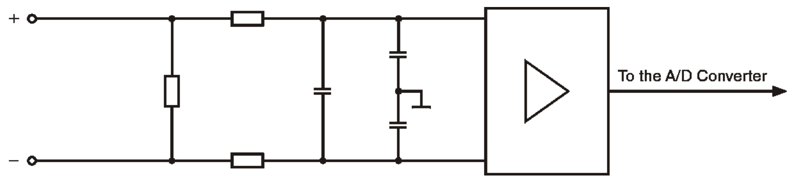


Figure 151: AM051 input circuit diagram

12.3.7 Output Circuit Diagram

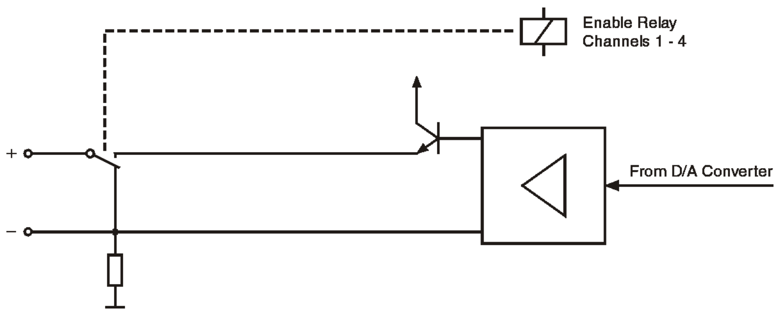


Figure 152: AM051 output circuit diagram

12.3.8 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset. The enable relay releases the outputs approximately 300 ms after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after power-on.

Analog Inputs

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation using mode register 1. The conversion time increases slightly to <1.5 ms, due to the higher computing time needed.

Analog Outputs

All values are read and written on the analog output channels. The update time for the analog outputs should be considered in the above listed conversion times for the analog inputs.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value : %00010000

In this operating mode, the conversion cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse).

All analog output values are then immediately read and written on the output channels. Finally, the conversion of all four input channels is carried out so that it does not react to another start pulse. The end of the cycles is registered by setting bit 7 in the status register 2.

Application example: Data acquisition (without jitter) in high-speed task classes (e.g. for a controller).

Mode Register 8	Analog Mixed Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in status register 2 = 0	t_0 + 20 to 40 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_0 + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 241: AM051 Special Operating Mode 1: Direct software timing

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

The mode register 2 must be set to the following value : %00110000

The procedure is similar to special operating mode 1. However in special operating mode 2 there is the option to set the time when the next conversion cycle should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles.

The reading of analog output values and the conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1. At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Mixed Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_St + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)

Table 242: AM051 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Mixed Module	Time
	Bit 7 in the status register 2 = 1(cycle end)	t_pre - 100 µs
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 242: AM051 Special Operating Mode 2: Software timing using default time (cont.)

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

12.3.9 Relationship between Converter Value and Input / Output Signals

Input Current 0 - 20 mA

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Current	Converter Value	
	Hexadecimal	Decimal
Error Status	$8000	-32768
≤0 A	$0000	0
4.883 µA	$0008	8
19.995 mA	$7FF0	32752
≥20 mA	$7FF8	32760

Table 243: AM051 Relationship between input current and converter value

Output Current 0 - 20 mA

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc).

Converter Value		Output Current
Hexadecimal	Decimal	
≤$0000	0	0 A
$0008	8	4.883 µA
≥$7F80	32640	20 mA

Table 244: AM051 relationship between output current and converter value

12.3.10 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 4
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 4
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1

Table 245: AM051 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

7							0
0	0	0	0	0	0		0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive limit for averaging is $7FF7 instead of $7FF8.

Mode Register 2

Bits 0 and -3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

7	6	5	4	3	2	1	0
0	0			0	0	0	0

SWT_DIR 0...... Normal operation (default setting)
1...... Special operating mode 1 (Direct Software Timing)

SWT_TIM SWT_TIM is only active if SWT_DIR is set to 1!
0...... Operating mode dependent on SWT_DIR (default setting)
1...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The conversion cycle of all analog inputs and analog outputs must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0

TRIGn	TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0). A write access with TRIGn = 0 triggers a conversion cycle. A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

7							0
x	x	x	x	x	x		

I_ERR 0...... Data values in the dual ported RAM (DPR) correspond to definitions.
1...... An internal error exists. Please contact B&R.

MW Averaging in normal operation is active (mode register 1 settings are repeated).

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

7							0
	x			x	x	x	x

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active, if a special operating mode is set.
0 ......Measurement or waiting loop is running.
1 ......The last cycle is completed.

12.4 AM055

12.4.1 General Information

The AM055 is a standard analog mixed module. The module is equipped with a potentiometer voltage. The potentiometer voltage is 2-fold and can be loaded parallel with 4 x 1 kΩ.

12.4.2 Order Data

Model Number	Short Description	Image
3AM055.6	2005 analog mixed module, 5 inputs, 0 to 10 V, 12-bit, 3 outputs, +/- 10 V, 12-bit, 1 potentiometer voltage +10 V, 2x. Order TB170 terminal blocks separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 246: AM055 order data

12.4.3 Technical Data

Product ID	AM055
General information	
C-UL-US Listed	Yes
B&R ID Code	$97
Slot Main Rack Expansion Rack	 Yes Yes
Inputs Input Signal	5 0 -10 V

Table 247: AM055 technical data

Product ID	AM055
Outputs Output Signal	3 ±10 V
Potentiometer Voltage	+10 V
Electrical Isolation Channel - PLC Channel - Channel	 Yes No
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 5.5 W, including potentiometer voltage Max. 7 W
Analog Inputs	
Input Signal Nominal Min./Max.	 0 to +10 V -20 to +20 V
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FF8 (1 LSB = $0008 = 2.441 µA)
Non-Linearity	±1 LSB
Load	2 MΩ
Basic Accuracy at 25° C	±0.05% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.005% /° C 2)
Analog Outputs	
Output Signal	±10 V
Digital Converter Resolution	12-bit
Output Format	INT $8080 - $7F80 (1 LSB = $0010 = 4.90 mV)
Non-Linearity	±1 LSB
Load	Min. 1 kΩ
Basic Accuracy at 25° C Offset Total	 ±0.025% 1) ±0.1% 1)
Offset Drift	Max. ±0.0013% /° C 1)
Gain Drift	Max. ±0.003% /° C 2)
Switch On/Off Behavior	Internal enable relay during boot procedure or error: short circuit Short circuit

Table 247: AM055 technical data (cont.)

Product ID	AM055
Potentiometer Voltage	
Output Voltage	+10 V
Load	4 x 1 kΩ parallel, max total 40 mA
Short Circuit Current	> 100 mA
Basic Accuracy	0.02% 3)
Drift over Temperature Range	0.04% 3)
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 247: AM055 technical data (cont.)

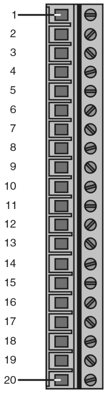
1) Refers to the measurement range.
2) Refers to the current measurement value.
3) Referring to 10 V.

12.4.4 Status LEDs

Image	LED	Description
	RUN	A lit RUN LED indicates the analog/digital converter and digital/analog converter are running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 248: AM055 status LEDs

12.4.5 Pin Assignments



TB170

Connection	Assignment
1	Pot. Supply I1 + 2
2	AGND I1 + 2
3	+ Input 1
4	- Input 1
5	+ Input 2
6	- Input 2
7	Pot. Supply I3 + 4
8	AGND I3 + 4
9	+ Input 3
10	- Input 3
11	+ Input 4
12	- Input 4
13	+ Input 5
14	- Input 5
15	+ Output 1
16	- Output 1
17	+ Output 2
18	- Output 2
19	+ Output 3
20	- Output 3

Table 249: AM055 pin assignment

Signal Cable Connection

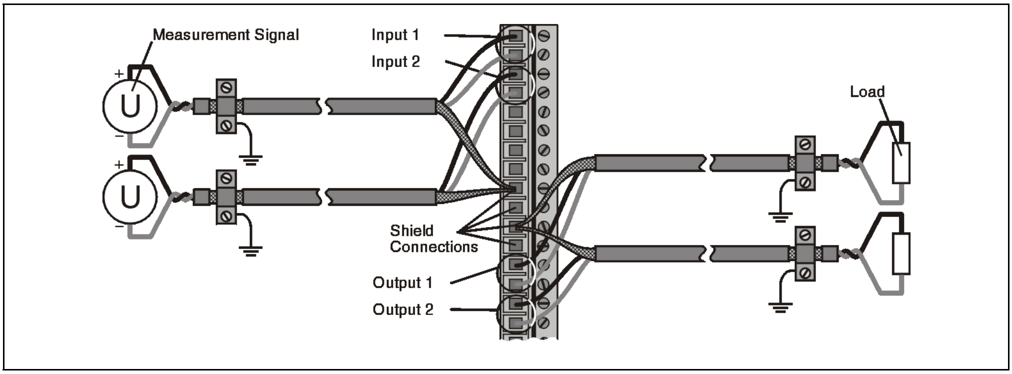


Figure 153: AM055 signal cable connection

Shielded cabling should be used for the mixed module's analog input and output signal cables. The cable shield must be grounded near the terminal block.

Due to EMC reasons, it is recommended to short circuit the inputs which are not used.

Potentiometer Operation

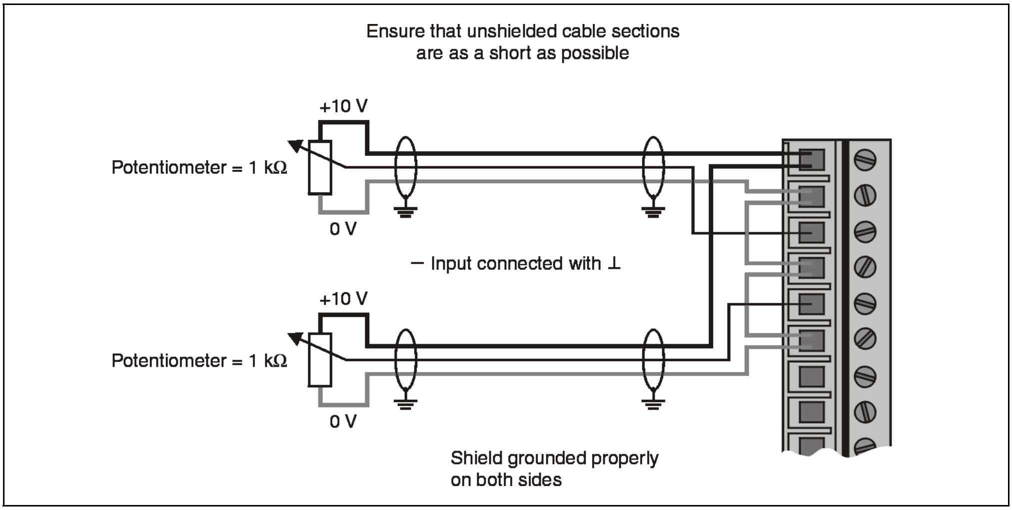


Figure 154: AM055 potentiometer operation

12.4.6 Input Circuit Diagram

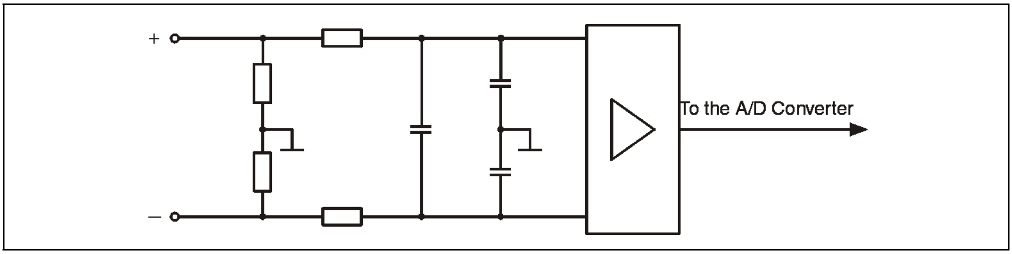


Figure 155: AM055 input circuit diagram

12.4.7 Output Circuit Diagram

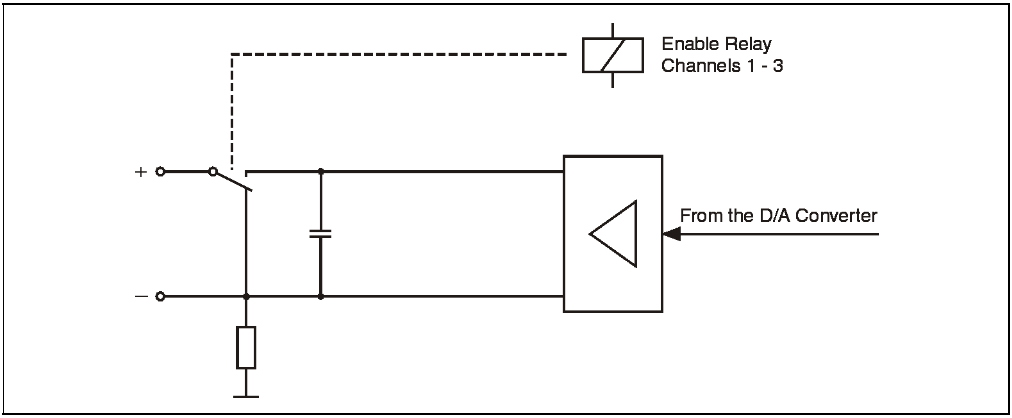


Figure 156: AM055 output circuit diagram

12.4.8 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset. The enable relay releases the outputs approximately 300 ms after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after a power-on.

Analog Inputs

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms due to the higher computing time needed.

Analog Outputs

All values are read and written on the analog output channels. The update time for the analog outputs should be considered in the above listed conversion times for the analog inputs.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value: %00010000

In this operating mode, the conversion cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse).

All analog output values are then immediately read and written on the output channels. Finally, the conversion of all five input channels is carried out so that it does not react to another start pulse. The end of the cycles is registered by setting bit 7 in the status register 2.

Application Example: Data acquisition (without jitter) in high-speed-task classes (e.g. for a controller).

Mode Register 8	Analog Mixed Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 -3	t_ao = t_0 + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Start measurement input channel 5	t_ao +5 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 250: AM055 Special Operating Mode 1: Direct software timing

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

Mode register 2 must be set to the following value: %00110000

The procedure is similar to special operating mode 1. However in special operating mode 2 there is the option to set the time when the next conversion cycle should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles.

The reading of analog output values and the conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: Equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1 . At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Mixed Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 -3	t_ao = t_St + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Start measurement input channel 5	t_ao +5 * 85 µs
	Write measurements in the DPR (start up)	1)

Table 251: AM055 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Mixed Module	Time
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_pre - 100 µs
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 251: AM055 Special Operating Mode 2: Software timing using default time (cont.)

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

12.4.9 Relationship between Converter Value and Input / Output Signals

Input Voltage 0 - 10 V

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Voltage	Converter Value	
	Hexadecimal	Decimal
Error Status	$8000	-32768
≤0 A	$0000	0
2.441 mV	$0008	8
9.997 V	$7FF0	32752
≥10 V	$7FF8	32760

Table 252: AM055 Relationship between input voltage and converter value

Output Voltage ±10 V

The converter value (INT format) changes in increments of 16 (..., -32, -16, 0, 16, 32, etc.).

Converter Value		Output Voltage
Hexadecimal	Decimal	
≤$8080	-32640	-10 V
$FFF0	-16	-4.901 mV
$0000	0	0 V
$0010	16	4.901 mV
≥$7F80	32640	10 V

Table 253: AM055 Relationship between output voltage and converter value

12.4.10 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 5
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 3
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1

Table 254: AM055 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

0	0	0	0	0	0		0

7 0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive limit for averaging is $7FF7 instead $7FF8.

Mode Register 2

Bits 0 - 3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

7							0
0	0			0	0	0	0

SWT_DIR 0 ...... Normal operation (default setting)
1 ...... Special operating mode 1 (Direct Software Timing)

SWT_TIM SWT_TIM is only active if SWT_DIR is set to 1!
0 ...... Operating mode dependent on SWT_DIR (default setting)
1 ...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The conversion cycle of all analog inputs and analog outputs must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

7							0
	0	0	0	0	0	0	0

TRIGn: TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0)
A write access with TRIGn = 0 triggers a conversion cycle.
A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

7							0
x	x	x	x	x	x		

I_ERR 0...... Data values in the dual ported RAM (DPR) correspond to definitions
1...... An internal error exists. Please contact B&R.

MW Averaging in normal operation is active (mode register 1 settings are repeated)

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

7							0
	x			x	x	x	x

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0......Measurement or waiting loop is running
1......The last cycle is completed

12.5 AM374

12.5.1 General Information

The AM374 is a standard analog mixed module. Two channels at a time are combined into a group. There are two input and output groups. The signal can be configured for each group (voltage or current).

12.5.2 Order Data

Model Number	Short Description	Image
3AM374.6	2005 analog mixed module, 4 inputs, 0-10 V / 0-20 mA, 12-bit, 4 outputs, +/- 10 V / 0-20 mA, 12-bit, signals can be switched in groups of 2. Order TB170 terminal blocks separately !	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 255: AM374 order data

12.5.3 Technical Data

Product ID	AM374
General information	
C-UL-US Listed	Yes
B&R ID Code	$8A
Slot Main Rack Expansion Rack	 Yes Yes
Inputs Input signal Group 1 Group 2	4 0 - 10 V / 0 - 20 mA, can be switched in groups of 2 Channel 1 +2 Channel 3 + 4
Outputs Output signal Group 1 Group 2	4 ±10 V / 0 - 20 mA, can be switched in groups of 2 Channel 1 +2 Channel 3 + 4
Electrical Isolation Channel - PLC Channel - Channel	 Yes No
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 5 W Max. 6.5 W
Analog Inputs Voltage	
Input signal Nominal Min./Max.	 0 to +10 V -20 to +20 V
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FFF (1 LSB = $0008 = 2.441 mV)
Non-Linearity	±1 LSB
Differential Input Resistance	2 MΩ
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz
Basic Accuracy at 25° C	±0.1% [1)]
Offset Drift	Max. ±0.0025% /° C [1)]
Gain Drift	Max. ±0.0075% /° C [2)]
Repeat Precision	±0.025% [1)]

Table 256: AM374 technical data

Product ID	AM374
Cross-Talk between Channels	-66 dB
Common-Mode Rejection DC 50 Hz	 50 dB 45 dB
Maximum Modulation Compared to Ground Potential	±50 VDC
Common Mode Modulation Capability between Two Channels	±10 VDC
Analog Inputs - Current	
Input Signal Nominal Min./Max.	 0 to 20 mA -50 to +50 mA
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FFF (1 LSB = $0008 = 4.883 µA)
Non-Linearity	±1 LSB
Load	50 Ω
Voltage Drop at 20 mA	1 V
Input Filter	Low pass 1st order / cut-off frequency: 450 Hz
Basic Accuracy at 25° C	±0.1% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.01% /° C 2)
Repeat Precision	±0.05% 1)
Cross-Talk between Channels	-66 dB
Common-Mode Rejection DC 50 Hz	 60 dB 55 dB
Maximum Modulation Compared to Ground Potential	±50 VDC
Common Mode Modulation Capability between Two Channels	±15 VDC
Analog Outputs - Voltage	
Output Signal	±10 V
Digital Converter Resolution	12-bit
Output Format	INT $8080 - $7F80 (1 LSB = $0010 = 4.90 mV)
Non-Linearity	±1 LSB
Load	Min. 1 kΩ
Short-circuit-proof	Current limit -15 mA to -30 mA / +15 mA to +30 mA
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz

Table 256: AM374 technical data (cont.)

Product ID	AM374
Basic Accuracy at 25° C Offset Total	 ±0.025% 1) ±0.15% 1)
Offset Drift	Max. ±0.0015% /° C 1)
Gain Drift	Max. ±0.0050% /° C 2)
Error caused by Load Change	Max. 0.013% (from 10 MΩ -> 1 kΩ, resistive)
Repeat Precision	±0.025% 1)
Switch On/Off Behavior	Internal enable relay, default setting: Short circuit
Analog Outputs Current	
Output signal	0 - 20 mA
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7F80 (1 LSB = $0080 = 4.90 µA)
Non-Linearity	±1 LSB
Load	Max. 600 Ω
Output Filter	Low pass 1st order / cut-off frequency: 1 kHz
Basic Accuracy at 25° C Offset Total	 -0.013% to +0.039% 1) ±0.15% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.008% /° C 2)
Error caused by Load Change	Max. 0.075% (from 1 Ω -> 600 kΩ, resistive)
Repeat Precision	±0.025% 1)
Switch On/Off Behavior	Internal enable relay, default setting: Short circuit
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 256: AM374 technical data (cont.)

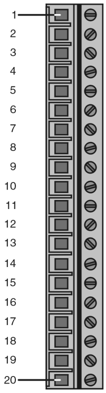
1) Refers to the measurement range.
2) Referring to the current measurement value.

12.5.4 Status LEDs

Image	LED	Description
	RUN	A slow blinking RUN LED indicates that the module has not yet been configured. A lit RUN LED indicates the analog/digital converter and digital/analog converter are running according to the configuration made.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.
	AI1, AI2	The LEDs AI1, AI2 indicate that input channels 1 and 2 are configured as current inputs.
	AI3, AI4	The LEDs AI3, AI4 indicate that input channels 3 and 4 are configured as current inputs.
	AO1, AO2	The LEDs AO1, AO2 indicate that output channels 1 and 2 are configured as current outputs.
	AO3, AO4	The LEDs AO3, AO4 indicate that output channels 3 and 4 are configured as current outputs.

Table 257: AM374 status LEDs

12.5.5 Pin Assignments



TB170

Connection	Assignment
1	+ Input 1
2	- Input 1
3	+ Input 2
4	- Input 2
5	+ Input 3
6	- Input 3
7	+ Input 4
8	- Input 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Output 1
14	- Output 1
15	+ Output 2
16	- Output 2
17	+ Output 3
18	- Output 3
19	+ Output 4
20	- Output 4

Table 258: AM374 pin assignment

Signal Cable Connection

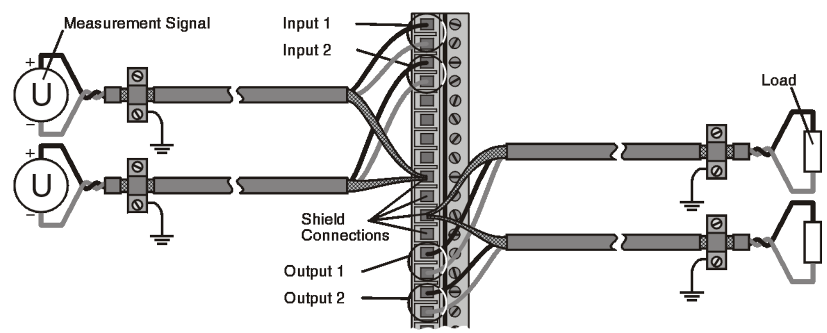


Figure 157: AM374 signal cable connection

Shielded cabling should be used for the mixed module's analog input and output signal cables. The shield is grounded for two inputs/outputs using one of the terminal block shield connections provided.

For EMC reasons, it is recommended to short circuit the inputs which are not used.

Minus connections for the analog outputs are switched over 22 Ω to the internal ground. A floating connection is recommended for large cable lengths. The potential displacement between minus connections is allowed to be a maximum of 4 V.

The four shielded connections are of the same value and each connected via 100 Ω resistors with ground (⏚, that means: a spring contact and a mounting rail).

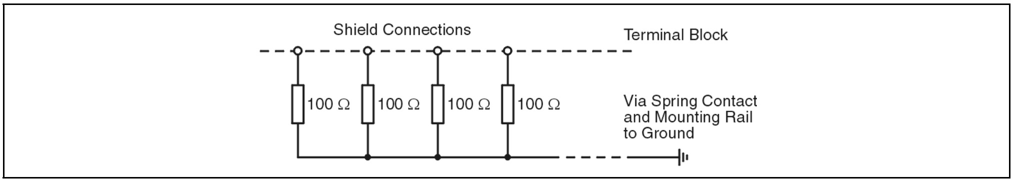


Figure 158: AM374 shielded connection

12.5.6 Input Circuit Diagram

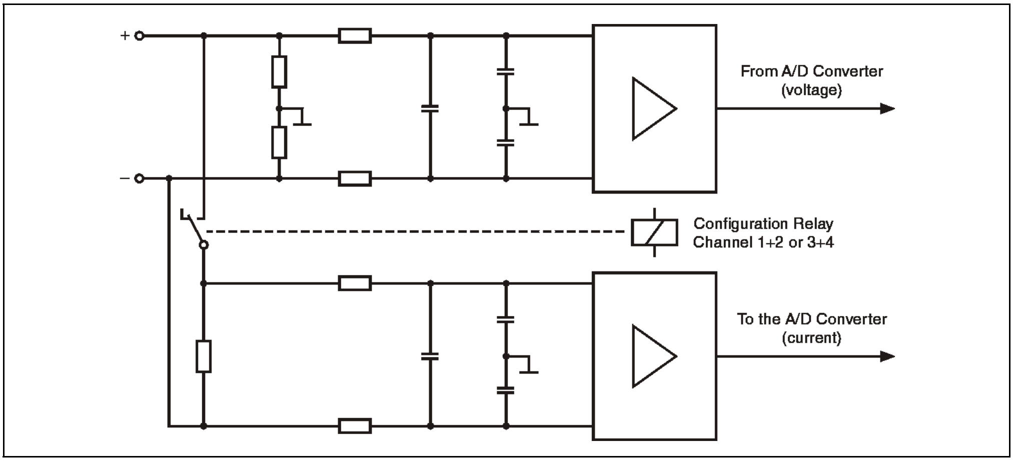


Figure 159: AM374 input circuit diagram

12.5.7 Output Circuit Diagram

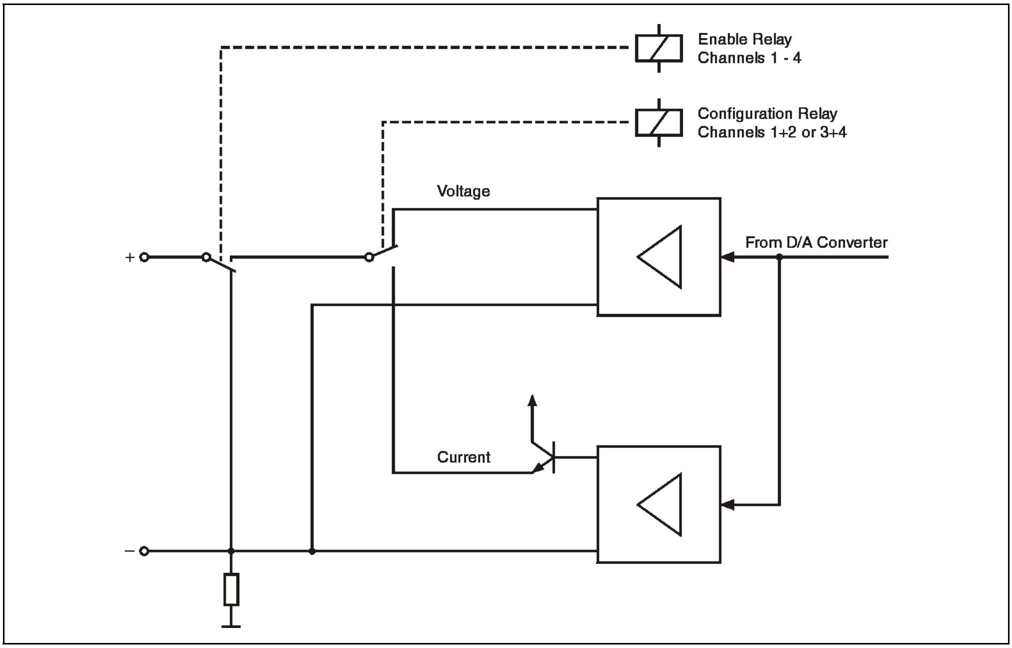


Figure 160: AM374 output circuit diagram

12.5.8 Configuration

The signal for analog inputs and analog outputs channels can be configured using the configuration register. The analog/digital and digital/analog converter begins to work after the configuration has been made.

There is no standby status! Without valid configuration, analog inputs remain highly resistive and the analog outputs are short circuited with the internal enable relay. The RUN LED blinks slowly. The error value $8000 (-32768) is returned as data value for the analog inputs.

The configuration remains in effect until the next start up or a reset is carried out in all operating modes. Changing during the operation is not possible. Configuration ideally takes place during the initialization sub-program (INIT SP). If PLC software ≥ V1.90 is used, then analog input values are already valid when the main program is started.

12.5.9 Operating Modes

Three operating modes are available:

- Normal operation: is set after configuration takes place
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- The module must be configured after the start up or after a reset. Normal operation is then active.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after start up and after configuration has been carried out.

Analog Inputs

All channels are converted cyclically and data is transferred to the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms, due to the higher computing time needed.

Analog Outputs

All values are read, and written on the analog output channels. The update time for the analog outputs should be considered in the above listed conversion times for the analog inputs.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value: %00010000

In this operating mode, the conversion cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse).

All analog output values are then immediately read and written on the output channels. Finally, the conversion of all four input channels is carried out so that it does not react to another start pulse. The end of the cycles is registered by setting bit 7 in status register 2.

Application example: Data acquisition (without jitter) in high-speed task classes (e.g. for a controller).

Mode Register 8	Analog Mixed Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_0 + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 259: AM374 Special Operating Mode 1: Direct software timing

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

The mode register 2 must be set to the following value : %00110000

The procedure is similar to special operating mode 1. However in special operating mode 2 there is the option to set the time when the next conversion cycle should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles.

The reading of analog output values and the conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is reported by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1. At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Mixed Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 - 4	t_ao = t_St + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)

Table 260: AM374 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Mixed Module	Time
	Bit 7 in the status register 2 = 1(cycle end)	t_pre - 100 µs
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 260: AM374 Special Operating Mode 2: Software timing using default time (cont.)

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

12.5.10 Relationship between Converter Value and Input / Output Signals

Input Voltage 0 - 10 V

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Voltage	Converter Value	
	Hexadecimal	Decimal
Error Status[1)]	$8000	-32768
≤0 V	$0000	0
2.441 mV	$0008	8
9.997 V	$7FF0	32752
≥10 V	$7FFF	32767

Table 261: AM374 Relationship between input voltage and converter value

1) For example, configuration that still has not been carried out.

Input Current 0 - 20 mA

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Current	Converter Value	
	Hexadecimal	Decimal
Error Status[1)]	$8000	-32768
≤0 A	$0000	0
4.883 µA	$0008	8
19.995 mA	$7FF0	32752
≥20 mA	$7FFF	32767

Table 262: AM374 Relationship between input current and converter value

1) For example, configuration that still has not been carried out.

Output Voltage ±10 V

The converter value (INT format) changes in increments of 16 (..., -32, -16, 0, 16, 32, etc.).

Converter Value		Output Voltage
Hexadecimal	Decimal	
≤$8080	-32640	-10 V
$FFF0	-16	-4.901 mV
$0000	0	0 V
$0010	16	4.901 mV
≥$7F80	32640	10 V

Table 263: AM374 Relationship between output voltage and converter value

Output Current 0 - 20 mA

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Converter Value		Output Current
Hexadecimal	Decimal	
≤$0000	0	0 A
$0008	8	4.883 µA
≥$7F80	32640	20 mA

Table 264: AM374 relationship between output current and converter value

12.5.11 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 4
Single Analog Output (channel x)	tc_global	INT	1	Analog Out	1 ... 4
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Configuration Register 1	tc_global	USINT	1	Status Out	2
Configuration Register 2	tc_global	USINT	1	Status Out	3
Status Register 1	tc_global	USINT	1	Status In	0

Table 265: AM374 variable declaration

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Status Register 2	tc_global	USINT	1	Status In	1
Status Register 3 (Reproduction of the configuration register 1)	tc_global	USINT	1	Status In	2
Status Register 4 (Reproduction of the configuration register 2)	tc_global	USINT	1	Status In	3

Table 265: AM374 variable declaration (cont.)

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

7							0
0	0	0	0	0	0		0

<u>Averaging</u>

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

Mode Register 2

Bits 0 and -3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

0	0			0	0	0	0
7							0

SWT_DIR 0...... Normal operation (default setting)
1...... Special operating mode 1 (Direct Software Timing)

SWT_TIM SWT_TIM is only active, if SWT_DIR is set to 1!
0...... Operating mode dependent on SWT_DIR (default setting)
1...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The conversion cycle of all analog inputs and analog outputs must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

	0	0	0	0	0	0	0

7 0

TRIGn	TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0) A write access with TRIGn = 0 triggers a conversion cycle. A write access with TRIGn = 1 is ignored.

Configuration Register 1

Bits 4 - 6 must be assigned with 0.

Configuration Reg. 1	Bit	Description
	7	VAL_AI
	6	0
	5	0
	4	0
	3	AI_ CONF4
	2	AI_CONF3
	1	AI_CONF2
	0	AI_CONF1

7							0
	0	0	0				

AI_CONF1, AI_CONF2 Input signal definition for analog inputs 1 and 2

AI_CONF2	AI_CONF1	Input Signal for Inputs 1 + 2
0	0	Voltage 0 - 10 V
0	1	Voltage 0 - 10 V
1	0	Voltage 0 - 10 V
1	1	Current 0 - 20 mA

Table 266: AM374 Input signal definition for analog inputs 1 and 2

AI_CONF3, AI_CONF4 Input signal definition for analog inputs 3 and 4

AI_CONF4	AI_CONF3	Input Signal for Inputs 3 +4
0	0	Voltage 0 - 10 V
0	1	Voltage 0 - 10 V
1	0	Voltage 0 - 10 V
1	1	Current 0 - 20 mA

Table 267: AM374 Input signal definition for analog inputs 3 and 4

VAL_AI 0 ..... Configuration is not valid
1 ..... Configuration is valid but only accepted if VAL_AO is also 1 in configuration register 2

Configuration Register 2

Bits 4 - 6 must be assigned with 0.

Configuration Reg. 2	Bit	Description
	7	VAL_AO
0	6	0
0	5	0
0	4	0
	3	AO_CONF4
	2	AO_CONF3
	1	AO_CONF2
	0	AO_CONF1

AO_CONF1, AO_CONF2 Output signal definition for analog outputs 1 and 2

AO_CONF2	AO_CONF1	Output Signal for Outputs 1 + 2
0	0	Voltage ±10 V
0	1	Voltage ±10 V
1	0	Voltage ±10 V
1	1	Current 0 - 20 mA

Table 268: AM374 Output signal definition for analog outputs 1 and 2

AO_CONF3, AO_CONF4 Output signal definition for analog outputs 3 and 4

AO_CONF4	AO_CONF3	Output Signal for Outputs 3 +4
0	0	Voltage ±10 V
0	1	Voltage ±10 V
1	0	Voltage ±10 V
1	1	Current 0 - 20 mA

Table 269: AM374 Output signal definition for analog outputs 3 and 4

VAL_AO 0 ..... Configuration is not valid
1 ..... Configuration is valid, but only accepted if VAL_AI is also 1 in configuration register 1

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	CONF_RDY
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

7							0
x	x	x	x		x		

I_ERR 0 ......Data values in the dual ported RAM (DPR) correspond to definitions
1 ......An internal error exists or the configuration has still not been carried out. If this bit has still not been deleted after the configuration has been made, please contact B&R.

MW Averaging in normal operation is active (mode register 1 settings are repeated)

CONF_RDY 0 ......No valid configuration exists
1 ......Configuration of analog input and output is terminated

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

7							0
	x			x	x	x	x

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0 ..... Measurement or waiting loop is running
1 ..... The last cycle is completed

Status Register 3

Status register 3 indicates the configuration of analog inputs . The content of the status register is valid if the CONF_RDY bit is set in status register 1.

Status Register 3	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	AI_CONF4
	2	AI_CONF3
	1	AI_CONF2
	0	AI_CONF1

x	x	x	x				

7 0

AI_CONF1, AI_CONF2 Input signal for analog inputs 1 and 2

AI_CONF2	AI_CONF1	Input Signal for Inputs 1 + 2
0	0	Voltage 0 - 10 V
1	1	Current 0 - 20 mA

Table 270: AM374 input signal for analog inputs 1 and 2

AI_CONF3, AI_CONF4 Input signal for analog inputs 3 and 4

AI_CONF4	AI_CONF3	Input Signal for Inputs 3 +4
0	0	Voltage 0 - 10 V
1	1	Current 0 - 20 mA

Table 271: AM374 input signal for analog inputs 3 and 4

Status Register 4

Status register 4 indicates the configuration of analog outputs. The content of the status register is valid if the CONF_RDY bit is set in the status register 1.

Status Register 4	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	AO_CONF4
	2	AO_CONF3
	1	AO_CONF2
	0	AO_CONF1

x	x	x	x				

7 0

AO_CONF1, AO_CONF2 — Output signal for analog outputs 1 and 2

AO_CONF2	AO_CONF1	Output Signal for Outputs 1 + 2
0	0	Voltage ±10 V
1	1	Current 0 - 20 mA

Table 272: AM374 output signal for analog outputs 1 and 2

AO_CONF3, AO_CONF4 — Output signal for analog outputs 3 and 4

AO_CONF4	AO_CONF3	Output Signal for Outputs 3 +4
0	0	Voltage ±10 V
1	1	Current 0 - 20 mA

Table 273: AM374 output signal for analog outputs 3 and 4

13. Temperature Modules

13.1 General Information

Temperature measurement values are converted into number values which can be processed by the PLC using temperature modules.

In the PLC, the number values are always in 16-bit 2s complement regardless of the resolution. In this way, the resolution (number of steps) of the temperature module does not have to be considered when creating the application program.

For temperature measurements, the temperature module returns the measured value in 0.1 ° steps. That means, a result of 750 corresponds to 75.0° C. The data format 0.1° C is supported as standard by all temperature modules. Some temperature modules can also be switched to other formats.

All temperature modules have a status LED labeled "RUN" which indicates that A/D conversion is active.

13.1.1 Overview

Module	AT350	AT450	AT660
Number of Channels	4	4	8
Measurement Range	-50 to +450° C	-50 to +450° C	-200 to +950° C -200 to +1,300° C
Sensor	PT100 / 3-line	PT100 / 4-line	FeCuNi / Type J + L NiCrNi / Type K
Resolution	13500 steps	13500 steps	23841 steps

Table 274: Temperature module overview

13.1.2 Programming

The analog data points are accessed directly in the application program using a variable name. The relationship between the channel for a certain module and the variable name is defined in the variable declaration. The declaration is made identically for each programming language using a table editor.

13.2 AT350 / AT450

13.2.1 General information

The AT350 and AT450 are temperature modules for PT100 temperature sensors.

13.2.2 Order Data

Model Number	Short Description	Image
3AT350.6	2005 Analog Input Module, 4 inputs, PT100 (3-line connection), -50 to +450 degrees C. Order TB170 terminal block separately.	
3AT450.6	2005 Analog Input Module, 4 inputs, PT100 (4-line connection), -50 to +450 degrees C. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 275: AT350 / AT450 order data

13.2.3 Technical Data

Product ID	AT350	AT450
C-UL-US Listed	Yes	Yes
B&R ID Code	$93	$92
Number of Inputs	4 inputs for resistance measurement	
Electrical Isolation Input - PLC Input - Input	 Yes No	
Sensor Type Connection Standard	 PT100 3 line connection IEC/EN 60751	 PT100 4 line connection IEC/EN 60751
Measurement Range	-50 to +450° C	
Resolution	Internal 13500 steps	
Measuring Procedure	Integrated Converter	
Measuring Time per Channel	20 or 16.67 ms	

Table 276: AT350 / AT450 technical data

Product ID	AT350	AT450
Conversion Time for all Channels	100 ms and 85 ms (depending on the measurement time per channel)	
Input Filter	Bessel low pass 1st order / cut-off frequency: 8 Hz	
Measurement Precision Basic Accuracy at 20° C Precision (0 to 60° C)	 ±0.1% ±0.2%	 ±0.1% ±0.15%
Linearization	Automatic in the module	
Measurement Current	2.5 mA (±0.2%)	
Power Consumption 5 V 24 V Total	 Max. 1 W Max. 3 W Max. 4 W	
Mechanical Characteristics		
Dimensions	B&R 2005 single-width	

Table 276: AT350 / AT450 technical data (cont.)

13.2.4 Status LEDs

Image	LED	Description
	RUN	The analog/digital converter is running.
	60Hz	This LED indicates, which measurement time is switched on. If this LED is lit, the measurement time is set to 16.67 ms, which filters out a 60 Hz mains power hum. Otherwise a measurement time of 20 ms is selected (filtering of 50 Hz power hum).

Table 277: AT350 / AT450 status LEDs

13.2.5 Pin Assignments

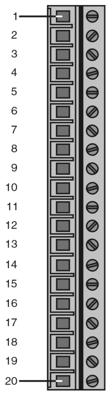
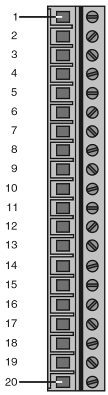
AT350	Connection	Assignment
 TB170	1	+ Sensor 1
	2	+ Sense 1
	3	- Sense/Sensor 1
	4	Shield
	5	+ Sensor 2
	6	+ Sense 2
	7	- Sense/Sensor 2
	8	Shield
	9	Shield
	10	Shield
	11	Shield
	12	Shield
	13	+ Sensor 3
	14	+ Sense 3
	15	- Sense/Sensor 3
	16	Shield
	17	+ Sensor 4
	18	+ Sense 4
	19	- Sense/Sensor 4
	20	Shield

Table 278: AT350 pin assignment



TB170

AT450	Connection	Assignment
	1	+ Sensor 1
	2	+ Sense 1
	3	- Sense 1
	4	- Sensor 1
	5	+ Sensor 2
	6	+ Sense 2
	7	- Sense 2
	8	- Sensor 2
	9	Shield
	10	Shield
	11	Shield
	12	Shield
	13	+ Sensor 3
	14	+ Sense 3
	15	- Sense 3
	16	- Sensor 3
	17	+ Sensor 4
	18	+ Sense 4
	19	- Sense 4
	20	- Sensor 4

Table 279: AT450 pin assignment

Signal Cable Connection

Shielded cables must be used for temperature sensor connection lines. The shield is grounded using the terminal block's shield connection.

3 line connection (AT350)

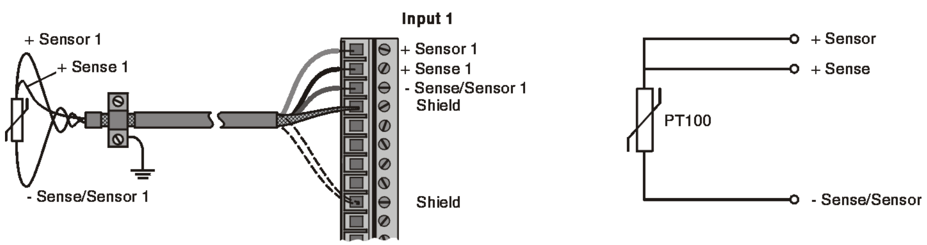


Figure 161: AT350 signal cable connection

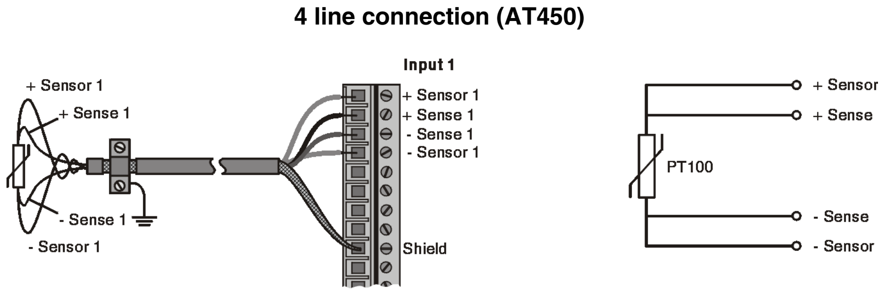


Figure 162: AT450 signal cable connection

All shielded connections are of the equal value and each connected via RC elements with ground (⏚, i.e. a spring contact and a mounting rail).

R: 22 kΩ, C: 10 nF / 60 V

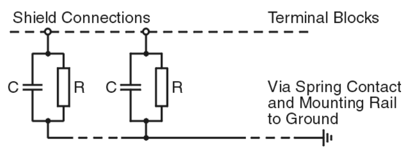


Figure 163: AT350 / AT450 shielded connection

With a 3-line connection (AT350), only sensors may be used for which the connection lines have the same electrical specifications i.e. same length, cross section, material and therefore very close to the same ohmic resistance.

The maximum total resistance between the + and - sensor connections may not exceed 600 Ω, otherwise the overload of internal current will lead to measurement errors.

Sensor or sensor lines are not allowed to be grounded or connected with any other sensor lines.

13.2.6 Input Circuit Diagram

AT350

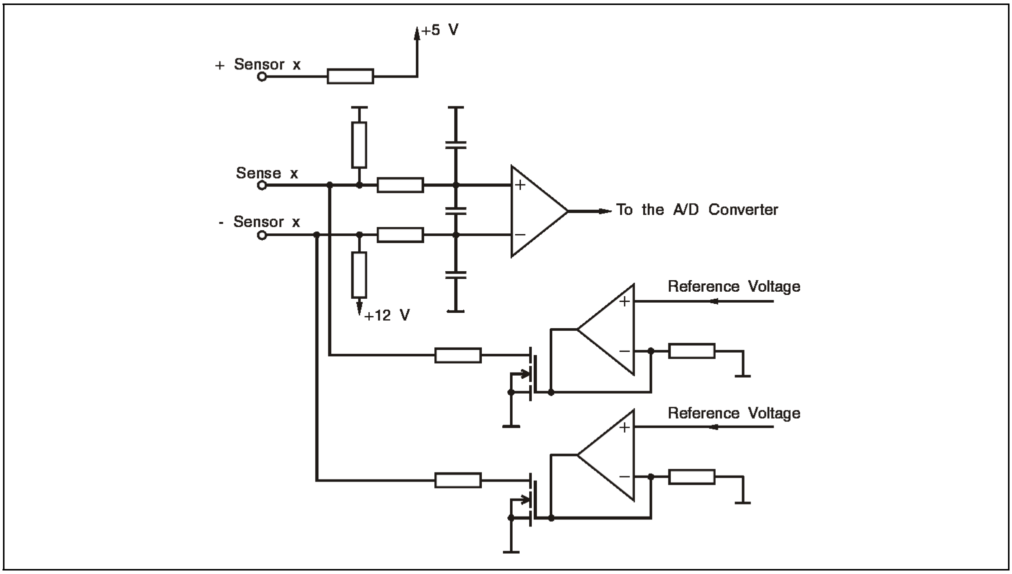


Figure 164: AT350 input circuit diagram

AT450

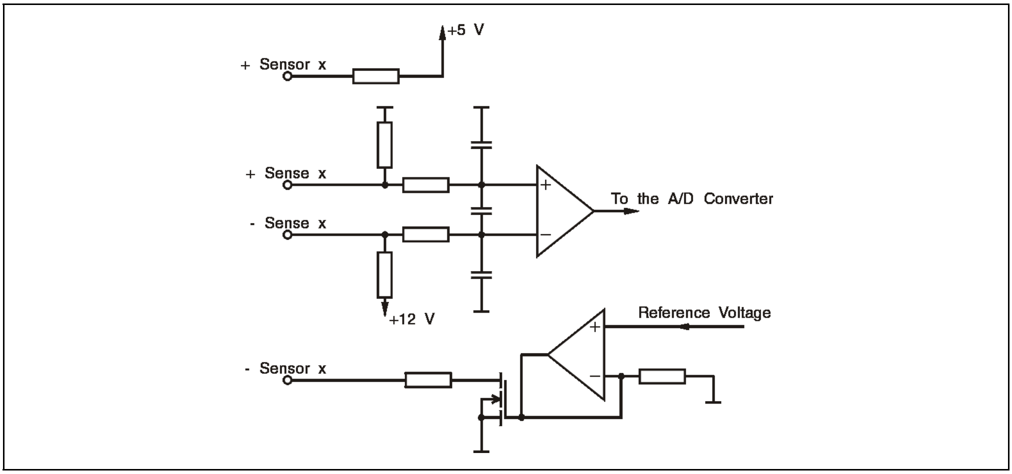


Figure 165: AT450 input circuit diagram

13.2.7 Relationship between Temperature and Converter Value

Data Format 1/10° C

Temperature	Converter Value	
	Hexadecimal	Decimal
< -65.8° C	8000	-32768
-65.8° C	FD6E	-658
:	:	:
-50.0° C	FE0C	-500
:	:	:
-0.1° C	FFFF	-1
0.0° C	0000	0
0.1° C	0001	1
:	:	:
50.0° C	01F4	500
:	:	:
+450.0° C	1194	4500
:	:	:
+474.1° C	1285	4741
> +474.1° C	7FFF	32767

Table 280: AT350 / AT450 data format 1/10° C

Values within the range of -50 to +450° C corresponding to the precision given in the technical data.

Over-range or under-range measurements of the -50 to +450° C range of measurements will be still interpreted as temperature values if they are between -65.8 to +474.1° C. However, the precision indicated in the technical data cannot be guaranteed for these values.

Values outside the range of -65.8 to +474.1° C give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

Data Format 1/100° C

Temperature	Converter Value	
	Hexadecimal	Decimal
< -64.65° C	8000	-32768
-64.65° C	E6BF	-6465
:	:	:
-50.00° C	EC78	-5000
:	:	:
-0.01° C	FFFF	-1
0.00° C	0000	0
0.01° C	0001	1
:	:	:
50.00° C	1388	5000
:	:	:
+250.00° C	61A8	25000
:	:	:
+265.07° C	678B	26507
> +265.07° C	7FFF	32767

Table 281: AT350 / AT450 data format 1/100° C

With this data format the measurement range is also (-50° C to +450° C) but because of the data format, the output range is limited and the values between +265.08 to +450° C can no longer be displayed. They receive the value 32767 (7FFF).

Values within the range of -50 to +250° C corresponding to the precision given in the technical data.

Over-range or under-range measurements of the -50 to +250° C range of measurements will be still interpreted as temperature values if they are between -64.65 to +265.07° C. However, the precision indicated in the technical data cannot be guaranteed for these values.

Values outside the range of -64.65 to +265.07° C give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

Data format 1/10 °F (Fahrenheit)

Temperature	Converter Value	
	Hexadecimal	Decimal
< -64.06° C	8000	-32768
-64.06° C	FCBF	-833
:	:	:
-45.56° C	FE0C	-500
:	:	:
-17.83° C	FFFF	-1
-17.78° C	0000	0
-17.72° C	0001	1
:	:	:
10.00° C	01F4	500
:	:	:
+454.44° C	2134	8500
:	:	:
+473.78° C	2290	8848
> +473.78° C	7FFF	32767

Table 282: AT350 / AT450 data format 1/10 °F (Fahrenheit)

	Values within the range of -50 to +850 °F corresponding to the precision given in the technical data.
	Over-range or under-range measurements of the -50 to +850 °F range of measurements will be still interpreted as temperature values if they are between -83.3 to +884.8 °F. However, the precision indicated in the technical data cannot be guaranteed for these values.
	Values outside the range of -83.3 to +884.8 °F give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

13.2.8 Open Line Detection

The converter values -32768 (8000) and +32767 (7FFF) are not only sent to the PLC from the module as under-range and over-range measurements, but are also given if inputs are open or contacts broken.

AT350

Error	Converter Value	
	Hexadecimal	Decimal
Open Input (sensor is not connected)	8000	-32768
Broken Sensor Line	8000	-32768
Broken Sense Line	7FFF	32767

Table 283: AT350 open line detection

AT450

Error	Converter Value	
	Hexadecimal	Decimal
Open Input (sensor is not connected)	8000	-32768
Broken Sensor Line	8000	-32768
Broken Sense Line	8000	-32768

Table 284: AT450 open line detection

13.2.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 4
Mode Register The following settings can be changed by writing to this register: - Measurement Time 20 or 16.67 ms - Scan Order for the channels - Selection of the data format	tc_global	USINT	1	Status Out	0

Table 285: AT350 / AT450 variable declaration

13.2.10 Mode Register

The user can make different settings using the mode register. When writing to this register, please make sure that only the relevant bits are changed.

Mode Register	Bit	Description
	7	0
	6	0
	5	0
	3 - 4	Choosing the desired data format (choice of three formats)
	1 - 2	Scan order of the individual channels (choice of three options)
	0	Measurement time 16.67 ms

0	0	0					
7							0

Measurement Time

By setting the measurement time, a mains power hum of 50 or 60 Hz is supressed. A choice of two measurement times are available:

Mode Register Bit 0	Measurement Time	Remark
0	20 ms	Standard setting after a hardware reset and switching on for 50 Hz
1	16.67 ms	Setting for 60 Hz

Table 286: AT350 / AT450 measurement time

Scan Order

It is possible to change the scan order, i.e. channels are not scanned and converted in succesion. Individual channels can be scanned more often in order to register fast thermal changes more rapidly (e.g. heating cartridges).

Status Register			
Bit 2	Bit 1	Scan Order	Remark
0	0	0	Standard settings after hardware reset or when switched on
0	1	1	
1	0	2	
1	1	3	not used (corresponds to the scan order 0)

Table 287: AT350 / AT450 scan order definition

The scan order is graphically shown in the following diagram (values in parentheses apply to a set measurement time of 16.67 ms):

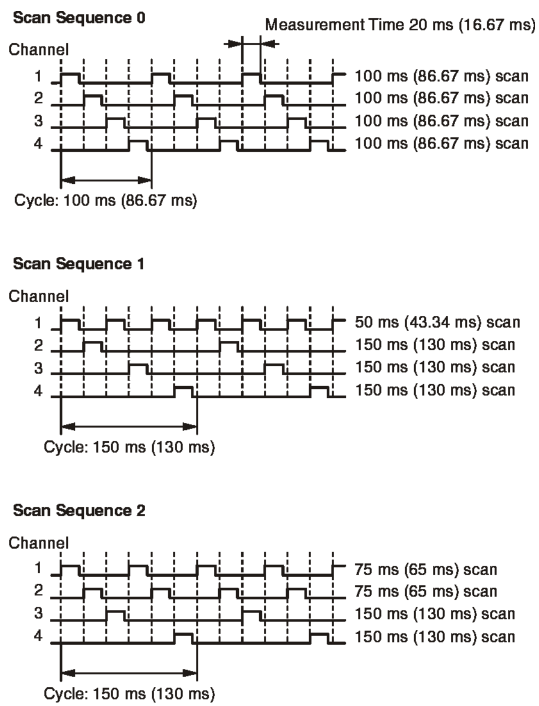


Figure 166: AT350 / AT450 scan order

Data Format

In addition to the 1/10° C data format, two further formats are available, which can be selected using bits 3 and 4 of the status register. The relationship between temperature and data format is clarified in Section 13.2.7 "Relationship between Temperature and Converter Value", on page 444.

The selected data format is always valid for all four inputs.

Status Register			
Bit 4	Bit 3	Data Format	Remark
0	0	1/10° C	Standard settings after hardware reset or when switched on
0	1	1/100° C	
1	0	1/-12.22° C	
1	1	---	Not used (reserved for service)

Table 288: AT350 / AT450 data format definition

13.3 AT660

13.3.1 General Information

The AT660 is a temperature module for temperature sensor type L, J and K.

13.3.2 Order Data

Model Number	Short Description	Image
3AT660.6	2005 analog input module, 8 inputs, temperature sensor type L/J/K, -200 to +1300 degrees C. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 289: AT660 order data

13.3.3 Technical Data

Product ID	AT660
C-UL-US Listed	Yes
B&R ID Code	$95
Number of Inputs Total in 2 Groups of	 8 4
Electrical Isolation Input - PLC Group - Group Input - Input	 Yes No No

Table 290: AT660 technical data

Product ID	AT660			
Each Group can be Set Sensor Sort Type Standard Measurement Voltage Range Measurement Range in 0.1° C Steps Linearization	 FeCuNi L Acc. to DIN 43710 -8.15 to 53.14 mV 1) -200.0 to +900.0° C Yes	 FeCuNi J Acc. to DIN IEC 584 -7.89 to 54.95 mV 1) -200.0 to +950.0° C Yes	 NiCrNi K Acc. to DIN IEC 584 -5.891 to 52.398 mV 1) -200.0 to +1,300.0° C Yes	 Raw Value Measurement --- Standardized, 2 µV 2) -15 to +55 mV Depends on sensor in CPU
Each group can be set				
Terminal Temperature Compensation				
Internal	-20 to +80° C from internal compensation measurement			Can be read
External	-100 to +200° C adjustable			---
Reference Junction (internal)				
Temperature Measurement	Temperature profile measurement on the module using four temperature sensors Compensation temperature measured separately for each channel			
Measurement Precision (with natural convection)	Max. ±4° C in total ambient temperature range (0 to 60° C) Type +3° C / -1° C with an ambient temperature of 25° C			
Repeat Precision	≤0.1° C			
Digital Converter Resolution	Internal >14-bit (23841 internal ADC converter values in 20 ms)			
Thermo Voltage Raw Value 3)	-7500 ($E2B4) at -15 mV 0 at 0 mV 27500 ($6B6C) at +55 mV			
Quantization (ADC value)	2.936 µV (internal)			
Measuring Procedure				
Conversion Principle	Integrated (voltage/frequence converter)			
Conversion Order of the Channels	1 and 5, 2 and 6, 3 and 7, 4 and 8 parallel			
Measurement Time per Conversion	20 ms / 16.67 ms / 10 ms / 8.33 ms (module related setting)			
Measurement Time for Internal Compensation Measurement	20 ms + 6 ms			
Maximum cycle time 4 * (measurement time per conversion + module computing time) Internal Compensation Measurement (if activated) Cycle Time	**50 Hz** 4 * (20 + 6) ms 20 ms + 6 ms 130 ms		**60 Hz** 4 * (16.67 + 6) ms 20 ms + 6 ms 116.68 ms	
Inputs	Differential Inputs			
Input Resistance	>1 MΩ			
Input Filter	Bessel low pass 2nd order, cut-off frequency 8 Hz, with NOTCH characteristic measurement procedure (depending on the measurement time at 50 Hz / 60 Hz / 100 Hz / 120 Hz)			

Table 290: AT660 technical data (cont.)

Product ID	AT660			
Status Display	RUN LED (green), 6 status LEDs (yellow)			
Measurement Range Monitoring Open Inputs Wire break Range Exceeded (neg.) Range Exceeded (pos.)	 $7FFF $7FFF $8000 4) $7FFF			
Measurement Precision at 25° C 5) 6)	Type L ±0.5° C	Type J ±0.5° C	Type K ±0.8° C	---
Offset Drift 6)	±2.5 µV /° C			
Gain Drift 7)	±100 ppm /° C			
Common Mode Deviation	±9 V between the channels			
Common-Mode Rejection	75 dB (DC) / 65 dB (50 Hz)			
Maximum Modulation Compared to Ground Potential	±50 V			
Repeat Precision Measurement time 20 ms Measurement time 16.67 ms Measurement time 10 ms Measurement time 8.33 ms	 ≤2 LSB ≤3 LSB (scaled to 20 ms) 8) ≤4 LSB (scaled to 20 ms) 8) ≤6 LSB (scaled to 20 ms) 8)			
Power Consumption 5 V 24 V Total	 Max. 1.25 W Max. 4.75 W Max. 6 W			
Dimensions	B&R 2005 single-width			

Table 290: AT660 technical data (cont.)

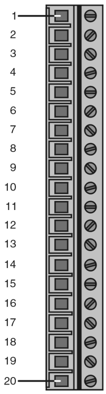
1) Standardized to 0° C compensation temperature.
2) Voltage standardized to 2 µV starting with rev. xx.01.
3) Specifications refer to 2 µV.
4) Not for raw value measurement.
5) Without consideration for the compensation measurement error.
6) Refers to the measurement range.
7) Refers to the current measurement value.
8) Depending on the measurement time, the internal resolution is reduced respectively, but the analog value is always scaled to 20 ms and output in this form. This prevents a value from being changed when the measurement time is changed.

13.3.4 Status LEDs

<table>
<tr><th>Image</th><th>LED</th><th>Description</th></tr>
<tr><td rowspan="5">
</td><td>RUN</td><td>The analog/digital converter is running.</td></tr>
<tr><td>60Hz</td><td>This LED indicates which measurement time is switched on. If this LED is lit, the measurement time is set to 16.67 ms, by which a 60 Hz mains power hum is filtered out. Otherwise a measurement time of 20 ms is selected. The measurement time is valid for all 8 channels.
Default Setting: 50 Hz; LED not lit</td></tr>
<tr><td>τ/2</td><td>This LED indicates if the half measurement time is set. If this LED is lit the measurement time is 10 ms or 8.33 ms (depending on whether the 60Hz LED is lit or not).
Default Setting: Full measuring time; LED not lit</td></tr>
<tr><td>ϑ1A/ϑ1B</td><td>These LEDs indicate the temperature sensor type setting for group 1 (channels 1 - 4).
Default Setting: Sensor type L; both LEDs not lit
<table>
<tr><th>ϑ1B</th><th>ϑ1A</th><th>Sensor Type</th></tr>
<tr><td>OFF</td><td>OFF</td><td>L (default setting) or wrong setting in mode register 2</td></tr>
<tr><td>OFF</td><td>ON</td><td>J</td></tr>
<tr><td>ON</td><td>OFF</td><td>K</td></tr>
<tr><td>ON</td><td>ON</td><td>Output of thermocouple voltage as standardized raw value [1)] or compensation temperature</td></tr>
</table>
1) Starting with Rev. xx.01.</td></tr>
<tr><td>ϑ2A/ϑ2B</td><td>These LEDs indicate the temperature sensor type setting for group 2 (channels 5 - 8).
Default Setting: Sensor type L; both LEDs not lit
<table>
<tr><th>ϑ2B</th><th>ϑ2A</th><th>Sensor Type</th></tr>
<tr><td>OFF</td><td>OFF</td><td>L (default setting) or wrong setting in mode register 2</td></tr>
<tr><td>OFF</td><td>ON</td><td>J</td></tr>
<tr><td>ON</td><td>OFF</td><td>K</td></tr>
<tr><td>ON</td><td>ON</td><td>Output of thermocouple voltage as standardized raw value [1)] or compensation temperature</td></tr>
</table>
1) Starting with Rev. xx.01.</td></tr>
</table>

Table 291: AT660 status LEDs

13.3.5 Pin Assignments



TB170

Connection	Assignment
1	+ Sensor 1
2	- Sensor 1
3	+ Sensor 2
4	- Sensor 2
5	+ Sensor 3
6	- Sensor 3
7	+ Sensor 4
8	- Sensor 4
9	Shield
10	Shield
11	Shield
12	Shield
13	+ Sensor 5
14	- Sensor 5
15	+ Sensor 6
16	- Sensor 6
17	+ Sensor 7
18	- Sensor 7
19	+ Sensor 8
20	- Sensor 8

Table 292: AT660 pin assignment

Signal Cable Connection

Shielded cables must be used for temperature sensor connection lines. The shield is grounded for two inputs using one of the terminal block shield connections provided. The minus leg of the sensor is grounded with some thermocouples, which does not affect the measurements negatively.

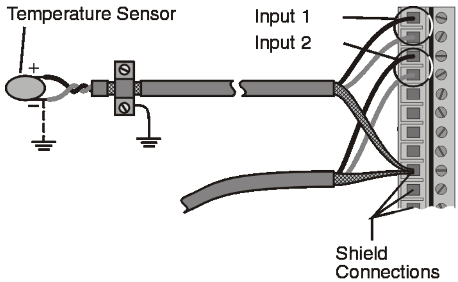


Table 293: AT660 signal cable connection

The four shielded connections are of equal value and each connected via RC elements with ground (⏚, i.e.: a spring contact and a mounting rail).

R: 22 kΩ, C: 10 nF / 60 V

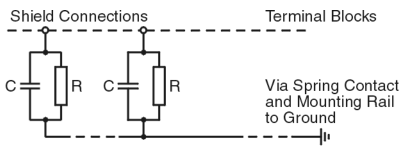


Figure 167: AT660 shielded connection

Influence of the Compensation Line Length

The measurement error caused by the line resistance can normally be disregarded. For a line resistance of Ω (this corresponds to a line length of approximately 40 m), the measurement errror is 9 µV.

13.3.6 Input Circuit Diagram

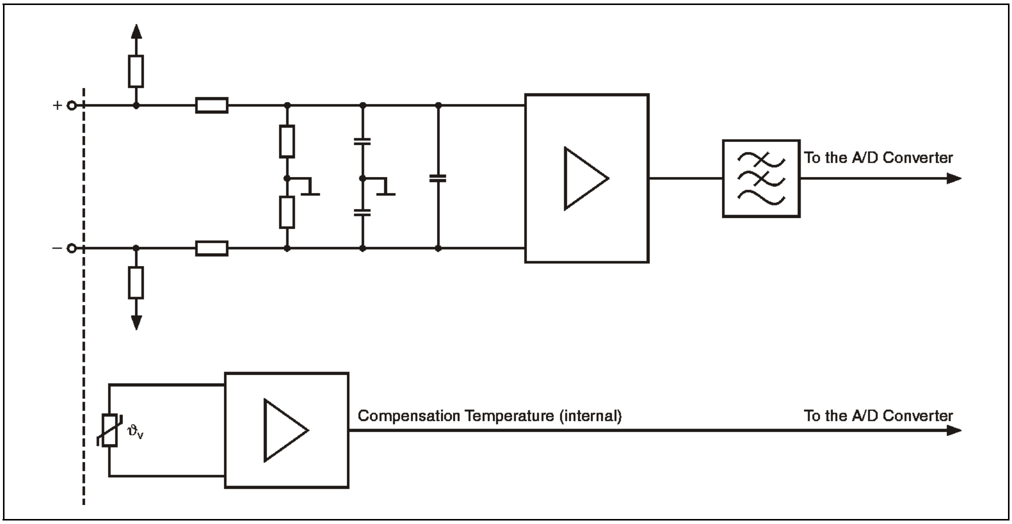


Figure 168: AT660 input circuit diagram

13.3.7 Measurement Range Monitoring

1) Causes for Exceeding the Measurement Range in the Positive Direction ($7FFF)

- No temperature sensor connected
- The input voltage from the temperature sensor is higher than the:
  - a) Voltage range
  - b) Measurement range of the temperature sensor

2) Causes for Exceeding the Measurement Range in the Negative Direction ($8000)

- The input voltage from the temperature sensor is lower than the:
  - a) Voltage range
  - b) Measurement range of the temperature sensor

3) Short Circuit Monitoring

Since a short circuit is generally a valid type of operation (0 mV), this cabling error status must be recognized with a plausibility check in the application program.

If 0° C is also in the operating range for the application, B&R recommend a plausibility check using additional logic.

Example: If the heater for Δt = n sec is switched on, the temperature must increase at least 2° C (reference value that can also be automatically, adaptively calculated).

13.3.8 Installation Notes

- Additional cooling lowers the absolute error of the internal compensation temperature calculation especially at higher environmental temperatures for the AT660 (to approximately ±2° C).
- For EMC reasons, it is recommended to short circuit open inputs.
- 5 minutes after switching on the controller, the AT660 has reached operating temperature for calculating the compensation temperature The measurement precision is now valid.

13.3.9 Internal Measurement Processing

A scaled raw value is created from the input voltage which has a linear relationship to the input voltage. Thermocouple temperature (for the given thermocouple type) is calculated from this raw value taking the compensation into consideration (compensation and linearization takes place internally).

The compensation temperature is calculated separately for each channel in the module. The required temperature measurement is made using four temperature sensors on the terminal block. The compensation temperature can be read by the user.

It is also possible to set the compensation temperature for each channel which will be used instead of the measured value for internal compensation ("external compensation"). Operation using external compensation is only possible for the entire module.

Special Types of Operation:

a) A thermocouple other than the defined types (J, K, L) is connected. Thermocouple temperature is calculated in an application program (main CPU) from the raw value and the compensation temperature measured on the module (for the respective channel).

b) It is necessary to install an external compensation reference junction (for long line lengths). Calculating thermocouple temperature should be done on an AT660 module in spite of this.

The thermocouple voltage is sent from the external compensation reference junction to the terminal of the AT660, the temperature measured on the external compensation reference junction (e.g. with PT100 - AT350) is placed in the IO area for the AT660 module. The AT660 module calculates thermocouple temperature internally from the measured voltage and the compensation temperature value (per channel).

Chapter 3
B&R 2005 Modules

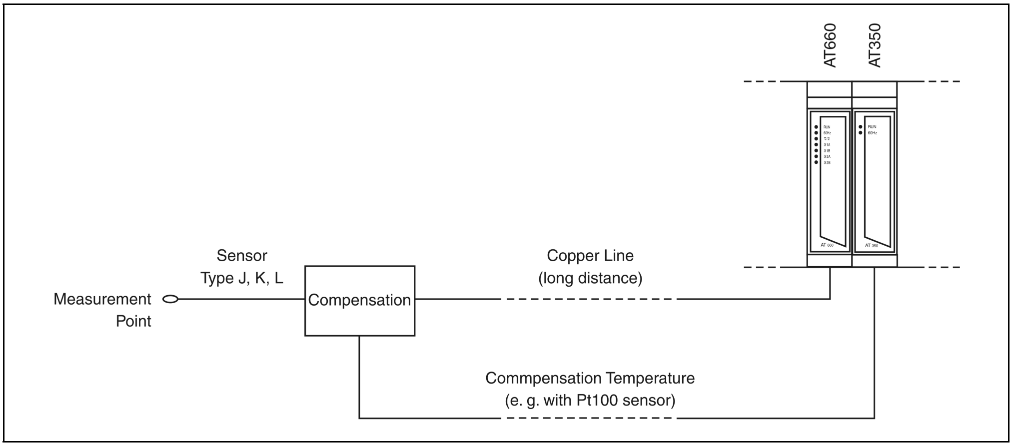


Figure 169: AT660 operation using an external compensation reference junction

13.3.10 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 8
Default External Reference Junction in 0.1° C Steps (channel x)	tc_global	INT	1	Analog Out	1 ... 8
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Register 3	tc_global	USINT	1	Status Out	2
Mode Register 4	tc_global	USINT	1	Status Out	3
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1
Status Register 3	tc_global	USINT	1	Status In	2
Status Register 4	tc_global	USINT	1	Status In	3

Table 294: AT660 variable declaration

Mode Register 1

Bits 1 - 6 must be assigned with 0.

Mode Register 1	Bit	Description
	7	$\tau/2$ - Half measurement time
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	τ - Measurement time 16.67ms

7							0
	0	0	0	0	0	0	

τ 0...... Measurement time per channel 20 ms (default setting) filtering of 50 Hz power hum
1...... Measurement time per channel 16.67 ms filtering of 60 Hz power hum

$\tau/2$ 0...... Depending on bit 0, the measurement time is 20 ms or 16.67 ms (default setting)
1...... Half measurement time: Depending on bit 0, the measurement time is 10 ms or 8.33 ms

Mode Register 2

Bits 4 - 7 must be assigned with 0. Please refer to the section "Relationship between Mode Registers 2 and 3".

Mode Register 2	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	ϑ2B - Sensor type for group 2 (channels 5 - 8)
	2	ϑ2A - Sensor type for group 2 (channels 5 - 8)
	1	ϑ1B - Sensor type for group 1 (channels 1 -4)
	0	ϑ1A - Sensor type for group 1 (channels 1 -4)
0 0 0 0 _ _ _ _ (7 … 0)		

With standardized raw values, settings are **not** relevant and can be chosen in any way desired.

B&R Recommendation: $00

ϑ2		ϑ1		Sensor Type
B	A	B	A	
0	0	0	0	L (default setting)
0	1	0	1	J
1	0	1	0	K
1	1	1	1	Invalid Sensor Type Output of: -3276.8

Table 295: Definition of the Sensor Type

Mode Register 3

Bits 2 and 3 as well as 6 and 7 must be assigned with 0. Please refer to the section "Relationship between Mode Registers 2 and 3".

Mode Register 3	Bit	Description
		0
		0
		Raw value 2 - Group 2: Temperature as standardized raw value
		Raw value 1 - Group 1: Temperature as standardized raw value
		0
		0
		VSϑ2 - Group 2: Compensation temperature
		VSϑ1 - Group 1: Compensation temperature

7							0
0	0			0	0		

VSϑ1 0...... Group 1: Sensor temperature output (default setting)
1...... Group 1: Compensation temperature output in 0.1° C steps 1)

VSϑ2 0...... Group 2: Sensor temperature output (default setting)
1...... Group 2: Compensation temperature output in 0.1° C steps 1)

Raw Value 1 0...... Group 1: Thermocouple voltage output as compensated temperature in 0.1° C steps (default setting)
1...... Group 1: Thermocouple voltage output as standardized raw value 2)

Raw Value 2 0...... Group 2: Thermocouple voltage output as compensated temperature in 0.1° C steps (default setting)
1...... Group 2: Thermocouple voltage output as standardized raw value 2)

1) The compensation temperature is either the terminal temperature (bit 5 in the mode register 4 = 0) or the temperature of an external compensation reference junction (bit 5 in the mode register 4 = 1).
2) It is not possible to output the compensation temperature as a standardized raw value. Standardization is made with 2 µV starting with rev. xx.01.

Relationship between Mode Registers 2 and 3

The output format is defined using both these registers.

	Mode Register 2 (bit 7 … bit 0)	Mode Register 3 (bit 7 … bit 0)
1) Compensation Temperature Output	0 0 0 0 x x x x	0 0 x x 0 0 1 1
2) Thermocouple Voltage Output as Standardized Raw Value	0 0 0 0 x x x x	0 0 1 1 0 0 0 0
3) L (default setting)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
4) Sensor Type J	0 0 0 0 0 1 0 1	0 0 0 0 0 0 0 0
5) Sensor Type K	0 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0

Table 296: AT660 relationship between mode register 2 and 3

Mode Register 4

Selectively switching off (locking) the channels or the compensation temperature reduces the cycle time.

Bits 6 and 7 must be assigned with 0.

Mode Register 4	Bit	Description	
	7	0	
	6	0	
	5	$COMP_{External}$	- External Compensation Temperature
	4	T_{Comp}	- Updating the internal compensation temperature locking
	3	C4/8	- Locking channels 4 and 8
	2	C3/7	- Locking channels 3 and 7
	1	C2/6	- Locking channels 2 and 6
	0	C1/5	- Locking channels 1 and 5

0	0						

7 0

C1/5 0 ......Measuring Channels 1 and 5 (default setting)
1 ......Locking channels 1 and 5. The value last measured is retained.

C2/6 0 ......Measuring Channels 2 and 6 (default setting)
1 ......Locking channels 2 and 6. The value last measured is retained.

C3/7 0 ......Measuring Channels 3 and 7 (default setting)
1 ......Locking channels 3 and 7. The value last measured is retained.

C4/8 0 ......Measuring Channels 4 and 8 (default setting)
1 ......Locking channels 4 and 8. The value last measured is retained.

T_{Comp} 0 ......The internal compensation temperature (terminal temperature) is constantly updated (default setting)
1 ......The internal compensation temperature is no longer being updated. The values last measured are retained and are used for terminal compensation temperature.

$COMP_{External}$ 0 ......Internal compensation reference junction is active (terminal compensation temperature is used - default setting)
1 ......External reference junction is active (applies to all 8 channels). If the operating mode is selected, Firmware does not use the sensor measurement values on the module for compensation temperature. Instead, a value is set by the user is used. These values are written in the I/O area in steps of 0.1° C using "Analog Out" channels 1 - 8.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	x
	0	IERR - Module error

x	x	x	x	x	x	x	
7							0

IERR 0 ...... Data values in the DPR correspond to definitions

1 ...... An internal error exists. That means that the data values in the DPR do not correspond to the definitions. Please contact B&R if this occurs.

Status Register 2, 3 and 4

Mode register settings 2, 3 and 4 are given again status registers 2, 3 and 4. Settings are only valid if the status register is the same as the mode register.

The respective status register returns a message (mode register) to the application program (task) when the settings have been transferred completely.

Status Register 2

Status Register 2	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	ϑ2B - Sensor type for group 2 (channels 5 - 8)
	2	ϑ2A - Sensor type for group 2 (channels 5 - 8)
	1	ϑ1B - Sensor type for group 1 (channels 1 -4)
	0	ϑ1A - Sensor type for group 1 (channels 1 -4)

x	x	x	x				
7							0

Status Register 3

Status Register 3	Bit	Description
		x
		x
		Raw value 2 - Group 2: Temperature as standardized raw value
		Raw value 1 - Group 1: Temperature as standardized raw value
		x
		x
		VSϑ2 - Group 2: Compensation temperature
		VSϑ1 - Group 1: Compensation temperature

x	x			x	x		
7							0

Status Register 4

Status Register 4	Bit	Description
	7	x
	6	x
	5	$COMP_{External}$ - External Compensation Temperature
	4	T_{Comp} - Updating the internal compensation temperature locking
	3	C4/8 - Locking channels 4 and 8
	2	C3/7 - Locking channels 3 and 7
	1	C2/6 - Locking channels 2 and 6
	0	C1/5 - Locking channels 1 and 5

x	x						
7							0

14. Other Modules

14.1 General Information

The universal mixed module is a combination of digital input/output modules and analog input/output modules.

The states of the digital inputs or outputs are shown by the status LEDs. A status LED labeled "RUN" indicates that D/A and A/D conversion is active.

Module	UM161
Digital Inputs	
Number of Inputs	16
Type of Inputs Channel 1 Channel 2 Channels 3 -14 Channels 15 - 16	 16-bit event counter or period measurement Latch input (Comparator input) Digital inputs Digital outputs (can also be used as digital inputs)
Nominal Input Voltage	24 VDC
Counter Input, Input 1 Rated Frequency	 Max. 10 kHz (symmetrical square wave)
Latch Input, Input 2 Max. Switching Delay	 10 µs
Input Delay, inputs 3 - 16 Typical Maximum	 0.6 ms 1 ms
Digital Outputs	
Number of Outputs	2
Switching Voltage	24 VDC
Continuous Current Output 1 (Channel 15) Output 2 (Channel 16)	 10 mA 2 A
Analog Inputs	
Number of Inputs	4
Input Signal	±10 V
Digital Converter Resolution	14-bit
Analog Outputs	
Number of Outputs	3
Output Signal	±10 V
Digital Converter Resolution	12-bit

Table 297: General information on other modules

14.2 UM161

14.2.1 General Information

The UM161 is a universal analog/digital mixed module. It offers very high component density using standard 3.5 mm terminal blocks.

Features

- 4 analog inputs ±10 V
- 3 analog outputs ±10 V
- 14 digital inputs 24 VDC
- 2 digital outputs 24 VDC (can be also used as digital inputs)

Features

- 1 potentiometer supply ±10 V
- The module is equipped with a comparator function, so that it can react quickly to changing analog inputs.

14.2.2 Order Data

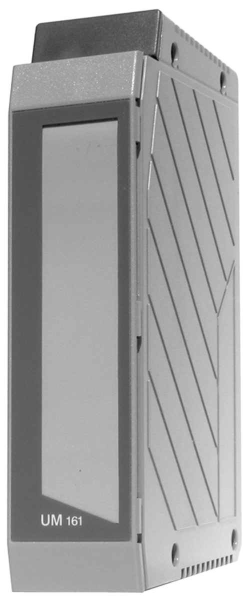
Model Number	Short Description	Image
3UM161.6	2005 universal mixed module, 1x4 analog inputs ±10 V, 14-bit, 1x3 analog outputs ±10 V, 12-bit, 1x14 digital inputs 24 VDC, 1 ms, 1 digital output 24 VDC, 2 A, 500 µs, 1 digital output 24 VDC, 10 mA, 10 µs, both outputs can be used as inputs. Order 2 x TB718 terminal blocks separately!	
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	
Terminal blocks are not included in the delivery.		

Table 298: UM161 order data

14.2.3 Technical Data

Product ID	UM161
General Information	
C-UL-US Listed	Yes
B&R ID Code	$99
Module Type	B&R 2005 I/O module
Slot Main Rack Expansion Rack	 Yes Yes
Power Consumption 5 V 24 V Total	 Max. 2 W Max. 4 W (+1.5 W for potentiometer supply) Max. 6 W
Potentiometer Voltage Outputs	
Number and Type of Potentiometer Voltages	1 Potentiometer supply ±10V
Electrical Isolation to PLC	Yes
Alignment Precision at 25° C Total	 ±0.4%
Temperature Drift	±0.5 mV/°C
Load	4 x 1 kΩ parallel, total of max. 80 mA
Short Circuit Protection	Yes
Analog Inputs	
Number of Inputs	4 differential inputs
Input Signal Nominal Min./Max.	 -10 to +10 V -20 to +20 V
Digital Converter Resolution	14-bit
Data Format	INT
Input Impedance in Signal Range Static Dynamic	 >10 MΩ 3 kΩ/10 nF
Isolation Voltage between Input and Bus	±50 V
Cut-off Frequency	8 kHz
Conversion Time	<45 µs for all 4 inputs
Maximum Error at 25° C Offset Gain	 ±4.5 mV ±0.05% [1)]
Linearity Error	±0.9 mV
Temperature Drift	±1.5 mV/°C
Analog Outputs	
Number of Outputs	3 voltage outputs
Output Signal	±10 V

Table 299: UM161 technical data

Product ID	UM161
Digital Converter Resolution	12-bit
Data Format	INT
Load Impedance	≥1 kΩ
Output Response when Power Supply is Switched On/Off	An enable relay is switched on at a defined value of 0 V, Default setting = 10 kΩ between the output terminals using relay contact
Conversion Time	<45 µs for all 3 outputs
Isolation Voltage between Output and Bus	±50 V
Alignment Precision at 25° C Offset Gain	 ±4.9 mV ±0.2% 1)
Linearity Error	±19.6 mV
Temperature Drift	±1.2 mV/°C
Digital inputs	
Number of Inputs	16
Type of Inputs Channel 1 Channel 2 Channels 3 -14 Channels 15 - 16	 16-bit event counter or period measurement Latch input (Comparator input) Digital inputs Digital outputs (can also be used as digital inputs)
Rated Voltage Nominal Maximum	 +24 VDC +30 VDC
Input Current at Nominal Voltage	Approx. 4mA (IEC 1131-2 type 1)
Switching Threshold LOW Range Switching range HIGH Range	 < 5 V 5 to 15 V > 15 V
Wiring	Sink or source
Counter Input, Input 1 Rated Frequency	 Max. 10 kHz (symmetrical square wave)
Latch Input, Input 2 Max. Switching Delay	 10 µs
Input Delay, Inputs 3 - 16 Typical Maximum	 0.6 ms 1 ms
Isolation Voltage between Input and Bus	±50 V
Voltage Monitoring	Supply voltage >18 V
Digital Outputs	
Number and Type of Outputs	2 transistor outputs
Rated Current Output 1 (Channel 15) Output 2 (Channel 16)	 10 mA 2 A
Rated Voltage	24 VDC

Table 299: UM161 technical data (cont.)

Product ID	UM161
Switching Voltage Range	18 - 30 VDC
Wiring	Source
Short Circuit Protection	Yes
Overload Protection	Yes
Braking Voltage when Switching Off Inductive Loads	59 V
Switching Delay 0 to 1 Output 1 Output 2	 Max. 10 µs Max. 500 µs
Switching Delay 1 to 0 Output 1 Output 2	 Max. 10 µs Max. 500 µs
Comparator Output Evaluation Reaction Time	 Output 1 can be set by the comparator logic < 50 µs
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 299: UM161 technical data (cont.)

1) Refers to the current measurement value.

14.2.4 Status LEDs

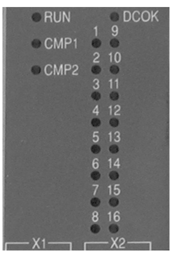
Image	LED	Description
	RUN	Indicates that both the analog/digital converter and digital/analog converter are running.
	DCOK	Lit as long as the supply for the digital inputs is in the defined range (greater than +18 VDC).
	CMP1	Comparator 1 is configured.
	CMP2	Comparator 2 is configured.
	1 - 14	Input state of the corresponding digital inputs.
	15 - 16	Using channels 15 and 16 as digital inputs: Input state of the corresponding digital inputs. Using channels 15 and 16 as digital outputs: Control status of the corresponding output. Take note that LEDs are also lit in green in this instance.

Table 300: UM161 status LEDs

14.2.5 Connection Elements

Two 18-pin terminal blocks are located next to each other in the lower part of the housing so that all signals can be connected using terminal blocks.

The TB718 terminal blocks are available with screw and cage clamps.

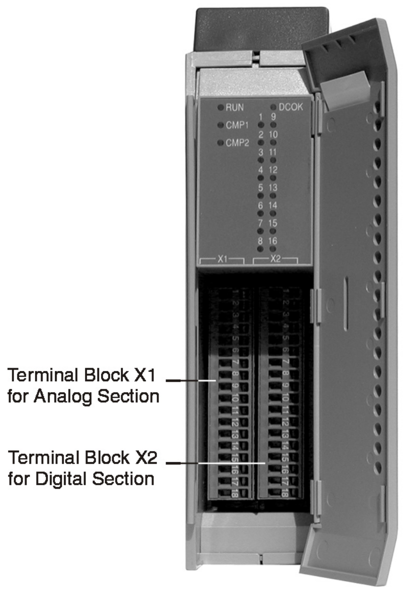


Figure 170: UM161 connection elements

14.2.6 Pin Assignments

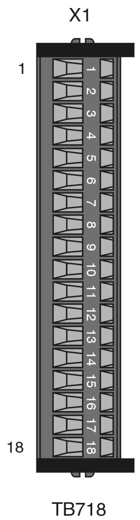
Left 18-pin Terminal Block	Connection	Assignment
	1	Potentiometer voltage +10 V (for channels 1 and 2)
	2	Potentiometer voltage -10 V (for channels 1 and 2)
	3	+ Analog input 1
	4	- Analog input 1
	5	+ Analog input 2
	6	- Analog input 2
	7	Potentiometer voltage +10 V (for channels 3 and 4)
	8	Potentiometer voltage -10 V (for channels 3 and 4)
	9	+ Analog input 3
	10	- Analog input 3
	11	+ Analog input 4
	12	- Analog input 4
	13	+ Analog output 1
	14	- Analog output 1 / GND analog signal
	15	+ Analog output 2
	16	- Analog output 2 / GND analog signal
	17	+ Analog output 3
	18	- Analog output 3 / GND analog signal

Table 301: UM161 pin assignments for terminal block X1

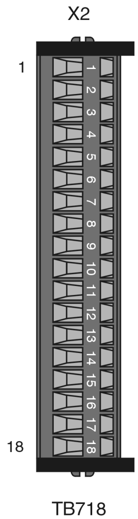
Right 18-pin Terminal Block	Connection	Assignment
	1	Digital input 1 (counter input or period measurement)
	2	Digital input 2 (Latch input)
	3	Digital input 3
	4	Digital input 4
	5	Digital input 5
	6	Digital input 6
	7	Digital input 7
	8	Digital input 8
	9	Digital input 9
	10	Digital input 10
	11	Digital input 11
	12	Digital input 12
	13	Digital input 13
	14	Digital input 14
	15	Digital input 15 or digital output 1 (10 mA)
	16	Digital input 16 or digital output 2 (2 A)
	17	COMs (+24 VDC in sink operation)
	18	COM (GND in sink operation)

Table 302: UM161 pin assignments for terminal block X2

14.2.7 Connection Example

Analog Inputs/Outputs

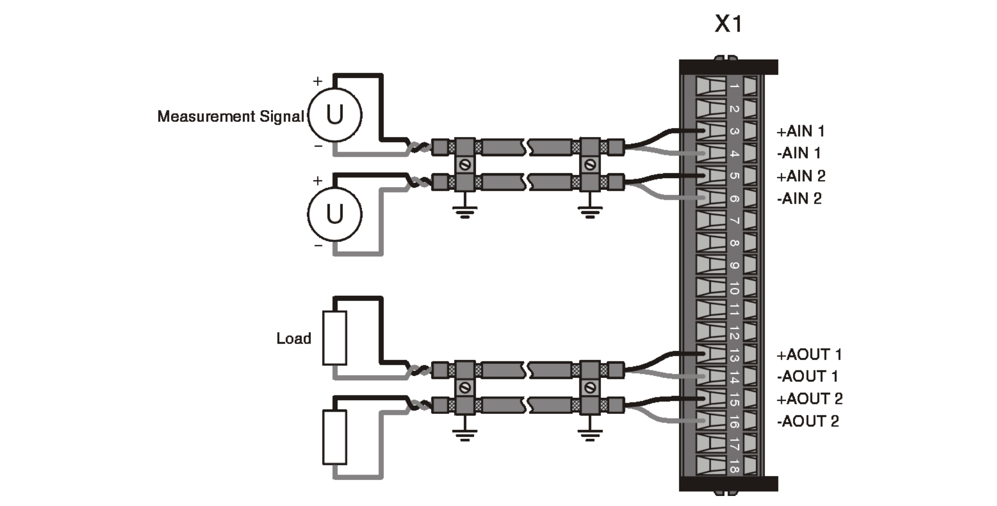


Figure 171: UM161 analog inputs/outputs connection example

Potentiometer Connection

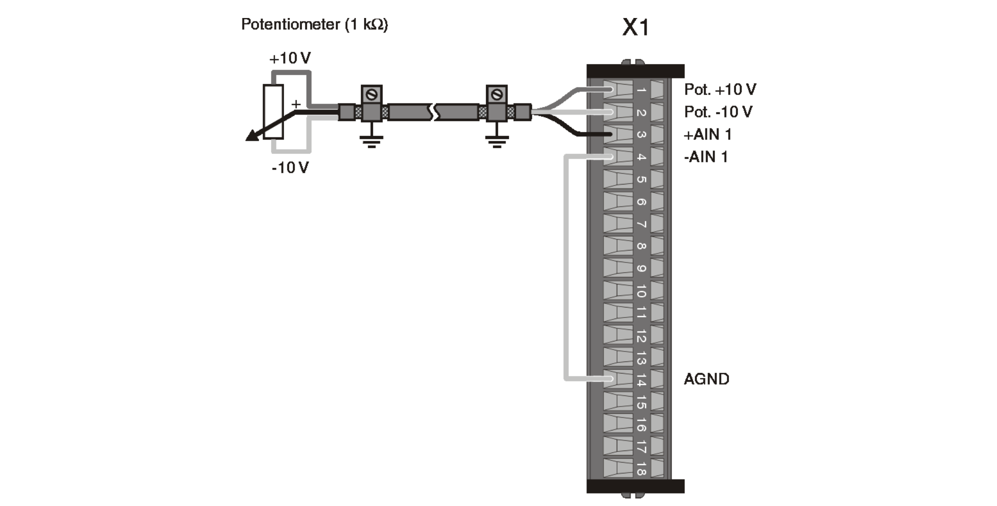


Figure 172: UM161 potentiometer connection example

Digital Inputs/Outputs

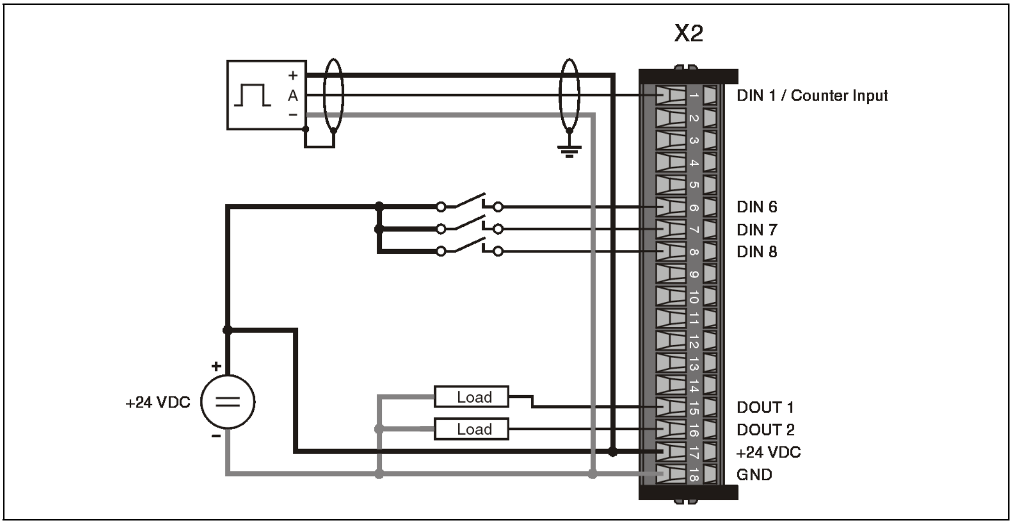


Figure 173: UM161 digital inputs/outputs connection example

14.2.8 Input Circuit Diagram

Analog Inputs

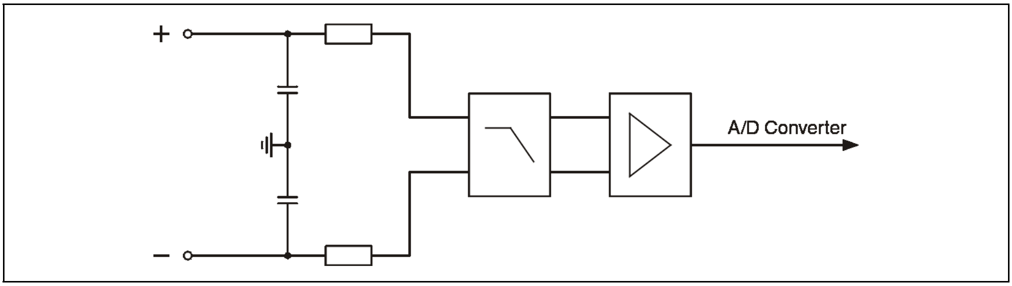


Figure 174: UM161 input circuit diagram analog inputs

Digital Inputs

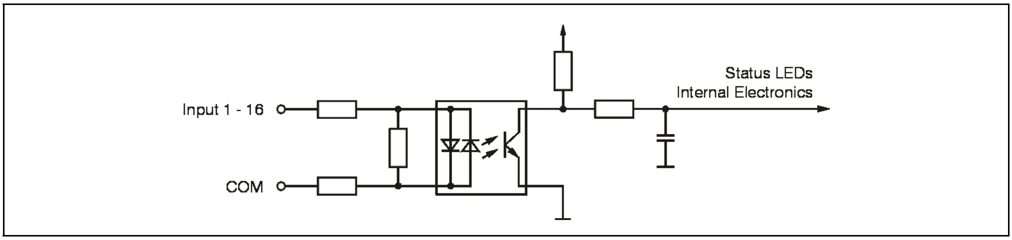


Figure 175: UM161 input circuit diagram digital inputs

14.2.9 Output Circuit Diagram

Analog Outputs

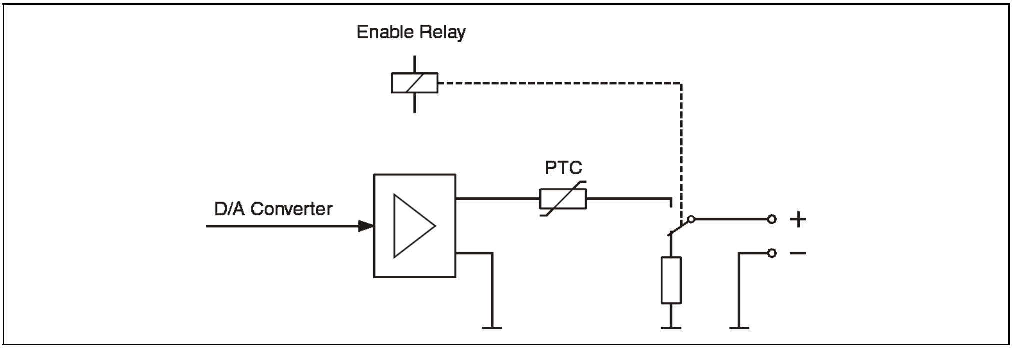


Figure 176: UM161 output circuit diagram analog outputs

Digital Outputs

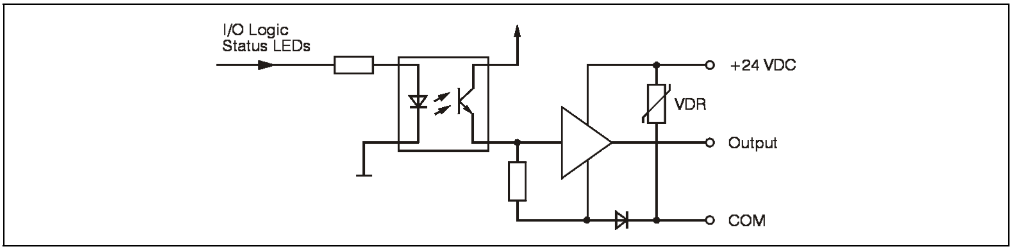


Figure 177: UM161 output circuit diagram digital outputs

Potentiometer Voltage Outputs

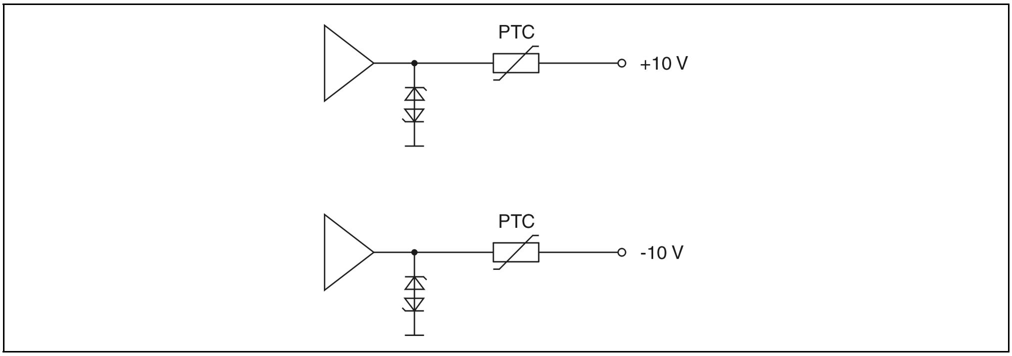


Figure 178: UM161 output circuit diagram potentiometer voltage outputs

14.2.10 Relationship between Converter Value and Input / Output Signals

Input Voltage ±10 V

The converter value (INT format) changes in increments of 4 (..., -8, -4, 0, 4, 8, etc.).

Input Voltage	Converter Value	
	Hexadecimal	Decimal
≤-10 V	$8000	-32768
-1.221 mV	$FFFC	-4
0 V	$0000	0
1.221 mV	$0004	4
≥10 V	$7FFC	32764

Table 303: UM161 Relationship between input voltage and converter value

Output Voltage ±10 V

The converter value (INT format) changes in increments of 16 (..., -32, -16, 0, 16, 32, etc.).

Converter Value		Output Voltage
Hexadecimal	Decimal	
≤$8080	-32640	-10 V
$FFF0	-16	-4.902 mV
$0000	0	0 V
$0010	16	4.902 mV
≥$7F80	32640	10 V

Table 304: UM161 relationship between output voltage and converter value

14.2.11 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Digital Input (Channel x)	tc_global	BOOL	1	Digit. In	1 ... 16
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	2 ... 5
Comparator 1 Actual Value	tc_global	INT	1	Analog In	6
Comparator 2 Actual Value	tc_global	INT	1	Analog In	7
Event Counter or Period Duration	tc_global	INT	1	Analog In	8
Single digital output (channel x)	tc_global	BOOL	1	Digit. Out	15, 16
Single analog output (channel x)	tc_global	INT	1	Analog Out	2 ... 4
Comparator 1 Comparison Value	tc_global	INT	1	Analog Out	5
Comparator 2 Comparison Value	tc_global	INT	1	Analog Out	6
Comparator 1 Switching Channel	tc_global	INT	1	Analog Out	7
Comparator 2 Switching Channel	tc_global	INT	1	Analog Out	8
Status Register 1: Timestamp for Comparator 1	tc_global	USINT	1	Status In	0
Status Register 2: Timestamp for Comparator 2	tc_global	USINT	1	Status In	1
Status Register 3: Event for Comparator 1	tc_global	USINT	1	Status In	2
Status Register 4: Event for Comparator 2	tc_global	USINT	1	Status In	3
Status Register 5: Timer reference value	tc_global	USINT	1	Status In	6
Mode Register 1: Configuration for Comparator 1	tc_global	USINT	1	Status Out	0
Mode Register 2: Configuration for Comparator 2	tc_global	USINT	1	Status Out	1
Mode Register 3: Acknowledge and Configure Comparator 1 and 2	tc_global	USINT	1	Status Out	3
Mode Register 4: Event counter / period duration	tc_global	USINT	1	Status Out	4

Table 305: UM161 variable declaration

Comparator 1 Actual Value

Analog actual value at the time of the comparator event.

Comparator 2 Actual Value

Analog actual value at the time of the comparator event.

Event counter / period duration

16-bit event counter on digital input 1 or period duration (resolution 10 µs).

Comparator 1 Comparison Value

Determines the comparator threshold for comparator 1.

Comparator 2 Comparison Value

Determines the comparator threshold for comparator 2.

Comparator 1 Switching Channel

After a comparator event, the switching value is output on the corresponding analog output until the event is cleared again.

Comparator 2 Switching Channel

After a comparator event, the switching value is output on the corresponding analog output until the event is cleared again.

Status Register 1: Timestamp for Comparator 1

Timer reference value at the time of the comparator event.

Status Register 2: Timestamp for Comparator 2

Timer reference value at the time of the comparator event.

Status Register 3: Event for Comparator 1

Bits 0 - 4 indicate which input the comparator event has triggered. Bit 7 indicates the status of the module supply for the digital component (24 VDC). It has the same status in status registers 3 and 4.

Status Register 3	Bit	Description
	7	0 ...... No supply voltage or supply voltage too low (24 VDC) 1 ...... Supply voltage in the valid range
	6	x
	5	x
	4	0 ...... Comparator 1 not triggered by external latch input 1 ...... Comparator 1 triggered by external latch input
	3	0 ...... Comparator 1 not triggered by analog input 4 1 ...... Comparator 1 triggered by analog input 4
	2	0 ...... Comparator 1 not triggered by analog input 3 1 ...... Comparator 1 triggered by analog input 3
	1	0 ...... Comparator 1 not triggered by analog input 2 1 ...... Comparator 1 triggered by analog input 2
	0	0 ...... Comparator 1 not triggered by analog input 1 1 ...... Comparator 1 triggered by analog input 1

	x	x					
7							0

Status Register 4: Event for Comparator 2

Bits 0 - 4 indicate which input the comparator event has triggered. Bit 7 indicates the status of the module supply for the digital component (24 VDC). It has the same status in status registers 3 and 4.

Status Register 4	Bit	Description
	7	0 ...... No supply voltage or supply voltage too low (24 VDC) 1 ...... Supply voltage in the valid range
	6	x
	5	x
	4	0 ...... Comparator 2 not triggered by external latch input 1 ...... Comparator 2 triggered by external latch input
	3	0 ...... Comparator 2 not triggered by analog input 4 1 ...... Comparator 2 triggered by analog input 4
	2	0 ...... Comparator 2 not triggered by analog input 3 1 ...... Comparator 2 triggered by analog input 3
	1	0 ...... Comparator 2 not triggered by analog input 2 1 ...... Comparator 2 triggered by analog input 2
	0	0 ...... Comparator 2 not triggered by analog input 1 1 ...... Comparator 2 triggered by analog input 1

7							0
	x	x					

Status Register 5: Timer reference value

Free running 8-bit counter. Cycle time 20 µs.

Mode Register 1: Configuration for Comparator 1

Along with the comparator source, an analog output can also be configured. The switching channel is output immediately by this analog output, when a comparator event occurs. It is also possible to output the switching value on several analog outputs.

Mode Register 1	Bit	Description
	7	0 ...... Switching value 1 not output on analog output 3 1 ...... Switching value 1 output on analog output 3
	6	0 ...... Switching value 1 not output on analog output 2 1 ...... Switching value 1 output on analog output 2
	5	0 ...... Switching value 1 not output on analog output 1 1 ...... Switching value 1 output on analog output 1
	4	0 ...... External latch off 1 ...... External latch triggers comparator 1
	3	0 ...... Comparator 1 analog input 4 off 1 ...... Comparator 1 analog input 4 on
	2	0 ...... Comparator 1 analog input 3 off 1 ...... Comparator 1 analog input 3 on
	1	0 ...... Comparator 1 analog input 2 off 1 ...... Comparator 1 analog input 2 on
	0	0 ...... Comparator 1 analog input 1 off 1 ...... Comparator 1 analog input 1 on

7 0

Mode Register 2: Configuration for Comparator 2

Along with the comparator source, an analog output can also be configured. The switching channel is output immediately by this analog output, when a comparator event occurs. It is also possible to output the switching value on several analog outputs.

Mode Register 2	Bit	Description
	7	0 ...... Switching value 2 not output on analog output 3 1 ...... Switching value 2 output on analog output 3
	6	0 ...... Switching value 2 not output on analog output 2 1 ...... Switching value 2 output on analog output 2
	5	0 ...... Switching value 2 not output on analog output 1 1 ...... Switching value 2 output on analog output 1
	4	0 ...... External latch off 1 ...... External latch triggers comparator 2
	3	0 ...... Comparator 2 analog input 4 off 1 ...... Comparator 2 analog input 4 on
	2	0 ...... Comparator 2 analog input 3 off 1 ...... Comparator 2 analog input 3 on
	1	0 ...... Comparator 2 analog input 2 off 1 ...... Comparator 2 analog input 2 on
	0	0 ...... Comparator 2 analog input 1 off 1 ...... Comparator 2 analog input 1 on

7 0

Mode Register 3: Acknowledge and Configure Comparators 1 and 2

In this register, the digital outputs are configured and the comparator event is acknowledged. The comparator event is reset by writing the bits. That means the analog value is output again on the analog output (no longer the switching value).

Mode Register 3	Bit	Description
	7	0 ...... Comparator 2 not acknowledged 1 ...... Comparator 2 acknowledged
	6	0 ...... Comparator 2 triggers for value > comparison value 1 ...... Comparator 2 triggers for value < comparison value
	5	0 ...... Digital output 14 normal operation 1 ...... Digital output 14 is switched off by comparator event 2
	4	0 ...... Digital output 15 normal operation 1 ...... Digital output 15 is switched on by comparator event 2
	3	0 ...... Comparator 1 not acknowledged 1 ...... Comparator 1 acknowledged
	2	0 ...... Comparator 1 triggers for value > comparison value 1 ...... Comparator 1 triggers for value < comparison value
	1	0 ...... Digital output 14 normal operation 1 ...... Digital output 14 is switched off by comparator event 1
	0	0 ...... Digital output 15 normal operation 1 ...... Digital output 15 is switched on by comparator event 1

7 0

Mode Register 4: Event Counter / Period Duration

The read-out for the digital input 1 can be toggled between event counter and period duration in this register.

Mode Register 4	Bit	Description
	1 - 7	0
	0	0 ...... Period Duration 1 ...... Event Counter

0	0	0	0	0	0	0	

7 0

15. Communication Modules

15.1 Overview

Module	Description
EX282	2005 ETHERNET Powerlink bus controller, 2 ETHERNET Powerlink interfaces, electrically isolated, power supply module insert
IF050	2005 interface module, 1 RS232 interface, 1 RS485/RS422, network capable, 1 RS232/TTY interface, all interfaces are electrically isolated
IF060	2005 interface module, 1 insert slot for interface module inserts
IF613	2005 interface module, 3 RS232 interfaces, CPU and IF-module insert
IF621	2005 interface module, 1 RS485/RS422 interface, 1 CAN interface, both electrically isolated and network capable, insert for CPU and IF-modules
IF622	2005 interface module, 1 RS232 interface, 2 RS485/RS422 interfaces: Electrically isolated, network capable, CPU and IF-module insert
IF661	2005 interface module, 1 RS485 interface, electrically isolated and network capable, transfer protocol: PROFIBUS-DP, CPU and IF-module insert
IF671	2005 interface module, 1 RS232 interface, 1 RS485/RS422 interface, electrically isolated, network capable, 1 CAN interface, electrically isolated, network capable, CPU and IF-module insert
IF672	2005 interface module, 1 RS232 interface, 2 CAN interfaces, CAN: Electrically isolated, network capable, CPU and IF-module insert
IF681.95	2005 interface module, 1 RS232 interface, 1 ETHERNET interface, with 10BASE2 CHEAPERNET BNC socket
IF681.96	2005 interface module, 1 RS232 interface, 1 ETHERNET interface, with 10BASE-T Twisted Pair RJ45 socket
IF686	2005 interface module, 1 ETHERNET Powerlink interface, manager or controller function, electrically isolated
IF772	2005 aPCI interface module, 1 RS232 interface, 2 CAN interfaces, max. 500 kbps, CAN: electrically isolated, network capable, object buffer in send and receive direction. Order 2 x TB704 terminal blocks separately.
NW150	2005 PROFIBUS network module, electrically isolated RS485 interface used to connect to PROFIBUS networks

Table 306: Communication module overview

15.2 EX282

15.2.1 General Information

The EX282 module is a Powerlink bus controller module. It is equipped with an internal hub with two RJ45 sockets.

The Powerlink bus controller is operated in an expansion slot on power supply module PS465.

The following should be noted:

- Only I/O modules are allowed to be operated
- The digital mixed module DM455 is not supported
- System modules are not supported

15.2.2 Order Data

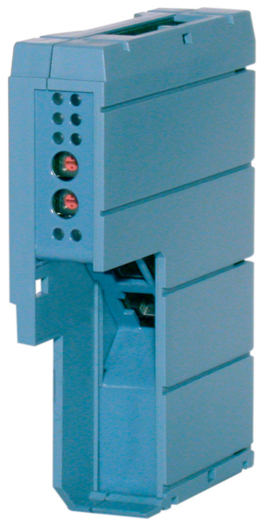
Model Number	Short Description	Figure
3EX282.6	2005 ETHERNET Powerlink bus controller, 2 ETHERNET Powerlink interfaces, electrically isolated, power supply module insert	

Table 307: EX282 order data

15.2.3 Technical Data

Product ID	EX282
General Information	
C-UL-US Listed	Yes
Slot	Insert for power supply PS465
Power Consumption 5 V 24 V Total	 Max. 3.8 W --- Max. 3.8 W
Peripheral	
Diagnosis LEDs	Yes
Station Number Dial	For setting the Powerlink station number
ETHERNET Powerlink Interface	
Standard (Compliance)	ANSI/IEEE 802.3
Data Rate	100 Mbps
Signal	100 Base-T
Port Design	Internal 2x hub 2 x shielded RJ45 port
Line Length Between Two Stations (Segment Length)	Max. 100 m

Table 308: EX282 technical data

15.2.4 Operational and Connection Elements

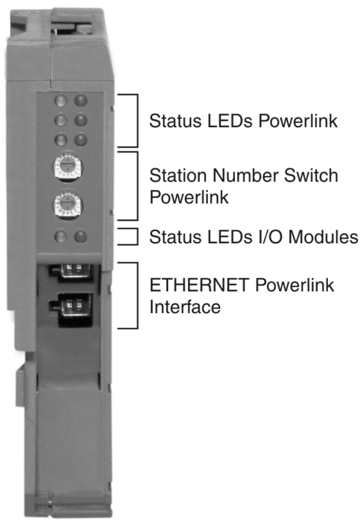


Figure 179: EX282 operational and connection elements

15.2.5 Status Display

Status of I/O Modules

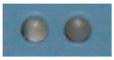
Figure	LED	Color	Description
RUN  I/O	RUN	Green	Blinking ... No I/O-module registered Lit .... At least one I/O-module is registered
	I/O	Red	The LED is lit when a registered I/O-module is faulty or not available.

Table 309: EX282 status display

ETHERNET Powerlink Interface

Figure	LED	Color	Description
L/C 1, L/C 2, Tx  Rx 1, Rx 2, Status	Status	Red/Green	See "Status LED", on page 489.
	Tx	Orange	The Powerlink station is sending data.
	Rx 1 + Rx 2	Orange	The RX LED is always lit when Powerlink activity is present on the bus.
	L/C 1 + L/C 2	Red/Green	Green ... Link Red ...... Collision

Table 310: EX282 status display

<u>Status LED</u>

Boot Phase

The red LED is lit during booting. After selecting the boot block, the LED indicates which block is being booted from:

Status LED Red Blinking	Boot Block
Blinking Slowly Twice	A
Blinking Slowly Three Times	B

Table 311: EX282 boot block indicator

After the initialization routines are executed without errors, the status LED changes from red to green.

Operation

During operation, the status LED indicate the following states:

Status LED		
Green	**Red**	**Status of the Powerlink Station**
On	Off	The Powerlink station is running with no errors.
Off	On	A fatal system error has occurred. The error type can be read using the PLC log book. It concerns an irreparable problem. The system cannot properly carry out its tasks. This status can only be changed by resetting the module.
Blinking Alternately		Powerlink Manager failed.
Off	Blinking	System failure. The red blinking LED signals an error code (see Section"System Failure Error Codes", on page 490).

Table 312: EX282 status LED

System Failure Error Codes

The error is displayed via the red status LED using four switch-on phases. The switch-on phases are either 150 ms or 600 ms long. Error code outputs are repeated cyclically after 2 seconds has passed.

Legend: • .... 150 ms
– .... 600 ms
Pause ... 2 s delay

Error Description	Error Code Displayed by Red Status LED									
Stack Overflow	•	•	•	•	Pause	•	•	•	•	Pause
RAM Error	•	•	•	–	Pause	•	•	•	–	Pause
Undefined Address: Access to a Non-Existent Address.	•	•	–	•	Pause	•	•	–	•	Pause
Instruction Fetch Memory Abort: Invalid Memory Access During Instruction Fetch (e.g. UINT access of an uneven address).	•	•	–	–	Pause	•	•	–	–	Pause
Data Access Memory Abort: Invalid Memory Access During Data Access (e.g. UINT access of an uneven address).	•	–	•	•	Pause	•	–	•	•	Pause
Error when Programming the FPGA.	•	–	–	•	Pause	•	–	–	•	Pause
Invalid Station Number (e.g. $00 for Controller Stations, and $FE, $FF)	•	–	–	–	Pause	•	–	–	–	Pause

Table 313: EX282 system failure error codes

15.2.6 ETHERNET Powerlink Station Number

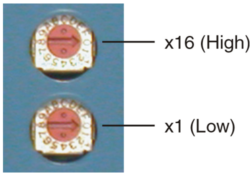


Figure 180: EX282 station number dial

The station number for the Powerlink station is set using both number switches. Station numbers are permitted between $01 and $FD.

Switch Position	Description
$00	Reserved for manager station, switch position is not permitted.
$01 - $FD	Station number for Powerlink station.
$FE	Reserved, switch position is not permitted.
$FF	Reserved, switch position is not permitted.

Table 314: EX282 station number

15.2.7 RJ45 Ports

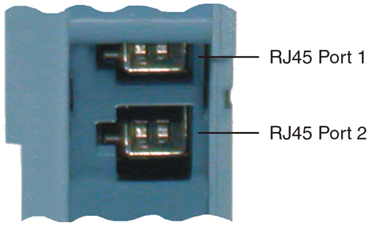


Figure 181: EX282 RJ45 ports

Pin	Assignment
1	RXD
2	RXD\
3	TXD
4	Termination
5	Termination
6	TXD\
7	Termination
8	Termination

Table 315: EX282 pin assignments for RJ45 port

RXD ... Receive Data   TXD ... Transmit Data

15.2.8 SG3

The EX282 module is not supported at the moment on SG3 targets.

15.2.9 SG4

The firmware update takes place automatically. The firmware is a component of the PLC operating system B&R Automation Runtime™.

15.2.10 Module Fastener

The EX282 module is equipped with a module fastener. The module fastener prevents the power supply from falling out of the bus controller during transport.

A screwdriver is required to install the module. The screwdriver should be inserted between the power supply and EX282 at the same height as the sloped marking (see figure). By simultaneously levering the screwdriver in the direction of the power supply and pulling the EX282, the bus controller is taken out from its bracing and can be removed from the power supply.

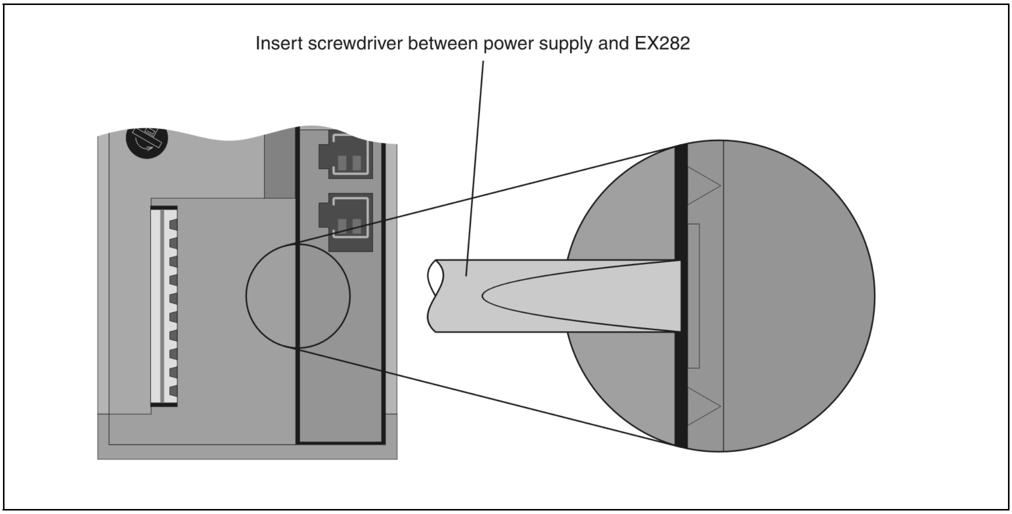


Figure 182: EX282 module fastener

15.3 IF050

15.3.1 General Information

PLC interface modules enable data transfer with other devices (other PLCs). This is especially important for complex applications, if e.g. the CPU's interfaces are not sufficient.

Due to the low cable requirements and sufficient worldwide standardization, serial interfaces are better suited for communication than parallel interfaces.

The following interfaces are available with the IF050 interface module. Operating the interfaces takes place using software, which is available on request from B&R.

Interface	Description
RS232	Communication is made using at least three lines (send, receive and protective ground). For synchronizing the transmitter and receiver (handshake), additional lines can be used. The coverage of the RS232 interface is limited to short distances. Characteristics : - Level: +3 V to +15 V / -3 V to -15 V - Short circuit protection - 19200 Baud with 15 m cable length
TTY	Communication takes place using a set current (20 mA). The TTY interface is therefore also called a current loop interface. Using applied current, a greater noise immunity over the same distance is achieved (in industrial environments up to 200 m). The maximum transfer rate is 2400 baud. The TTY interface requires four lines.
RS422	With this interface, send and receive lines and also handshake lines are doubled (differential signal). The distance that can be achieved with an RS422 interface is significantly greater than the RS232 interface and is a maximum of 1200 m depending on the baud rate.
RS485	This type of interface can be used in a network and is therefore best suited for industrial applications. The interface can handle 32 transmitters and receivers and two terminating resistors on one bus segment.

Table 316: IF050 interface description

15.3.2 Order Data

Model Number	Short Description	Image
	Interface module	
3IF050.6	2005 interface module, 1 RS232 interface, 1 RS485/RS422, network capable, 1 RS232/TTY interface, all interfaces are electrically isolated	
	Accesories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
0G1000.00-090	Bus Connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 317: IF050 order data

15.3.3 Technical Data

Product ID	IF050		
C-UL-US Listed	Yes		
B&R ID Code	$60		
Processor	RISC		
Dual Ported RAM (DPR)	576 bytes		
Number of Interfaces	3		
Type	RS232	RS485/RS422 1)	RS232/TTY 1)
Input Filter / Protective Circuit	Yes	Yes	Yes
Electrical Isolation Interface - PLC Interface - Interface	 Yes Yes	 Yes Yes	 Yes Yes
Design	9-pin DSUB plug	9-pin DSUB socket	9-pin DSUB plug

Table 318: IF050 technical data

Product ID	IF050		
Maximum Distance	15 m / 19200 Baud	1200 m (without repeater)	RS232: 15 m / 19200 Baud TTY: 300 m
Handshake Lines	DCD, DTR, DSR, RTS, CTS, RI	---	RS232: RTS, CTS TTY: ---
Baud Rates 1)	Max. 64 kBaud	Max. 347 kBaud	RS232: Max. 64 kBaud TTY: Max. 2.4 kBaud
Network Capable	No	Yes (with a max. of 32 transmitters, 32 receivers and two terminating resistors can be loaded per bus segment)	No
Data Formats 1)	5 to 8 data bits, parity yes / no / even / odd , 1 / 1.5 / 2 stop bits		
Power Consumption 5 V 24 V Total	 Max. 7 W --- Max. 7 W		
Dimensions	B&R 2005 single-width		

Table 318: IF050 technical data (cont.)

1) Can be configured using software.

15.3.4 Status LEDs

Image	LED	Description
	Tx y	Data is sent using interface Y.
	Rx y	Data is received using interface Y.

Table 319: IF050 status LEDs

15.3.5 Operational and Connection Elements

Three interfaces are located behind the module door of the IF050 module. These interfaces can be configured using software.

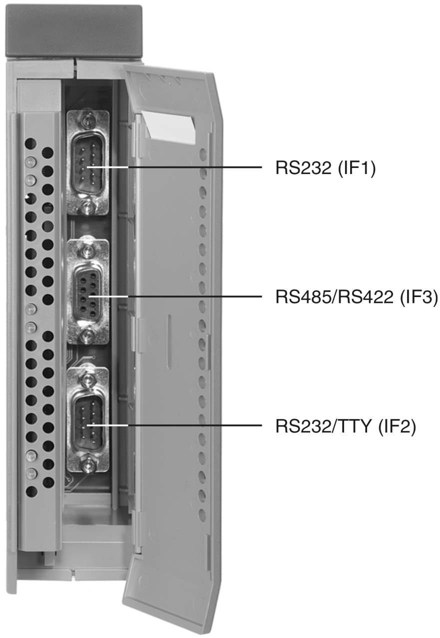


Figure 183: IF050 operational and connection elements

15.3.6 RS232 Interface (IF1)

The electrically isolated IF1 application interface can be used for connecting a fiber optic cable. The fiber optic cable is supplied with a short circuit proof 4.8 V voltage supply on pin 4 of the DSUB plug.

The status LEDs Rx and Tx are lit during data transfer via the RS485 interface.

Cable Length: Max. 15 m
Baud Rate: Max. 64 kBaud

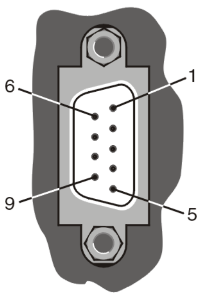
Interface	Pin Assignments		
RS232	**Pin**	**RS232**	
	1	DCD	Data Carrier Detect
	2	RXmD	Receive Signal
	3	TXD	Transmit Signal+
	4	DTR	Data Terminal Ready (+4.8 V / 150 mA)
	5	GND	Ground
	6	DSR	Data Set Ready
	7	RTS	Request To Send
	8	CTS	Clear To Send
	9	RI	Ring Indicator
9-pin DSUB plug			

Table 320: IF050 RS232 Interface (IF1)

15.3.7 RS232/TTY Interface (IF2)

The application interface is electrically isolated. The configuration is made using software in the application program.

RS232 Interface

Cable Length: Max. 15 m / 19200 Baud
Baud Rate: Max. 64 kBaud

TTY interface

Cable Length: Max. 300 m
Baud Rate: Max. 2.4 kBaud

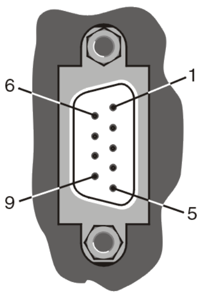
Interface	Pin Assignments		
RS232/TTY	**Pin**	**RS232**	**TTY**
	1		TXD
	2	RXD	Current 1
	3	TXD	
	4		RXD
	5	GND	GND
	6		TXD Ret
	7	RTS	Current 2
	8	CTS	
	9		RXD Ret
9-pin DSUB plug			

Table 321: IF050 RS232/TTY interface (IF2)

15.3.8 RS485/RS422 interface (IF3)

The 5 V supply is electrically isolated and is used for connecting terminating resistors (for networking several RS485 interfaces).

The electrically isolated RS485/RS422 interface can be used for connecting a fiber optic cable. The fiber optic cable is supplied with an electrically isolated 5 V voltage supply on pin 6 of the DSUB socket.

Cable Length: Max. 1,200 m
Baud Rate: Max. 347 kBaud

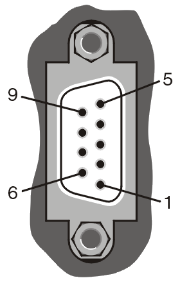
<table>
<tr><th rowspan="2">Interface</th><th colspan="3">Pin Assignments</th></tr>
<tr><th>Pin</th><th>RS485</th><th>RS422</th></tr>
<tr><td rowspan="9">RS485/RS422

9-pin DSUB socket</td><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td>TXD</td></tr>
<tr><td>3</td><td>DATA</td><td>RXD</td></tr>
<tr><td>4</td><td></td><td></td></tr>
<tr><td>5</td><td>GND</td><td>GND</td></tr>
<tr><td>6</td><td>+5 V / 200 mA</td><td>+5 V / 200 mA</td></tr>
<tr><td>7</td><td></td><td>TXD\</td></tr>
<tr><td>8</td><td>DATA\</td><td>RXD\</td></tr>
<tr><td>9</td><td></td><td></td></tr>
</table>

Table 322: IF050 RS485/RS422 interface (IF3)

15.4 IF060

15.4.1 General Information

The IF060 interface module is a system module and is equipped with a insert slot for interface modules.

Therefore, the IF060 allows every B&R SYSTEM 2005 CPU to integrate different bus or network systems in the B&R SYSTEM 2005 via the system bus.

The interface data must be prepared in the CPU. The IF060 module provides the physical connection to the insert modules.

Multiple IF060 interface modules can be inserted on the main backplane as required. The maximum number of IF060 modules that can be used depends on the type of interface module inserted, the baud rate used and the performance of the CPU.

The following interface module inserts can be used with the IF060

Module	Description
3IF613.9	Interface module with three RS232 interfaces
3IF621.9	Interface module with one RS485/RS422 interface and one CAN interface
3IF622.9	Interface module with one RS232 interface and two RS485/RS422 interfaces
3IF661.9	Interface module with one RS485 interface (PROFIBUS DP slave)
3IF671.9	Interface module with one RS232 interface, one RS485/RS422 interface and one CAN interface
3IF672.9	Interface module with one RS232 interface and two CAN interfaces
3IF686.9	2005 interface module, 1 ETHERNET Powerlink interface, manager or controller function, electrically isolated

Table 323: IF060 interface module inserts

15.4.2 Order Data

Model Number	Short Description	Image
3IF060.6	2005 interface module, 1 insert slot for interface module inserts	
The following interface module inserts can be used with the IF060:		
Model Number	**Description**	
3IF613.9	Three RS232 interfaces	
3IF621.9	One RS485/RS422 interface and one CAN interface	
3IF622.9	One RS232 interface and two RS485/RS422 interfaces	
3IF661.9	One RS485 interface (PROFIBUS-DP Slave)	
3IF671.9	One RS232 interface, one RS485/RS422 interface and one CAN interface	
3IF672.9	One RS232 interface and two CAN interfaces	

Table 324: IF060 order data

15.4.3 Technical Data

Product ID	IF060
C-UL-US Listed	Yes
B&R ID Code	$63
Can be Installed on Main Rack Expansion Rack	 Yes No
Insert Slot	1 (for interface module inserts)
Power Consumption 5 V 24 V Total	 Max. 1 W --- Max. 1 W
Dimensions	B&R 2005 single-width

Table 325: IF060 technical data

15.5 IF613

15.5.1 General Information

The IF613 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with three RS232 interfaces and is used to connect several peripheral devices which cannot be networked (modem, printer, barcode reader, terminals, etc.).

15.5.2 Order Data

Model Number	Short Description	Image
	Interface module	
3IF613.9	2005 interface module, 3 RS232 interfaces, CPU and IF-module insert	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	

Table 326: IF613 order data

15.5.3 Technical Data

Product ID	IF613
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interfaces	3 x RS232
Power Consumption 5 V 24 V Total	 Max. 1.2 W --- Max. 1.2 W
Application Interface IF1	
Type	RS232
Controller	UART Type ST16C654
FIFO	64 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	DTR, DSR, RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2
Application Interfaces IF2 and IF3	
Type	RS232
Controller	UART Type ST16C654
FIFO	64 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2

Table 327: IF613 technical data

15.5.4 Operational and Connection Elements

Status LEDs via the interfaces indicate whether data is being received (RXD) or sent (TXD).

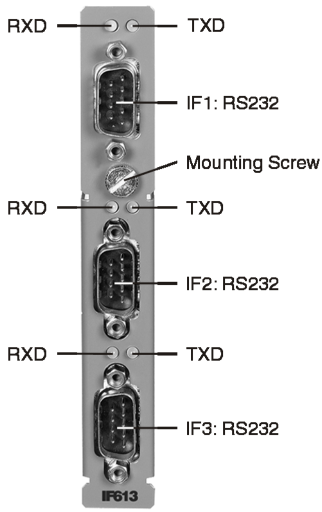


Figure 184: IF613 operational and connection elements

15.5.5 RS232 Interface (IF1)

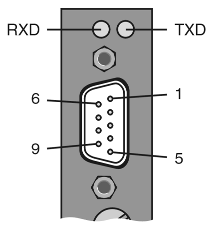
Interface	Description	Pin Assignments		
		Pin	**RS232**	
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 328: IF613 RS232 Interface (IF1)

15.5.6 RS232 Interfaces (IF2 and IF3)

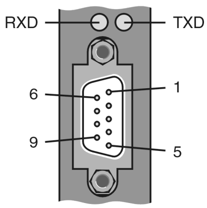
Interface	Description	Pin Assignments		
		Pin	**RS232**	
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	NC	
		5	GND	Ground
		6	NC	
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 329: IF613 RS232 interfaces (IF2 and IF3)

15.6 IF621

15.6.1 General Information

The IF621 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with an RS485/RS422 interface and a CAN interface.

The RS485/RS422 interface is used mostly for visualization and networking based on different protocols (e.g. NET2000).

15.6.2 Order Data

Model Number	Short Description	Image
	Interface Module	
3IF621.9	2005 interface module, 1 RS485/RS422 interface, 1 CAN interface, both electrically isolated and network capable, insert for CPU and IF-modules	
	Accessories	
0G1000.00-090	Bus connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 330: IF621 order data

15.6.3 Technical Data

Product ID	IF621
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interfaces	1 x RS485/RS422 1 x CAN
Power Consumption 5 V 24 V Total	 Max. 1.5 W --- Max. 1.5 W
Application Interface IF1	
Type	RS485/RS422
Controller	UART Type ST16C650
FIFO	32 bytes in send and receive direction
Design	9-pin DSUB socket
Electrical Isolation IF1 - PLC IF1 - IF2	 Yes Yes
Input Filter / Protective Circuit	Yes
Maximum Distance	1,200 m
Maximum Baud Rate	115.2 kBaud
Network Capable	Yes
Bus Termination Resistor	External T-connector (0G1000.00-090)
Application Interface IF2	
Type	CAN
Controller	Controller 82527
Design	4-pin multipoint connector
Electrical Isolation IF2 - PLC IF1 - IF2	 Yes Yes
Maximum Distance	1,000 m
Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	 500 kBit/s 250 kBit/s 50 kBit/s
Network Capable	Yes
Bus Termination Resistor	Optional (externally wired)

Table 331: IF621 technical data

15.6.4 Operational and Connection Elements

Status LEDs via the interfaces indicate whether data is being received (RXD) or sent (TXD).

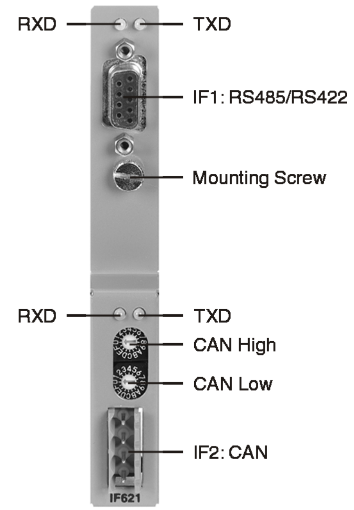


Figure 185: IF621 operational and connection elements

15.6.5 CAN Node Number Switch

The CAN node number is set with the two hex switches. CAN node numbers can also be set using the software.

15.6.6 RS485/RS422 Interfaces (IF1)

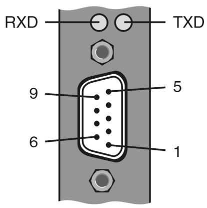
Interface	Description	Pin Assignments		
		Pin	**RS485**	**RS422**
Application interface RS485/RS422  9-pin DSUB socket	The RS485/RS422 interface is electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB socket's housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 1,200 m	1	Shield	Shield
		2	res.	TXD [1]
		3	DATA	RXD
		4	res.	res.
		5	GND	GND
		6	5 V / 50 mA	5 V / 50 mA
		7	res.	TXD\ [1]
		8	DATA\	RXD\
		9	res.	res.

Table 332: IF621 RS485/RS422 interfaces (IF1)

1) RS422 send data is TRISTATE capable.

15.6.7 CAN Interface (IF2)

A 4-pin terminal block and an 120 Ω bus termination resistor are included in the delivery. The resistor can be inserted between pin 1 and pin 3.

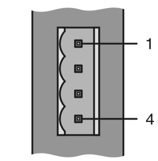
Interface	Description	Pin Assignments	
		Terminal	**CAN**
Application interface CAN  4-pin Multipoint connector	The electrically isolated CAN interface is a 4-pin multipoint connector. LEDs show on the interface whether data is being received (RXD) or sent (TXD). Max. Baud Rate: 500 kBit/s Bus Length: ≤60 m 250 kBit/s Bus Length: ≤200 m 50 kBit/s Bus Length: ≤1,000 m	1	CAN_H
		2	GND
		3	CAN_L
		4	Shield

Table 333: IF621 CAN interface (IF2)

15.7 IF622

15.7.1 General Information

The IF622 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with an RS232 interface and two RS485/RS422 interfaces.

15.7.2 Order Data

Model Number	Short Description	Image
	Interface Module	
3IF622.9	2005 interface module, 1 RS232 interface, 2 RS485/RS422 interfaces: Electrically isolated, network capable, CPU and IF-module insert	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 334: IF622 order data

15.7.3 Technical Data

Product ID	IF622
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interfaces	1 x RS232 2 x RS485/RS422
Power Consumption 5 V 24 V Total	 Max. 1.8 W --- Max. 1.8 W
Application Interface IF1	
Type	RS232
Controller	UART Type ST16C654
FIFO	64 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	DTR, DSR, RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2
Application Interfaces IF2 and IF3	
Type	RS485/RS422
Controller	UART Type ST16C654
FIFO	64 bytes in send and receive direction
Design	9-pin DSUB socket
Electrical Isolation	Yes
Input Filter / Protective Circuit	Yes
Maximum Distance	1,200 m
Maximum Baud Rate	115.2 kBaud
Network Capable	Yes
Connection	Via active RS485 bus termination (model number 0AC916.9)
Bus Termination Resistor	External, integrated in active RS485 bus termination

Table 335: IF622 technical data

15.7.4 Operational and Connection Elements

Status LEDs via the interfaces indicate whether data is being received (RXD) or sent (TXD).

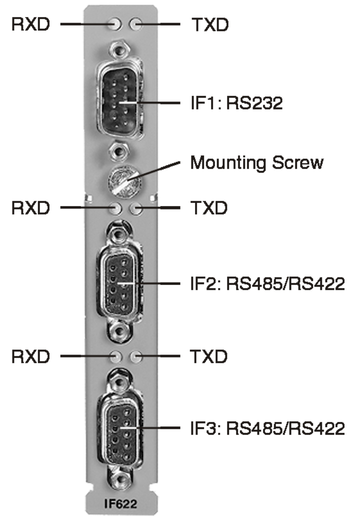


Figure 186: IF622 operational and connection elements

15.7.5 RS232 Interface (IF1)

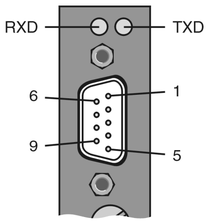
Interface	Description	Pin Assignments		
Application Interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	**Pin**	**RS232**	
		1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 336: IF622 RS232 Interface (IF1)

15.7.6 RS485/RS422 Interface (IF2 and IF3)

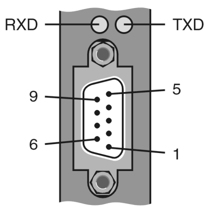
Interface	Description	Pin Assignments		
Application interface RS485/RS422  9-pin DSUB socket	The RS485/RS422 interface is electrically isolated. LEDs above the interface indicate whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB socket's housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 1,200 m	**Pin**	**RS485**	**RS422**
		1	NC	NC
		2	res.	TXD [1)]
		3	DATA	RXD
		4	NC	NC
		5	GND	GND
		6	+5 V / 50 mA	+5 V / 50 mA
		7	res.	TXD\ [1)]
		8	DATA\	RXD\
		9	NC	NC

Table 337: IF622 RS485/RS422 interface (IF2 and IF3)

1) RS422 send data is TRISTATE capable

15.8 IF661

15.8.1 General Information

The IF661 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with an electrically isolated RS485 interface. The PROFIBUS DP format is used as transfer protocol. The B&R 2005 PLC can therefore be connected to a PROFIBUS DP network as a slave.

15.8.2 Order Data

Model Number	Short Description	Image
	Interface Module	
3IF661.9	2005 interface module, 1 RS485 interface, electrically isolated and network capable, transfer protocol: PROFIBUS-DP, CPU and IF-module insert	
	Accessories	
0G1000.00-090	Bus connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 338: IF661 order data

15.8.3 Technical Data

Product ID	IF661
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interface	1 x RS485 (PROFIBUS-DP slave)
Power Consumption 5 V 24 V Total	 Max. 2 W --- Max. 2 W
Application Interface IF1	
Type	RS485
Controller	ASIC SPC3
RAM	1.5 KB
Transfer Protocol	PROFIBUS-DP
Design	9-pin DSUB socket
Electrical Isolation	Yes
Input Filter / Protective Circuit	Yes
Maximum Distance	1,000 m
Maximum Baud Rate Bus Length <100 m Bus Length <200 m Bus Length <400 m Bus Length <1,000 m	 12 MBit/s 1.5 MBit/s 500 kBit/s 187.5 kBit/s
Network Capable	Yes
Bus Termination Resistor	External T-connector

Table 339: IF661 technical data

15.8.4 Operational and Connection Elements

Status LEDs via the interfaces indicate whether data is being received (RXD) or sent (TXD).

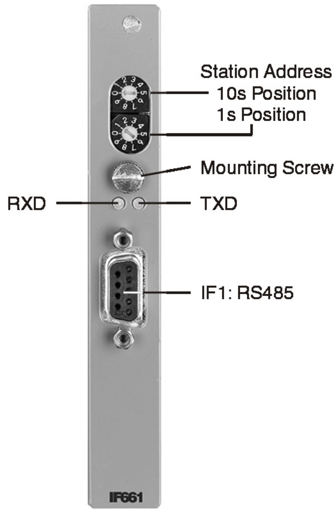


Figure 187: IF661 operational and connection elements

15.8.5 Station Number Dial

The RS485 interface station number is set up using both BCD dials.

15.8.6 RS485 Interface (IF1)

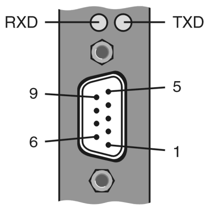
Interface	Description	Pin Assignments		
		Pin	**RS485**	
Application interface RS485  9-pin DSUB socket	The electrically isolated RS485 interface is used for coupling to a PROFIBUS-DP network. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB socket's housing. Max. Baud Rate: 12 MBaud	1		Shield
		2	NC	
		3	DATA	
		4	CTRL	1)
		5	GND	Electrically Isolated Supply
		6	5 V / 50 mA	Electrically Isolated Supply
		7	NC	
		8	DATA\	
		9	CTRL\	1)

Table 340: IF661 RS485 interface (IF1)

1) Directional switch for external repeater

15.9 IF671

15.9.1 General Information

The IF671 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with an RS232 interface, an RS485/RS422 interface and a CAN interface.

15.9.2 Order Data

Model Number	Short Description	Image
	Interface Module	
3IF671.9	2005 interface module, 1 RS232 interface, 1 RS485/RS422 interface, electrically isolated, network capable, 1 CAN interface, electrically isolated, network capable, CPU and IF-module insert	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
0G1000.00-090	Bus connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 341: IF671 order data

15.9.3 Technical Data

Product ID	IF671
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interfaces	1 x RS232 1 x RS485/RS422 1 x CAN
Power Consumption 5 V 24 V Total	 Max. 2 W --- Max. 2 W
Application Interface IF1	
Type	RS232
Controller	UART Type ST16C650
FIFO	32 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	DTR, DSR, RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2
Application Interface IF2	
Type	RS485/RS422
Controller	UART Type ST16C650
FIFO	32 bytes in send and receive direction
Design	9-pin DSUB socket
Electrical Isolation IF1 - PLC IF1 - IF2	 Yes Yes
Input Filter / Protective Circuit	Yes
Maximum Distance	1,200 m
Maximum Baud Rate	115.2 kBaud
Network Capable	Yes
Bus Termination Resistor	External T-connector (0G1000.00-090)

Table 342: IF671 technical data

Product ID	IF671
Application Interface IF3	
Type	CAN
Controller	Controller 82527
Design	4-pin multipoint connector
Electrical Isolation	Yes
Maximum Distance	1,000 m
Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200m Bus Length ≤1,000 m	 500 kBit/s 250 kBit/s 50 kBit/s
Network Capable	Yes
Bus Termination Resistor	Optional (externally wired)
CAN node number	Can be set using software

Table 342: IF671 technical data (cont.)

15.9.4 Operational and Connection Elements

Status LEDs indicate whether data is being received (RXD) or sent (TXD).

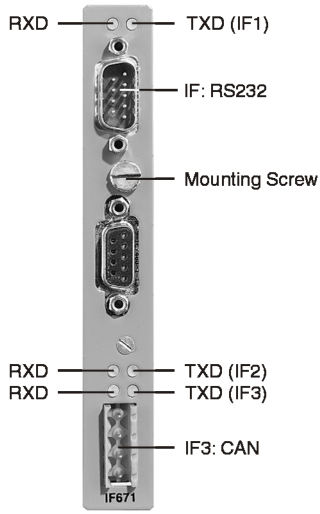


Figure 188: IF671 operational and connection elements

15.9.5 RS232 Interface (IF1)

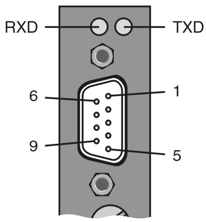
Interface	Description	Pin Assignments		
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	**Pin**	**RS232**	
		1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 343: IF671 RS232 Interface (IF1)

15.9.6 RS485/RS422 Interface (IF2)

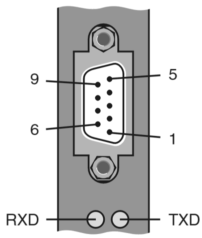
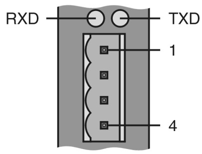
Interface	Description	Pin Assignments		
Application interface RS485/RS422  9-pin DSUB socket	The RS485/RS422 interface is electrically isolated. LEDs below the interface indicate whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB socket's housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 1,200 m	**Pin**	**RS485**	**RS422**
		1	Shield	Shield
		2	res.	TXD 1)
		3	DATA	RXD
		4	res.	res.
		5	GND	GND
		6	5 V / 50 mA	5 V / 50 mA
		7	res.	TXD\ 1)
		8	DATA\	RXD\
		9	res.	res.

Table 344: IF671 RS485/RS422 interface (IF2)

1) RS422 send data is TRISTATE capable.

15.9.7 CAN Interface (IF3)

A 4-pin terminal block and an 120 Ω bus termination resistor are included in the delivery. The resistor can be inserted between pin 1 and pin 3.

<table>
<tr><th rowspan="2">Interface</th><th rowspan="2">Description</th><th colspan="2">Pin Assignments</th></tr>
<tr><th>Terminal</th><th>CAN</th></tr>
<tr><td rowspan="5">Application interface
CAN


4-pin Multipoint connector</td><td rowspan="5">The electrically isolated CAN interface is a 4-pin multipoint connector.

LEDs show on the interface whether data is being received (RXD) or sent (TXD).

Max. Baud Rate:

500 kBit/s Bus Length: ≤60 m
250 kBit/s Bus Length: ≤200 m
50 kBit/s Bus Length: ≤1,000 m</td><td>1</td><td>CAN_H</td></tr>
<tr><td>2</td><td>GND</td></tr>
<tr><td>3</td><td>CAN_L</td></tr>
<tr><td>4</td><td>Shield</td></tr>
<tr><td></td><td></td></tr>
</table>

Table 345: IF671 CAN interface (IF3)

15.10 IF672

15.10.1 General Information

The IF672 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260 / IF060.

The module is equipped with an RS232 interface and two CAN interfaces.

15.10.2 Order Data

Model Number	Short Description	Image
	Interface Module	
3IF672.9	2005 interface module, 1 RS232 interface, 2 CAN interfaces, CAN: Electrically isolated, network capable, CPU and IF-module insert	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
Additional accessories see sections "Accessories" and "Manuals".		

Table 346: IF672 order data

15.10.3 Technical Data

Product ID	IF672
General Information	
C-UL-US Listed	Yes
Slot	Insert e.g. in CP260, IF260, IF060
Interfaces	1 x RS232 2 x CAN
Power Consumption 5 V 24 V Total	 Max. 1.8 W --- Max. 1.8 W
Application Interface IF1	
Type	RS232
Controller	UART Type ST16C650
FIFO	32 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	DTR, DSR, RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2
Application Interfaces IF2 and IF3	
Type	CAN
Controller	Controller 82527
Design	2 x 4-pin multipoint connector
Electrical Isolation to PLC Between Interfaces	 Yes Yes
Maximum Distance	1,000 m
Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	 500 kBit/s 250 kBit/s 50 kBit/s
Network Capable	Yes
Bus Termination Resistor	Optional (externally wired)

Table 347: IF672 technical data

15.10.4 Operational and Connection Elements

Status LEDs show for the IF1 interface whether data is being received (RXD) or sent (TXD).

Both CAN interfaces have a status LED that indicates when data is being sent.

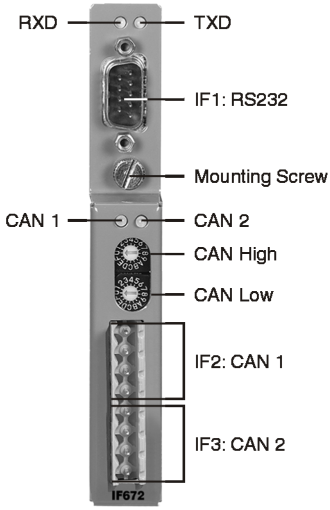


Figure 189: IF672 operational and connection elements

15.10.5 CAN Node Number Switch

The node numbers for the first two CAN interface (IF2) are set with the two hex switches. The following formula is used to set the second CAN interface (IF3):

Node number CAN 2 (IF3) = Node number CAN 1 (IF2) + 1

The CAN node number can also be set using the software.

15.10.6 RS232 Interface (IF1)

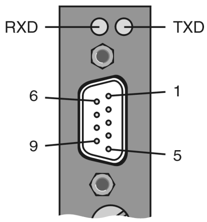
Interface	Description	Pin Assignments		
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	**Pin**	**RS232**	
		1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 348: IF672 RS232 Interface (IF1)

15.10.7 Interfaces CAN 1 and CAN 2 (IF2 and IF3)

Two 4-pin terminal block and two 120 Ω bus termination resistors are included in the delivery. The resistors can be installed between pin 1 and pin 3 or between pin 5 and pin 7.

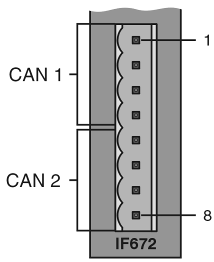
Interface	Description	Pin Assignments	
Application interface CAN 1 + CAN 2  8-pin Multipoint connector	The electrically isolated CAN interfaces IF2 and IF3 are 8-pin multipoint connectors. The status LED CAN 1 or CAN 2 are lit when data is sent to the corresponding CAN interface. Max. Baud Rate: 500 kBit/s Bus Length: ≤60 m 250 kBit/s Bus Length: ≤200 m 50 kBit/s Bus Length: ≤1,000 m	**Terminal**	**CAN 1 and CAN 2**
		1	CAN_H1
		2	GND1
		3	CAN_L1
		4	Shield 1
		5	CAN_H2
		6	GND2
		7	CAN_L2
		8	Shield 2

Table 349: IF672 interfaces CAN 1 and CAN 2 (IF2 and IF3)

15.11 IF681

15.11.1 General Information

The IF681 interface module can be operated e.g. in an interface module slot on the CP260 or in the IF260.

The module is equipped with an RS232 interface and an ETHERNET interface.

The IF681 module is available in two versions. The modules differ from one another with regard to their ETHERNET connection:

Model Number	ETHERNET Connection
3IF681.95	10BASE2: CHEAPERNET BNC socket
3IF681.96	10BASE-T: Twisted Pair RJ45 socket

15.11.2 Order Data

Model Number	Short Description	Image
	Interface Modules	3IF681.95 3IF681.96 
3IF681.95	2005 interface module, 1 RS232 interface, 1 ETHERNET interface, with 10BASE2 CHEAPERNET BNC socket	
3IF681.96	2005 interface module, 1 RS232 interface, 1 ETHERNET interface, with 10BASE-T Twisted Pair RJ45 socket	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	

Table 350: IF681 order data

15.11.3 Technical Data

Product ID	IF681.95	IF681.96
General Information		
C-UL-US Listed	Yes	
Slot	Insert e.g. in CP260, IF260	
Interfaces	1 x RS232 1 x ETHERNET	
Power Consumption 5 V 24 V Total	 Max. 2.4 W --- Max. 2.4 W	 Max. 1.65 W --- Max. 1.65 W
Application Interface IF1		
Type	RS232	
Controller	UART Type ST16C650	
FIFO	32 bytes in send and receive direction	
Design	9-pin DSUB plug	
Electrical Isolation	No	
Input Filter / Protective Circuit	Yes	
Maximum Distance	15 m / 19200 Baud	
Maximum Baud Rate	115.2 kBaud	
Handshake Lines	DTR, DSR, RTS, CTS	
Network Capable	No	
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2	
Application Interface IF2		
Type	ETHERNET	
Design	10BASE2: CHEAPERNET BNC socket	10BASE-T: twisted pair RJ45 socket
Electrical Isolation	Yes	
Controller	Controller AM79C960	
Send and receive buffer	128 KB	
Maximum Baud Rate	10 MBit/s	
Bus Capable	Yes	

Table 351: IF681 technical data

15.11.4 Operational and Connection Elements

Status LEDs show for the IF1 interface whether data is being received (RXD) or sent (TXD).

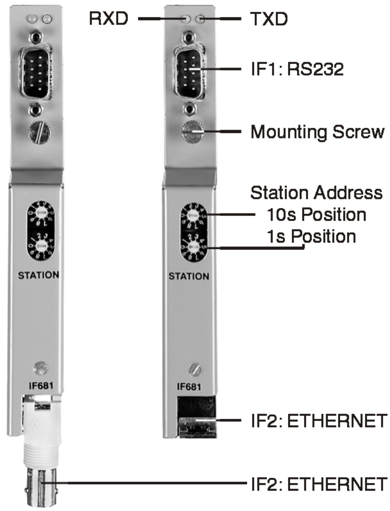


Figure 190: IF681 operational and connection elements

15.11.5 Station Number Dial

The INA2000 station number for the ETHERNET interface is set with both BCD dials.

15.11.6 RS232 Interface (IF1)

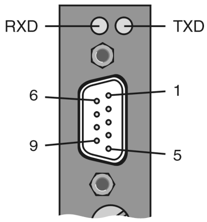
Interface	Description	Pin Assignments		
		Pin	**RS232**	
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	DTR	Data Terminal Ready
		5	GND	Ground
		6	DSR	Data Set Ready
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 352: IF681 RS232 interface (IF1)

15.11.7 Application Interface (IF2)

IF2 is an ETHERNET interface. The connection is made for each module using a 10BASE2 CHEAPERNET BNC socket or a 10BASE-T Twisted Pair RJ45 socket.

15.12 IF686

15.12.1 General Information

The module IF686 is a Powerlink interface module. It can be used as a manager or bus controller module. The connection is made via an RJ45 port.

15.12.2 Order Data

Model Number	Short Description	Figure
3IF686.9	2005 interface module, 1 ETHERNET Powerlink interface, manager or controller function, electrically isolated	

Table 353: IF686 order data

15.12.3 Technical Data

Product ID	IF686
General Information	
C-UL-US Listed	In preparation
Slot	Insert e.g. in CP260, IF260, IF060
Interface	1 x ETHERNET Powerlink
Power Consumption 5 V 24 V Total	 Max. 1.76 W --- Max. 1.76 W

Table 354: IF686 technical data

Product ID	IF686
ETHERNET Powerlink Interface	
Standard (Compliance)	ANSI/IEEE 802.3
In/Out Buffer	11 KB
Data Rate	100 Mbps
Signal	100 Base-T
Port Design	Shielded RJ45 port
Line Length Between Two Stations (Segment Length)	Max. 100 m

Table 354: IF686 technical data (cont.)

15.12.4 Operational and Connection Elements

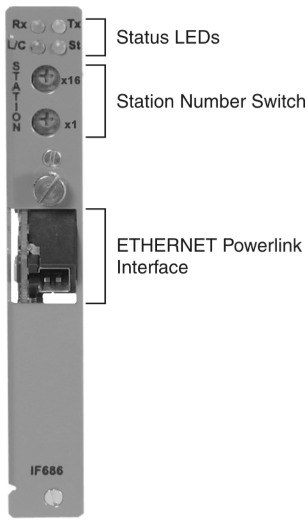


Figure 191: IF686 operational and connection elements

15.12.5 Status Display

Figure	LED	Color	Description
	St	Red/Green	See "Status LED", on page 534.
	Tx	Orange	The Powerlink station is sending data.
	Rx	Orange	The Rx LED is always lit when Powerlink activity is present on the bus.
	L/C	Red/Green	Green ... Link Red ...... Collision

Table 355: IF686 status display

Status LED

Boot Phase

The red LED is lit during booting. After selecting the boot block, the LED indicates which block is being booted from:

Status LED Red Blinking	Boot Block
Blinking slowly twice	A
Blinking Slowly Three Times	B

Table 356: IF686 boot block indicator

After the initialization routines are executed without errors, the status LED changes from red to green.

Operation

During operation, the status LED indicate the following states:

<table>
<tr><th colspan="2">Status LED</th><th rowspan="2">Status of the Powerlink Station</th></tr>
<tr><th>Green</th><th>Red</th></tr>
<tr><td>On</td><td>Off</td><td>The Powerlink station is running with no errors.</td></tr>
<tr><td>Off</td><td>On</td><td>A fatal system error has occurred. The error type can be read using the PLC log book. It concerns an irreparable problem. The system cannot properly carry out its tasks. This status can only be changed by resetting the module.</td></tr>
<tr><td colspan="2">Blinking Alternately</td><td>Powerlink Manager failed. This error code can only occur in bus controller operation. i.e. the set station number lies within the range $01 - $FD.</td></tr>
<tr><td>Off</td><td>Blinking</td><td>System failure. The red blinking LED signals an error code (see Section "System Failure Error Codes", on page 535).</td></tr>
</table>

Table 357: IF686 status LED

System Failure Error Codes

The error is displayed via the red status LED using four switch-on phases. The switch-on phases are either 150 ms or 600 ms long. Error code outputs are repeated cyclically after 2 seconds has passed.

Legend: • .... 150 ms
– .... 600 ms
Pause ... 2 s delay

Error Description	Error Code Displayed by Red Status LED									
Stack Overflow	•	•	•	•	Pause	•	•	•	•	Pause
RAM Error	•	•	•	–	Pause	•	•	•	–	Pause
Undefined Address: Access to a Non-Existent Address.	•	•	–	•	Pause	•	•	–	•	Pause
Instruction Fetch Memory Abort: Invalid Memory Access During Instruction Fetch (e.g. UINT access of an uneven address).	•	•	–	–	Pause	•	•	–	–	Pause
Data Access Memory Abort: Invalid Memory Access During Data Access (e.g. UINT access of an uneven address).	•	–	•	•	Pause	•	–	•	•	Pause
Error when Programming the FPGA.	•	–	–	•	Pause	•	–	–	•	Pause
Invalid Station Number (e.g. $FE or $FF)	•	–	–	–	Pause	•	–	–	–	Pause

Table 358: IF686 system failure error codes

15.12.6 ETHERNET Powerlink Station Number

Figure 192: IF686 station number switch

The station number for the Powerlink station is set using both number switches. Station numbers are permitted between $00 and $FD.

Switch Position	Description
$00	Operated as manager station.
$01 - $FD	Station number for Powerlink station. Operated as controller station.
$FE	Reserved, switch position is not permitted.
$FF	Reserved, switch position is not permitted.

Table 359: IF686 station number

15.12.7 ETHERNET Powerlink interface

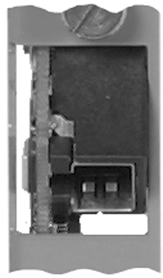


Figure 193: IF686 ETHERNET Powerlink interface

Pin	Assignment
1	RXD
2	RXD\
3	TXD
4	Termination
5	Termination
6	TXD\
7	Termination
8	Termination

Table 360: IF686 pin assignment for ETHERNET Powerlink interface

RXD ... Receive Data   TXD ... Transmit Data

15.12.8 Firmware Update

The firmware update takes place automatically via the CPU (see online help in B&R Automation Studio™: Powerlink - Firmware Update). If an IF686 is operated in controller mode, then it can only be updated locally and not via the Powerlink network.

SG3

The firmware update takes place automatically if the Powerlink library and the data object plfif686.br are present in the PLC.

SG4

No firmware update for the IF686 module is supported at the moment.

15.13 IF772

15.13.1 General Information

The IF772 interface module is an aPCI module and can be installed in all corresponding interface module slots e.g. in the CP360.

The module is equipped with a modem capable RS232 interface and two CAN interfaces with their own object buffers in send and receive direction.

15.13.2 Order Data

Model Number	Short Description	Image
	Interface module	
3IF772.9	2005 aPCI interface module, 1 RS232 interface, 2 CAN interfaces, max. 500 kbps, CAN: electrically isolated, network capable, object buffer in send and receive direction. Order 2 x TB704 terminal blocks separately.	
0TB704.9	Accessory, terminal block, 4-pin, screw clamps, 1.5 mm²	
0TB704.91	Accessory, terminal block, 4-pin, cage clamps, 2.5 mm²	
	Accessories	
0G0001.00-090	Cable PC <-> PLC/PW, RS232, online cable	
Additional accessories see sections "Accessories" and "Manuals". **The 4-pin terminal block TB704 is not included in the delivery.**		

Table 361: IF772 order data

15.13.3 Technical Data

Product ID	IF772
General Information	
C-UL-US Listed	Yes
Slot	aPCI insert
Interfaces	1 x RS232 2 x CAN
Power Consumption 5 V 24 V Total	 Max. 2.1 W --- Max. 2.1 W
Application Interface IF1	
Type	RS232
Controller	UART Type 16C550 compatible
FIFO	16 bytes in send and receive direction
Design	9-pin DSUB plug
Electrical Isolation	No
Input Filter / Protective Circuit	Yes
Maximum Distance	15 m / 19200 Baud
Maximum Baud Rate	115.2 kBaud
Handshake Lines	RTS, CTS
Network Capable	No
Data Formats Data Bits Parity Stop Bits	 5 to 8 Yes / No / Even / Odd 1 / 2
Application Interfaces IF2 and IF3	
Type	CAN
Controller	Controller SJA 1000
Design	2 x 4-pin multipoint connector
Electrical Isolation to PLC Between Interfaces	 Yes Yes
Maximum Distance	1,000 m
Maximum Baud Rate Bus Length ≤60 m Bus Length ≤200 m Bus Length ≤1,000 m	 500 kBit/s 250 kBit/s 50 kBit/s
Network Capable	Yes
Bus Termination Resistor	Optional (externally wired)

Table 362: IF772 technical data

15.13.4 Operational and Connection Elements

Status LEDs show for the IF1 interface whether data is being received (RXD) or sent (TXD).

Both CAN interfaces have a status LED that indicates when data is being sent.

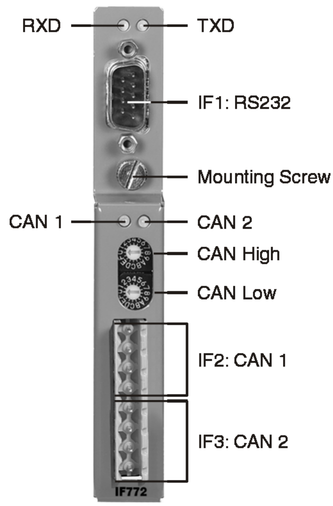


Figure 194: IF772 operational and connection elements

15.13.5 CAN Node Number Switch

The node numbers for the first two CAN interface (IF2) are set with the two hex switches. The following formula is used to set the second CAN interface (IF3):

Node number CAN 2 (IF3) = Node number CAN 1 (IF2) + 1

The CAN node numbers can also be set by the software (in preparation).

15.13.6 RS232 Interface (IF1)

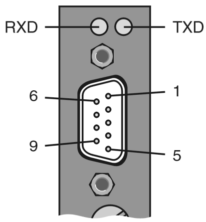
Interface	Description	Pin Assignments		
Application interface RS232  9-pin DSUB plug	The standard RS232 interface is not electrically isolated. LEDs show on the interface whether data is being received (RXD) or sent (TXD). The shield is connected to the DSUB connectors housing. Max. Baud Rate: 115.2 kBaud Max. Cable Length: 15 m	**Pin**	**RS232**	
		1	NC	
		2	RXD	Receive Signal
		3	TXD	Transmit Signal
		4	NC	
		5	GND	Ground
		6	NC	
		7	RTS	Request To Send
		8	CTS	Clear To Send
		9	NC	

Table 363: IF772 RS232 Interface (IF1)

15.13.7 Interfaces CAN 1 and CAN 2 (IF2 and IF3)

Two 120 Ω terminating resistors are included with delivery. The resistors can be installed between pin 1 and pin 3 or between pin 5 and pin 7.

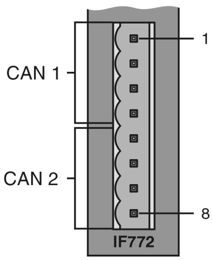
Interface	Description	Pin Assignments	
Application interface CAN 1 + CAN 2  8-pin Multipoint connector	The electrically isolated CAN interfaces IF2 and IF3 are 8-pin multipoint connectors. The status LED CAN 1 or CAN 2 are lit when data is sent to the corresponding CAN interface. Max. Baud Rate: 500 kBit/s Bus Length: ≤60 m 250 kBit/s Bus Length: ≤200 m 50 kBit/s Bus Length: ≤1,000 m	**Terminal**	**CAN 1 and CAN 2**
		1	CAN_H1
		2	GND1
		3	CAN_L1
		4	Shield 1
		5	CAN_H2
		6	GND2
		7	CAN_L2
		8	Shield 2

Table 364: IF772 CAN 1 and CAN 2 interfaces (IF2 and IF3)

15.14 NW150

15.14.1 General Information

The PROFIBUS network (FMS) is used for communication between PROFIBUS capable I/O components, such as PLC components, panels and industrial PCs (e.g. PROVIT from B&R).

The NW150 PROFIBUS module is operated using software, which is available from B&R.

15.14.2 Order Data

Model Number	Short Description	Image
	PROFIBUS network module	
3NW150.60-1	2005 PROFIBUS network module, electrically isolated RS485 interface used to connect to PROFIBUS networks	
	Accessories	
0G1000.00-090	Bus Connector, RS485, for PROFIBUS networks, remote I/O	
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	
Additional accessories see sections "Accessories" and "Manuals".		

Table 365: NW150 order data

15.14.3 Technical Data

Product ID	NW150
C-UL-US Listed	Yes
B&R ID Code	$10
Serial Interface Design Electrical Isolation Baud Rates 9.6 kBit/s 19.2 kBit/s 93.75 kBit/s 187.5 kBit/s 500 kBit/s	RS485 9-pin DSUB socket Yes Depends on the distance Max. 1,200 m Max. 1,200 m Max. 1,200 m Max. 1,000 m Max. 400 m
PROFIBUS Data Transfer Protocol Access Procedure Number of Stations Topology Connection to the Bus Transfer Media	 According to PROFIBUS standard, DIN 19245 parts 1 and 2 (FMS) Token passing principle with underlying master/slave principle Max. 127 (with repeater) Physical bus Direct Shielded, twisted pair
Power Consumption 5 V 24 V Total	 Max. 7 W --- Max. 7 W
Dimensions	B&R 2005 single-width

Table 366: NW150 technical data

15.14.4 Status LEDs

<table>
<tr><th>Image</th><th>LED</th><th>Description</th></tr>
<tr><td rowspan="6">
</td><td>RUN</td><td>Network processor is initialized by CPU's PLC.</td></tr>
<tr><td>ERROR</td><td>Error</td></tr>
<tr><td>CONNECT</td><td>At least one connection is established.</td></tr>
<tr><td>COMM</td><td>Connection is established and PROFIBUS services are being processed.</td></tr>
<tr><td>Tx</td><td>Data is being sent.</td></tr>
<tr><td>Rx</td><td>Data is being received.</td></tr>
</table>

Table 367: NW150 status LEDs

15.14.5 Operational and Connection Elements

The number switch for setting the station address, the baud rate and the connection socket for the RS485 interface are located behind the module door.

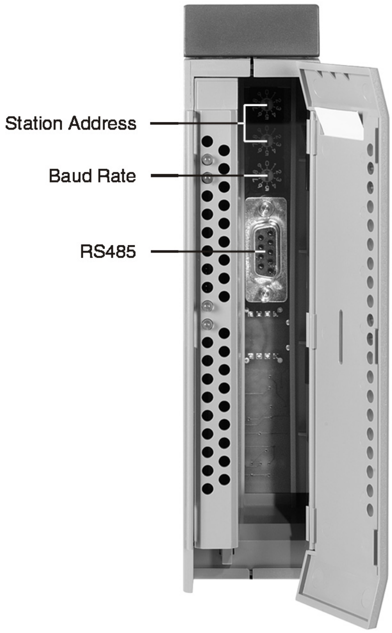


Figure 195: NW150 operational and connection elements

15.14.6 Number Switch

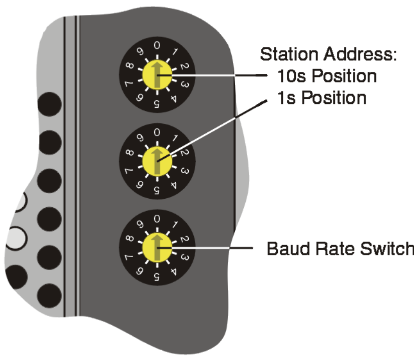


Figure 196: NW150 number switch

Baud Rate

The lower number switch is used to set the baud rate which allows the transfer to take place via PROFIBUS.

The following baud rates can be set:

Baud Rate Switch	
Position	**Baud Rate**
0	9.6 kBit/s
1	19.2 kBit/s
2	93.75 kBit/s
3	187.5 kBit/s
4	500 kBit/s

Table 368: NW150 baud rates

Station Address

The two upper number switches are used to set the station address for the network module. The station is accessed using this address.

15.14.7 RS485 Interface

The interface is electrically isolated. The status LEDs Rx and Tx are lit during data transfer via the RS485 interface.

Maximum Transfer Rate: 2 MBit/s
Max. Distance: 1,200 m

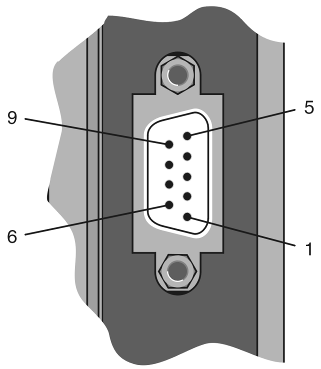
Interface	Pin Assignments		
RS485	**Pin**	**RS485**	
	1	Shield	
	2		
	3	DATA	Data
	4	CTRL	Transmit enable
	5	GND	Electrically isolated supply
	6	5 V / 200 mA	Electrically isolated supply
	7		
	8	DATA\	Data\
	9	CTRL\	Transmit Enable\
9-pin DSUB socket			

Table 369: NW150 RS485 interface

15.14.8 Wiring a PROFIBUS System

The wiring for PROFIBUS is also used for the remote I/O bus. Information concerning specifications for the bus cable and wiring can be found in Chapter 2 "Installation", Section 2.1.3 "Remote I/O Bus", on page 58.

16. Counter and Positioning Modules

16.1 Overview

Module	Description
NC150	2005 counter module, 2 inputs for incremental encoder, 32-bit, input frequency 100 kHz, encoder supply 5 to 30 VDC, 2 analog outputs +/- 10 V, 12-bit, 8-pin. Terminal block is included in the delivery.
NC154	2005 axis controller, 3 axes. Each axis has the following data: Input frequency 150 kHz, incremental or absolute, 32-bit, encoder supply 5 VDC or 24 VDC, 5 digital inputs 24 VDC, sink, 1 relay output 24 VAC / 24 VDC, 1 A, 1 analog output +/- 10 V, 12-bit, 12-pin. Order 3 x TB162 terminal blocks separately.
NC157	2005 positioning module, CAN bus interface for controlling up to 8 axes, 2 trigger inputs, 24 VDC, sink, 4-pin terminal block included in the delivery.
NC352	B&R 2005 transducer module with 3 pulse interfaces, 3 digital inputs (24 V DC) (can be configured as event counter, for gate and frequency measurement and as A/B counter with external count frequency option) and also one digital output (24 V DC). Order TB708 terminal block separately.

Table 370: Counter and Positioning Module Overview

16.2 NC150

16.2.1 General Information

The NC150 counter module is mainly used for positioning tasks. The most important areas of use are the single or dual axis controller and calculating path and position.

16.2.2 Order Data

Model Number	Short Description	Image
3NC150.6	2005 counter module, 2 inputs for incremental encoder, 32-bit, input frequency 100 kHz, encoder supply 5 to 30 VDC, 2 analog outputs +/- 10 V, 12-bit, 8-pin. Terminal block is included in the delivery.	
Additional accessories see sections "Accessories" and "Manuals".		

Table 371: NC150 order data

16.2.3 Technical Data

Product ID	NC150
General Information	
C-UL-US Listed	Yes
B&R ID Code	$98
Slot Main Rack Expansion Rack	 Yes Yes
Status Display	LEDs
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 3.5 W Max. 5 W
Encoder 1 and 2	
Design of the Signal Encoder Connections	Two 9-pin DSUB sockets
Encoder Inputs	Symmetric and asymmetric
Electrical Isolation Input - PLC Input - Input	 Yes No
Encoder Supply Module Requirements	5 to 30 V external Typically 40 mA at 5 V / 120 mA at 30 V
Input Filter	2 times can be set using software
Input Frequency Short Filter Time Long Filter Time	 Max. 100 kHz Max. 20 kHz
Counter Frequency with 4x Evaluation	Max. 400 kHz
Phase Offset between Counter Channels A and B	90° ±45°
Counters Amount Counter Size Operating Modes [1)]	 2 32-bit Incremental (4x, 2x and 1x evaluation) up/down counter
Analog Outputs	
Amount	2
Output Voltage	-10 V to +10 V
Digital Converter Resolution	12-bit
Max. Load per Output	±10 mA (load ≥1 kΩ)
Conversion Time for All Outputs	35 µs
Short Circuit Protection (current limit)	Current limit to >20 mA

Table 372: NC150 technical data

Product ID	NC150
Precision Basic Accuracy (at 20° C) Precision (0 to 60° C)	 ±0.5% ±1.0%
Electrical Isolation Output - PLC Output - Output Counter Channels - Analog Outputs	 Yes No Yes
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 372: NC150 technical data

1) Can be selected using software.

16.2.4 Status LEDs

Image	LED	Description
	UP	Counter counts upwards.
	DOWN	Counter counts downwards.
	REF	Counter is referenced.
	GND OFFSET	The potential offset current on the analog outputs is >15 mA.

Table 373: NC150 status LEDs

16.2.5 Operational and Connection Elements

Two 9-pin DSUB sockets and an 8-pin terminal block are located behind the module door of the NC150 module:

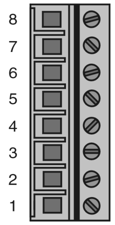
① Connecting socket for encoder 1 (9-pin DSUB socket)

① Connecting socket for encoder 2 (9-pin DSUB socket)

③ 8-pin terminal block with extraction clip for connecting the external encoder supply and two analog outputs.

Figure 197: NC150 operational and connection elements

16.2.6 External Encoder Supply / Analog Outputs



8-pin terminal block

Pin Assignments	
1	+ Analog output 1
2	- Analog output 1
3	Shield
4	+ Analog output 2
5	- Analog output 2
6	Shield
7	+ External encoder supply
8	GND external encoder supply

Table 374: NC150 external encoder supply / analog outputs

Encoder Supply

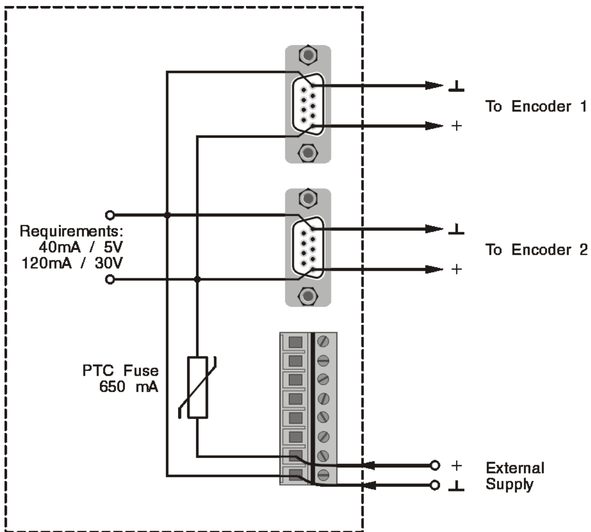


Figure 198: NC150 encoder supply

The encoder must be externally supplied. The encoder supply is fed through the 8-pin terminal block to the module through a polymer PTC protective element (Polyswitch™ [1]). The supply for the input stage of approx. 80 mA (at 24 V) is necessary. The encoder supply is passed on to the encoders using 2 pins on the DSUB sockets.

1) Polyswitch™ is a registered trademark of RAYCHEM.

The encoders are not permitted to be supplied directly from an external source!

Metallic DSUB connectors and shielded cables must be used to connect the encoder (see Chapter 2 "Installation", Section 3 "Grounding and Shielding Measures", on page 69)

Both symmetrical encoder signals (A, A\, B, B\, Z, Z\), and asymmetrical signals (A, B, Z) can be processed. If an asymmetrical encoder is connected, the inverted inputs are to be linked with pin 9 (trigger level). The connection should be made in the DSUB connector and not in the encoder cable (as shown in the diagram below).

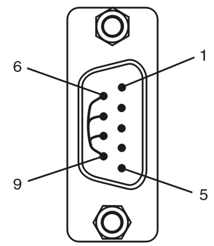


Figure 199: NC150 asymmetrical encoder: inverted inputs connected to the trigger level

The cutoff threshold of the PTC protective element depends on the environmental temperature (at 0° C approx. 800 mA, at 60° C approx. 450 mA). The internal supply (consumption) must also be considered. At a supply of 30 V, consumption of 120 mA and an environmental temperature of 60° C, the maximum amount of current available for the encoder supply would be 330 mA (450 mA - 120 mA).

If an overload or short circuit occurs, the protective element becomes highly resistive and breaks the flow of current. In this case the external supply must be switched off (removing the overload or the short circuit is normally not enough). The reset time of the PTC is approximately 20 seconds.

16.2.7 Output Diagram for Analog Outputs

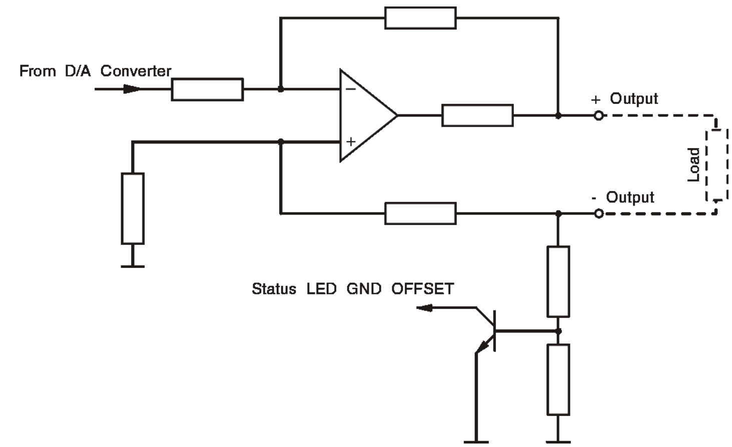


Figure 200: NC150 output diagram for analog outputs

16.2.8 Counter Inputs

Both symmetrical and asymmetrical incremental encoders can be connected to the counter inputs. When connecting asymmetrical encoders, the inverted inputs A\, B\ and Z\ are to be connected with the trigger level (pin 9).

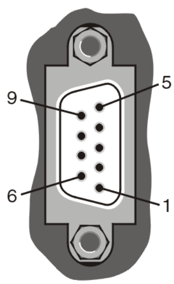
<table>
<tr><th>Counter 1 / Counter 2</th><th colspan="2">Pin Assignments</th></tr>
<tr><td rowspan="10">9-pin DSUB socket</td><td>1</td><td>+ Encoder supply</td></tr>
<tr><td>2</td><td>Counter input A</td></tr>
<tr><td>3</td><td>Counter input B</td></tr>
<tr><td>4</td><td>Reference pulse Z</td></tr>
<tr><td>5</td><td>GND encoder supply</td></tr>
<tr><td>6</td><td>Counter input A\</td></tr>
<tr><td>7</td><td>Counter input B\</td></tr>
<tr><td>8</td><td>Reference pulse Z\</td></tr>
<tr><td>9</td><td>Trigger level</td></tr>
<tr><td></td><td></td></tr>
</table>

Table 375: NC150 counter inputs

Input Circuit for Counter Inputs

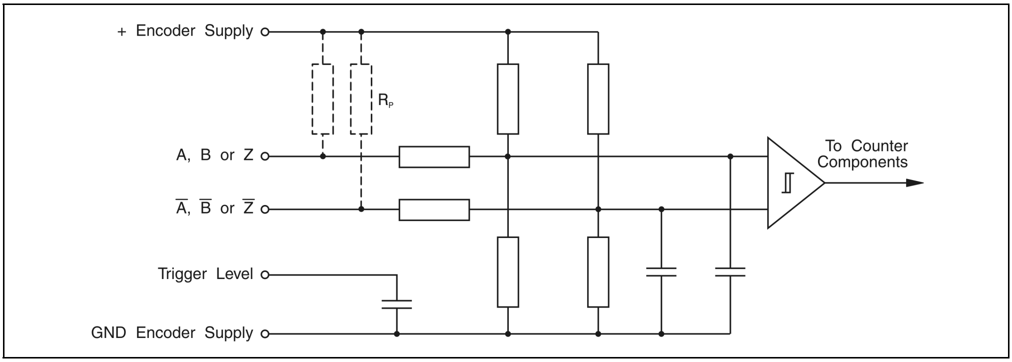


Figure 201: NC150 input circuit for counter inputs

Signal Level for Counter Inputs

The maximum input level permitted depends heavily on the encoder supply. In practice, the following levels are defined for the most frequently used encoders:

5 V Encoder with Differential Outputs (symmetrical encoder)	
Encoder Supply	5 to 8 V
Input Signals Differential Voltage Common Mode Voltage	 ±0.4 V ±7 V
Asymmetrical Encoder with Transistor Outputs	
Encoder Supply	5 to 30 V (= $V_{encoder}$)
Input Signals HIGH LOW Switching Threshold	 0.4 x $V_{encoder}$ to 2 x $V_{encoder}$ (30 V may not be exceeded) -10 V to 0.16 x $V_{encoder}$ The thresholds corresponds with TTL levels
Symmetrical Encoder with Transistor Outputs	
Encoder Supply	5 to 30 V (= $V_{encoder}$)
Input Signals HIGH LOW Idle Threshold	 A, B, Z > A\, B\, Z\ + differential voltage A, B, Z < A\, B\, Z\ - differential voltage The idle threshold is logical 0
Differential Voltage for Input Signals (V_{IN}) within the Encoder Supply	Differential Voltage = 0.15 x $V_{encoder}$ when GND encoder supply < V_{IN} < $V_{encoder}$
Differential Voltage for Input Signals (V_{IN}) for the Entire Modulation Range	Differential voltage = 0.2 x $V_{encoder}$ at 10 V < V_{IN} < 2 x $V_{encoder}$ (30 V may not be exceeded)

Table 376: NC150 signal level for counter inputs

Encoder with Open Collector Outputs	
When using encoders with open collector outputs, an external pull-up resistor (R_P) must be switched on. To achieve the HIGH threshold for asymmetrical inputs the pull-up resistor (independent of the external encoder supply) is permitted to have a maximum of 30 kΩ. Normally, the pull-up resistor is not used in situations dealing with speed.	
Recommended Values Encoder supply 5 V Encoder supply 24 V	 R_P = 300 Ω - 2 kΩ R_P = 1.5 kΩ - 10 kΩ

Table 376: NC150 signal level for counter inputs (cont.)

16.2.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Counter 1	tc_global	DINT	1	Transp.In	0
Reset Register 1	tc_global	USINT	1	Status Out	0
Mode Register 1	tc_global	USINT	1	Status Out/In	1
Counter 2	tc_global	DINT	1	Transp.In	4
Reset Register 2	tc_global	USINT	1	Status Out	2
Mode Register 2	tc_global	USINT	1	Status Out/In	3
Analog Output 1	tc_global	INT	1	Analog Out	5
Analog Output 2	tc_global	INT	1	Analog Out	6

Table 377: NC150 variable declaration

Reset Register X

Reset Register X	Bit	Description
	7	Software reset of the counter status
	0 - 6	0

7							0
	0	0	0	0	0	0	0

Clearing bit 7 in reset register x causes a software reset of the counter status for counter x. Since the status of the variables is transferred after every cycle to the module, this reset is also performed after every cycle . For this reason, bit 7 must be written to with log. 1 again in the following cycle.

Mode Register X - Write (Status Out)

Mode Register X Write	Bit	Description
	7	DIS - Mode register disabled
	6	0
	5	HS - Home Search
	4	FT - Filter Time
	3	OM3
	2	OM2 - Operating Mode (OM1 - OM3)
	1	OM1
	0	DIR - Counting direction

7	6	5	4	3	2	1	0
	0						

DIS 0...... The module uses the current values when writing to the mode register.
1...... Changes to bits 0 to 6 have no effect when writing to the module.

Since the status of the variables is transferred to the module after every cycle, the mode register is written to after each cycle when DIS = 0. For this reason, bit 7 must be written to with log. 1 to again in the following cycle.

RF 0...... Home search mode is disabled: Reference pulse for the encoder has no affect.
1...... Home search mode is enabled: If a reference pulse occurs, counter x is reset to zero.

FT 0...... large filter time (maximum input frequency 20 kHz)
1...... small filter time (maximum input frequency 100 kHz)

OMx The operating mode for the counter is set with these three bits:

OM3	OM2	OM1	Operating Mode
0	0	0	Positioning, 4x evaluation
1	0	0	Positioning, 2x evaluation
1	1	0	Positioning, 1x evaluation, positive
0	1	0	Positioning, 1x evaluation, negative
1	0	1	2 channel up/down counter, positive edge
0	0	1	2 channel up/down counter, negative edge
1	1	1	1 channel up/down counter, positive edge
0	1	1	1 channel up/down counter, negative edge

DIR 0...... positive counting direction
1...... negative counting direction

The status of bits DIS, HS, FT, OMx and DIR are set as default to log. 0 after start up.

Mode Register X - Read (Status In)

Mode Register X Read	Bit	Description	
	7	x	
	6	PV	- Potential variation of the analog outputs
	5	HS	- Home search mode
	0 - 4	x	

x			x	x	x	x	x

7 0

PV This bit is identical to the GND OFFSET status LED.

0 ..... Compensating current between the channels is within the range ±15 mA

1 ..... Compensating current between the channels lies outside the range ±15 mA; The PV bit remains set, even if the value returns inside the valid range. The PV bit in both registers and the LED are cleared again when one of the two mode registers is read.

RF If the home search mode has been enabled, it can be used to indicate whether the reference pulse has already arrived and the counter is reset (see also Section 16.2.12 "Home Search Procedure", on page 562).

0 ..... The reference pulse has been recognized and the counter is reset. The LED REF is lit. Home search mode has been disabled. If the counter is referenced again (e.g. from the other direction), home search mode must be first activated.

1 ..... The reference pulse has still not been recognized.

16.2.10 Basic Counting Direction

The counting direction can be switched between positive and negative using software. The counting direction effects only the counting mode. An example of operating mode positioning:

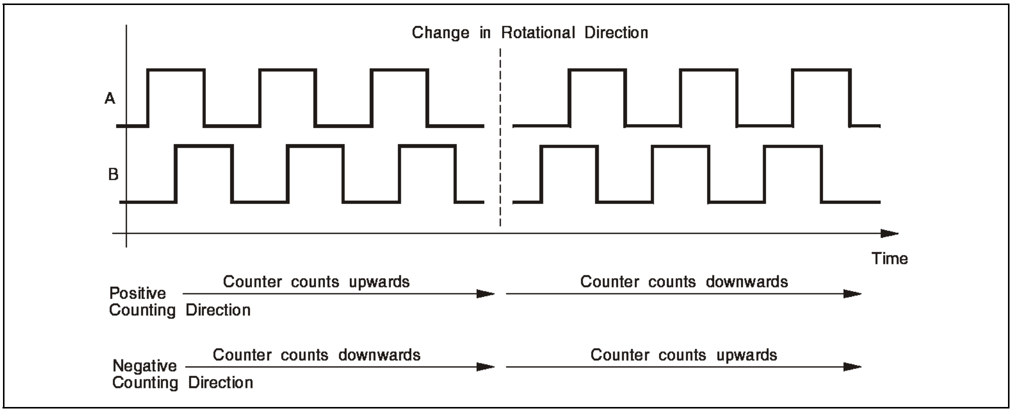


Figure 202: NC150 counting direction in operation mode positioning

The evaluation of reference pulse Z is independent of the counting direction. It is always referenced by a negative edge at Z.

16.2.11 Counter Operating Modes

Positioning

In this operating mode, the encoder provides two square wave signals (A and B), at a defined time difference to each other. Both signals are 90 ° out of phase, allowing the counting direction to be recognized. The following positioning operating modes are possible. [1] [2]

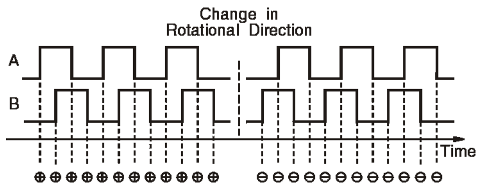


Figure 203: NC150 4x evaluation

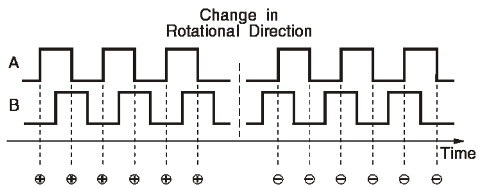


Figure 204: NC150 2x evaluation

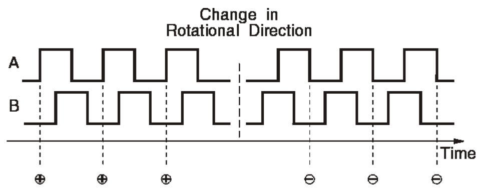


Figure 205: NC150 1x evaluation, positive

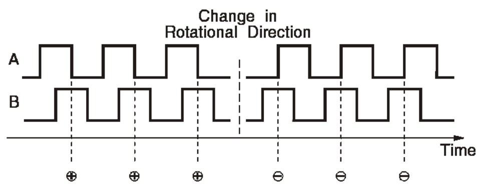


Figure 206: NC150 1x evaluation, negative

1) (+) => counter counting upwards; (-) => counter counting downwards
2) The diagram refers to the positive counting direction. For the negative counting direction, the symbols (+) and (-) are exchanged.

Up/Down Counters

The **2 channel**up/down counter counts the positive (negative) edges of channel A up and the positive (negative) edges of channel B down. 1) 2)

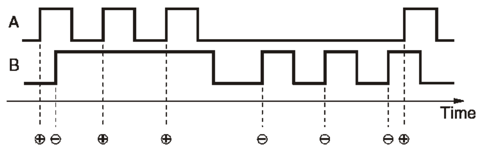


Figure 207: NC150 2 channel, positive edge

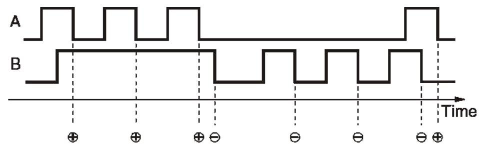


Figure 208: NC150 2 channel, negative edge

The **1 channel** up/down counter counts the positive (negative) edges of channel A up and the positive (negative) edges of channel B down. (counting direction: 1 => up, 0 => down). 1) 2)

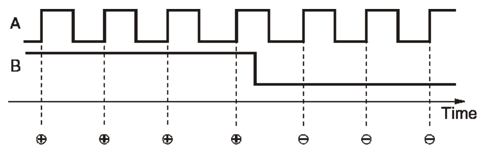


Figure 209: NC150 1 channel, positive edge

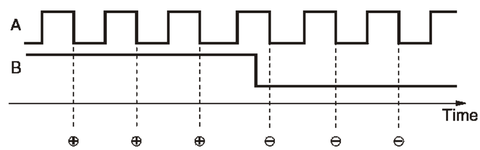


Figure 210: NC150 1 channel, negative edge

1) (+) => counter counting upwards; (-) => counter counting downwards
2) The diagram refers to the positive counting direction. For the negative counting direction, the symbols (+) and (-) are exchanged.

16.2.12 Home Search Procedure

With all positioning applications, determining the home position with incremental encoders is absolutely necessary. Normally, the reference pulse of the incremental encoder is generated once per rotation.

Order for Homing Procedure

1) The home search mode is activated by setting bit 5 in the mode register (status out). Bit 7 must be written to the respective mode registers with log. 0 for this write cycle.
2) Continually reading back bit 5 (mode register / status in) checks whether the reference pulse has occurred. Wait until bit 5 = 0, that means until a reference pulse has occurred.
3) If a reference pulse occurs, the counter status is set to zero and the LED REF is switched on. The counter counts in the rotation direction and the set operation mode.
4) If the homing procedure is repeated (e.g. with slower speeds in the opposite direction), the procedure begins again at step 1.

In each operating mode where the home search mode is activated, the counter is reset to zero by the negative edge of the reference pulse.

16.3 NC154

16.3.1 General Information

The NC154 axis controller is an active axis module, which includes all functions for operating three servo axes:

- Encoder Input
- Servo output (±10 V, 12-bit)
- Closed loop position controller (digital sampling controller)
- Limit and reference switch inputs
- Input "Controller Ready"
- Output "Enable Controller"

In addition, three fast trigger inputs are provided to latch the actual position for measurements.

Positioning Software

The software for axis control is found in the axis controller FlashPROM. The software can be downloaded. Therefore, positioning software can be updated if necessary.

Controller

The NC154 axis controller has a lag-free predictable PI closed loop controller. This algorithm guarantees a high degree of dynamic rigidity and excellent path precision.

Positioning Types

The user has a choice between several types of positioning:

- **Online Positioning**
  Changing the values for a movement (position, speed and acceleration) is possible at any sampling instant.
- **Electronic Gears**
  One or more gear axes have a certain relationship to a reference axis. The gear ratio and the angles of the gear axes to each other can be changed during a movement. The gear ratio or axes coupling (turning gear axes on and off) can be defined when the movement is stopped.
- **Electronic Cam Profile**
  Electronic cam profiles allow a non-linear connection between two drives (coupling functions) to be easily created. Several cam profiles can exist simultaneously on the NC154 and they can be switched when needed. Up and down synchronization is also possible when the reference axis is not stopped. All limits are taken into consideration during this procedure (speed, acceleration).

Additional Applications:

- **Flying Saw**
  - Optimized timing for movements
  - Immediate return when cut is completed
- **Cross Cutter**
  - Optimized movement
  - Print mark control
- **Interpolation**
  - Extensive NC interpreter
  - Linear, circular and helix interpolation with tangential axis
  - Dynamic "Look Ahead"
  - Gantry axes
  - Real-time intervention using virtual axes
- **Axis Synchronization**
  - Real-time positioning
  - Varied synchronization conditions
- **Virtual Axes**
  - Virtual master
  - Real-time intervention in active processes (to superimpose real axes)
- **Remote Axes**
  - Distributed axis controller according to machine functions
  - Connected via fieldbus

CNC Functions

Languages

In addition to the standard DIN 66025 syntax, the user is also provided very useful language expansions. Therefore, e.g. statements such as IF, ELSE, WHILE, SWITCH or arithmetic and trigonometric instructions (e.g. +, *, /, sin, cos, arctan) can be used. Up to 1000 R parameters are available as variables.

Interpolation

Straight, circular (helix) with tangential axes, level tool radian correction.

"Look Ahead" Function

A "Look Ahead" function is implemented which is used to make sure that axes limits are not exceeded.

Object-oriented Axis Programming

Tasks can be created quickly and reused using the new type of object-oriented axis programming. Thoroughly tested, high performance tools are used for this purpose.

The success of this new principle has been indicated by solutions in the main areas of automation technology.

Synchronization

If several NC154 axis controllers are used in a system, the sampling instant can be synchronized by linking the "Sync" connections. This guarantees high precision even when coupling gears between different NC154 modules.

Axis Coupling over Multiple Modules

When coupling axes over multiple modules (gears, cams, CNC), the set positions of the master axes are sent to the NC154 modules with the slave axes in an interrupt routine running on the main CPU. The interrupt routine is not allowed to be stopped. These requirements are fulfilled by the following CPUs:

- CP260
- IF260 when it is used as a main CPU

Restrictions

If electronic gears or cam profiles which are coupled between different modules or racks [1] are used in the application, no other interrupt capable modules (e.g. IF050, IF060, IF260 or IP161 as a parallel processor, EX150 and NW150) can be used in combination with the NC154.

16.3.2 Order Data

Model Number	Short Description	Image
	Axis Controller	
3NC154.60-2	2005 axis controller, 3 axes. Each axis has the following data: Input frequency 150 kHz, incremental or absolute, 32-bit, encoder supply 5 VDC or 24 VDC, 5 digital inputs 24 VDC, sink, 1 relay output 24 VAC / 24 VDC, 1 A, 1 analog output +/- 10 V, 12-bit, 12-pin. Order 3 x TB162 terminal blocks separately.	
3TB162.9	2005 terminal block, 12-pin, screw clamps	
	Software	
1A3502.01	2005 Positioning Software, NC154.60-2 standard operating system	
Terminal blocks are not included in the delivery (see "Accessories").		

Table 378: NC154 order data

16.3.3 Technical Data

Product ID	NC154
C-UL-US Listed	Yes
B&R ID Code	$61
RAM	2 MB DRAM
System PROM	2 MB FlashPROM
NC154 Axis Coupling over Multiple Modules Supported by	CP260, IF260
Status Display	LEDs
Number of Axes	3
Operating Temperature	0 to 55° C

Table 379: NC154 technical data

1) Coupling between racks: The data exchange required for axes coupling takes place via the CPU's CAN bus.

Product ID	NC154
Power Consumption 5 V 24 V Total	 Max. 6 W --- Max. 6 W
Axis Data	**Entries are Valid for all Three Axes**
Encoder Input	15-pin DSUB socket Incremental encoder or SSI absolute encoder (both electrically isolated)
Incremental encoder Signal Form Evaluation Input Frequency Count Frequency Counter Size Inputs Input Level Distance between Edges Monitoring	 Square wave pulse 4-fold Max. 150 kHz Max. 600 kHz 32-bit A, A\, B, B\, R, R\ 5 V (differential input) Min. 0.8 µs Broken Connection, Signal Disturbance
SSI Absolute Encoder Coding Word Size Baud Rate Data Input Level Clock Output Level Monitoring	 Gray, Binary Max. 31-bit 230 kBaud 5 V (differential signal) 5 V (differential signal) Signal disturbance, parity, plausibility
Encoder Supply External Input Voltage Load at Output Level 5 VDC 24 VDC Protection	 24 VDC Max. 400 mA per axis Max. 250 mA per axis Short circuit and overload protection
Servo Output	**Entries are Valid for all Three Axes**
Output Voltage	±10 V, electrically isolated
Load	5 mA
Resolution	12-bit
Output Filter	Low pass 1st order
Disturbance Suppression	Disturbance compensation
Digital Inputs	**Entries are Valid for all Three Axes**
Amount	5
Electrical Isolation	Yes (optocoupler)
Input Voltage	24 VDC
Input Current	Approx. 10 mA
Wiring	Sink

Table 379: NC154 technical data (cont.)

Product ID	NC154
Digital Output	**Entries are Valid for all Three Axes**
Type	Relay
Switching Voltage	Max. 30 VDC / VAC
Continuous Current	Max. 1 A
Short Circuit Protection	Soldered fuse 1.5 A
Mechanical Characteristics	
Dimensions	B&R 2005 double-width

Table 379: NC154 technical data (cont.)

16.3.4 Status LEDs

Image	LED	Description
	ERROR	The ERROR LED blinks in a 500 ms cycle (READY LED goes out, UP and DN continue to function). The ERROR LED is constantly lit during a hardware reset.
	READY	The READY LED blinks slowly (once every 2 seconds) if the software module BOOT is not present. The READY LED blinks quickly (5 time per second) if the software module BOOT is present, but the operating system is not present. The READY LED is lit constantly after a successful initialization i.e. the NC154 is ready for operation.
	STATUS	The STATUS LED indicates the individual boot phases.
	UP	The UP LED indicates an increasing actual position for axis n.
	DN	The DN LED indicates a decreasing actual position for axis n.

Table 380: NC154 status LEDs

16.3.5 Operational and Connection Elements

The connections for the individual axes, status LEDs and terminals for encoder supply and synchronization can be found behind the module door.

① Status LEDs

② Interface used to download the BOOT software module

③ 4-pin terminal block (encoder supply, connection for synchronization with other NC154 modules)

④ Encoder inputs for each axis

⑤ 12-pin terminal blocks to connect digital inputs and outputs for individual axes (e.g. limit switch, reference switch, etc.)

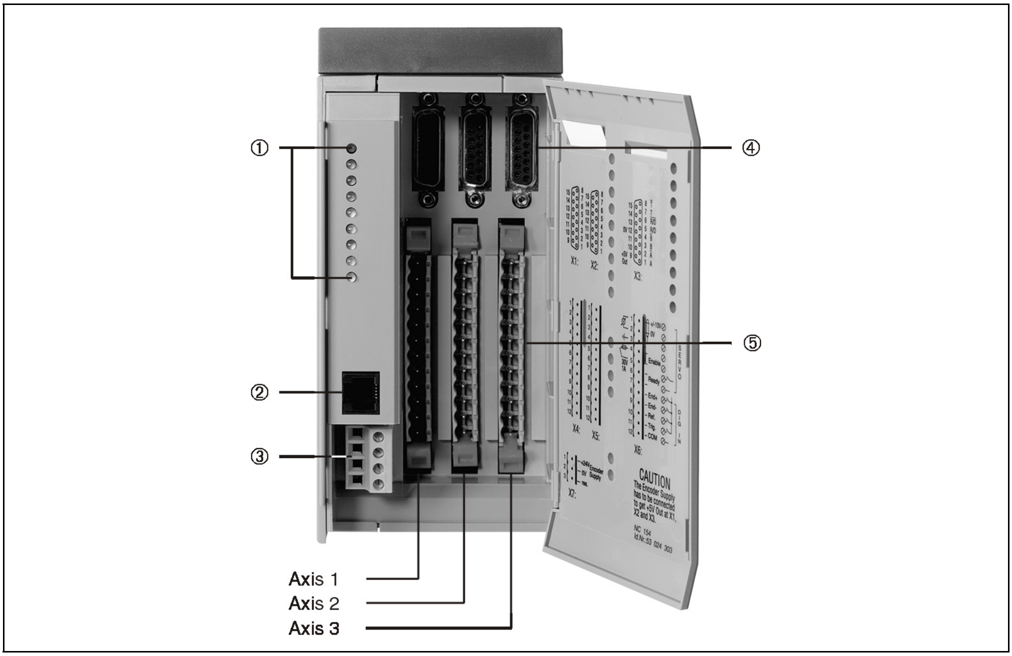


Figure 211: NC154 operational and connection elements

16.3.6 Encoder Connection

An encoder connection is available for each of the three axes. Either an incremental or SSI absolute encoder can be used.

Pin Assignments

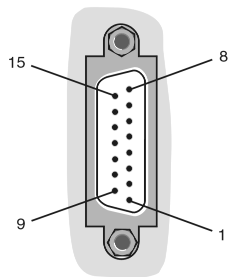
15-pin DSUB socket	Pin	Name	Incremental encoder	Name	Absolute encoder	Name	Encoder Supply
	1	A	Channel A				
	2	A\	A inverted				
	3	B	Channel B				
	4	B\	B inverted				
	5	R	Reference Pulse	D	Data input		
	6	R\	R inverted	D\	D inverted		
	7			T	Clock output		
	8			T\	C inverted		
	9					ES_5V	Encoder Supply +5 V / 400 mA
	10						
	11						
	12					COM	Encoder Supply ⊥
	13					ES_24V	Encoder Supply +24 V / 250 mA external voltage from terminals
	14						
	15						

Table 381: NC154 pin assignments for encoder connections

16.3.7 Encoder Supply / Synchronization

Pin Assignments

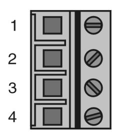
4-pin Terminal Block	Terminal	Description
	1	Encoder Supply: +24 VDC supply
	2	Encoder Supply: ⊥
	3	Synchronization +
	4	Synchronization -

Table 382: NC154 pin assignments for encoder supply /synchronization

16.3.8 I/O Connection

On each axis of the NC154 module there is a 12-pin terminal block with connections for 5 digital inputs, 1 digital output and 1 analog output. The terminal blocks can be removed with the help of ejection levers (12-pin terminal block, model number 3TB162.9).

Pin Assignments

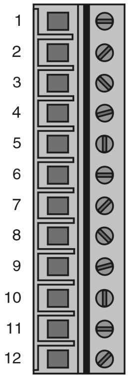
12-pin Terminal Block	Terminal	Description
	1	Analog output ±10V
	2	Analog output GND
	3	Shield
	4	Controller enable (relay output)
	5	Controller enable (relay output)
	6	Controller ready - input
	7	Controller ready - common
	8	Limit switch in positive direction
	9	Limit switch in negative direction
	10	Reference switch for search home
	11	Trigger input
	12	Common for pins 8 to 11

Table 383: NC154 pin assignments for I/O connection

16.3.9 Interface Used to Download the BOOT Software Module

The BOOT software module is required to update the NC154 operating system (operating system update). This module is already installed on NC154 modules starting from revision number 54.23.

For NC154 modules with a revision number <54.23, the software module BOOT has to be installed in the module before the operating system update.

A PC can be connected to the NC154 via this interface using a cable available from B&R (0G2001.00-090). The software module BOOT (NC154.S1) can be downloaded using this connection.

The operating system is updated using the programming device via the CPU's online interface.

Figure 212: NC154 interface used to download the BOOT software module

16.4 NC157

16.4.1 General Information

The NC157 axis controller is an active axis module that can be used to control up to eight ACOPOS axes. The number of axes depends on the scan time specified on the NC157 module. The cycle time can be set as a multiple of 400 μs between 2.4 ms and 5.6 ms.

A higher cycle time setting can be necessary depending on the positioning functions used.

Number of Axes	Minimum Cycle Time
1	2.4 ms
2	2.8 ms
3	3.2 ms
4	4.0 ms
5	4.4 ms
6	4.8 ms
7	5.2 ms
8	5.6 ms

Table 384: NC157 minimum cycle time

Positioning Software

The software for axis control is found in the axis controller FlashPROM. The software can be downloaded. Therefore, positioning software can be updated if necessary.

Drive Interface

The NC157 axis controller has a set value generator for each axis which cyclically calculates the set positions. These set positions are transferred to the ACOPOS drives in each NC157 scan step via the CAN network.

Positioning Types

The user has a choice between several types of positioning:

- **Online Positioning**

  Changing the values for a movement (position, speed and acceleration) is possible at any sampling instant.

- **Electronic Gears**

  One or more gear axes have a certain relationship to a reference axis. The gear ratio and the angles of the gear axes to each other can be changed during a movement. The gear ratio or axes coupling (turning gear axes on and off) can be defined when the movement is stopped.

- **Electronic Cam Profile**

  Electronic cam profiles allow a non-linear connection between two drives (coupling functions) to be easily created. Several cam profiles can exist simultaneously on the NC157 and they can be switched when needed. Up and down synchronization is also possible when the reference axis is not stopped. All limits are taken into consideration during this procedure (speed, acceleration).

Additional Applications:

- **Flying Saw**

  - Optimized timing for movements

  - Immediate return when cut is completed

- **Cross Cutter**

  - Optimized movement

  - Print mark control

- **Interpolation**

  - Extensive NC interpreter

  - Linear, circular and helix interpolation with tangential axis

  - Dynamic "Look Ahead"

  - Gantry axes

  - Real-time intervention using virtual axes

- **Axis Synchronization**

  - Real-time positioning

  - Varied synchronization conditions

- **Virtual Axes**

  - Virtual master

  - Real-time intervention in active processes (to superimpose real axes)

- **Remote Axes**
  - Distributed axis controller according to machine functions
  - Connected via fieldbus

CNC Functions

Languages

In addition to the standard DIN 66025 syntax, the user is also provided very useful language expansions. Therefore, e.g. statements such as IF, ELSE, WHILE, SWITCH or arithmetic and trigonometric instructions (e.g. +, *, /, sin, cos, arctan) can be used. Up to 1000 R parameters are available as variables.

Interpolation

Straight, circular (helix) with tangential axes, level tool radian correction.

"Look Ahead" Function

A "Look Ahead" function is implemented which is used to make sure that axes limits are not exceeded.

Object-oriented Axis Programming

Tasks can be created quickly and reused using the new type of object-oriented axis programming. Thoroughly tested, high performance tools are used for this purpose.

The success of this new principle has been indicated by solutions in the main areas of automation technology.

Synchronization

If several NC157 axis controllers are used in a system, the sampling instant can be synchronized by linking the "Sync" connections. This guarantees high precision even when coupling gears between different NC157 modules.

Axis Coupling over Multiple Modules

When coupling axes over multiple modules (gears, cams, CNC), the set positions of the master axes are sent to the NC157 modules with the slave axes in an interrupt routine running on the main CPU. The interrupt routine is not allowed to be stopped. These requirements are fulfilled by the following CPUs:

- CP260
- IF260 when it is used as a main CPU

Restrictions

If electronic gears or cam profiles which are coupled between different modules or racks [1)] are used in the application, no other interrupt capable modules (e.g. IF050, IF060, IF260 or IP161 as a parallel processor, EX150 and NW150) can be used in combination with the NC157.

16.4.2 Order Data

Model Number	Short Description	Image
	Axis Controller	
3NC157.60-1	2005 positioning module, CAN bus interface for controlling up to 8 axes, 2 trigger inputs, 24 VDC, sink, 4-pin terminal block included in the delivery.	
	Software	
1A3530.01	2005 positioning software, NC157.60-1 standard operating system	
Additional accessories see sections "Accessories" and "Manuals".		

Table 385: NC157 order data

1) Coupling between racks: The data exchange required for axes coupling takes place via the CPU's CAN bus.

16.4.3 Technical Data

Product ID	NC157
General Information	
C-UL-US Listed	Yes
B&R ID Code	$66
Module Type	B&R 2005 system module
Can be Installed on Main Rack Expansion Rack	 Yes No
RAM	2 MB DRAM
System PROM	2 MB FlashPROM
NC157 Axis Coupling over Multiple Modules Supported by	CP260, IF260
Status Display	LEDs
Number of Axes	8
Operating Temperature	0 to 55° C
Power Consumption 5 V 24 V Total	 Max. 6 W --- Max. 6 W
Servo Interface	
Type	CAN
Controller	Controller 82527
Design	9-pin DSUB plug
Electrical Isolation	Yes
Maximum Distance	60 m
Maximum Baud Rate Bus Lengths up to 60 m	 500 kBit/s
Network Capable	Yes
Bus Termination Resistor	External
CAN Node Number	Selection switch
Mechanical Characteristics	
Dimensions	B&R 2005 double-width

Table 386: NC157 technical data

16.4.4 Status LEDs

Image	LED	Description
	ERROR	The ERROR LED blinks in a 500 ms cycle (READY LED goes out). The ERROR LED is constantly lit during a hardware reset.
	READY	The READY LED blinks slowly (once every 2 seconds) if the software module BOOT is not present. The READY LED blinks quickly (5 time per second) if the software module BOOT is present, but the operating system is not present. The READY LED is lit constantly after a successful initialization i.e. the NC157 is ready for operation.
	STATUS	The STATUS LED indicates the individual boot phases.

Table 387: NC157 status LEDs

16.4.5 Operational and Connection Elements

The CAN interface, status LEDs, the terminal block for the trigger supply and synchronization and the terminal block for the triggerinputs can be found behind the module door.

① Interface used to download the BOOT software module

② 4-pin terminal block (trigger supply, connection for synchronization with other NC157 modules)

③ Node number switch

④ CAN interface

⑤ 4-pin terminal block (connection for trigger inputs)

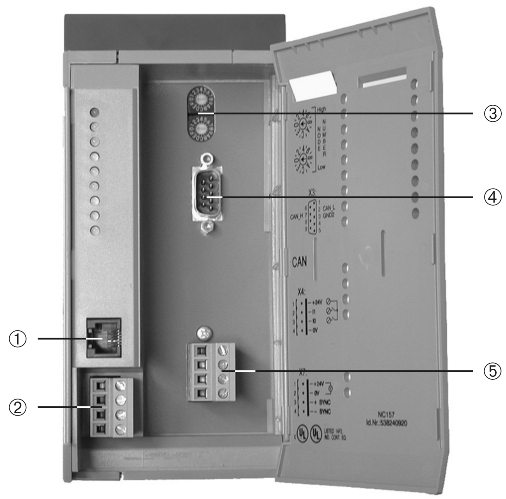


Figure 213: NC157 operational and connection elements

16.4.6 Interface Used to Download the BOOT Software Module

The BOOT software module is required to update the NC157 operating system (operating system update). This module is already installed.

A PC can be connected to the NC157 via this interface using a cable available from B&R (0G2001.00-090). The BOOT (NC157.S1) software module can be downloaded using this connection.

The operating system is updated using the programming device via the CPU's online interface.

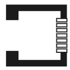


Figure 214: NC157 interface used to download the BOOT software module

16.4.7 Trigger Supply / Synchronization

To supply the triggers inputs, + 24 VDC must be applied to this connector. The trigger inputs are connected to the plug described previously (position 5).

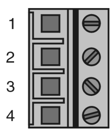
4-pin Terminal Block	Terminal	Assignment	Description
	1	+24 V (Trigger)	Trigger Supply: +24 VDC
	2	COM (Trigger)	Trigger Supply: ⊥
	3	Sync+	Synchronization +
	4	Sync-	Synchronization -

Table 388: NC157 pin assignments for trigger supply /synchronization

16.4.8 CAN Interface

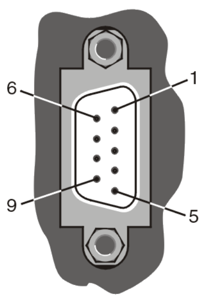
9-pin DSUB plug	Pin	Assignment	Description
	1	NC	Not assigned
	2	CAN_L	CAN Low
	3	CAN_GND	COM
	4	NC	Not assigned
	5	NC	Not assigned
	6	Res.	Reserved
	7	CAN_H	CAN High
	8	NC	Not assigned
	9	NC	Not assigned

Table 389: NC157 CAN interface

16.4.9 Trigger Inputs

Pin Assignments

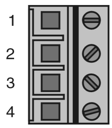
4-pin Terminal Block	Terminal	Assignment	Description
	1	+24 VDC	+24 VDC Output
	2	Trigger 1	Trigger Input 1
	3	Trigger 0	Trigger Input 0
	4	COM (2, 3)	Ground: ⊥

Table 390: NC157 pin assignments for trigger inputs

Connection Example

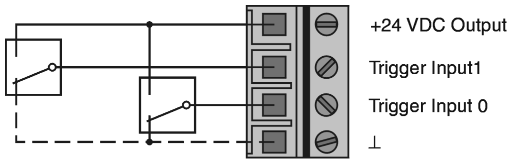


Figure 215: NC157 connection example for trigger inputs

16.5 NC352

16.5.1 General Information

The NC352 ultrasonic transducer module is used for measuring path and speed.

Features

- 3 channels for ultra sonic transducer using the RS422 interface
- 3 digital inputs that can be operated in different count modes
    - Event counter
    - Gate and frequency measurement
    - A/B counter with internal/external count frequency
- 1 digital output

16.5.2 Order Data

Model Number	Short Description	Image
3NC352.6	2005 ultrasonic transducer module, 3 inputs for ultrasonic transducer, 3 digital inputs, 24 VDC, sink, can be configured as event counter, or gate/frequency measurement, or as incremental encoder input, 1 digital output, 24 VDC, 20 mA. Order TB708 terminal blocks separately.	
0TB708.91	Accessory terminal block, 8-pin, cage clamp, 1.5 mm²	

Table 391: NC352 order data

16.5.3 Technical Data

<table>
<tr><th>Product ID</th><th colspan="3">NC352</th></tr>
<tr><th>General Information</th><th colspan="3"></th></tr>
<tr><td>C-UL-US Listed</td><td colspan="3">In preparation</td></tr>
<tr><td>B&R ID Code</td><td colspan="3">$9A</td></tr>
<tr><td>Module Type</td><td colspan="3">B&R 2005 I/O module</td></tr>
<tr><td>Slot
Main Rack
Expansion Rack</td><td colspan="3">
Yes
Yes</td></tr>
<tr><th>Static Characteristics</th><th colspan="3"></th></tr>
<tr><td>Number of Path Measurement Inputs/Outputs</td><td colspan="3">3</td></tr>
<tr><td>Number of Digital Inputs</td><td colspan="3">3</td></tr>
<tr><td>Number of Digital Outputs</td><td colspan="3">1</td></tr>
<tr><td>Power Consumption
5 V
24 V
Total</td><td colspan="3">
Max. 2.3 W
Max. 1.7 W
Max. 4 W</td></tr>
<tr><th>Channels for Path and Speed Measurements</th><th colspan="3"></th></tr>
<tr><td>Supported Encoder Types</td><td colspan="3">Ultrasonic transducer with RS422 interface (start/stop, stop, gate time)</td></tr>
<tr><td>Encoder Input</td><td colspan="3">9-pin DSUB socket</td></tr>
<tr><td>Encoder Supply</td><td colspan="3">24 VDC external supply
Distribution to the encoder and short circuit protection through NC352, with configurable overvoltage/undervoltage monitoring (±10%, ±15%, ±20%, ±25%)</td></tr>
<tr><td>Number of Channels</td><td colspan="3">3</td></tr>
<tr><td>Electrical Isolation
Channel - PLC
Channel - Channel</td><td colspan="3">
Yes
No</td></tr>
<tr><td>Input and Output Levels</td><td colspan="3">RS422 differential level</td></tr>
<tr><td rowspan="6">Multi-magnet Measurement</td><td colspan="3">Yes (max. 4 magnets in total – possible combinations):</td></tr>
<tr><td>Magnets on Channel 1</td><td>Magnets on Channel 2</td><td>Magnets on Channel 3</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>2</td></tr>
<tr><td>2</td><td>2</td><td>0</td></tr>
<tr><td>1</td><td>3</td><td>0</td></tr>
<tr><td>Outputs
Durational Initialization Pulse</td><td colspan="3">
1.6 µs</td></tr>
<tr><td>Inputs
Resolution/Measurement Range for
Path Measurement
Speed Measurement
Precision</td><td colspan="3">

0.01 mm / ±5.2 m
0.1 mm/s / ±3.2 m/s
±25 ppm</td></tr>
</table>

Table 392: NC352 technical data

Product ID	NC352
Digital Output	
Number of Outputs	1
Type	Highside driver (Source)
Switching Voltage Minimum Nominal Maximum	 18 V 24 V 30 V
Output Current	20 mA
Switching Delay	Max. 5 µs
Short Circuit Protection	Yes
Overload Protection	Yes
Status display	LED (yellow)
Digital Input	
Number of Inputs	3
Wiring	Sink
Input Voltage Minimum Nominal Maximum	 18 VDC 24 VDC 30 VDC
Input Delay at Nominal Voltage	< 12 µs
Switching Threshold Low High	 < 5 V > 15 V
Input Current at Nominal Voltage	Approx. 8.7 mA
Status Display	LED (green)
Counter Modes Mode 1 Mode 2 Mode 3	 32-bit event counter in input 1 (max. 20 KHz at nominal voltage) AB counter 32-bit (A: input 1, B: input 2) max. 10 KHz at nominal voltage Input 1: Gate or period measurement Measurement Frequency: 8 MHz, 31.25 kHz, external counter frequency on input 3: Max. 20 kHz
Operating Characteristics	
Electrical Isolation Input - PLC Input - Output Output - PLC	 Yes No Yes
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 392: NC352 technical data (cont.)

16.5.4 Status LEDs

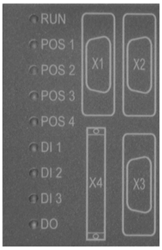
Image	LED	Description
	RUN	**Off** The NC352 has not booted and/or the CPU has not accessed the NC352. **Blinking symmetrically, 1 time per second** NC352 is ready for operation, the configuration files for the transducer have not been spooled on the NC352. **Blinking symmetrically, 8 times per second** Spooled during new Firmware on the NC352. **Always lit** NC352 is ready for operation and configured - Normal operation.
	POS 1 - POS 4	Lit as soon/until it receives a valid measurement signal from the assigned measurement channel.
	DI 1 - DI 3	These LEDs are lit when the status of the assigned digital inputs is logical "1".
	DO	This LED is lit when the status of the digital output is logical "1".

Figure 216: NC352 status LEDs

16.5.5 Operational and Connection Elements

Status LEDs, connections for the encoder and the terminals for the encoder supply and digital inputs/outputs, can all be found behind the module door.

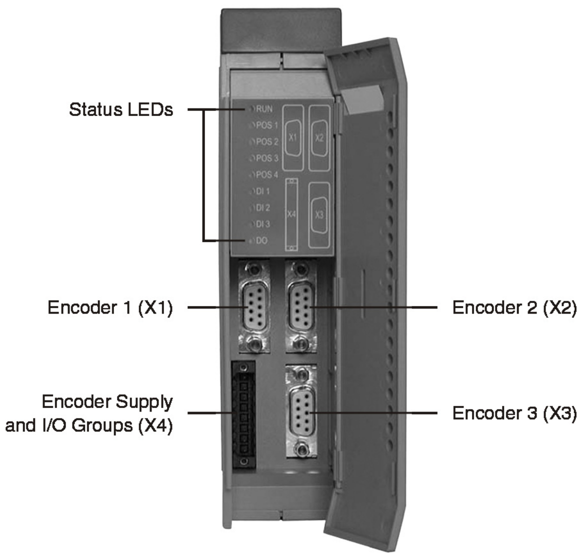
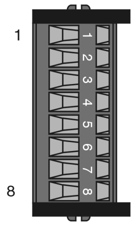


Figure 217: NC352 operational and connection elements

16.5.6 Pin Assignments

Connections for 8-pin Terminal Block (X4)



TB708

Terminal	Description
1	GND encoder supply
2	+24 VDC encoder supply
3	GND reference for digital inputs /outputs
4	Digital output
5	Shield
6	Digital input 3
7	Digital input 2
8	Digital input 1

Table 393: NC352 connections for 8-pin terminal blocks (X4)

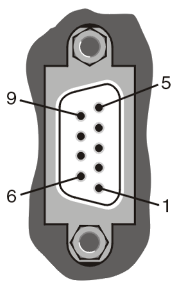
Assignment for the 9-pin DSUB Sockets

Encoder Connections Assignment:

X1...... Transducer rod 1

X2...... Transducer rod 2

X3...... Transducer rod 3



9 pin DSUB Socket

Pin	Description
1	NC
2	Init +
3	Start/Stop +
4	NC
5	GND Supply
6	+24 VDC Supply
7	Init -
8	Start/Stop -
9	NC

Table 394: NC352 pin assignments for the 9-pin DSUB socket

16.5.7 Specifications for the 9-pin DSUB Plug

Subject	Specification
Housing	Metal plated, with 45° cable output
Dimensions	L ≤ 31.5 mm W ≤ 15.4 mm H ≤ 37.0 mm
Manufacturer Information	e.g. TYCO: V42254-A6000-G109 or Fischer electronics: Art. No. DH09KM

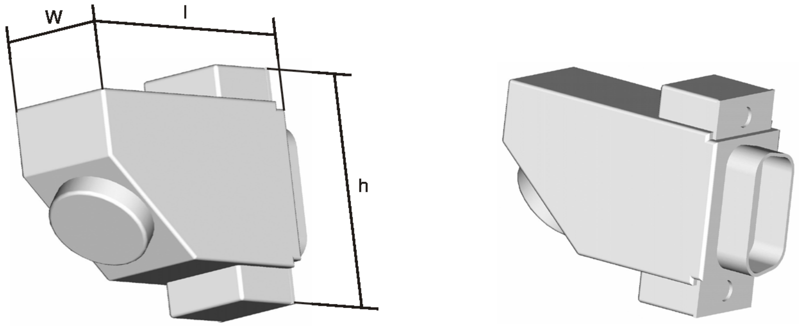


Table 395: NC352 specification for 9-pin DSUB plug

16.5.8 Input/Output Circuit Diagram

Input Circuit Diagram

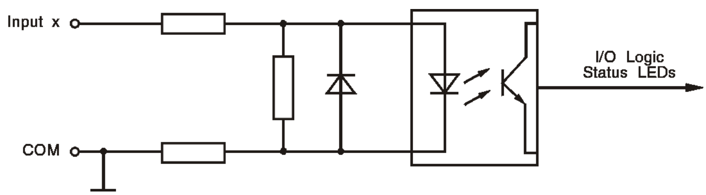


Figure 218: NC352 input circuit diagram

Output Circuit Diagram

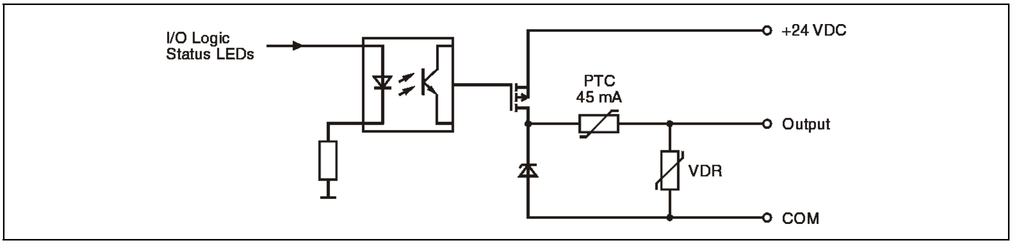


Figure 219: NC352 output circuit diagram

16.5.9 Ultrasonic Transducer Supply

The ultrasonic transducer can be connected using shielded cable and metal plated DSUB plug. The shield is connected to ground in the NC352 module.

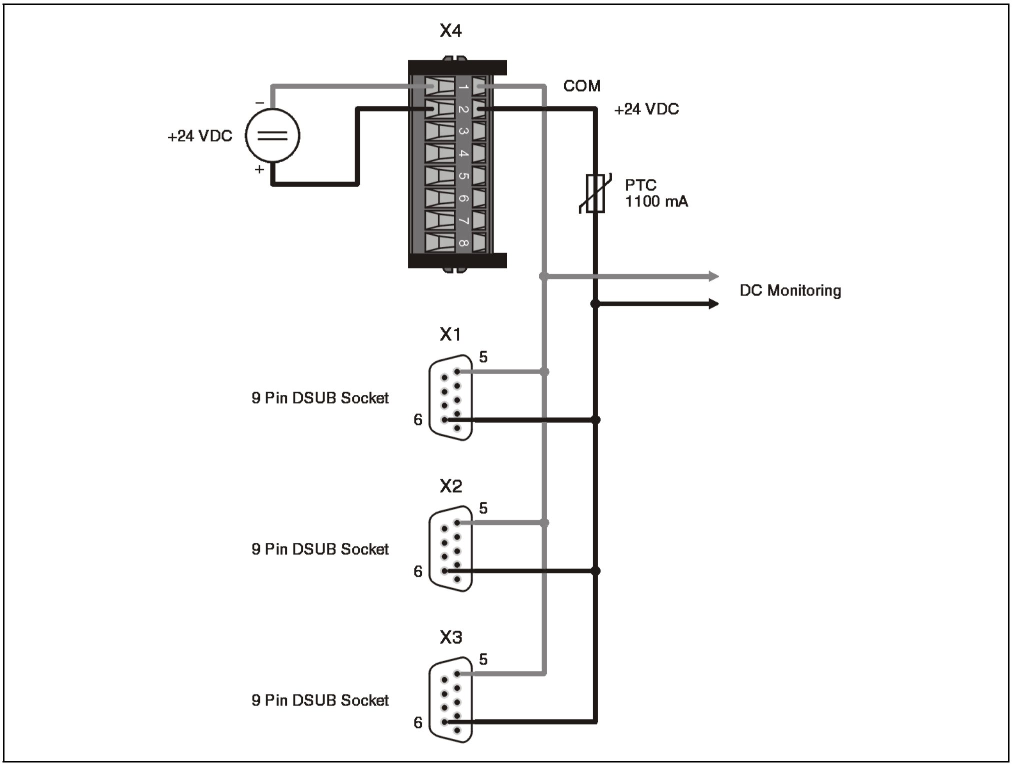


Figure 220: NC352 ultrasonic transducer supply

16.5.10 Digital Input/Output Connection Example

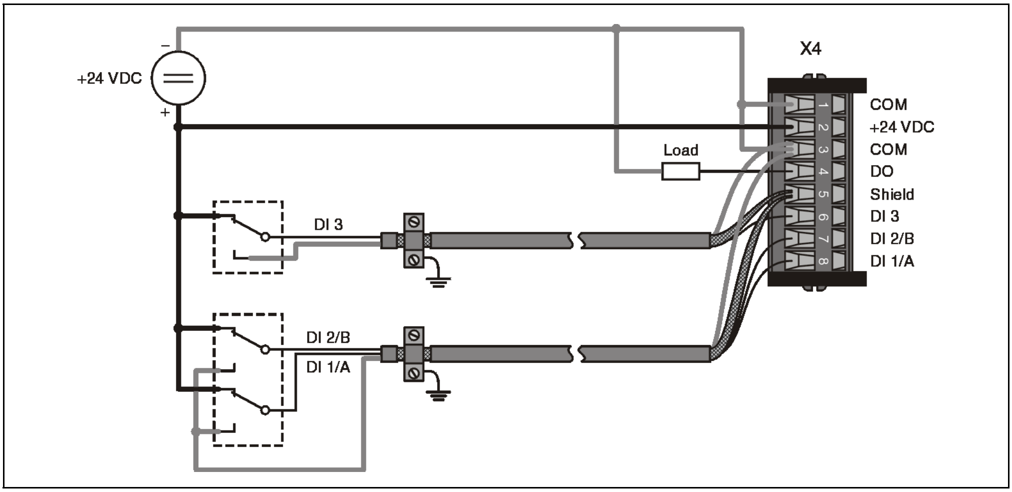


Figure 221: NC352 digital inputs/outputs connection example

16.5.11 Variable Declarations

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Displacement Gauge 1	tc_global	DINT	1	Analog In	1 ... 2
Displacement Gauge 2	tc_global	DINT	1	Analog In	3 ... 4
Displacement Gauge 3	tc_global	DINT	1	Analog In	5 ... 6
Displacement Gauge 4 / Incremental Encoder/ Comparator Value	tc_global	DINT	1	Analog In	7 ... 8
Configuration 1	tc_global	UINT	1	Analog Out	1
Configuration 2	tc_global	UINT	1	Analog Out	2
Path Measurement 1 Mode Register	tc_global	UINT	1	Analog Out	3
Path Measurement 2 Mode Register	tc_global	UINT	1	Analog Out	4
Path Measurement 3 Mode Register	tc_global	UINT	1	Analog Out	5
Reserved	tc_global	UINT	1	Analog Out	6
Comparator Set Value	tc_global	DINT	1	Analog Out	7 ... 8
Reserved for Spooler	tc_global	USINT	1	Status Out	0 ... 7

Table 396: NC352 variable declaration

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Comparator Actual Value	tc_global	USINT	1	Status In	0
Error & Status Register	tc_global	USINT	1	Status In	1 ... 3
Module Code = $B1	tc_global	USINT	1	Status In	4
Module Number = $9A	tc_global	USINT	1	Status In	5
Timer Reference Value	tc_global	USINT	1	Status In	6
Firmware Version / Reserved as a Return Channel for Spooler	tc_global	USINT	1	Status In	7

Table 396: NC352 variable declaration (cont.)

Displacement Gauges 1 - 4

Since only 32-bit reference data is available for data transfer with each measurement magnet, there are limitations where simultaneous path and speed measurements are needed. There are two modes. With the first mode, path data and speed data are retrieved in sequence using direct IO access. This procedure delivers both sets of data with full resolution and full measurement range, but requires additional CPU resources.

In the second mode, data is provided in a UDINT variable. However this limits the resolution and/or the maximum value for the path and speed. The same maximum resolution is always used internally so that no computing errors occur.

The position and speed are encoded in the displacement gauge value. The separation between speed and path can be configured between bit 16 and 19. The counter always internally counts using 20-bits.

Bits 31-16	Bits 19-0
Speed in 0.1 - 1.6 mm/s	Path in 0.01 mm - 0.16 mm

Table 397: NC352 coding of position and speed

Displacement gauge 4 has three functions and can be used for incremental encoder operation to represent the counter status, as well as in comparator operation for storing comparator values.

Configuration 1

The mode for the incremental or event counter is set in this register.

The signal source of the event counter/incremental encoder can be set using bit 3. In contrast to the event counter, incremental encoder operation evaluates all edges of the signal (4-x).

The signal source for period measurement can also be the event counter or the incremental encoder.

In order to recognize a standstill within a sufficient time frame, the counter size for the incremental encoder period measurement is limited to 24-bit (2 s at 8 MHz, 520 s at 31.25 kHz count frequency).

Additionally, 24 V monitoring can be controlled in 5% steps with this configuration register. Likewise, the multiplexer for status register 1, 2 and 7 and displacement gauge register 4 can also be controlled.

Configuration Register 1	Bit	Description
	15	0
	14	0...... Default: Status register 7 is reserved as a return channel for spooler 1...... Status register 7 contains the firmware version [1]
	12 - 13	Analog In Channel 7 - 8 00.... Path measurement 4 01.... Comparator value 10.... Incremental encoder/ event counter 11.... Reserve
	10 - 11	Error counter in status register 1 and 2 00.... Sum of plausibility errors + error measurements 01.... Number of error measurements 10.... Number of plausibility errors 11.... Reserve
	8 - 9	00.... 24 V monitoring ±25% 01.... 24 V monitoring ±20% 10.... 24 V monitoring ±15% 11.... 24 V monitoring ±10%
	6 - 7	00.... Count frequency 8 MHz 01.... Count frequency 31250 Hz 10.... External count frequency (input 3) 11.... Reserve
	5	0
	4	0...... Beginning of measurement at rising edge 1...... Beginning of measurement at falling edge
	3	0...... Signal source: Event counter input A (= input 1) 1...... Signal source: Incremental encoder (A/B)
	1 - 2	Measurement mode for AB counters / event counter 00.... No measurement operation (counter is cleared) [2] 01.... Incremental encoder/ event counter 10.... Period measurement 11.... Gate measurement, see Section "Measurement Mode for Gate Measurement", on page 591
	0	0

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0										0					0

1) WARNING: Spooling of configuration data or new firmware is **not** possible when this bit is set.

2) Configuring and reconfiguring the counter (edges, signal source, count frequency) must be made in the "No Measurement Operation", because invalid count edges can occur. The counter is reset to 0 every time the measurement mode is changed and begins immediately then to work in the new mode.

Measurement Mode for Gate Measurement

If the "Gate Measurement" mode has been selected, bit 4 is used as follows:

Bit 4	Gate Time
1	Gate Time = begin measurement at rising edge, stop measurement at falling edge
0	Gate Time = begin measurement at falling edge, stop measurement at rising edge

Table 398: NC352 gate measurement mode

Configuration 2

This register controls the following functions:

- Status of the digital outputs
- Comparator settings
- Configuring multi-magnet measurement
- Activation of the raw values mode

Configuration Register 2	Bit	Description
	15	0...... Default 1...... Raw values 1) for the counter are output on analog in register 1 - 8
	7 - 14	0
	5 - 6	00.... No multi-channel measurements 01.... 2 channel measurement transducer rod 3 10.... 3 channel measurement transducer rod 2 (transducer rod 3 is deactivated) 11.... 2 channel measurement transducer rod 1 and 2 (transducer rod 3 is deactivated)
	3 - 4	00.... Comparator affects displacement gauge 1 01.... Comparator affects displacement gauge 2 10.... Comparator affects displacement gauge 3 11.... Comparator affects displacement gauge 4
	2	0...... Comparator is triggered when > comparison value (see analog out 7 - 8) 1...... Comparator is triggered when < comparison value
	1	0...... Comparator function deactivated 1...... Comparator function activated
	0	0...... Digital output off (only where the comparator function has been switched off) 1...... Digital output on (only where the comparator function has been switched off)

15							8	7						0
	0	0	0	0	0	0	0	0						

1) The raw value corresponds to the time required for the ultrasonic signal to travel from the location of the magnet to the receiver (in units of 3.125 ns).
Warning: When this bit is set, the raw values are output in metric units (and not positions/speeds) even after a configuration module has been spooled.

Description of the Comparator

If the comparator is activated (bit 1 in configuration 2), bit 0 in configuration 2 is ignored, and the actual value of the digital output is then determined by the status of the comparator.

If the comparator has been triggered once, i.e. the selected displacement gauge is above or below the set threshold value (refer to analog output 7 - 8), the digital output is set, bit 3 in status register 3 is set, the actual value of status register 6 is copied to status register 0 and the value of the selected displacement gauge when triggered can now be read from Analog In registers 7 - 8 (refer to also bit 12 - 13 in configuration 1). The comparator cannot be triggered each time by moving back and forth across the threshold value, but instead must be activated again.

This is achieved by resetting and applying a new setting to bit 1 in configuration 2. When resetting, bit 3 in status register 3 is cleared and the digital output is set according to bit 0 in configuration 2. The other entries (see above) are not influenced by this, and are only overwritten when the comparator has been triggered again.

Explanation of Multi-magnet Measurement (assignment of the displacement gauge register to transducer rods/magnets)

The assignment only depends on settings in configuration register 2. Measurement pulses from magnets which may be present but have not been configured are ignored.

If the reverse is the case and more magnets have been configured on a transducer rod than are actually present, the NC352 then delivers an error for the respective displacement gauge register (the error counter in status register 1 and 2 are increased).

Magnets are numbered per rod, increasing in order according to their relative distance to the ultrasonic receiver/evaluation electronics of the transducer rod.

Mode	Displacement Gauge Register	Assigned Transducer Rod/Measurement Magnet
No multichannel measurements	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 3: Magnet 1
	4	No magnet assigned
2 channel measurement on transducer rod 3	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 3: Magnet 1
	4	Transducer Rod 3: Magnet 2
3 channel measurement on transducer rod 2 (transducer rod 3 is deactivated)	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 2: Magnet 1
	3	Transducer Rod 2: Magnet 2
	4	Transducer Rod 2: Magnet 3
2 channel measurement transducer rod 1 and 2 (transducer rod 3 is deactivated)	1	Transducer Rod 1: Magnet 1
	2	Transducer Rod 1: Magnet 2
	3	Transducer Rod 2: Magnet 1
	4	Transducer Rod 2: Magnet 2

Table 399: NC352 numbering of magnets

Path Measurement Mode 1 - 3

This register contains settings, which are specifically for the transducer rod with the corresponding number. They determine the transducer rod type, the method of path measurement and the content of the displacement gauge register.

Mode Registers 1 -3	Bit	Description
	14 - 15	Transducer rod type (measurement from to) 00...... Start/Stop Signal: rising edge - rising edge 01...... Start/Stop Signal: falling edge - falling edge 10...... Start/Stop Signal: rising edge - falling edge (gate time) 11...... Only Stop Signal. Start with trigger of signal (initialization pulses).
	12 - 13	0
	9 - 11	Types of displays for packed mode. Description: See Table 400 "NC352 types of displays for packed mode.", on page 595
	7 - 8	Displacement Gauge Register 00...... Magnet position (path) 01...... Magnet speed 10...... Path and speed in packed form 11...... Reserve
	6	0........ Default (is reset by the module) 1........ Strobe - trigger for measurement start
	3 - 5	Cycle time for path measurement (in cyclic operation) 000.... 131.072 ms 001.... 65.536 ms 010.... 8.192 ms 011.... 4.096 ms 100.... 2.048 ms 101.... 1.024 ms 110.... 512 µs 111.... Reserved
	2	0
	1	0........ Cyclic measurement according to a specified cycle time, see bits 3 - 5 1........ Measurement triggered by strobe signal (2 measurements separated by half cycle time, see bits 3 - 5)
	0	0

15							8	7							0
		0	0										0		0

Types of displays for packed mode.

Bit	Status	Path Resolution	Speed Resolution	Max. Path	Max. Speed	Speed on Bit	Path on Bit
9 - 11	000	0.01 mm	1.6 mm/s	± 5.24 m	±3.28 m/s	31 - 20	19 - 0
9 - 11	001	0.04 mm	0.4 mm/s	± 5.24 m	±3.28 m/s	31 - 18	17 - 0
9 - 11	010	0.16 mm	0.1 mm/s	± 5.24 m	±3.28 m/s	31 - 16	15 - 0
9 - 11	011	0.01 mm	0.1 mm/s	± 5.24 m	±0.20 m/s	31 - 20	19 - 0
9 - 11	100	0.01 mm	0.1 mm/s	± 2.62 m	±0.41 m/s	31 - 19	18 - 0
9 - 11	101	0.01 mm	0.1 mm/s	± 1.31 m	±0.82 m/s	31 - 18	17 - 0
9 - 11	110	0.01 mm	0.1 mm/s	± 0.65 m	±1.64 m/s	31 - 17	16 - 0
9 - 11	111	0.01 mm	0.1 mm/s	± 0.33 m	±3.28 m/s	31 - 16	15 - 0

Table 400: NC352 types of displays for packed mode.

Maximum path and speed entries given in the above table are rounded off to two decimal places and calculated from the resolution multiplied by the largest number that can be represented using the defined number of bits.

Status Register 1 - 3

Status Register 1 - Error Counter Encoder 1 and 2 (hex format)

Status Register 1	Bit	Description
	4 - 7	Continuous (rotating) counter for error measurement of encoder 2
	0 - 3	Continuous (rotating) counter for error measurement of encoder 1

Status Register 2 - Error Counter Encoder 3 and 4 (hex format)

Status Register 2	Bit	Description
	4 - 7	Continuous (rotating) counter for error measurement of encoder 4
	0 - 3	Continuous (rotating) counter for error measurement of encoder 3

Status Register 3

Status Register 3	Bit	Description
	7	0 ...... Configuration data present 1 ...... Configuration data not present
	5 - 6	00 .... Default / OK 01 .... 24 V - under voltage 10 .... 24 V - over voltage 11 .... Reserved
	4	0 ...... Digital output: ok 1 ...... Digital output: Error (value which is read back does not match)
	3	0 ...... Selected displacement gauge has not exceeded the comparator threshold in either direction 1 ...... Selected displacement gauge has exceeded the comparator threshold in either direction
	2	0/1 ... Status digital input 3
	1	0/1 ... Status digital input 2
	0	0/1 ... Status digital input 1

7 0

Status Register 7

Depending on the configuration (see Section "Configuration 1", on page 589) this register is used either as a return channel when spooling or contains the firmware version in BCD format. Since the content of the first instance is of no interest to the user, the following table describes only the format for the firmware version.

Status Register 7	Bit	Description
	4 - 7	High nibble for firmware version (BCD)
	0 - 3	Low nibble for firmware version (BCD)

7 0

Configuration Module

An additional data module is required for the I/O registers when configuring the NC352. The module name can be selected. The full path measurement function (display of path and speed in metric units, plausibility test) is only available after a data module has been created (format see Table 401 "NC352 content of the configuration files", on page 597) and spooled on the NC352. This module can be either spooled in INIT SP or anytime during operation (FBK: SPDownModule). Settings for the last data module spooled are effective as soon as they have been completely transferred to the NC352.

When no configuration module has been spooled on the NC352, this is signaled by bit 7 of status register 3 and by the RUN LED blinking (after the configuration has been made the RUN LED is permanently lit).

The content of the configuration files is broken down in the following table:

Name	Length/Bit	Sign Change	Meaning	
Enable	16	No	Bit 0	0...... Deactivating measurements on transducer rod 1 1...... Activating measurements on transducer rod 1
			Bit 1	0...... Deactivating measurements on transducer rod 2 1...... Activating measurements on transducer rod 2
			Bit 2	0...... Deactivating measurements on transducer rod 3 1...... Activating measurements on transducer rod 3
			Bits 3-7	0
			Bit 8	0...... Default - Filter for transducer rod 1 is activated using a filter constant = 200 ns 1...... Filter for transducer rod 1 is deactivated
			Bit 9	0...... Default - Filter for transducer rod 2 is activated using a filter constant = 200 ns 1...... Filter for transducer rod 2 is deactivated
			Bit 10	0...... Default - Filter for transducer rod 3 is activated using a filter constant = 200 ns 1...... Filter for transducer rod 3 is deactivated
			Bits 11-15	0
Transducer Rod 1				
OFFSET	32	No	Common null position for all measurement magnets (raw value)	
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) 1)	
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)	
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)	
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)	
RESERVE	16			
RESERVE	16			
RESERVE	16			
Transducer Rod 2				
OFFSET	32	No	Common null position for all measurement magnets (raw value)	
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) 1)	
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)	
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)	
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)	
RESERVE	16			
RESERVE	16			
RESERVE	16			

Table 401: NC352 content of the configuration files

Name	Length/Bit	Sign Change	Meaning
Transducer Rod 3			
OFFSET	32	No	Common null position for all measurement magnets (raw value)
CORR_FAC	32	No	Correction value for calibrating the path measurement (= v_us/100 * 2^19) 1)
PATH_MIN	32	Yes	Minimum valid path (in 0.01 mm/s)
PATH_MAX	32	Yes	Maximum valid path (in 0.01 mm/s)
V_MAX	32	No	Maximum valid path difference (absolute value) of two consecutive measurements (in 0.1 mm/s)
RESERVE	16		
RESERVE	16		
RESERVE	16		

Table 401: NC352 content of the configuration files (cont.)

1) v_us: Ultrasonic speed according to the type plate of the transducer rod.

The correct order and length for entries must be taken into account. RESERVE words must be present. See also the following example:

```
;Enable(UINT)
$0007,

;Offset,  Corr_fac,  Path_min, Path_max, V_max,  reserve1,  reserve2,  reserve3
005000,   15040302,  0000000,  0100000,  001000, 0000,      0000,      0000,    ;
Channel 1
000000,   15040302,  0000000,  0100000,  000256, 0000,      0000,      0000,    ;
Channel 2
010000,   15040302, -0000010,  0013000,  005000, 0000,      0000,      0000     ;
Channel 3
```

The first time the configuration module is created, raw values for magnet positions can already be read before successful spooling of the configuration module, in which in configuration register 2-bit 15 is set.

An encoder magnet can now be moved on the desired zero mark. The path raw value measured is entered as an OFFSET parameter together with other parameters in the configuration files, before it can be spooled (again) on the NC352. The application does not need to be restarted because the process can be carried out at anytime in the cyclic part of the application!

If the offset is known, the OFFSET parameter can be calculated as follows:

OFFSET parameter = Offset (in 1/100 mm) * 3200/v_us

v_us ... Ultrasonic speed in the transducer rod in m/s (see type plate)

Guidelines for Configuring the NC352

Setting the period duration (bit 3 - 5 in path measurement mode register)	
Adjusting the Length of the Transducer Rod	Path measurement is not allowed to be started before the last measurement is completed. It is also recommended by most transducer rod manufacturers to wait until the specified recovery time of the bar has passed, which is double the time required for the ultrasonic signal to travel the length of the transducer rod. Therefore, the current path between the encoder position and the measurement receiver is not decisive, but rather the entire transducer rod length - the maximum possible ultrasonic signal travel time. Please note that when the NC352 is in strobe mode (CPU triggers measurement) , two measurements in the half distance of the set period duration are independently made. That means that the permitted rod length with the given period duration is halved compared to the periodic measurement operation.
Adjusting the Cycle Time for the CPU	To guarantee a correct evaluation of the error counter, the counter value can be increased to a maximum of 15 (4-bit counter) during a CPU cycle (t_{cycl}). That means a maximum of 15 path measurements can take place from the last reading of the error counter. Recommended measurement period (t_{per}): $\mathbf{t_{cycl}/8 < t_{per} < t_{cycl}}$
Example for Cyclic Measurement Accepted ultrasonic speed v_us = 2800 m/s	**1. Transducer Rod Length = 0.15 m / t_{cycl} = 1 ms** Recovery time of the transducer rod:0.15/2800 * 2 = 0.107 ms This results in: Physically permitted t_{per} = 512 µs This period duration is also compliant with the CPU cycle time -> ok **2. Transducer Rod Length = 0.15 m / t_{cycl} = 10 ms** Recovery time of the transducer rod:0.15/2800 * 2 = 0.107 ms This results in: Physically permitted $t_{per} \geq$ 512 µs That means: In practice 8.192 ms $\geq t_{per} \geq$ 1.024 ms must be selected because otherwise more than 15 measurement errors could occur per CPU cycle which in turn could cause the error counter to overflow. **3. Transducer Rod Length = 3 m / t_{cycl} = 10 ms** Recovery time of the transducer rod:3/2800 * 2 = 2.14 ms This results in : Physically permitted t_{per} = 4.096 ms or t_{per} = 8.192 ms That means: 1 to 3 path measurements can be made per CPU cycle -> OK **4. Transducer Rod Length = 1 m / t_{cycl} = 1 ms** Recovery time of the transducer rod:1/2800 * 2 = 0.714 ms Only 512 µs as t_{per} makes sense due to the cycle time of 1 ms. This lies below the recovery time of the transducer rod. Only a maximum path of 0.73 m can be measured without reducing precision.
Speed Measurement	
If the NC352 is operated in periodic measurement mode, it uses path measurement results for the last 131 ms when determining the current speed. A time span of 100 ms is needed so that a change of the path measurement results in a digit (corresponding to 0.01 mm) with the minimum measurable speed of 0.1 mm/s. With shorter measurement intervals, losses in resolution properties for speed measurement must be taken into account. Very small speeds cannot be measured at all. Also note that measurement precision/resolution at the beginning of measurement or at reconfiguring the cycle time (bit 3 - 5 from measurement path mode register) increases in intervals and only after 131 ms has full precision been achieved. If the NC352 is operated in strobe mode (measuring triggered by CPU), the module makes two path measurements in half of the defined period duration. Only both these path measurements can be used to calculate the speed. Attainable resolution for speed in strobe mode = 0.1 mm/s * 200/period duration (in ms). **The periodic measuring operation which has been set as the default is recommended for measuring speed.**	

Table 402: Guidelines for configuring the NC352

24 VDC Supply	
Current Limitation	The 24 V supply is fed through to the transducer rods and is safeguarded with a protective element (minimum holding current :1.1 A at 20° C). For less than one second, 3 A can also be removed (starting currents for the transducer rods).
Tolerance Threshold	Selecting the tolerance threshold (±10% to ±25%) should be set up according to the information in the data sheet of the transducer rod's manufacturer. NC352 hardware tolerates 24 V ±25%.
Packed Mode	
The measurement range set must be adjusted to the physical requirements (length of the transducer rod or other limitations).	
Threshold Value	
Both the lower and upper threshold values for the plausibility test of the paths and comparator threshold values are DINT values (signed). The threshold value for the plausibility test of speed is however an unsigned UDINT value. Only the 24 lowest value bits of the NC352 are evaluated which applies to all threshold values.	
Error Counters are Read Cyclically	
Please note that the rate of measurement on the NC352 is set so that the error counter cannot overflow within one CPU cycle and therefore become ambiguous. It is up to the user to decide what particular actions should be taken to deal with sporadic errors.	
Filtering on the Start/Stop Interface	
The start/stop inputs for the NC352 are protected against disturbances with an additional digital filter. As a result disturbance pulses <200 ns are suppressed. This setting guarantees that the start/stop pulses for the most common measurement rods can take place unhindered because the duration is in the range >1 µs and therefore large enough to suppress the majority of disturbances. Using the configuration module, the user has the option to switch off this filtering for each individual rod (see "Enable" in Table 401 "NC352 content of the configuration files", on page 597). This option can be helpful when analyzing disturbances, but it is not recommended during normal operation.	

Table 402: Guidelines for configuring the NC352 (cont.)

Firmware Update

If necessary, firmware for the NC352 can be updated via the CPU. This takes place using a BR data module containing the new firmware, which must be spooled from the CPU on the NC352.

The download process on the NC352 is represented by the RUN LED blinking quickly. After completion of the process, the LED changes to slow blinking or is continually lit. The new firmware is booted the first time during the next start-up. The firmware version number can be checked by reading status register 7 (see also bit 14 of configuration register 1).

17. Accessories

17.1 Overview

Model Number	Description
0AC240.9	2005 battery module
0G2001.00-090	2005 positioning accessory, cable for operating system download directly from the PC to the NC154
3BM150.9	2005 dummy module
3TB162.9	2005 terminal block, 12-pin, screw clamps
3TB170.9	2005 terminal block, 20-pin, screw clamps
3TB170.91	2005 terminal block, 20-pin, cage clamps
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps

Table 403: Accessory Overview

17.2 AC240

17.2.1 General Information

The battery module is used for central data buffering on the 2005 PLC (e.g. data and real-time clock for the XP152). It has two battery compartments for 9 V block cells.

Connection to the power supply module is made with a 40 cm long cable. The cable is connected to a 5-pin terminal block. A second 5-pin terminal block is included in the delivery. The two together replace the 10-pin terminal block on the power supply.

A single-width backplane is delivered with the battery module. The backplane is to be installed to the left of the main backplane. The battery module is inserted on this backplane and is therefore installed to the left of the power supply.

If a slot is free on the main backplane next to the power supply, the AC240 module can also be inserted there.

17.2.2 Order Data

Model Number	Short Description	Image
0AC240.9	2005 battery module	

Table 404: AC240 order data

17.2.3 Technical Data

Product ID	AC240
C-UL-US Listed	Yes
Battery	9 V block cell
Number of Battery Compartments	2
Connection Cable Length Connection	 40 cm 5-pin terminal block, prewired
Slot	On backplane included in the delivery
Buffer duration with two alkali manganese "Extra Longlife" batteries	See technical data for the processor module used
Dimensions	B&R 2005 single-width

Table 405: AC240 technical data

17.2.4 Battery Compartment

Two battery compartments are located behind the module door.

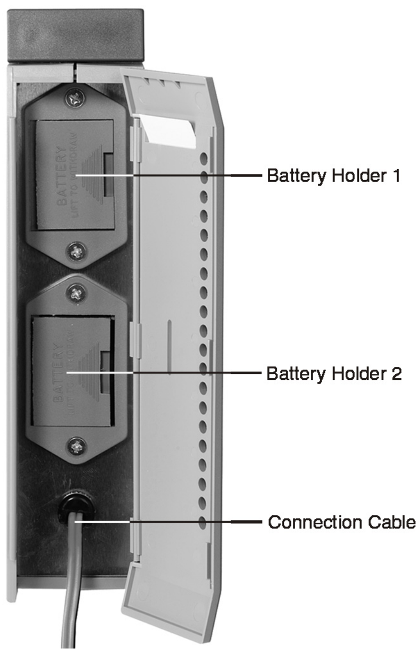


Figure 222: AC240 battery compartment

17.2.5 Backup Battery

Battery Change Interval

Batteries installed in the AC240 battery module should be changed at the following interval:

Change interval: every 4 years[1)]

Buffer Time

Buffer time is reduced when more processors e.g. IP161, XP152 or IF260 are operated from the same backplane module and when the rechargeable battery is already empty.

Reductions factor = Number of all processor modules on the backplane

17.2.6 Changing 9 V Block Cells

The product design allows the battery to be changed with the PLC switched on or off. In some countries, safety regulations do not allow batteries to be changed while the module is switched on. Therefore, B&R recommends the battery is changed when the power supply is switched off.

When changing the batteries, make sure that one of both batteries remains inserted (data buffering).

Procedure for Changing the Battery

1) Disconnect the power supply.
2) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.
3) Open the module door.
4) Open the upper battery compartment using a screwdriver. The screwdriver should be placed in the slot and by simulateneously levering it upwards and pulling at it, the compartment can be opened.
5) Remove the battery compartment.
6) Removed the used battery.
7) Insert the new battery with correct polarity.
8) Place the battery compartment in the module again.
9) Open the lower battery compartment using a screwdriver.
10) Remove the battery compartment.
11) Removed the used battery.

1) The change interval refers to the average life span and operating conditions and are recommended by B&R. This does not correspond to the maximum buffer duration.

12) Insert the new battery with correct polarity.

13) Place the battery compartment in the module again.

14) Close the module door.

15) Connect the lines to the power supply.

Batteries are considered hazardous waste. Used batteries should be disposed of accordingly.

17.3 NC154 - PC Cable

17.3.1 General Information

For NC154 modules with a Rev. <54.23, the software module BOOT has to be installed in the module before the operating system update.

This cable is used to connect a PC to the NC154 module. The software module BOOT (NC154.S1) can be downloaded using this connection.

17.3.2 Order Data

Model Number	Short Description
0G2001.00-090	2005 positioning accessory, cable for operating system download directly from the PC to the NC154

Table 406: Cable NC154 - PC order data

17.4 Dummy Module - BM150

17.4.1 General Information

Dummy modules are used to fill slots which are not needed. We recommend that you fill all unused slots with dummy modules.

17.4.2 Order Data

Model Number	Short Description	Image
3BM150.9	2005 dummy module	

Table 407: BM150 order data

17.4.3 Technical Data

Product ID	BM150
Dimensions	B&R 2005 single-width

Table 408: BM150 technical data

17.5 TB162

17.5.1 General Information

The NC154 module is equipped with three 12-pin terminal blocks. The TB162 terminal block is used to make connections. The terminal blocks can be removed using an ejection lever on the module.

17.5.2 Order Data

Model Number	Short Description	Image
3TB162.9	2005 terminal block, 12-pin, screw clamps	

Table 409: TB162 order data

17.5.3 Technical Data

Product ID	TB162
Number of Pins	12
Type of Terminal	Screw clamps
Distance between Contacts	5.08 mm
Resistance between Contacts	6 mΩ
Rated Voltage	250 V
Current Load	Max. 12 A / contact
Connection Cross Section	0.14 mm² -2.5 mm² (AWG 26 - 12)
Cable Type	Only copper wires (no aluminum wires!)
Removal	Mechanical
Stress Relief	Cable tie on the module

Table 410: TB162 technical data

17.6 TB170

17.6.1 General Information

Many B&R 2005 modules are connected using the a single row 20-pin terminal block.

The terminal block can be easily removed using two ejection levers on the module (see Chapter 2 "Installation", Section 1 "Dimensions and Installation", on page 43).

17.6.2 Order Data

Model Number	Short Description	Image
3TB170.9	2005 terminal block, 20-pin, screw clamps	 TB170.9  TB170.91
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	

Table 411: TB170 order data

17.6.3 Technical Data

Product ID	TB170
Number of Pins	20
Type of Terminal	Screw or cage clamps
Distance between Contacts	5.08 mm
Resistance between Contacts	6 mΩ
Rated Voltage	250 V
Current Load 1)	Max. 12 A / contact
Connection Cross Section	0.14 mm² -2.5 mm² (AWG 26 - 12)
Cable Type	Only copper wires (no aluminum wires!)
Removal	Mechanical
Stress Relief	Cable tie on the module

Table 412: TB170 technical data

1) Take the respective limit data for the I/O modules into consideration!

18. Manuals

18.1 Overview

Model Number	Description
MASYS22005-0	B&R 2005 User's Manual, German
MASYS22005-E	B&R 2005 User's Manual, English
MASYS22005-F	B&R 2005 User's Manual, French

Table 413: Manual Overview

Chapter 4 • General Accessories

1. Overview

Model Number	Description	Page
0AC001.9	Retaining clips (500 pieces)	---
0AC171.9	Glass tube fuses 5 x 20 mm, 20 pieces, 3.15 A T / 250 V	---
0AC200.9	Lithium batteries, 5 pcs., 3 V / 950 mAh, cylindrical battery	---
0AC201.9	Lithium batteries, 5 pcs., 3 V / 950 mAh, button cell	---
0AC401.9	Encoder 5 V - 24 V, converter for 5 V encoders (abs. or incr.)	613
0AC410.9	Interface converter TTY - RS232	614
0AC912.9	Bus adapter, CAN, 1 CAN interface	615
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable (DSUB connector)	616
0AC913.93	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable (TB704)	616
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	617
0G0001.00-090	Cable PC <-> PLC/PW, RS232, Online cable	---
0G0010.00-090	Cable I/O bus expansion, 1 m, bus expansion for B&R 2005/B&R 2010	---
0G0012.00-090	Cable I/O bus expansion, 2 m, bus expansion for B&R 2005 / B&R 2010	---
0G1000.00-090	Bus Connector, RS485, for PROFIBUS networks, remote I/O	618
0MC111.9	PCMCIA Memory Card, 2 MB FlashPROM	---
0MC112.9	PCMCIA Memory Card, 4 MB FlashPROM	---
0MC211.9	PCMCIA Memory Card, 2 MB SRAM	---
5CFCRD.0032-01	Compact Flash 32 MB ATA/IDE SanDisk	---
5CFCRD.0064-01	Compact Flash 64 MB ATA/IDE SanDisk	---
5CFCRD.0128-01	Compact Flash 128 MB TrueIDE SanDisk	---
5CFCRD.0256-01	Compact Flash 256 MB ATA/IDE SanDisk	---
5CFCRD.0512-01	Compact Flash 512 MB ATA/IDE SanDisk	---
7AC911.9	Bus connector, CAN	619
0TB704.9	Accessory terminal block, 4-pin, screw clamp, 1.5 mm^2	620
0TB704.91	Accessory terminal block, 4-pin, cage clamp, 2.5 mm^2	620
0TB708.91	Accessory terminal block, 8-pin, cage clamp, 1.5 mm^2	621

Table 414: General accessories overview

Model Number	Description	Page
7TB710.9	Accessory terminal block, 10-pin, screw clamp, 1.5 mm²	622
7TB710.91	Accessory terminal block, 10-pin, cage clamp, 2.5 mm²	622
7TB710:90-01	Accessory terminal block, 10-pin , 30 pieces, screw clamp, 1.5 mm²	622
7TB710:91-01	Accessory terminal block, 10-pin, 30 pieces, cage clamp, 2.5 mm²	622
7TB712.9	Accessory terminal block, 12-pin, screw clamp, 1.5 mm²	623
7TB712.91	Accessory terminal block, 12-pin, cage clamp, 1.5 mm²	623
7TB712:90-02	Accessory terminal block, 12-pin , 20 pieces, screw clamp, 1.5 mm²	623
7TB712:91-02	Accessory terminal block, 12-pin, 20 pieces, cage clamp, 1.5 mm²	623
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	624
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	624
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	624
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	624
0TB108.91	Accessory terminal block, 2x12-pin, cage clamp, 1.0 mm²	625
0TB112.91	Accessory terminal block, 2x12-pin, cage clamp, 1.0 mm²	625
0TB124.91	Accessory terminal block, 2x12-pin, cage clamp, 1.0 mm²	625
ECINT1-1	RS232/RS485 interface converter, electrically isolated, for coupling RS232 interface modules to an RS485 twisted pair bus, without lightning protection	626
ECINT1-11	RS232/RS485 interface converter, electrically isolated, for coupling RS232 interface modules to an RS485 twisted pair bus, with lightning protection	626

Table 414: General accessories overview (cont.)

2. AC401 Encoder 5 V - 24 V

2.1 General Information

The adapter is used as a converter for 5 V encoders. The 5 V differential signals delivered by the encoder are converted to 24 V signals. Absolute and incremental encoders can be used.

2.2 Order Data

Model Number	Short Description	Image
0AC401.9	Encoder 5 V - 24 V, converter for 5 V encoders (abs. or incr.)	

Table 415: AC401 order data

3. AC410 Interface Converter

3.1 General Information

The AC410 interface converter is used to convert a TTY signal into an RS232 signal or an RS232 signal into a TTY signal. To be able to connect simple PANELWARE operator panels (e.g. P120 or P121), the 24 V supply voltage is converted into a 5 V output voltage. This voltage can be loaded with up to 0.5 A.

The maximum baud rate is 19200 baud.

3.2 Order Data

Model Number	Short Description	Image
0AC410.9	Interface converter TTY - RS232	

Table 416: AC410 order data

4. AC912 Bus Adapter, CAN 1x

4.1 General Information

The CAN bus adapter is used to connect a controller to a CAN network. The network connection is made using the 6-pin terminal block. The connection to the controller is made using the 9-pin DSUB socket. The termination resistor is integrated in the bus adapter. The terminating resistor can be turned on or off.

The cable from the controller to the bus adapter is not in the B&R product line. It must be constructed by the customer.

4.2 Order Data

Model Number	Short Description	Image
0AC912.9	Bus adapter, CAN, 1 CAN interface	

Table 417: AC912 order data

5. AC913 Bus Adapter, CAN 2x

5.1 General Information

The CAN bus adapter is used to connect a controller to a CAN network. The network connection is made using the 9-pin DSUB plug (C1) and the 9-pin DSUB socket (C2). The 6-pin terminal block has a 30 cm long cable attached. Depending on the design of the bus adapter, the connection to the controller is made using this cable via a DSUB connector or terminal block. The termination resistor is integrated in the bus adapter. The terminating resistor can be turned on or off.

The bus adapter is available to two version:

Model Number	Connection on the Cable
0AC913.92	9-pin DSUB housing
0AC913.93	4-pin plug

Table 418: AC913 available versions

5.2 Order Data

0AC913.92

0AC913.93

Model Number	Short Description
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable (DSUB connector)
0AC913.93	Bus adapter, CAN, 2 CAN interfaces, including 30 cm connection cable (TB704)

Table 419: AC913 order data

6. AC916 Bus Termination, RS485 Active

6.1 General Information

An active bus termination is available for PROFIBUS networks and remote I/O. The active bus termination allows the network to be terminated independent of the supply for the communication modules.

The supply voltage for the active bus termination is 120 / 230 VAC.

6.2 Order Data

Model Number	Short Description	Image
0AC916.9	Bus termination, RS485, active, for PROFIBUS networks, remote I/O, standard mounting rail installation, supply voltage: 120 / 230 VAC	

Table 420: AC916 order data

7. RS485 Bus Connector

7.1 General Information

The RS485 bus connector is used to connect a controller to remote I/O, in a PROFIBUS network or in a RS485 network. The termination resistor is integrated in the bus connector. The terminating resistor can be turned on or off.

7.2 Order Data

Model Number	Short Description	Image
0G1000.00-090	Bus Connector, RS485, for PROFIBUS networks, remote I/O	

Table 421: RS485 bus connector order data

8. AC911 Bus Connector, CAN

8.1 General Information

The bus connector enables you to:

- Exchange a CAN node without shutting down the network since the connection is not broken, and
- Change the termination resistance quickly and easily (e.g. if the last node in a network is removed).

8.2 Order Data

Model Number	Short Description	Image
7AC911.9	Bus connector, CAN	

Table 422: AC911 order data

8.3 Technical Data

Product ID	AC911
Lines	Connection for two bus lines
Terminating Resistance	120 Ω - can be switched on
Stress Relief	Built-in

Table 423: AC911 technical data

9. TB704 4-pin Terminal Block

9.1 General Information

This single row 4-pin terminal block is mainly used to connect the supply voltage.

9.2 Order Data

Model Number	Short Description	Image
0TB704.9	Accessory terminal block, 4-pin, screw clamp, 1.5 mm²	 0TB704.9  0TB704.91
0TB704.91	Accessory terminal block, 4-pin, cage clamp, 2.5 mm²	

Table 424: TB704 order data

9.3 Technical Data

Product ID	0TB704.9	0TB704.91
Number of Pins	4	
Type of Terminal	Screw clamps	Cage clamps
Distance between Contacts	5.08 mm	
Resistance between Contacts	≤5 mΩ	
Rated Voltage	250 V	
Current Load 1)	Max. 10 A / contact	
Connection Cross Section	0.08 mm² - 1.5 mm² (AWG 22 - 12)	0.08 mm² -2.5 mm² (AWG 26 - 12)
Cable Type	Only copper wires (no aluminum wires!)	

Table 425: TB704 technical data

1) Take the respective limit data for the I/O modules into consideration!

10. TB708 8-pin Terminal Block

10.1 General Information

The terminal block TB708 is used to connect various B&R modules. Removal is simplified by two ejection levers on the terminal block.

10.2 Order Data

Model Number	Short Description	Image
0TB708.91	Accessory terminal block, 8-pin, cage clamp, 1.5 mm²	

Table 426: TB708 order data

10.3 Technical Data

Product ID	TB708
Number of Pins	8
Type of Terminal	Cage clamps
Distance between Contacts	3.5 mm
Rated Voltage	125 V
Current Load 1)	Max. 12 A / contact
Connection Cross Section	0.08 mm² - 1.5 mm² (AWG 28 -16)
Cable Type	Only copper wires (no aluminum wires!)
Removal	Mechanical

Table 427: TB708 technical data

1) Take the respective limit data for the I/O modules into consideration!

11. TB710 10-pin Terminal Block

11.1 General Information

This single row 10-pin terminal block is used to connect I/O modules. The terminal block can be easily removed using two ejection levers on the module.

11.2 Order Data

Model Number	Short Description	Image
7TB710.9	Accessory terminal block, 10-pin, screw clamp, 1.5 mm²	 TB710.9  TB710.91
7TB710.91	Accessory terminal block, 10-pin, cage clamp, 2.5 mm²	
7TB710:90-01	Accessory terminal block, 10-pin , 30 pieces, screw clamp, 1.5 mm²	
7TB710:91-01	Accessory terminal block, 10-pin, 30 pieces, cage clamp, 2.5 mm²	

Table 428: TB710 order data

11.3 Technical Data

Product ID	7TB710.9	7TB710.91
Number of Pins	10	
Type of Terminal	Screw clamps	Cage clamps
Distance between Contacts	5.08 mm	
Resistance between Contacts	6 mΩ	
Rated Voltage	250 V	
Current Load 1)	Max. 12 A / contact	
Connection Cross Section	0.14 mm² - 1.5 mm² (AWG 26 -16)	0.14 mm² -2.5 mm² (AWG 26 - 12)
Cable Type	Only copper wires (no aluminum wires!)	
Removal	Mechanical	

Table 429: TB710 technical data

1) Take the respective limit data for the I/O modules into consideration!

12. TB712 12-pin Terminal Block

12.1 General Information

This single row 12-pin terminal block is used to connect I/O modules. Removal is simplified by two ejection levers on the terminal block.

12.2 Order Data

Model Number	Short Description	Image
7TB712.9	Accessory terminal block, 12-pin, screw clamp, 1.5 mm²	 TB712.9  TB712.91
7TB712.91	Accessory terminal block, 12-pin, cage clamp, 1.5 mm²	
7TB712:90-02	Accessory terminal block, 12-pin , 20 pieces, screw clamp, 1.5 mm²	
7TB712:91-02	Accessory terminal block, 12-pin, 20 pieces, cage clamp, 1.5 mm²	

Table 430: TB712 order data

12.3 Technical Data

Product ID	TB712
Number of Pins	12
Type of Terminal	Screw or cage clamps
Distance between Contacts	3.5 mm
Rated Voltage	125 V
Current Load 1)	Max. 12 A / contact
Connection Cross Section	0.08 mm² - 1.5 mm² (AWG 28 -16)
Cable Type	Only copper wires (no aluminum wires!)
Removal	Mechanical

Table 431: TB712 technical data

1) Take the respective limit data for the I/O modules into consideration!

13. TB718 18-pin Terminal Block

13.1 General Information

This single row 18-pin terminal block is used to connect I/O modules. Removal is simplified by two ejection levers on the terminal block.

13.2 Order Data

Model Number	Short Description	Image
7TB718.9	Accessory terminal block, 18-pin, screw clamp, 1.5 mm²	 TB718.9  TB718.91
7TB718.91	Accessory terminal block, 18-pin, cage clamp, 1.5 mm²	
7TB718:90-02	Accessory terminal block, 18-pin, 20 pieces, screw clamp, 1.5 mm²	
7TB718:91-02	Accessory terminal block, 18-pin , 20 pieces, cage clamp, 1.5 mm²	

Table 432: TB718 order data

13.3 Technical Data

Product ID	TB718
Number of Pins	18
Type of Terminal	Screw or cage clamps
Distance between Contacts	3.5 mm
Rated Voltage	125 V
Current Load 1)	Max. 12 A / contact
Connection Cross Section	0.08 mm² - 1.5 mm² (AWG 28 -16)
Cable Type	Only copper wires (no aluminum wires!)
Removal	Mechanical

Table 433: TB718 technical data

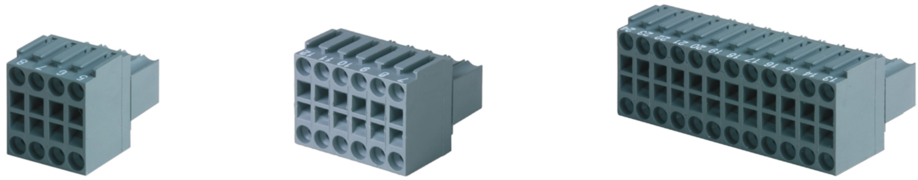
1) Take the respective limit data for the I/O modules into consideration!

14. TB108, TB112 and TB124, 8/12/24-pin terminal blocks

14.1 General Information

The terminal blocks TB108, TB112 and TB124 are used for connecting various B&R modules. TB108 and TB112 can be combined and used instead of the TB124.

14.2 Order Data



TB108 TB112 TB124

Model Number	Short Description
0TB108.91	Accessory terminal block, 2x4-pin, cage clamp, 1.0 mm²
0TB112.91	Accessory terminal block, 2x6-pin, cage clamp, 1.0 mm²
0TB124.91	Accessory terminal block, 2x12-pin, cage clamp, 1.0 mm²

Table 434: TB108, TB112 and TB124 order data

14.3 Technical Data

Product ID	TB108	TB112	TB124
Number of Pins	8	12	24
Type of Terminal	2-row cage clamp terminal block		
Distance between Contacts	3.5 mm		
Rated Voltage	50 V		
Current Load 1)	Max. 5 A / contact		
Connection Cross Section	0.5 mm² -1.0 mm² (AWG 22 -18)		
Cable Type	Only copper wires (no aluminum wires!)		

Table 435: TB108, TB112 and TB124 technical data

1) Take the respective limit data for the I/O modules into consideration!

15. INT1 Interface Converter

15.1 General Information

The INT1 interface converter is used to convert RS232 interface signals to an RS485 signal level. It is used if:

- Data transfer over a long distance is required which cannot be bridged by an RS232 interface. The distance between two stations can be max. 5000 m when using shielded RS485 cables.
- Electrical isolation is required for the interface.
- A PLC is to be connected to a network using an RS232 interface.

The interface converter INT1 has lightning protection.

15.2 Order Data

Model Number	Short Description	Image
ECINT1-1	RS232/RS485 interface converter, electrically isolated, for coupling RS232 interface modules to an RS485 twisted pair bus, without lightning protection	
ECINT1-11	RS232/RS485 Interface Converter, electrically isolated, for coupling RS232 interface modules to an RS485 twisted pair bus, with lightning protection	

Table 436: INT1 interface converter order data

15.3 Supply

The INT1 interface converter requires an external 24 VDC supply voltage. Current consumption can be maximum of 400 mA.

Chapter 5 • Standards and Certifications

1. Standards and Limits Used

The product standard EN 61131-2 is generally valid for B&R industrial products (identical with IEC 61131-2). The following standards provide a detailed definition of proper functionality in a typical industrial environment (charged with electromagnetic energy):

Standard	Description
IEC 61000-6-4	Electromagnetic compatibility (EMC); Generic standard - emission standard Part 2: Industrial environment (EN 50081-2 will be replaced by IEC 61000-6-4)
IEC/CISPR 11	Information technology equipment - radio disturbance characteristics limits and measuring procedures
IEC 61000-6-2	Electromagnetic compatibility (EMC) - Generic standard, emission standard Part 2: Industrial environment (EN 50082-2 will be replaced by IEC 61000-6-2)
EN 61131-2 Edition 2	Programmable logic controllers Part 2: Equipment requirements and tests
UL 508	Industrial Control Equipment, (UL = Underwriters Laboratories)
EN 60204-1	Safety of machinery - electrical equipment on machines Part 1: General requirements

Table 437: Overview of standards

Limit Values

In the following tables, the criteria A and B describe the test conditions:

Criteria	Description
A	Uninterrupted operation during the test.
B	Brief interruption during the test allowed.

Table 438: The criteria A and B describe the test conditions

IEC 61000-4-2 Electrostatic Discharge	
	IEC 61131-2 Ed. 2
Contact discharge to powder-coated and bare metal parts	±4 kV, criteria B
Air discharge to plastic parts	±8 kV, criteria B

Table 439: Limits for electrostatic discharge

IEC 61000-4-3 Electromagnetic Fields	
Housing, completely wired	80 MHz - 1 GHz, 10 V/m, criteria A 80% amplitude modulation at 1 kHz

Table 440: Limits for electromagnetic fields

IEC 61000-4-4 Burst, Fast Transients		
	IEC 61131-2 Edition 2	B&R Limits
Power supplies and AC inputs/outputs	2 kV, 1 min, criteria B	4 kV, 5 min, criteria A
Data cable	1 kV, 1 min, criteria B	2 kV, 5 min, criteria A
Digital inputs/outputs	1 kV, 1 min, criteria B	2 kV, 5 min, criteria A
Analog I/O	1 kV, 1 min, criteria B	2 kV, 5 min, criteria B

Table 441: Limits for fast transients

IEC 61000-4-5 Surge		
	Common Mode, unsymmetrical	Differential Mode, symmetrical
AC power supplies	2 kV (12 Ω), criteria B	1 kV (2 Ω), criteria B
DC power supplies	1 kV (12 Ω), criteria B	0.5 kV (2 Ω), criteria B
Digital and analog I/O, AC, unshielded AC auxiliary voltage outputs for sensors, etc.	2 kV (42 Ω), criteria B	1 kV (42 Ω), criteria B
Digital and analog I/O, DC, unshielded Data lines, unshielded DC auxiliary voltage outputs for sensors, etc.	0.5 kV (42 Ω), criteria B	0.5 kV (42 Ω), criteria B
All shielded lines	1 kV (2 Ω), criteria B	---

Table 442: Limits for surge

IEC 61000-4-6 Conducted Disturbances (radio frequency)	
Network I/O Signal connections >10 m Functional ground connection	150 kHz - 80 MHz, 10 V, (in broadcast range 3 V), criteria A 80% amplitude modulation at 1 kHz

Table 443: Limits for conducted disturbances (radio frequency)

IEC 60664-1   Pollution Degree
Pollution degree 2:   non-conductive material

Table 444: Degree of pollution

EN 60068-2-6, Vibration		
Frequency Range [Hz]	Continuous	Periodic
$5 \leq f < 9$	1.75 mm amplitude	3.5 mm amplitude
$9 \leq f \leq 150$	0.5 g constant acceleration	1 g constant acceleration
$f > 150$	not defined	not defined

Table 445: Limit values for vibration

EN 60068-2-27, shock
15 g over 11 ms, half sine waves, 3 shocks per axis and direction (total of 18 shocks)

Table 446: Limit values for shock

2. International Standards

B&R products and services comply with all applicable standards. They are international standards from organizations such as ISO, IEC and CENELEC, as well as national standards from organizations such as UL, CSA, FCC, VDE, ÖVE, etc. We give special consideration to the reliability of our products in an industrial environment.

Certifications	
USA and Canada	All important B&R products are tested and listed by Underwriters Laboratories and are checked quarterly by a UL inspector. This mark is valid in the USA and Canada and makes it considerably easier to license your machines and systems in these areas.
Europe	All harmonized EN standards for the valid guidelines are met.
Russian Federation	GOST-R certification is available for the export of all B&R products in the Russian Federation.

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