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<b>TEST REPORT</b>	
<b>Performance of PV Battery Charge Controllers for Use with Lead-Acid Batteries</b>	
<b>Report reference No.</b> .....:	REP-R012-T-0014 Rev 0
Tested by (name + signature) .....	Wayne Clarke
Supervised by (name + signature) :	Oscar Arteaga
Approved by (name + signature)....:	Oscar Arteaga
Date of issue.....:	30/Jun/2008
<b>Testing laboratory</b> .....	ResLab
Address .....	Research Institute for Sustainable Energy, Murdoch University, Murdoch WA 6150
<b>Applicant</b> .....	RISE Developmental Test
Address .....	
<b>Test specification</b>	
Standard .....	Draft IEC PV Battery charge controller performance
Test procedure .....	TP-RESL-T-0016 Rev C
Non-standard method.....:	N/A
<b>Test item identification</b> .....	
Manufacturer .....	██████████
Model.....:	██████████
Serial No.....:	██████████
Date of manufacture.....:	Not Specified
Hardware version .....	Not Specified
Firmware version.....:	Not Specified
<b>Uncertainties</b>	
The uncertainties quoted in this test report have been calculated at the 95% confidence level. This means that the chance of the reported value to be in error by more than the stated uncertainty is five in one hundred. Unless otherwise stated the uncertainty reported is as a percentage of the reading.	
All measurements are carried out using equipment that holds calibration traceable to national standards held by the National Measurements Institute.	
DC Voltage .....	± 0.2% of reading
DC Current .....	± 0.3% of reading
DC Power .....	± 0.3% of reading
Temperature rise .....	± 3 °K

## GENERAL INFORMATION

### Nameplate picture



### EUT Pictures



### Summary of testing / verification:

This report summarises battery charge controller performance tests results and compliance with IEC 62509 draft standard "Performance and functioning of battery charge controllers". The results in this report cover battery lifetime protection requirements, efficiency requirements, protection and fail safe requirements, user interface requirements and marking and documentation requirements.

## GENERAL INFORMATION

### Test item specifications

Type of Controller.....:	PWM, Series
Maximum $V_{OC}$ .....:	Not Specified
Nominal battery voltage.....:	12V
Nominal charging current.....:	10A
Class of equipment.....:	Not Specified
IP rating.....:	Not Specified
Accessories included for testing.....:	None
Other options.....:	None

### Testing

Date of receipt of test item.....:	N/A
Date(s) of performance of test.....:	02/05/2008 – 26/05/2008

### Possible test case verdicts

- test case does not apply to the test object.....:	N/A
- test object meets requirement.....:	Pass
- test object does not meet requirement.....:	Fail
- verdict given in adjacent row(s) or not required.:	—

### Abbreviations and acronyms used in this report

- Average.....:	Avg.	- pulse width modulation.....:	PWM
- battery charge controller.....:	BCC	- temperature.....:	Temp.
- equipment under test.....:	EUT		
- maximum power point tracking.....:	MPPT		

### General remarks

"(See Enclosure #)" refers to additional information appended to the report.

"(See appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

The tests results presented in this report relate only to the object tested.

This report shall not be reproduced except in full without the written approval of the testing laboratory.

List of test equipment must be kept on file and available for review.

Summary of contents provided on the last page of this report.

This Test Report Form is intended for the investigation of PV battery charge controller performance testing in accordance with IEC 62509 draft standard "Performance and functioning of battery charge controllers"..

TEST RESULTS			
Cl.	Requirement – Test	Result	Verdict
2.3	BATTERY LIFETIME PROTECTION REQUIREMENTS		—
2.3.1	Prevent Leakage Current from Battery to PV Array		Pass
	$I_{REV} \leq 0.1\%$ of the rated charging current with nominal battery voltage	4 $\mu$ A @ 12V (0.00004%); limit is 0.1% of rated current	—
2.3.2	Basic Battery Charging Functions		—
2.3.2.1	General		Pass
	Appropriate charging & load disconnect/reconnect set points for intended battery technology	Yes Appropriate for lead-acid batteries (See Table 1)	—
2.3.2.2	Protect Battery from Overcharge		Pass
	Appropriate end of charge set points	Appropriate for lead-acid batteries (See Table 1)	—
2.3.2.3	Protect Battery from Over-discharge		Pass
	Low battery load disconnect terminals, or control signal, or alarm provided	Yes	—
2.3.2.4	Set Point Accuracy		Fail
	$\pm 2\%$ or better	No, failed on float charge at 25°C (See Table 1)	—
2.3.3	Charging Regime		—
2.3.3.1	General – Suited for intended battery technology(es)	EUT documentation does not clearly specify the type of batteries it is suited for.	Fail
2.3.3.2	Required Charging Stages		Pass
	Bulk (maximum EUT charging current or maximum current available from PV array)	Yes	—
	Float (constant voltage stage)	Yes	—
2.3.3.3	Recommended Charging Stages		Fail ①
	Provide equalisation charge	No equalisation stage provided	—
2.3.3.4	Adjustable Charging Set-points		Fail ①
2.3.3.5	Temperature Compensated Charging Set-points ( $\approx -5$ mV/°C–Cell for lead acid batt.)		Pass ①
	Manufacturer specified value	Yes, -20mV/°C (-3.33 mV/°C-Cell)	—
	Compensated set-points identified in documentation	Yes	—
2.3.3.6	Voltage Sense Leads for Battery Voltage Measurement		Pass
	Voltage sense terminals, and	No	—
	Ability to operate with or without sense wires or	N/A	—
	Installation instructions to minimise voltage drop, or	No	—
	Voltage drop compensation by BCC	LVD only	—
2.3.4	Set Point Security		—
	Secured against change other than by a deliberate and qualified action	N/A	—
2.3.5	Load Disconnect Capability		Pass ①
2.4	ENERGY PERFORMANCE REQUIREMENTS		—
2.4.1	Stand by Self Consumption		Pass
	Nominal charging current $< 5A : \leq 10$ mA	N/A	—
	$5A \leq$ Nominal charging current $\leq 50$ A : 0.2% of nominal charging current	4.5 mA @ 12.6V (0.045 % of rated current)	—
	Nominal charging current $> 50A : \leq 100$ mA	N/A	—
2.4.2	BCC Efficiency		—
	Minimum efficiency / % of rated charging current @ 25°C	99.2% @ 100% current (see Table 2)	—
	Peak efficiency / % of rated charging current @ 40°C	99.3% @ 10% (see Table 2)	—
2.5	PROTECTION AND FAIL SAFE REQUIREMENTS		—

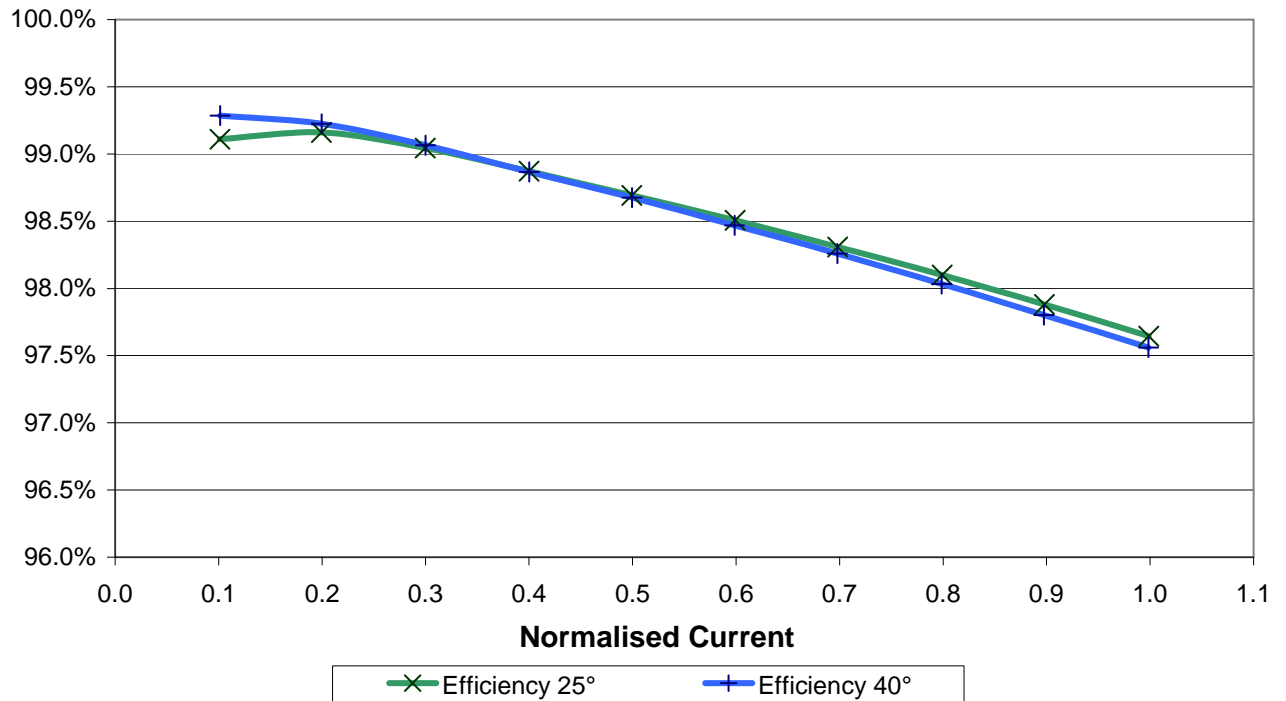
<b>TEST RESULTS</b>			
Cl.	Requirement – Test	Result	Verdict
2.5.1	Thermal Performance		Pass
	Capable of supplying rated charging current for 1 hour at maximum rated ambient operating temperature	Yes (See Table 3)	—
2.5.2	Over Current Protection		—
2.5.2.1	PV Side (125% of rated), no damage, auto reset if BCC trips	Yes (See Table 4)	Pass
2.5.2.2	Load Side (125% of rated), no damage	Yes (See Table 4)	Pass
2.5.3	PV Array and Battery Reverse Polarity		Pass
	PV Array – No damage after reverse polarity connection; and	No damage after reverse polarity connection for 5 min.	—
	PV Array – No reverse voltage applied to load; or	OK – No reverse voltage	—
	Warning in BCC operating manual and terminal block to avoid PV array reverse polarity	Warning in manual	—
	Battery – No damage after reverse polarity connection; and	No damage after reverse polarity connection for 5 min.	—
	Battery – No reverse voltage applied to load; or	OK – No reverse voltage	—
	Warning in BCC operating manual and terminal block to avoid battery reverse polarity	Warning in manual	—
2.5.4	Short Circuit Protection		—
2.5.4.1	Short Circuit on PV Input Wiring		Pass
	No damage to EUT after short circuit; or	No damage after short circuit applied for 5 min.	—
	Warning in BCC operating manual and terminal block to avoid short circuit on PV input	No	—
2.5.4.2	Short Circuit on Battery Wiring		Pass
	No damage to EUT after short circuit; or	No damage after short circuit applied for 5 min.	—
	Warning in BCC operating manual and terminal block to avoid short circuit on battery wiring	No	—
2.5.4.3	Short Circuit on Load Terminals		Pass
	No damage to EUT after short circuit, or	No damage after short circuit applied for 5 min.	—
	Instructions to install external protective device.	No	—
2.5.5	Open circuit on Battery Terminals (no battery connection)		Pass
	No damage to itself after battery disconnection; and	No damage observed after disconnecting the battery for 5 min with 100 % PV current	—
	Protect load from open circuit voltage of the PV array	OK – No open circuit voltage present on load terminals	—
2.6	<b>USER INTERFACE REQUIREMENTS</b>		
2.6.1	General		Pass
	User interface provided	Yes, via LEDs	—
2.6.2	Operational Information		—
2.6.2.1	Statement of intended application and level of information provided by the user interface	Yes	Pass
2.6.2.2	Recommended Operation Information		Pass
	the state-of-charge	Yes	—
	load-disconnect state	Yes	—
	charging stage	Yes	—
2.6.2.3	Additional Operational information		Fail ①
	Charging set points	No Indication	—
	Battery voltage	No Indication	—
	Charging current	No Indication	—
	Ah charge	No Indication	—
	Ah discharge	No Indication	—

<b>TEST RESULTS</b>			
Cl.	Requirement – Test	Result	Verdict
2.6.3	User Adjustable Set-points and Parameters		—
	Facility to modify and display the charging regime parameters	N/A	—
2.6.4	Alarms		Pass ①
	Low battery state of charge / Low battery voltage	Yes	—
	Load disconnect	Yes	—
	BCC trip (eg by over temperature)	Yes	—
	BCC failure	No alarm	—
2.7	MARKING AND DOCUMENTATION		—
	IEC 62109-1 requirements	Inspected for clauses 5.1, 5.2 & 5.3 of the draft standard	—
	Information about functionality and specific installation requirements for correct functioning of the BCC	Yes (in EUT manual)	—
Notes:			
1. This is a recommended provision only. It does not affect the EUT compliance to the current draft standard.			
2. IEC 62109-1 is a draft document, not a standard yet.			

Table 1 Set-Point Measurement Results							
Description		Bulk	Abs	Float	Equal	LVD	LVR
EUT Setting	Setpoint (V)	14.5	N/A	14.1	N/A	11.5	12.7
	Temperature Compensated	Yes	N/A	Yes	N/A	No	No
	Batt. Current Compensated	No	N/A	No	N/A	Yes	No
	Time/Delay (hh:mm:ss)	N/A	N/A	N/A	N/A	N/A	N/A
25°C Tests	Actual Test Temperature (°C)	24.9	N/A	24.9	N/A	24.9	24.9
	Test Battery Current (A)	0.985	N/A	0.939	N/A	0.913	1.0
	Measured Values (V)	<b>14.43</b>	<b>N/A</b>	<b>13.78</b>	<b>N/A</b>	<b>11.59</b>	<b>12.56</b>
	Corrected Setpoints (V)*	14.50	N/A	14.10	N/A	11.46	12.70
	Measured Setpoint Error	-0.52%	N/A	<b>-2.30%</b>	N/A	1.14%	-1.12%
	Time / Delay (hh:mm:ss)	N/A	N/A	N/A	N/A	N/A	N/A
40°C Tests	Actual Test Temperature (°C)	39.9	N/A	40.1	N/A	39.8	39.8
	Test Battery Current (A)	0.986	N/A	0.925	N/A	0.912	0.990
	Measured Values (V)	<b>14.18</b>	<b>N/A</b>	<b>13.55</b>	<b>N/A</b>	<b>11.58</b>	<b>12.62</b>
	Corrected Setpoints (V)*	14.20	N/A	13.80	N/A	11.46	12.70
	Measured Setpoint Error	-0.14%	N/A	-1.83%	N/A	1.00%	-0.62%
	Time / Delay (hh:mm:ss)	N/A	N/A	N/A	N/A	N/A	N/A
Additional EUT programmed or manufacturer declared parameters							
Temperature compensation (mV/°C-Cell)						-3.33	
Nominal system voltage (V)						12	
Reference temperature (°C)						25	
Reference temperature (°C)						-40	
Notes:							

**Table 2 Efficiency Measurement Results**

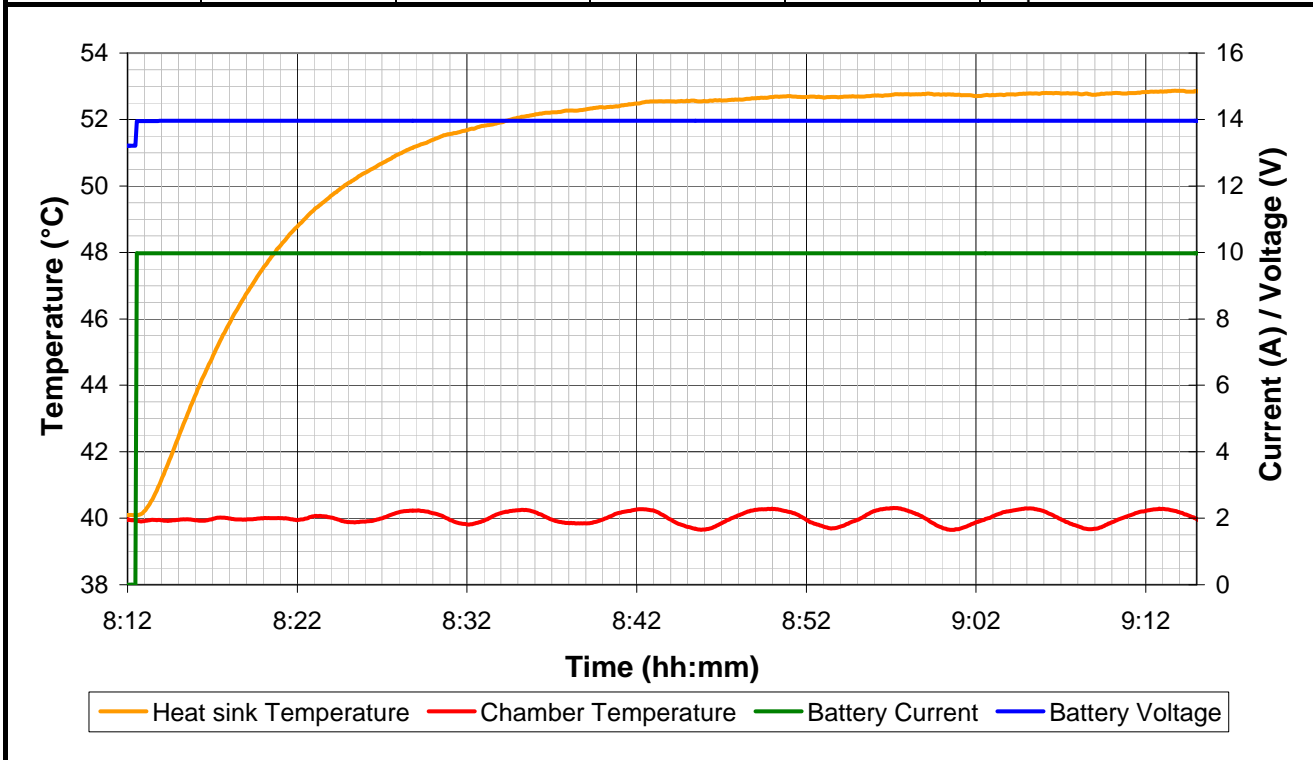
Test Temperature	Normalised Charge Current	Efficiency	Ambient Temp. (°C)	PV Voltage (V)	Battery Voltage (V)
25°C	0.10	99.1%	25.1	13.23	13.18
	0.20	99.2%	25.0	13.32	13.25
	0.30	99.0%	25.0	13.42	13.33
	0.40	98.9%	25.1	13.52	13.40
	0.50	98.7%	25.0	13.62	13.47
	0.60	98.5%	25.0	13.73	13.55
	0.70	98.3%	25.0	13.83	13.62
	0.80	98.1%	25.1	13.94	13.69
	0.90	97.9%	25.0	14.05	13.77
	1.00	97.6%	25.0	14.16	13.84
	Average	98.5%	25.0	13.68	13.51
40°C	0.10	99.3%	39.9	13.23	13.19
	0.20	99.2%	39.9	13.33	13.26
	0.30	99.1%	39.9	13.44	13.34
	0.40	98.9%	39.9	13.54	13.41
	0.50	98.7%	39.9	13.64	13.48
	0.60	98.5%	39.9	13.75	13.56
	0.70	98.3%	39.9	13.86	13.63
	0.80	98.0%	39.9	13.97	13.71
	0.90	97.8%	39.9	14.08	13.78
	1.00	97.6%	39.9	14.20	13.86
	Average	98.5%	39.9	13.70	13.52



Notes:

**Table 3 Thermal Performance Results**

Avg. Battery Voltage (V)	Avg. Battery Current (A)	Avg. Test Temp. (°C)	Stabilisation Time (h:mm:ss) ①	Stabilisation Temp. (°C) ①	Protection Mode
13.96	9.97	40.0	0:54:30	52.8	EUT operated at this condition without damage or protection activated

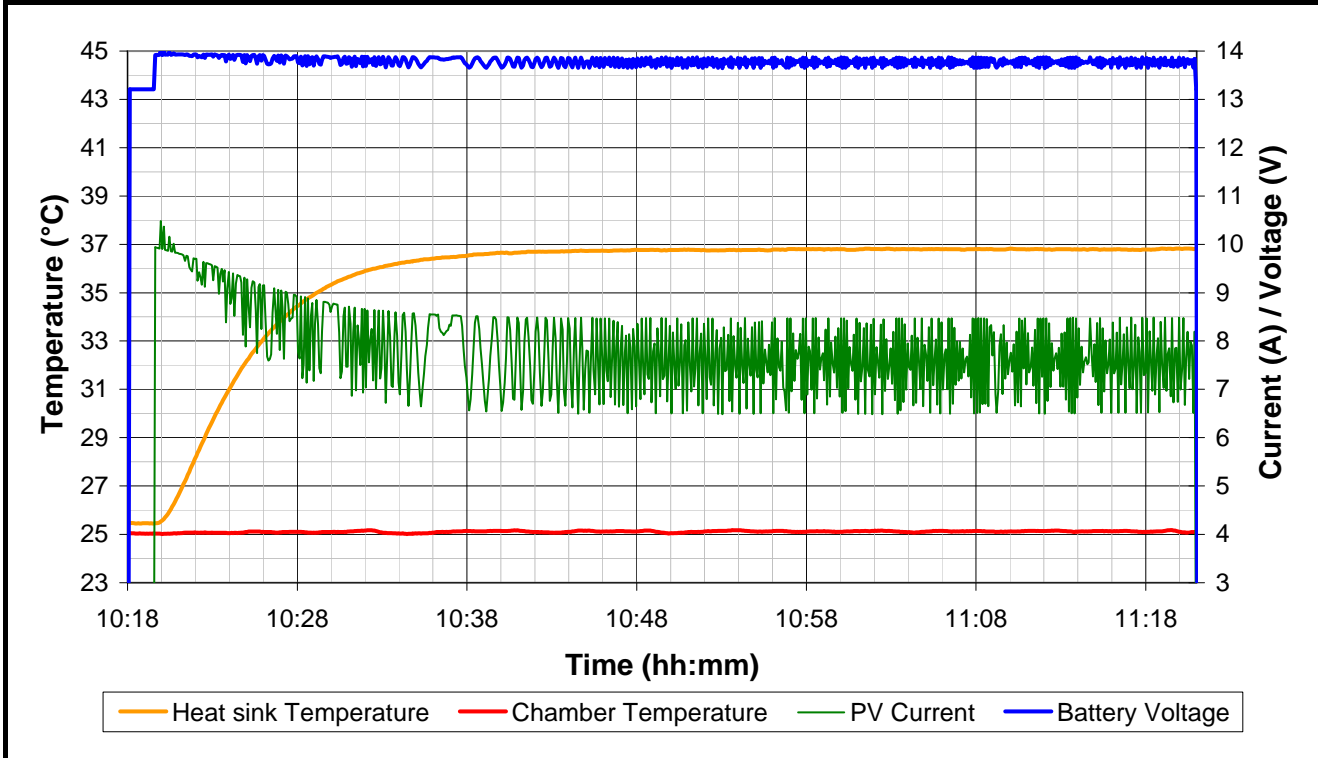


Notes:

1. Stabilisation criteria is less than 1° change in the previous 30 min.

**Table 4 PV Current Overload Results**

Avg. Battery Voltage (V)	Avg. Battery Current (A)	Avg. Test Temp. (°C)	Stabilisation Time (h:mm:ss) ①	Stabilisation Temp. (°C) ①	Protection Mode
13.77	7.78	25.1	0:42:25	36.8	EUT operated at this condition without damage or protection activated

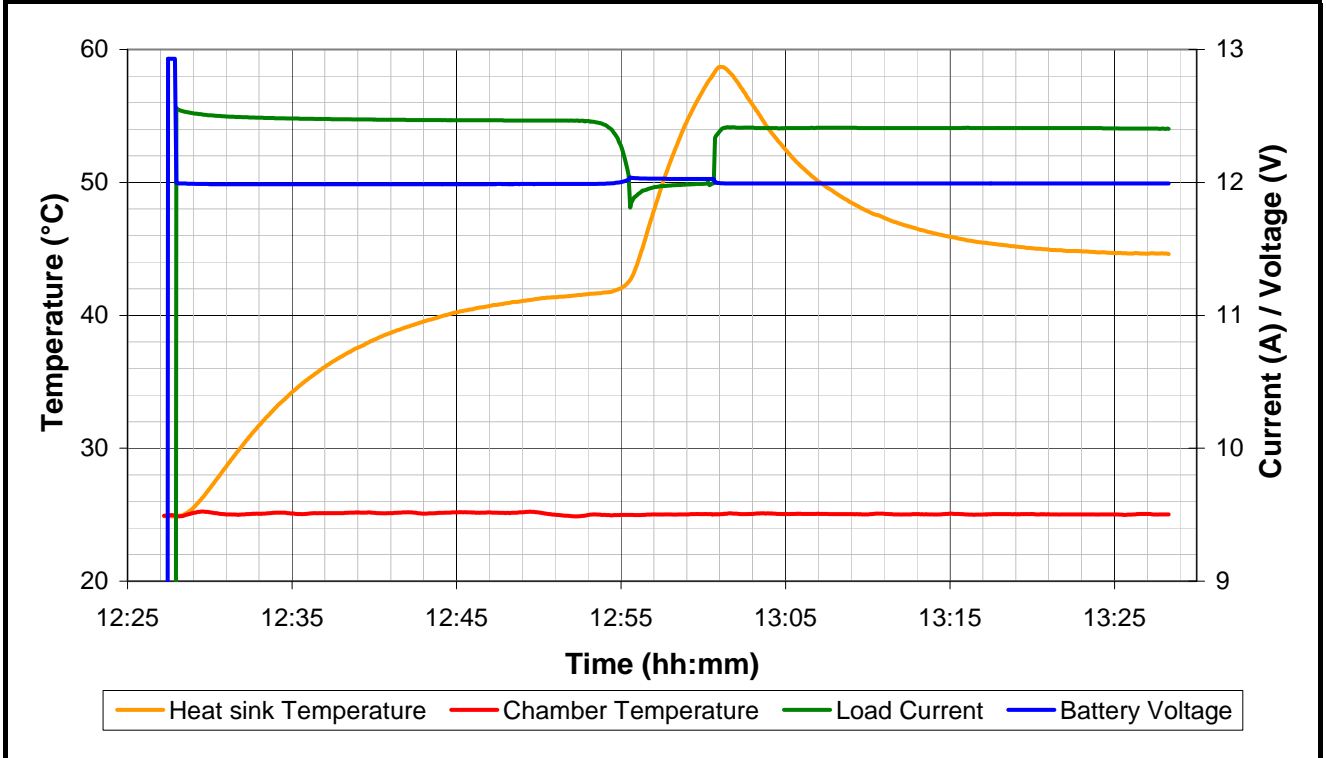


**Notes:**

1. Stabilisation criteria are less than 1° change in the previous 30 min.
2. The unit does not allow the PV current to go beyond the rating of the unit. It achieves this by PWM regulation. It actually maintained the average PV current well below 10A

**Table 5 Load Terminals Overload Results**

Avg. Battery Voltage (V)	Avg. Load Current (A)	Avg. Test Temp. (°C)	Stabilisation Time (h:mm:ss) ①	Stabilisation Temp. (°C) ①	Protection Mode
11.99	12.40	25.1	Not Reached	Not Reached	EUT operated at this condition without damage or protection activated



**Notes:**

1. Stabilisation criteria is less than 1° change in the previous 30 min.
2. This unit displayed an atypical thermal performance characteristic with a large temperature peak (around 59°C) accompanied with a reduction in load current, presumably load current regulation occurred during this period which lasted around 3 minutes. The unit returned to “normal” operation after that.

**End of Test Report**