Certificate
No. 0815 / FhG-ISE / 001

_____

Manufacturer: phocos China Ltd.
Charge regulator type: CMLmppt 10

_____

The above mentioned family of charge controllers have been subjected voluntarily to the qualification tests according to IEC 62 509 / 2010-12 Edition 1.0 "Battery Charge Controllers for Photovoltaic Systems – Performance and Functioning".

On the basis of the test results (CMLmppt 10) that are laid down in the measurement protocol (test report) dated 10.08.2015 herewith we confirm that the tested charge controller type fulfils or exceeds controller specifications required by IEC 62 509 / 2010-12 Edition 1.0.

Remarks
1. This certificate is only valid in combination with above mentioned test report.
2. Any change in the electronic design, materials, components or processing of the CMLmppt 10 charge controllers may require a repetition of some or all qualification tests to maintain type approval.

Freiburg,
August 10th, 2015

Fraunhofer-Institut für
Solare Energiesysteme ISE
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Confirmed

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Head of Testing Team

Test and Measurement Protocol
- Charge Controllers -

Tests according to IEC 65 209:2010

Model/Type
Phocos CMLmppt

DuT	Serial Number	Reference number	Date	Update
1	150429 0015	CMLMP1-phc-2007	10.08.2015	
2	150429 0013	CMLMP2-phc-2007		

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DuT: Phocos CMLmppt
Ref. nr.:   CMLMP1-phc-2007

Tests based on standard / requirements: **IEC 62 509 / 2010-12 Ed. 1.0**

General remarks, recommendations
The charge controller family CMLup of phocos AG are professional manufactured charge controllers.The performance in all areas (efficiency, protection features, self-consumption etc.) is very high. The voltage thresholds are well adjusted and the displayed information via LEDs is suitable for the user. The charge controllers are protected against short circuit and reversed polarity PV module, short circuited and overload and reversed polarity battery using a reliable electronic fuse.

tested?	not tested (see commen		IEC 62 509 requirements	value / claim [1]	tolerance	measured value / result	requirements fulfilled?	comments
			Battery Lifetime Protection Tests					
✓			PV leakage current test	≤ 0.1 % I_N	---	171 µA	✓	@ 12.6 V; R_{PVLoop} = 150 Ohm
✓			end of charge voltage boost mode	**14.4 V**	± 1 %	14,36 V	✓	values are within ± 1 % of manufact. statement
✓			end of charge voltage overcharge / equalization mode	**14.8 V**	± 1 %	14,78 V	✓	values are within ± 1 % of manufact. statement
✓			end of charge voltage floating mode	**13,8 V**	± 1 %	13,50 V	✓	values are within ± 1 % of manufact. statement
✓			low voltage disconnect @ 0.1 x I_{10}	**11.0 V**	± 2 %	11.04 V	✓	values are within ± 2 % of manufact. statement
✓			temperature compensation HVD	**- 5 mV/cell/°C**	n. d.	3,7 to 4,2 mV/cll/°C	✓	From ISE perspective a range of -3 to -6 mV/cell/°C is o.k.!
			Energy Performance Tests					
✓			self-consumption (including lights / LCD)	0.1 % I_N	n. d.	7,3 mA	✓	max. self consumption
✓			charge efficiency	n. d.	n. d.	97,2 %	✓	at max. current
✓			discharge efficiency	n. d.	n. d.	99,2 %	✓	at max. current
			charging technology	MPPT				For information only

[1] Values in **bold** are recommended values according to IEC 62 509

➔ next page

Overview Evaluation / Summary, page 2/2

tested?	not tested (see comment)	IEC 62 509 requirements	Value / claim	tolerance	measured value / result	requirements fulfilled?	comments
		Protection and Fail Safe Tests					
✓		protection against wrong polarity battery	compulsory	---	o.k.	✓	
✓		battery open circuit test	compulsory	---	o.k.	✓	Load voltage 0 V @ removed battery
✓		protection against wrong polarity module	compulsory	---	o.k.	✓	
✓		protection against shorted load	compulsory	---	o.k.	✓	
✓		PV overcurrent protection test	$1.25 \times I_N$ @ 25 °C	---	o.k.	✓	MPPT Power limitation
✓		Load overcurrent protection test	$1.25 \times I_N$ @ 25 °C	---	12,5 A	✓	
✓		Thermal performance test	I_{PVmax} and $I_{Loadmax}$ @T_{max} for 1 h	---	o.k.	✓	test with max. currents at 45 °C ambient temperature for 1 hour
		User Interface Tests					
✓		display (charging, batt. charged, discharged)	charging	n. d.	available	✓	Signalled by LED
✓			batt. charged	n. d.	available	✓	Signalled by LEDs
✓			discharg. batt.	n. d.	available	✓	Signalled by LED
✓		The following lettering / labelling should be available: manufacturer, model/type, serial no, rated voltage, max. charge current, max. load current, terminals, display, fuses	must be durable	---	o.k.	✓	The availability of lettering/Labelling is not postulated by IEC 62 509. From Fraunhofer ISE perspective a labelling should be available. Visual test
✓		Complete documentation should be available: data sheet, user manual, installation instructions, operation instructions, trouble shooting guide, calibration instructions (if on site calibration is possible) , safety instructions, warranty, information about spare parts	---	---	o.k.	✓	The availability of documentation is not postulated by IEC 62 509. From Fraunhofer ISE perspective a documentation should be available. Visual test.

n.d. = not defined

T_{max} = manufacturer's specified max. rated ambient operation temperature

I_N = nominal current

I_{PVmax} = manufacturer's specified max. PV current

$I_{Loadmax}$ = manufacturer's specified max. load current

1 Pretests

1.1 Information given by the manufacturer

Manufacturer		phocos AG
Country/Origin		Germany
Model/Type		CMLmppt
Serial / Batch Nr.	1	150429 0015
	2	150429 0013

Mechanical data

Dimensions (l * w * h) [mm]	38*127*126
Weight [g]	260
Case material	plastic
Protection class (IP)	20
Case mounting	screws
Connection type	screws
Cable stress relief	n.a.
Cable diameter [mm²]	16
Label	yes

Electrical data

At ambient temperature of [°C]		25 °C			
Rated voltage		12V		24V	x	12 & 24V
Automatic adjustment 12/24V	x	yes				no
Max. module power [W]		---				
Max. charge current [A]		10 @ 45 °C				
Max. discharge current [A]		10 @ 45 °C				
Type of controller		shunt		serial	x	other: MPPT
Technique of regulation		two point		PWM	x	other: MPPT
Self consumption [mA]		< 10 mA				
End of charge voltage [V]		13.8 / 27,6 (float voltage)				
return switch-on voltage (two point regulation) [V]		--				
load disconnect warning on [% SOC]		--				
load disconnect voltage [V]		11.0 / 22.0				
time delay at load sheding [s]		no information				
Reconnection voltage load [V]		12.8 / 25.6				
time delay at reconnection [s]		no information				
load reconnection manually [V]		no				
operation temperature range [°C]		-40 up to +50				
display	x	LED		LCD		LED & LCD	

Information given by the manufacturer (continued)

Additional functions

boost/gassing function	x	yes				no
boost activation voltage [V]		< 12.3 / 24.6				
final boost voltage [V]		14.4 / 28.8 (25°C), 2 h				
equalization activation voltage [V]		< 12.1 / 24.2				
final equalization (gassing) voltage [V]		14.8 / 29.6 (25°C) 2 h				
Temperature compensation	x	yes				no
temperature compensation [mV/K*cell]		-4,2				
Battery voltage sensor		yes			x	no
DC/DC-Converter		yes			x	no
MPPT	x	yes				no
adjustable for different battery types	x	yes				no
adjustable thresholds		yes			x	no
end of charge [V]		min.				max.
load disconnect [V]		min.				max.
selectable priority at load disconnection		yes			x	no
Protection against reversed battery polarity	x	yes[1]		no		not specified
Protection against reversed PV polarity	x	yes[1]		no		not specified
Others	USB-Charger					
	Jumpers for Alarm, LVD and Battery type					

[1] Electronic protection

listed values rated for	x	12V	x	24V

Others

Interfaces	no
Price	not available
Service	only manufacturer website
Warranty	no information

1 Pretests

1.2 Visual Inspection

Connection type		plug	x	screw		other:		
Cable stress relief		o.k.		not o.k.	x	not available		
Cable diameter stranded [mm²]		2,5		4		6	x	16
Cable diameter solid [mm²]		2,5		4		6	x	16
Case quality		very good	x	good		bad		
Connector quality		very good	x	good		bad		
Electronic quality	x	very good		good		bad		
Packing of charge controller		very good	x	good		bad		
Lettering of packing	x	very good		good		bad		
Fuse changing		very good		good		bad	x	n.a. [1]
Mounting of charge contr.		very good	x	good		bad		
Others:								
Comment quality	very good quality							
Damages		yes			x	no		

Lettering of the charge controller

Manufacturer	x	yes		no		
Model / type	x	yes		no		
Serial / batch number	x	yes		no		
Nominal voltage	x	yes		no		
Connectors	x	yes		no		
Fuse		yes		no	x	n.a. [1]
LED, displays	x	yes		no		
Comment labeling:	o.k.					

Documentation

Data sheet	x	o.k.		not o.k.		not available
User manual						
Operating instructions	x	o.k.		not o.k.		not available
Troubleshooting guide	x	o.k.		not o.k.		not available
Safety instructions	x	o.k.		not o.k.		not available
Installation instructions	x	o.k.		not o.k.		not available
Calibration instructions		o.k.		not o.k.	x	not available
Others	user manuals in different languages (german, english, french, spainish, portugese, chineese)					
Comment documentation	o.k.					

Spare parts

Fuse		availabe	x	not available [1]
Mounting parts		availabe	x	not available
Connectors		availabe	x	not available
Others				
Comment spare parts	---			

Support

Repair / Service address		availabe	x	not available
Warranty		availabe	x	not available
Others				
Comment support	a support address should be given			

[1] Electronic protection

Is it possible to test the charge controller?	x	yes		no
IEC 62 509 requirements fulfilled?	x	passed		failed
If failed, reason?	------------------------------			

2 Battery Lifetime Protection Tests

2.1 Leakage Current

Ambient temperature	25,5	°C
Rated voltage	12,0	V

DuT		1	
Reference	CMLMP1-phc-2007		
Inspector	bg		

<

Test	Behaviour / results			
	Revers current [µA]			
Protection against night discharge of the battery (leakage current)	171,2	p	Vbatt: 12.6 V PV loop resistor: 150 Ohm	

Used measurement equipment:	Vbat:	Zimmer LMG95
	Ibat:	---
	Vpv:	---
	Ipv:	Fluke 87
	Vload:	---
	Iload:	---
	Ta:	Maxim DS18S20

DuT = device under test

p/f = passed / failed

IEC 62 509 requirements?

If failed, reason?

x	passed		failed

2 Battery Lifetime Protection Tests

2.2 Set-points

Ambient temperature	25,5	°C
Rated voltage	12,0	V

DuT		1	
Reference	CMLMP1-phc-2007		
Inspector		bg	

Voltage thresholds	Specification (manufacturer) [V]	Measured [V] DuT 1		DuT 2		p / f	Remarks
		Regula-tion start	Cut-off				
End of charge voltage (floating)	13,8	13,74	13,76			p	
final voltage equalisation (gassing)	14,8	14,76	14,79			p	Only if flooded battery is selected.
final voltage boost	14,4	14,35	14,37			p	
		LVD	LVR				
Deep discharging cut-off voltage	11,0	11,04				p	Alarm before Cut-Off
Reconnect voltage load	12,8		12,76			p	

Time delay load disconnect [s]	appr. 1min.		
Time delay load reconnect [s]		0	
Type of controller	MPPT		
equal to manufacturer data	x	yes		no

Used measurement equipment:	Vbat:	Zimmer LMG 95
	Ibat:	Zimmer LMG 95
	Vpv:	Oscilloscope Agilent DSO-X-3014A
	Ipv:	Zimmer LMG 95
	Vload:	Zimmer LMG 95
	Iload:	Zimmer LMG 95
	Ta:	Maxim DS18S20

DuT = device under test

p/f = passed / failed

IEC 62 509 requirements / recommendations?

If failed, reason?

x	passed		failed

2 Battery Lifetime Protection Tests

2.3 Temperature Compensation of the Set-points

Ambient temperature	see below	°C		DuT	1	
Rated voltage	12,0	V		Reference	CMLMP1-phc-2007	
				Inspector	bg	

Voltage thresholds	ambient temperature [°C]				temp. comp [mV/K] / cell	DuT
	@ 25,5 °C		@ Temp. °C			1
End of charge voltage (float) [V] [1)2)]	13,74	13,42	39,0		-3,8	1
	13,76	13,45	39,0		-3,7	1
Equalization voltage [V] [1)2)]	14,76	14,42	39,0		-4,0	1
	14,79	14,44	39,0		-4,2	1
Boost voltage [V] [1)2)]	14,35	14,01	39,0		-4,0	1
	14,37	14,02	39,0		-4,2	1
Deep discharging cut-off voltage [V]	11,04	11,04	39,0	stable		1
Reconnect voltage load [V]	12,76	12,76	39,0	stable		1

[1)] regulation start

[2)] cut off

Remarks	Equalization charge only in flooded battery mode.
Used measurement equipment:	Vbat: Zimmer LMG 95
	Ibat: Zimmer LMG 95
	Vpv: Oscilloscope Agilent DSO-X-3014A
	Ipv: Zimmer LMG 95
	Vload: Zimmer LMG 95
	Iload: Zimmer LMG 95
	Ta: Maxim DS18S20

IEC 62 509 requirements?	x	passed	failed
If failed, reason?			

3 Energy Performance Tests

3.1 Self Consumption Tests

Ambient temperature	26,0	°C
Rated voltage	12,0	V

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector	bg	
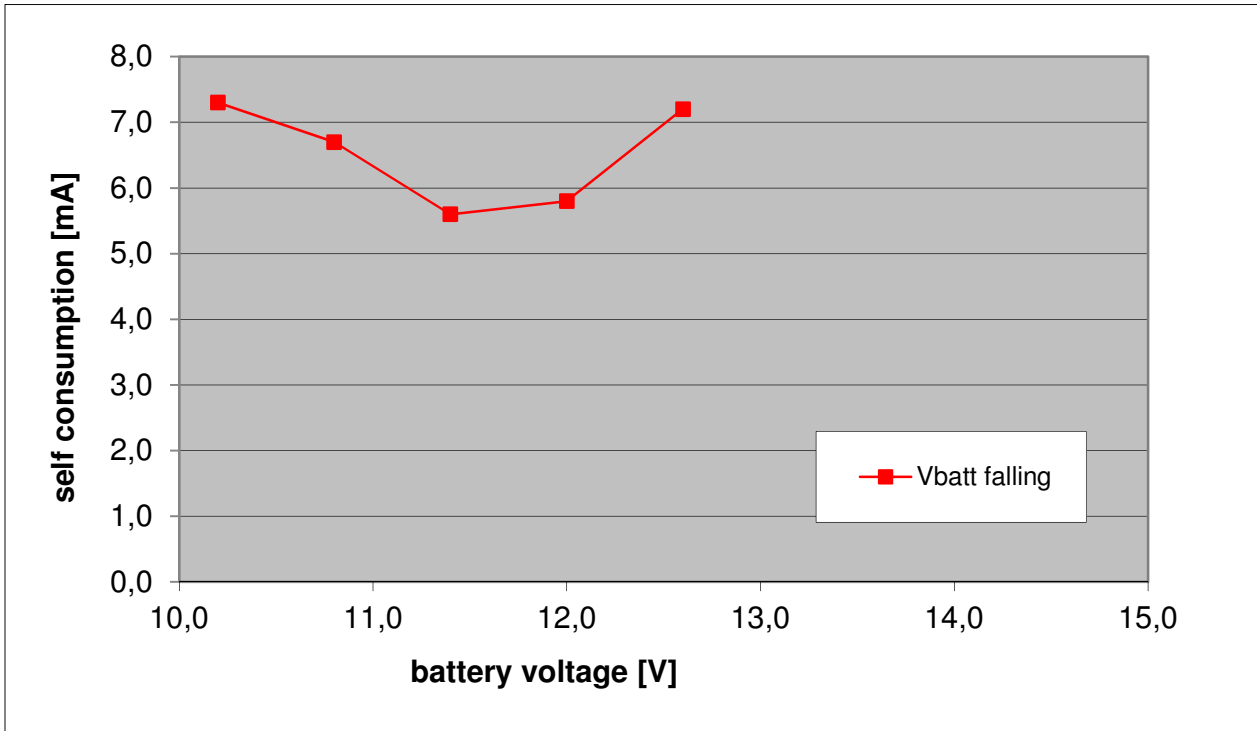
				DuT
max. selfconsumption	7,3	mA @	10,2 V	1
average selfconsumption	6,5	mA @	12.6 - 10.2 V	1

Comment	
Used measurement equipment:	Ibat: Fluke 87
	Ubat: Zimmer LMG 95
	Ta: Maxim DS18S20

IEC 62 509 requirements? | x | | | failed |

If failed, reason?

Measured data

Nr.	Batt. Volt. [V]	Self consumpt. [mA]	Self consumpt. [mW]	DuT	Comment
1	12,6	7,2	90,7	1	3 State of charge Leds On
2	12,0	5,8	69,6	1	1 State of charge Led On
3	11,4	5,6	63,8	1	1 State of charge Led flashing
4	10,8	6,7	72,4	1	Load status Led On
5	10,2	7,3	74,5	1	Load status Led On

3 Energy Performance Tests

3.2 Efficiency Tests

Ambient temperature:	25,1	°C
Rated voltage:	12,0	V
Rated max. charge current:	10,0	A
Rated max. discharge current:	10,0	A

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector:	NP	

3.2.1 Charging efficiency @ 10 % to 100 % rated charging current

PV-Module			Battery			efficiency	Vpv-Vbat	DuT
[V]	[A]	[W]	[V]	[A]	[W]	[%]	[V]	
17,24	0,60	10,34	13,22	0,78	10,31	99,7	4,02	1
18,49	1,11	20,52	13,21	1,53	20,21	98,5	5,28	1
18,73	2,13	39,89	13,21	2,93	38,71	97,0	5,52	1
18,50	5,13	94,91	13,21	7,05	93,13	98,1	5,29	1
18,72	7,66	143,40	13,21	10,55	139,37	97,2	5,51	1
21,92	6,45	141,38	13,20	10,20	134,64	95,2	8,72	1

3.2.2 Discharging efficiency @ 100 % rated load current

Battery			Load			efficiency	Vbat-Vload	DuT
[V]	[A]	[W]	[V]	[A]	[W]	[%]	[V]	
13,21	10,47	138,31	13,11	10,47	137,26	99,2	0,10	1

min. discharge efficiency [%]:   99,2

Remarks: Because of the DC/DC converter PV and battery currents and voltages are different very high efficiencies		
Used measurement equipment:	Vbat:	Zimmer LMG 95
	Ibat:	Zimmer LMG 95
	Vpv:	Zimmer LMG 95
	Ipv:	Zimmer LMG 95
	Vload:	Zimmer LMG 95
	Iload:	Zimmer LMG 95
	Ta:	Maxim DS18S20

IEC 62 509 requirements? | x | p | | | f |

If failed, reason?

Charge efficiencies
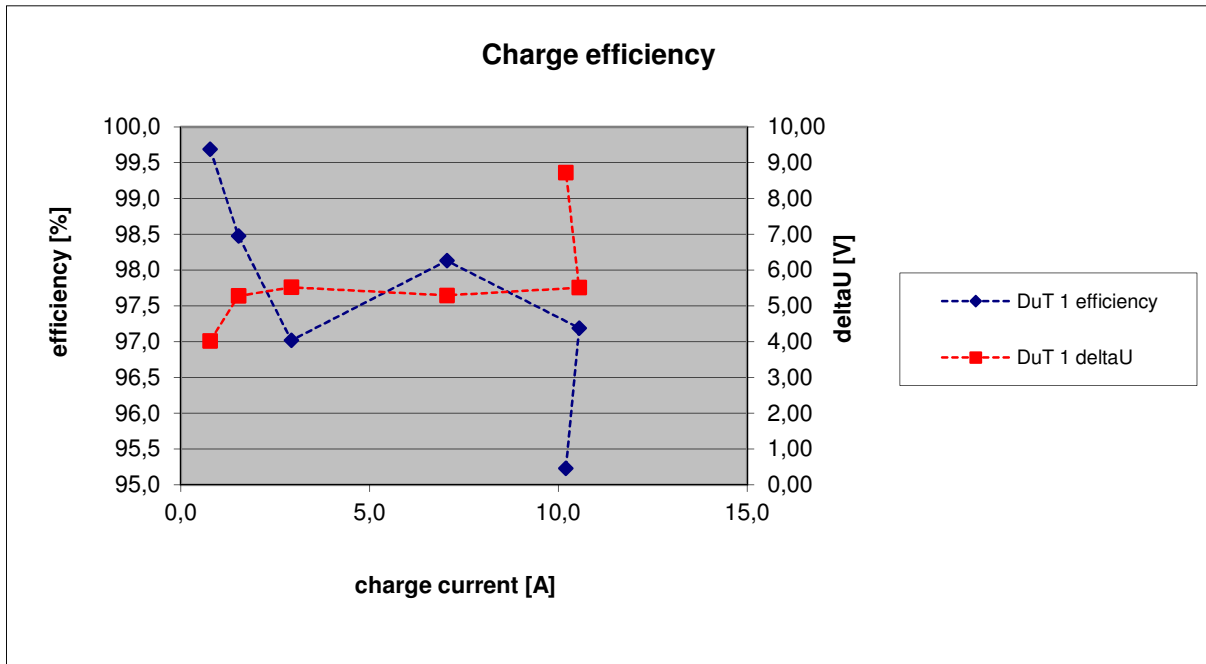
4 Protection and Fail-Safe Tests

4.1 Thermal Performance Tests

Ambient temperature:	see below
Rated voltage:	12 V
Rated max. charge current:	10 A
Rated max. discharge current:	10 A

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector:	bg	

Test at extented ambient temperature

time	PV-module		Battery		Load		$T_{heatsink}$	$T_{ambient}$	DuT	Comment
[min]	[V]	[A]	[V]	[A]	[V]	[A]	[°C]	[°C]		
0	20,95	6,9	13,21	0,7	13,11	10,1	45,5	44,0	1	
5	20,95	7,0	13,21	0,6	13,12	10,1	47,0	45,0	1	
10	20,95	7,0	13,21	0,7	13,11	10,1	47,0	44,5	1	
15	20,95	6,9	13,21	0,8	13,11	10,1	47,0	44,5	1	
20	20,95	6,9	13,21	0,7	13,11	10,1	48,0	45,0	1	
25	20,95	7,0	13,21	0,7	13,12	10,1	48,0	45,0	1	
30	20,95	7,0	13,21	0,7	13,12	10,1	48,0	45,0	1	
35	20,95	7,0	13,20	0,6	13,11	10,1	47,5	45,0	1	
40	20,96	7,0	13,21	0,7	13,11	10,1	48,0	45,0	1	
45	20,96	7,1	13,21	0,6	13,12	10,1	47,5	45,0	1	
50	20,96	7,1	13,21	0,7	13,11	10,1	48,0	45,0	1	
55	20,96	7,0	13,21	0,7	13,11	10,1	47,5	45,0	1	
60	20,96	7,0	13,21	0,7	13,11	10,1	48,0	45,0	1	

Remarks:

Used measurement equipment:	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Maxim DS18S20
	Tc:	Maxim DS18S20

IEC 62 509 requirements?

x	p		f

If failed, reason?

4 Protection and Fail-Safe Tests

4.2 Overcurrent protection tests

Ambient temperature:	see below °C
Rated voltage:	12,0 V
Rated max. charge current:	10,0 A
Rated max. discharge current	10,0 A

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector:	bg	

4.2.1 PV overcurrent protection test

time	PV-module		Battery		Remark	$T_{heatsink}$	$T_{ambient}$	DuT
[min]	[V]	[A]	[V]	[A]		[°C]	[°C]	
0	20,94	7,6	13,45	11,0		31,0	29,5	1
15	20,95	7,2	13,44	10,7		30,5	28,5	1
30	20,95	7,3	13,44	10,7	The PV Power is limited by the BCC to Pmax = 150 W	30,5	28,0	1
45	20,95	7,2	13,44	10,7		30,5	28,0	1
60	20,95	7,2	13,44	10,7		30,5	28,0	1

4.2.2 Load overcurrent protection test

time	Remark	Battery		Load		$T_{heatsink}$	$T_{ambient}$	DuT
[min]		[V]	[A]	[V]	[A]	[°C]	[°C]	
0		12,00	12,6	11,88	12,5	28,5	27,0	1
15		12,00	12,6	11,88	12,6	28,5	27,0	1
30		12,00	12,7	11,88	12,6	28,5	27,5	1
45		12,00	12,6	11,88	12,6	29,0	27,5	1
60		12,00	12,6	11,88	12,6	29,0	28,0	1

Used measurement equipment:	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Maxim DS18S20
	Tc:	Maxim DS18S20

IEC 62 509 requirements?

If failed, reason?

x	passed		failed

4 Protection and Fail-Safe Tests

4.3 Protection Against Reversed Polarity and Short Circuits

Ambient temperature	25,5	°C
Rated voltage	12,0	V

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector	bg	

Test	Behaviour / results		
	DuT 1	p/f	remarks
Protection against short circuited PV[1]		p	Voc = 21 V Ipv = 1 A
Protection against reversed polarity PV Module		p	
Protection against short circuited load[1]		p	Iload = 1 A
Operation with reversed polarity battery		p	Load status Led indicates the reverse battery voltage.The reverse voltage was fed to the load. The charge controller didn't suffer any damage. According to the manual there is a warning to reverse the polarity.

p/f: passed/failed

[1] Not mandatory according to IEC 62 509

Remarks	the charge controller is protected against short circuited PV, reversed polarity PV module, short circuited load, overload and reversed polarity battery
Used measurement equipment:	Vbat: Zimmer LMG95
	Ibat: Zimmer LMG95
	Vpv: Zimmer LMG95
	Ipv: Zimmer LMG95
	Vload: Zimmer LMG95
	Iload: Zimmer LMG95
	Ta: Maxim DS18S20

IEC 62 509 requirements? | x | passed | | failed

If failed, reason?

4 Protection and Fail-Safe Tests

4.4 Battery Open Circuit Test

Ambient temperature	25,1	°C
Rated voltage	12,0	V

DuT	1	
Reference	CMLMP1-phc-2007	
Inspector	NP	

Test	Behaviour / results			DuT
operating with disconnected battery	Load will be switched off.			1
	V load = 0,0 V	p	Passed/failed	
removing battery during normal operation	Load will be switched off.			1
	V load = 0,0 V	p	Passed/failed	

Remarks	
Used measurement equipment:	Vbat: Zimmer LMG95
	Ibat: Zimmer LMG95
	Vpv: Zimmer LMG95
	Ipv: Zimmer LMG95
	Vload: Zimmer LMG95
	Iload: Zimmer LMG95
	Ta: Maxim DS18S20

IEC 62 509 requirements?

x	p		f

If failed, reason?

5 User Interface Tests

5.1 Display

Ambient temperature			DuT	1	
Rated voltage			Reference	CMLMP1-phc-2007	
			Inspector	bg	

		DuT
charging indication	yes, 1 green LED	1
battery charged indication (charge status)	yes, 3 Leds	1
load cut off warning	yes, acoustic signal	1
battery discharged indication (load disconnection)	yes, 1 red LED	1

Remarks:		
Used measurement equipment:	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Maxim DS18S20

IEC 62 509 requirements?	x	p		f
If failed, reason?				

Overview of measurement equipment used (following DIN ISO 9001:2000)

device	type	measured dimensions	reference number following DIN EN ISO 9001:2000
HP 34401A	Precision system-multimeter	voltages, currents up to 3 A	421-DC-10 421-DC- 11
Zimmer LMG 95	Precision-wattmeter	voltages, currents up to 40 A, power	421-DC-16 421-DC-25 421-LI-5
Temperature sensors	Maxim DS18S20	temperatures	
Agilent DSO-X 3014A	4-channel-digital oszilloscope	control of PWM behaviour	
Fluke 87	multimeter	voltage, current, resistor	421-DC-17 / 421-DC-18

Das Management-System vom

Fraunhofer-Institut für
Solare Energiesysteme ISE

Heidenhofstraße 2
DE-79110 Freiburg

wurde auditiert und hat den Nachweis erbracht, dass die Anforderungen folgender Norm erfüllt werden

ISO 9001:2008

Die Zertifizierung umfasst

Forschung, Entwicklung und Dienstleistungen auf den Gebieten thermische und elektrische Solarenergienutzung, Gebäudetechnik und Wasserstofftechnologie

Weitere Einzelheiten zum Geltungsbereich dieses Zertifikats und der Anwendbarkeit der
Anforderungen der Norm ISO 9001:2008 können bei der Organisation erfragt werden

Dieses Zertifikat ist gültig vom 30/04/2013 bis 29/04/2016
Ausgabe 5. Zertifiziert seit März 2001

Freigegeben durch

Mark Piekereit
Geschäftsführer

Christian Rathje
Leiter der Zertifizierungsstelle

TGA-ZM-17-93-00

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