



# Test Report: RCB-1600-48

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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 57.6V±0.48V	I/P: 230 VAC O/P: CV MODE Ta:25°C	57.609V
2	FLOAT CHARGE VOLTAGE	Default, programmable 55.2V±0.48V	I/P: 230 VAC O/P: CV MODE Ta:25°C	55.212V
3	OUTPUT CURRENT	27.5A±0.825A	I/P: 230 VAC O/P:CV MODE-2V Ta:25°C	27.253A
4	VOLTAGE ADJ. RANGE	47.5V~58.8V DIP switch position 4 : OFF	I/P: 230 VAC O/P:NO LOAD Ta:25°C	45.62V~60.1V/230VAC 45.62V~60.1V/115VAC
5	LEAKAGE CURRENT FROM BATTERY (Typ.)	<45mA	I/P: AC OFF O/P:BATTERY Ta:25°C	28mA

**INPUT FUNCTION TEST**

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	INPUT VOLTAGE RANGE	90VAC~264VAC	I/P:TESTING O/P: FULL LOAD O/P:60% LOAD Ta:25°C	150 V~ 264 V 87V~264V
			I/P: (1)LOW-LINE-3V=87 V HIGH-LINE+15%=300 V O/P:FULL/MIN LOAD (PLEASE CHECK DERATING CURVE) ON: 30 Sec OFF: 30 Sec 10MIN (2)230Vac ON: 0.5 Sec OFF: 0.5 Sec 20MIN (3)230Vac ON:3Sec OFF:3Sec 12HOURS ( 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	INPUT CURRENT (Typ.)	230V/ 8.5 A 115V/ 15 A	I/P : 230 VAC I/P : 115 VAC O/P : FULL LOAD (PLEASE CHECK DERATING CURVE) Ta : 25°C	I =7.72A/ 230VAC I =12.7A/ 115VAC
4	LEAKAGE CURRENT	<1.5mA / 230 VAC	I/P : 230 VAC O/P : Min LOAD Ta : 25°C	L-FG : 0.84 mA N-FG : 0.84 mA
5	POWER FACTOR (Typ.)	0.97 / 230VAC	I/P : 230 VAC O/P : FULL LOAD Ta : 25°C	PF=0.978/230VAC

6	EFFICIENCY(Typ.)	93%	I/P:230 VAC O/P:FULL LOAD Ta:25°C	93.15%
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
<p>INPUT=230VAC/50HZ @ FULL LOAD CH1 : Input current</p>				

**PROTECTION FUNCTION TEST**

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	OVER VOLTAGE PROTECTION	63 V~ 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	69V/ 264VAC 69V/ 230VAC 69V/ 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	4.78 V 0.3A ; ripple: 15.9mVp-p 11.16V 0.8 A ; ripple: 100 mVp-p						
2	REMOTE ON/OFF CONTROL	<p>The charger can be turned ON/OFF individually or along with other units in parallel by using the "Remote ON-OFF" function.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <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> <p>I/P: 230 VAC O/P:FULL LOAD Ta:25°C Test Result :</p>			Between Remote ON-OFF and +5V-AUX	Charger Status	Switch Short	ON	Switch Open	OFF
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3	ALARM SIGNAL	<p>1. DC OK SIGNAL            High (4.5 ~ 5.5V) : When the <math>V_{out} \leq 8V/16V/32V \pm 1V</math>.            Low (0 ~ 0.5V) : When <math>V_{out} \geq 8V/16V/32V \pm 1V</math>. The maximum sourcing current is 10mA and only for output.            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><math>V_{out} \leq 75\%</math></td> <td>5.037 V</td> </tr> <tr> <td><math>V_{out} \geq 85\%</math></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>4.998V</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 <math>\geq 87V_{rms}</math></td> <td>100%±2%</td> <td>4.5~5.5V</td> </tr> <tr> <td>AC I/P <math>\leq 75V_{rms}</math></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 <math>\geq 87V</math></td> <td>100.4%</td> <td>5.39V</td> </tr> <tr> <td>AC I/P <math>\leq 75V</math></td> <td>0.002V</td> <td>0.002</td> </tr> </tbody> </table>			Vout	DC OK SIGNAL	$V_{out} \leq 75\%$	5.037 V	$V_{out} \geq 85\%$	-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	4.998V	AC IN	Vo	AC OK	AC I/P $\geq 87V_{rms}$	100%±2%	4.5~5.5V	AC I/P $\leq 75V_{rms}$	0V	0~0.5V	AC IN	Vo	AC OK	AC I/P $\geq 87V$	100.4%	5.39V	AC I/P $\leq 75V$	0.002V	0.002
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4	OUTPUT VOLTAGE PROGRAMMABLE(PV)	<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>OUTPUT VOLTAGE (%)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>36</td> </tr> <tr> <td>0</td> <td>48</td> </tr> <tr> <td>0</td> <td>60</td> </tr> <tr> <td>0.4</td> <td>9</td> </tr> <tr> <td>0.4</td> <td>12</td> </tr> <tr> <td>0.4</td> <td>15</td> </tr> <tr> <td>1</td> <td>36</td> </tr> <tr> <td>4.7</td> <td>60</td> </tr> <tr> <td>5</td> <td>60</td> </tr> </tbody> </table> <p>I/P: 230 VAC            O/P: FULL LOAD</p>			EXTERNAL VOLTAGE (DC) (V)	OUTPUT VOLTAGE (%)	0	36	0	48	0	60	0.4	9	0.4	12	0.4	15	1	36	4.7	60	5	60																			
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<p>6 TEMPERATURE COMPENSATION</p>		<p>Temperature sense associated with the temperature compensation function.</p> <p>◎ To exploit the temperature compensation function, please attach the temperature sensor, NTC, to the battery or the battery's vicinity. ◎ The charger is able to work normally without the NTC.</p> <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>57.6V = +1.80V ±0.48V</td> <td>57.51</td> <td>59.21</td> </tr> <tr> <td>( Ta=25°C )</td> <td>57.6V = 0V</td> <td>57.54</td> <td>57.54</td> </tr> <tr> <td>( Ta=50°C )</td> <td>57.6V = -1.80V ±0.48V</td> <td>57.55</td> <td>55.86</td> </tr> </tbody> </table>	TEMP	Voltage compensation	Temperature compensation		BEFORE	AFTER	( Ta=0°C )	57.6V = +1.80V ±0.48V	57.51	59.21	( Ta=25°C )	57.6V = 0V	57.54	57.54	( Ta=50°C )	57.6V = -1.80V ±0.48V	57.55	55.86
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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"> <thead> <tr> <th>MODEL</th> <th>Description</th> <th>Vboost</th> <th>Vfloat</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></td> <td>Pre-defined, gel batter</td> <td>56</td> <td>54.4</td> </tr> <tr> <td></td> <td>Pre-defined, flooded battery</td> <td>56.8</td> <td>53.6</td> </tr> <tr> <td></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"> <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">48V</td> <td>57.6V± 0.48V</td> <td>55.2V± 0.48V</td> <td>2.75A± 0.825A</td> </tr> <tr> <td>57.609V</td> <td>55.212V</td> <td>2.845A</td> </tr> </tbody> </table>	MODEL	Description	Vboost	Vfloat	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	48V	57.6V± 0.48V	55.2V± 0.48V	2.75A± 0.825A	57.609V	55.212V	2.845A
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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 37A/600V	I/P:High-Line +3V =267V AC ON/OFF VDS: O/P: (1)Full Load Ta:25°C	VDS: (1)566V
2	P.F.C Transistor (D to S) or (C to E) Peak Voltage	Q52 Rated 33A/600V	I/P:High-Line +3V =267 V AC ON/OFF O/P: (1)Full Load Ta:25°C	VDS: (1)480V
3	Diode Peak Voltage	Q101 Rated 65A/200 V Q104 Rated 65A/200 V	I/P:High-Line +3V =267 V AC ON/OFF O/P: (1)Full Load Ta:25°C	Q101: VDS: (1)187V Q104: VDS: (1)189V
4	Input Capacitor Voltage	C5 Rated: 680 μ /400V SURGE VOLTAGE:450V	I/P:High-Line +3V =267 V O/P: (1)Full Load input on/off Ta:25°C	(1)398V
5	Control IC Voltage Test	PFC IC U51 Rated 6V~16V PWM IC U901 Rated	I/P:High-Line +3V =267 V AC ON/OFF O/P(1)FULL LOAD Ta:25°C	U51 (1) 11.68V U901 (1)12.56V

		5.5V~ 24V		
6	Transistor	Q154 Rated : 100A/40V	I/P:High-Line +3V =267 V (HOT SWAP TEST) O/P: (1)Full Load	(1)400mV
7	Transistor	Q163 Rated : 2.4A/100V	I/P:High-Line +3V =267 V (HOT SWAP TEST) O/P: (1)Full Load	(1)600mV

### 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:6.9mA I/P-FG:8.04mA O/P-FG:6.28m 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: 8.16GΩ I/P-FG: 9.35GΩ O/P-FG: 9.4GΩ NO DAMAGE
3	GROUNDING CONTINUITY	FG(PE) TO CHASSIS OR TRACE < 100 mΩ	40A / 2min Ta:25°C	17 mΩ

### 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 2. HIGH AMBIENT BURN-IN : 3 HRS I/P : 230VAC O/P : FULL LOAD Ta= 52.5 °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	± 0.03 %/°C (0~50°C)	I/P : 230 VAC O/P : FULL LOAD	± 0.005 %/°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 476.7K hrs min. Telcordia SR-332 (Bellcore) ; 38.7K 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