



# Test Report:RCB-1600-12

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1600W Rack Mountable Front End Battery Charger

## ■ DESIGN VERIFY TEST

Output Function Test

Input Function Test

Protection Function Test

Control Function Test

Component Stress Test

## ■ SAFETY & E.M.C. TEST

Safety Test

E.M.C. Test

## ■ RELIABILITY TEST

ENVIRONMENT TEST

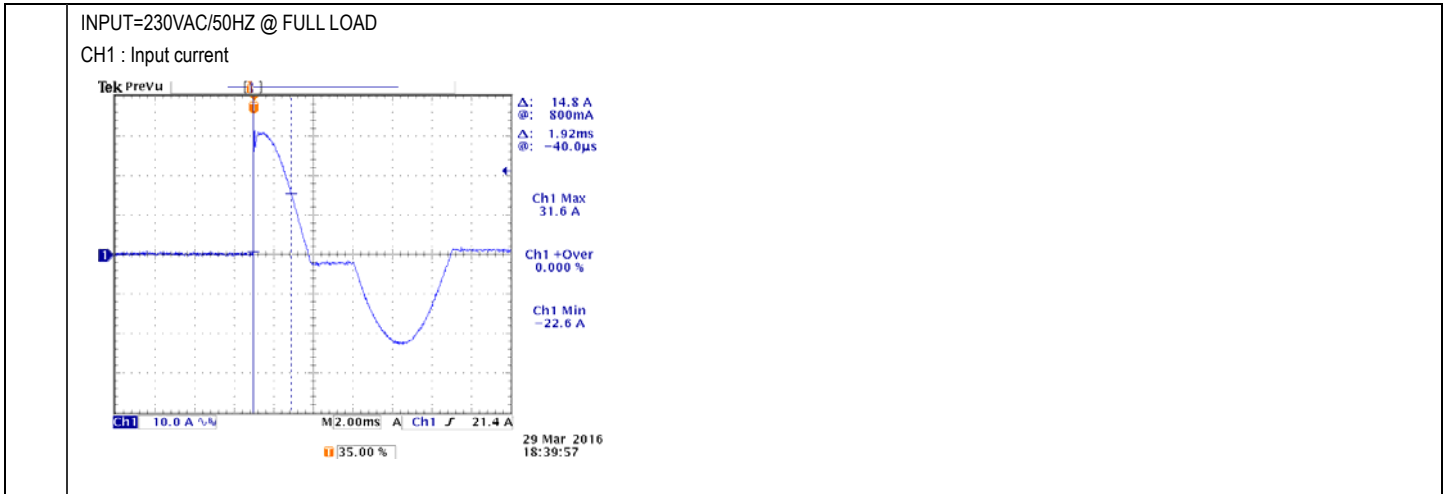
## ■ DESIGN VERIFY TEST

### OUTPUT FUNCTION TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	BOOST CHARGE VOLTAGE(Vboost)(default)	Default, programmable 14.4V±0.12V	I/P: 230 VAC O/P: CV MODE Ta:25°C	14.409V
2	FLOAT CHARGE VOLTAGE	Default, programmable 13.8V±0.12V	I/P: 230 VAC O/P: CV MODE Ta:25°C	13.874V
3	OUTPUT CURRENT	100A±3A	I/P: 230 VAC O/P:CV MODE-2V Ta:25°C	100A
4	VOLTAGE ADJ. RANGE	11.5V~15V DIP switch position 4 : OFF	I/P: 230 VAC O/P:NO LOAD Ta:25°C	11.03V~15.26V/230VAC 11.03V~15.26V/115VAC
5	LEAKAGE CURRENT FROM BATTERY (Typ.)	<1mA	I/P: AC OFF O/P:BATTERY Ta:25°C	3uA

### INPUT FUNCTION TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	INPUT VOLTAGE RANGE	90VAC~264VAC	I/P:TESTING O/P: FULL LOAD Ta:25°C	150 V~ 264 V
			I/P: LOW-LINE-3V=87 V HIGH-LINE+15%= 300 V O/P:BAT. LOAD (PLEASE CHECK DERATING CURVE) ON: 30 Sec . OFF: 30 Sec 10MIN ( AC POWER ON/OFF NO DAMAGE )	TEST: OK
2	INPUT FREQUENCY RANGE	47HZ ~63 HZ NO DAMAGE	I/P: 100 VAC ~264 VAC O/P:FULL-MIN LOAD Ta:25°C	TEST: OK
3	LEAKAGE CURRENT	< 1.5 mA / 230VAC	I/P: 230 VAC O/P:Min LOAD Ta:25°C	L-FG: 0.74 mA N-FG:0.74 mA
4	INPUT CURRENT (TYP)	230 V/ 8 A 115 V/ 14 A	I/P: 230 VAC I/P: 115 VAC O/P: FULL LOAD Ta:25°C	I =7.49A/ 230VAC I =12.41A/ 115VAC
5	POWER FACTOR (TYP)	0.97/ 230 VAC	I/P: 230 VAC O/P: FULL LOAD Ta:25°C	PF= 0.977 / 230VAC
6	EFFICIENCY (TYP)	90.5%	I/P: 230 VAC O/P: FULL LOAD Ta:25°C	90.97 %
7	INRUSH CURRENT(Typ.)	230V/35 A COLD START	I/P : 230 VAC O/P : FULL LOAD Ta : 25°C	I =31.6A/ 230VAC T50= 1920 us/230V



**PROTECTION FUNCTION TEST**

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	OVER VOLTAGE PROTECTION	15.75 V~ 18.75 V PROTECTION TYPE : Shut down o/p voltage, re-power on to recover	I/P: 264VAC I/P: 230VAC I/P: 90VAC O/P:MIN LOAD Ta:25°C	17.5V/ 264VAC 17.5V/ 230VAC 17.5V/ 90VAC PROTECTION TYPE : Shut down o/p voltage, re-power on to recover
2	OVER TEMPERATURE PROTECTION	NO DAMAGE PROTECTION TYPE : Shut down o/p voltage, recovers automatically after temperature goes down	I/P: 264VAC I/P: 90VAC O/P:FULL LOAD	O.T.P. Active PROTECTION TYPE : Shut down o/p voltage, recovers automatically after temperature goes down

**CONTROL FUNCTION TEST**

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT											
1	AUXILIARY POWER (AUX)	1. 5V±10%@0.3A ripple:150mVp-p  2. 12V±10%@0.8A ripple:250mVp-p	I/P: 230 VAC O/P:FULL LOAD Ta:25°C	4.74 V 0.3 A ; ripple: 24mVp-p 11.28V 0.8 A ; ripple: 195 mVp-p											
2	REMOTE ON/OFF CONTROL	The charger can be turned ON/OFF individually or along with other units in parallel by using the "Remote ON-OFF" function.   I/P: 230 VAC O/P:FULL LOAD Ta:25°C Test Result : <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Between Remote ON-OFF and +5V-AUX</th> <th>OUTPUT</th> </tr> </thead> <tbody> <tr> <td>SW SHORT</td> <td>ON</td> </tr> <tr> <td>SW OPEN</td> <td>OFF</td> </tr> </tbody> </table>	Between Remote ON-OFF and +5V-AUX	OUTPUT	SW SHORT	ON	SW OPEN	OFF	<table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Between Remote ON-OFF and +5V-AUX</th> <th>Charger Status</th> </tr> </thead> <tbody> <tr> <td>Switch Short</td> <td>ON</td> </tr> <tr> <td>Switch Open</td> <td>OFF</td> </tr> </tbody> </table>	Between Remote ON-OFF and +5V-AUX	Charger Status	Switch Short	ON	Switch Open	OFF
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3	ALARM SIGNAL	1. DC OK SIGNAL High (4.5 ~ 5.5V) : When the Vout ≤ 8V/16V/32V ±1V. Low (0 ~ 0.5V) : When Vout ≥ 8V/16V/32V ±1V. The maximum sourcing current is 10mA and only for output.													

		<p>DC OK is associated with battery low protection.          I/P: 230 VAC          O/P: FULL LOAD          Ta: 25°C          Test Result :</p> <table border="1"> <thead> <tr> <th>Vout</th> <th>DC OK SIGNAL</th> </tr> </thead> <tbody> <tr> <td>Vout ≤ 75%</td> <td>5V</td> </tr> <tr> <td>Vout ≥ 85%</td> <td>-0.09V</td> </tr> </tbody> </table> <p>2. T-ALARM</p> <table border="1"> <thead> <tr> <th>P.S.U STATUS</th> <th>Vo</th> <th>T-ALARM</th> </tr> </thead> <tbody> <tr> <td>NORMAL</td> <td>100%±2%</td> <td>-0.1 ~-0.5V</td> </tr> <tr> <td>OTP OR FAN LOCK</td> <td>0V</td> <td>4.5~5.5V</td> </tr> </tbody> </table> <p>I/P: 230 VAC          O/P: FULL LOAD          Ta: 25°C          Test Result :</p> <table border="1"> <thead> <tr> <th>P.S.U STATUS</th> <th>T-ALARM</th> </tr> </thead> <tbody> <tr> <td>NORMAL</td> <td>-0.09V</td> </tr> <tr> <td>OTP OR FAN LOCK</td> <td>4.937V</td> </tr> </tbody> </table> <p>3. AC-OK :</p> <table border="1"> <thead> <tr> <th>AC IN</th> <th>Vo</th> <th>AC OK</th> </tr> </thead> <tbody> <tr> <td>AC I/P ≥ 87Vrms</td> <td>100%±2%</td> <td>4.5~5.5V</td> </tr> <tr> <td>AC I/P ≤ 75Vrms</td> <td>0V</td> <td>0~0.5V</td> </tr> </tbody> </table> <p>I/P: TEST          O/P: 60% LOAD          Test Result :</p> <table border="1"> <thead> <tr> <th>AC IN</th> <th>Vo</th> <th>AC OK</th> </tr> </thead> <tbody> <tr> <td>AC I/P ≥ 87V</td> <td>100.4%</td> <td>5.36V</td> </tr> <tr> <td>AC I/P ≤ 75V</td> <td>0.002V</td> <td>0.00V</td> </tr> </tbody> </table>	Vout	DC OK SIGNAL	Vout ≤ 75%	5V	Vout ≥ 85%	-0.09V	P.S.U STATUS	Vo	T-ALARM	NORMAL	100%±2%	-0.1 ~-0.5V	OTP OR FAN LOCK	0V	4.5~5.5V	P.S.U STATUS	T-ALARM	NORMAL	-0.09V	OTP OR FAN LOCK	4.937V	AC IN	Vo	AC OK	AC I/P ≥ 87Vrms	100%±2%	4.5~5.5V	AC I/P ≤ 75Vrms	0V	0~0.5V	AC IN	Vo	AC OK	AC I/P ≥ 87V	100.4%	5.36V	AC I/P ≤ 75V	0.002V	0.00V
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4	<p>OUTPUT VOLTAGE PROGRAMMABLE(PV)</p>	<p>DIP switch position 4 : OFF          ※ In addition to the adjustment via the built-in potentiometer, the output voltage can be trimmed to 75~125% of the nominal voltage by applying EXTERNAL VOLTAGE.</p> <p>RCB-1600-48 RCB-1600-24 RCB-1600-12</p> <table border="1"> <thead> <tr> <th>EXTERNAL VOLTAGE (DC) [V]</th> <th>RCB-1600-48 [%]</th> <th>RCB-1600-24 [%]</th> <th>RCB-1600-12 [%]</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>60</td> <td>30</td> <td>15</td> </tr> <tr> <td>0</td> <td>48</td> <td>24</td> <td>12</td> </tr> <tr> <td>0</td> <td>36</td> <td>18</td> <td>9</td> </tr> <tr> <td>0.4</td> <td>36</td> <td>18</td> <td>9</td> </tr> <tr> <td>1</td> <td>36</td> <td>18</td> <td>9</td> </tr> <tr> <td>4.7</td> <td>60</td> <td>30</td> <td>15</td> </tr> </tbody> </table> <p>OUTPUT VOLTAGE(%)</p> <p>EXTERNAL VOLTAGE (DC)</p> <p>I/P: 230 VAC          O/P: FULL LOAD          Test Result :          Ta: 25°C</p>	EXTERNAL VOLTAGE (DC) [V]	RCB-1600-48 [%]	RCB-1600-24 [%]	RCB-1600-12 [%]	0	60	30	15	0	48	24	12	0	36	18	9	0.4	36	18	9	1	36	18	9	4.7	60	30	15
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5	OUTPUT CURRENT PROGRAMMABLE (PC)	<p>DIP switch position 4 : OFF          ※ The output current can be trimmed to 20~100% of the rated current by applying EXTERNAL VOLTAGE.</p> <p>PIN26 PC    PIN29 -V-signal    EXTERNAL VOLTAGE (DC)</p> <p>OUTPUT CURRENT (%) vs EXTERNAL VOLTAGE (VDC)</p> <p>I/P: 230 VAC          O/P: TESTING          Ta: 25°C          Test Result :</p> <table border="1"> <tr> <td>ADJ V</td> <td>&lt;0.4V</td> <td>1V</td> <td>4.7V</td> <td>5V</td> </tr> <tr> <td>SPEC</td> <td>100%±10%</td> <td>20%±10%</td> <td>100%±10%</td> <td>100%±10%</td> </tr> <tr> <td>Iout</td> <td>101.45%</td> <td>20.58%</td> <td>101.45%</td> <td>102.18%</td> </tr> </table>	ADJ V	<0.4V	1V	4.7V	5V	SPEC	100%±10%	20%±10%	100%±10%	100%±10%	Iout	101.45%	20.58%	101.45%	102.18%									
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6	TEMPERATURE COMPENSATION	<p>-3mV /°C/ cell / (12V = 6 cells ; 24V = 12 cells ; 48V = 24 cells)</p> <p>PIN30 RTH+    NTC    PIN31 RTH-</p> <ul style="list-style-type: none"> <li>⊙ To exploit the temperature compensation function, please attach the temperature sensor, NTC, to the battery or the battery's vicinity.</li> <li>⊙ The charger is able to work normally without the NTC.</li> </ul> <p>I/P: 230 VAC          O/P: FULL LOAD          Test Result :</p> <table border="1"> <thead> <tr> <th rowspan="2">TEMP</th> <th rowspan="2">Voltage compensation</th> <th colspan="2">Temperature compensation</th> </tr> <tr> <th>BEFORE</th> <th>AFTER</th> </tr> </thead> <tbody> <tr> <td>( Ta=0°C )</td> <td>14.4V = + 0.45V ±0.12V</td> <td>14.438V</td> <td>14.871V</td> </tr> <tr> <td>( Ta=25°C )</td> <td>14.4V = 0V</td> <td>14.443V</td> <td>14.443V</td> </tr> <tr> <td>( Ta=50°C )</td> <td>14.4V = - 0.45V ±0.12V</td> <td>14.444V</td> <td>14.038V</td> </tr> </tbody> </table>	TEMP	Voltage compensation	Temperature compensation		BEFORE	AFTER	( Ta=0°C )	14.4V = + 0.45V ±0.12V	14.438V	14.871V	( Ta=25°C )	14.4V = 0V	14.443V	14.443V	( Ta=50°C )	14.4V = - 0.45V ±0.12V	14.444V	14.038V						
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7	Charging Curve	<p>※ By factory default, this charger performs the default curve which can be programmed via PMBus.                  ※ To disable / enable the charging curve, change to a 2 stage curve, a different curve frequently used for certain types of batteries in the industry, and so on, please refer to the Installation Manual.</p> <p>⊙ Default 3 stage charging curve</p> <p>⊙ Embedded 3 stage charging curve</p> <table border="1" data-bbox="1082 353 1485 667"> <thead> <tr> <th>MODEL</th> <th>Description</th> <th>V<sub>boost</sub></th> <th>V<sub>float</sub></th> </tr> </thead> <tbody> <tr> <td rowspan="3">12V</td> <td>Default, programmable</td> <td>14.4</td> <td>13.8</td> </tr> <tr> <td>Pre-defined, gel batter</td> <td>14</td> <td>13.6</td> </tr> <tr> <td>Pre-defined, flooded battery</td> <td>14.2</td> <td>13.4</td> </tr> <tr> <td rowspan="3">24V</td> <td>Pre-defined, AGM battery</td> <td>14.5</td> <td>13.5</td> </tr> <tr> <td>Default, programmable</td> <td>28.8</td> <td>27.6</td> </tr> <tr> <td>Pre-defined, gel batter</td> <td>28</td> <td>27.2</td> </tr> <tr> <td rowspan="3">48V</td> <td>Pre-defined, flooded battery</td> <td>28.4</td> <td>26.8</td> </tr> <tr> <td>Pre-defined, AGM battery</td> <td>29</td> <td>27</td> </tr> <tr> <td>Default, programmable</td> <td>57.6</td> <td>55.2</td> </tr> <tr> <td colspan="2"></td> <td>Pre-defined, gel batter</td> <td>56</td> <td>54.4</td> </tr> <tr> <td colspan="2"></td> <td>Pre-defined, flooded battery</td> <td>56.8</td> <td>53.6</td> </tr> <tr> <td colspan="2"></td> <td>Pre-defined, AGM battery</td> <td>58</td> <td>54</td> </tr> </tbody> </table> <p>⊙ Suitable for lead-acid batteries (flooded, Gel and AGM) and Li-ion batteries (lithium iron and lithium manganese).                  I/P: 230 VAC                  O/P: FULL LOAD                  Test Result :</p> <table border="1" data-bbox="470 772 1460 898"> <thead> <tr> <th>MODEL</th> <th>Constant voltage(V<sub>boost</sub>)</th> <th>Float (V<sub>float</sub>)</th> <th>Turn state current</th> </tr> </thead> <tbody> <tr> <td rowspan="2">12V</td> <td>14.4V± 0.12V</td> <td>13.8V± 0.12V</td> <td>10A± 3.0A</td> </tr> <tr> <td>14.43V</td> <td>13.82V</td> <td>9.85A</td> </tr> </tbody> </table>	MODEL	Description	V <sub>boost</sub>	V <sub>float</sub>	12V	Default, programmable	14.4	13.8	Pre-defined, gel batter	14	13.6	Pre-defined, flooded battery	14.2	13.4	24V	Pre-defined, AGM battery	14.5	13.5	Default, programmable	28.8	27.6	Pre-defined, gel batter	28	27.2	48V	Pre-defined, flooded battery	28.4	26.8	Pre-defined, AGM battery	29	27	Default, programmable	57.6	55.2			Pre-defined, gel batter	56	54.4			Pre-defined, flooded battery	56.8	53.6			Pre-defined, AGM battery	58	54	MODEL	Constant voltage(V <sub>boost</sub> )	Float (V <sub>float</sub> )	Turn state current	12V	14.4V± 0.12V	13.8V± 0.12V	10A± 3.0A	14.43V	13.82V	9.85A
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### COMPONENT STRESS TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	PWM Transistor (D to S) or (C to E) Peak Voltage	Q901 Rated 29A/600 V	I/P:High-Line +3V =267V AC ON/OFF VDS: O/P: (1)Full Load Ta:25°C	VDS: (1)494V
2	P.F.C Transistor (D to S) or (C to E) Peak Voltage	Q52 Rated 52 A/600 V	I/P:High-Line +3V =267 V AC ON/OFF O/P: (1)Full Load Ta:25°C	VDS: (1)439V
4	Input Capacitor Voltage	C5 Rated: 680µ/400V SURGE VOLTAGE:450V	I/P:High-Line +3V =267 V O/P: (1)Full Load Ta:25°C	(1)397V
5	Control IC Voltage Test	PWM IC U901 Rated 6.5 V~24 V  PFC IC U51 Rated 6V~16V  O/P IC U142 Rated 4V~ 15V	I/P:High-Line +3V =267 V AC ON/OFF O/P(1)FULL LOAD Ta:25°C	U901 13.4 V U51 12.93V U142 12.5 V
6	Transistor	Q154 Rated : 100A/40V	I/P:High-Line +3V =267 V O/P: (1)FULL LOAD	(1)2.4 V
7	Transistor	Q163 Rated : 3.8A/100V	I/P:High-Line +3V =267 V  O/P: (1) FULL LOAD	(1)0.948V (2)0.744V

			(2)NO LOAD	
8	Diode Peak Voltage	Q101 Rated 74A/150 V VGS:±20V  Q104 Rated 74A/150 V	I/P:High-Line +3V =267 V AC ON/OFF O/P: (1) FULL LOAD (2)Output Short (3).NO LOAD Ta:25°C	VDS: (1)58.4V (2)51.2V (3)61.0V  VDS: (1)49.4V (2)51.4V (3)72.3V

### SAFETY TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	WITHSTAND VOLTAGE	I/P-O/P: 3KVAC/min I/P-FG : 2KVAC/min O/P-FG:1.5KVAC/min	I/P-O/P: 3.6 KVAC/min I/P-FG: 2.4 KVAC/min O/P-FG:1.8 KVAC/min Ta:25°C	I/P-O/P:6.23mA I/P-FG:5.77mA O/P-FG:6.08m A NO DAMAGE
2	ISOLATION RESISTANCE	I/P-O/P:500VDC>100MΩ I/P-FG: 500VDC>100MΩ O/P-FG:500VDC>100MΩ	I/P-O/P: 500 VDC I/P-FG: 500 VDC O/P-FG: 500 VDC Ta:25°C	I/P-O/P: 7.28GΩ I/P-FG: 5.7GΩ O/P-FG: 9.2GΩ NO DAMAGE
3	GROUNDING CONTINUITY	FG(PE) TO CHASSIS OR TRACE < 100 mΩ	40A / 2min Ta:25°C	17mΩ

### E.M.C TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	HARMONIC	EN61000-3-2 CLASS A	I/P:230VAC/50HZ O/P:100% LOAD Ta:25°C	PASS
2	CONDUCTION	EN55022 CLASS B	I/P : 230 VAC (50HZ) O/P : FULL/50% LOAD Ta : 25°C	PASS Test by certified Lab
3	RADIATION	EN55022 CLASS A	I/P : 230 VAC (50HZ) O/P : FULL LOAD Ta : 25°C	PASS Test by certified Lab
4	E.S.D	EN61000-4-2 INDUSTRY AIR : 8KV / Contact : 4KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25°C	CRITERIA A
5	E.F.T	EN61000-4-4 INDUSTRY INPUT : 2KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25°C	CRITERIA A
6	SURGE	IEC61000-4-5 INDUSTRY L-N : 2KV L,N-PE : 4KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25°C	CRITERIA A
7	Test by certified Lab & Test Report Prepare			

■ **RELIABILITY TEST**

**ENVIRONMENT TEST**

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT																																																																																																																																					
1	TEMPERATURE RISE TEST	MODEL : RCB-1600-24																																																																																																																																							
		1. ROOM AMBIENT BURN-IN : 1 HRS I/P : 230VAC O/P : FULL LOAD Ta= 28.3 °C																																																																																																																																							
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2	LOW TEMPERATURE TURN ON TEST	TURN ON AFTER 2 HOUR	I/P : 230VAC/180VAC O/P : 100 % LOAD Ta= -35°C / -30°C	TEST : OK																																																																																																																																					
3	HIGH HUMIDITY HIGH TEMPERATURE HIGH VOLTAGE TURN ON TEST	AFTER 12 HOURS IN CHAMBER ON CONTROL 50 °C NO DAMAGE	I/P : 272 VAC O/P : FULL LOAD Ta= 50 °C HUMIDITY= 95 %R.H	TEST : OK																																																																																																																																					





4	TEMPERATURE COEFFICIENT	$\pm 0.03\%/^{\circ}\text{C}$ (0-50°C)	I/P : 230 VAC O/P : FULL LOAD	$\pm 0.005\%/^{\circ}\text{C}$ (0-50°C)
5	STORAGE TEMPERATURE TEST	1. Thermal shock Temperature : -45°C~ +90°C 2. Temperature change rate : 25°C / MIN 3. Dwell time low and high temperature : 30 MIN/EACH 4. Total test cycle : 5 CYCLE 5. Input/Output condition : STATIC		OK
6	THERMAL SHOCK TEST	1. Thermal shock Temperature : -35°C~ +55°C 2. Temperature change rate : 25°C / MIN 3. Dwell time low and high temperature : 30 MIN/EACH 4. Total test cycle : 10 CYCLE 5. Input/Output condition :  15cycle:230V/ FULL LOAD AC ON 3sec/AC OFF 1sec TEST(13500 TIMES)  1cycle:230V/ FULL LOAD Burn In Test		OK
7	VIBRATION TEST	1 Carton & 1 Set (1) Waveform : Sine Wave (2) Frequency : 10-500Hz (3) Sweep Time : 12min/sweep cycle (4) Acceleration : 2G (5) Test Time : 60min in each axis (X.Y.Z) (6) Ta : 25°C		TEST : OK
8	CAPACITOR LIFE CYCLE	SUPPOSE C101 IS THE MOST CRITICAL COMPONENT (1) I/P : 230VAC O/P : FULL LOAD Ta= 25°C LIFE TIME (2) I/P : 230VAC O/P : FULL LOAD Ta= 50°C LIFE TIME (3) I/P : 230VAC O/P : 75% LOAD Ta= 50°C LIFE TIME (4) I/P : 230VAC O/P : 50% LOAD Ta= 50°C LIFE TIME		(1) 781466HRS (2) 119480HRS (3) 179758HRS (4) 222934HRS
9	MTBF	Conducted by Parts Stress Analysis Prediction 160.9K hrs min. Telcordia SR-332 (Bellcore) ; 42.1K hrs min. MIL-HDBK-217F (25°C)		
10	DMTBF/Accelerated Life Test	Demonstration Mean Time Between Failure (Expected Life): Above 50,000 hours @ TA 50°C		

TEST RESULT	TESTER	REVIEW	APPROVAL
PASS	DANIEL GAO	SANFORD SU	VINCENT TSENG

12.10.30 A50-F031