Fraunhofer
ISE

Certificate
No. 1015 / FhG-ISE / 001

Manufacturer: phocos China Ltd.
Charge regulator type: CIS MPPT 85/20

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 (CIS MPPT 85/20) that are laid down in the measurement protocol (test report) dated 22.05.2014 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 CIS MPPT 85/20 charge controllers may require a repetition of some or all qualification tests to maintain type approval.

Freiburg,
October 7th, 2015

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Test and Measurement Protocol
- Charge Controllers -

Tests according to IEC 65 209:2010

Model/Type
Phocos CIS MPPT 85/20

DuT	Serial Number	Reference number	Date	Update
1	131121 0117	CIS201-phc-1405	22.05.2014	
2	131121 0118	CIS202-phc-1405		

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DuT: Phocos CIS-MPPT 85/20
Ref. nr.: CIS201-phc-1405 / CIS202-phc-1405

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

General remarks, recommendations

The charge controller family CIS mppt 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. 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	---	252 µA	✓	@ 12.6 V; R_{PVLoop} = 150 Ohm
✓			end of charge voltage boost mode	**14.4 V**	± 1 %	14.38 V	✓	(start of PWM, at 24.4 °C); values are within ± 1 % of manufact. statement
✓			end of charge voltage overcharge / equalization mode	**14.7 V – 15.3 V**	± 1 %	14.79 V	✓	(start of PWM, at 24.4 °C); values are within ± 1 % of manufact. statement
✓			end of charge voltage floating mode	**14.1 V**	± 1 %	13.75 V	✓	(start of PWM, at 24.4 °C); values are within ± 1 % of manufact. statement
✓			low voltage disconnect @ 0.1 x I_{10}	**11.7 V – 12.0 V**	± 2 %	10.86 V	✓	11.0 < Vbatt < 12.0 according to programming
✓			temperature compensation HVD	**- 5 mV/cell/°C**	n. d.	-3.0 to -5.0 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.	12.8 mA	✓	average self-consumption 10.2 – 12.6 V
✓			charge efficiency	n. d.	n. d.	94.1 %	✓	at max. battery current
✓			discharge efficiency	n. d.	n. d.	97.8 %	✓	at max. battery current
			charging technology	MPPT				For information only

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

➔ next page

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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 x I_N @ 25 °C	---	21.9 A	✓	charge contr. limits current to 21.9 A
✓			Load overcurrent protection test	1.25 x I_N @ 25 °C	---	25 A	✓	auto disconnect after 2 min.
✓			Thermal performance test	I_{PVmax} and $I_{Loadmax}$ @T_{max} for 1 h	---	o.k.	✓	test with max. charging current at 60 °C ambient temperature for 1 hour
			User Interface Tests					
✓			display (charging, batt. charged, discharged)	charging	n. d.	available	✓	Moving bar graph
✓				batt. charged	n. d.	Not available		
✓				discharg. batt.	n. d.	available	✓	Signalled by LEDs
✓			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		Deutschland
Model/Type		CIS-MPPT 85/20
Serial / Batch Nr.	1	131121 0117
	2	131121 0118

Mechanical data

Dimensions (l * w * h) [mm]	150 * 130 * 43 (l*h*w)
Weight [g]	1287
Case material	metall, black
Protection class (IP)	68
Case mounting	screws
Connection type	cable strand
Cable stress relief	n.a.
Cable diameter [mm²]	n.a.
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]	20 @ 60 °C						
Max. discharge current [A]	20 @ 60 °C						
Type of controller		shunt	x	serial		other:	
Technique of regulation		two point		PWM	x	other: MPPT	
Self consumption [mA]	7 - 15						
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 - 12.0 / 22.0 - 24.0 programmable						
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 +60						
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	x	yes			no
MPPT	x	yes			no
adjustable for different battery types	x	yes			no
adjustable thresholds	x	yes software adjustable			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)]			not specified
Protection against reversed PV polarity	x	yes[1)]			not specified
Others	Dimming function				
	optical interface for programing				
	external temperature sensor				
	night light function				

[1)] Electronic protection

listed values rated for x 12V 24V

Others

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

1 Pretests

1.2 Visual Inspection

Connection type		plug		screw	x	other: cables		
Cable stress relief	x	o.k.		not o.k.		not available		
Cable diameter stranded [mm²]	x	2,5		4		6		16
Cable diameter solid [mm²]		2,5		4		6		16
Case quality	x	very good		good		bad		
Connector quality		very good		good		bad		
Electronic quality		very good		good		bad	not visible	
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	27,0 °C
Rated voltage	12,0 V

DuT	1	2
Reference	CIS201-phc-1405	
Inspector	fs	

Test	**Behaviour / results** 1	p/f	remarks	DuT
	Revers current [µA]			
Protection against night discharge of the battery (leakage current)	252	p	Vbatt: 12.6 V PV loop resistor: 72 Ohm	

Used measurement equipment	Vbat:	Zimmer LMG95
	Ibat:	---
	Vpv:	---
	Ipv:	HP 34401A
	Vload	---
	Iload:	---
	Ta:	Tinsley 5885A

DuT = device under test
p/f = passed / failed

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

2 Battery Lifetime Protection Tests

2.2 Set-points

Ambient temperature	24,4 °C
Rated voltage	12,0 V

DuT	1	2
Reference	CIS201-phc-1405	
Inspector	fs	

Voltage thresholds	Specification (manufacturer) [V]	Measured [V] DuT 1		DuT 2		p / f	Remarks
		PWM start	Cut-off				
End of charge voltage (floating)	13,8	13,75	13,80			p	
final voltage equalisation (gassing)	14,8		14,79			p	DUT 3
final voltage boost	14,4	14,38	14,40			p	
Load disconnect warning on							
Deep discharging cut-off voltage	11.00 - 12.02	10,86				p	default setting is 10,984V (Base Voltage LVD)
Reconnect voltage load	12,8	12,80				p	

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

Used measurement equipment	Vbat:	Zimmer LMG 95
	Ibat:	Zimmer LMG 95
	Vpv:	Oscilloscope Agilent DSO-X-3032A
	Ipv:	Zimmer LMG 95
	Vload	---
	Iload:	Zimmer LMG 95
	Ta:	Tinsley 5885A

DuT = device under test
p/f = passed / failed

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

2 Battery Lifetime Protection Tests

2.3 Temperature Compensation of the Set-points

Ambient temperature	see below	°C
Rated voltage	12	V

DuT	1	2
Reference	CIS201-phc-1405	
Inspector	fs	

Voltage thresholds	ambient temperature [°C]				temp. comp [mV/ K*cell]	DuT
	@ 24,4 °C		@ Temp. °C			1
End of charge voltage (float) [V] 1)2)	13,75	13,47	40,9		-3,0	1
	13,80	13,53	39,1			1
Equalization voltage [V] 1)2)	0,00		40,9		0,0	1
	14,79	14,42	40,0		-4,1	3
Boost voltage [V] 1)2)	14,31	13,85	40,4		-5,0	1
	14,44	13,98	40,4			1
Deep discharging cut-off voltage [V]	10,86	10,99	39,8		1,5	1
						1
Reconnect voltage load [V]	12,80	12,80	39,8	stable	0,0	1

1) PWM start
2) cut off

Remarks	Boost voltage should also be compensated	
Used measurement equipment	Vbat:	Zimmer LMG 95
	Ibat:	Zimmer LMG 95
	Vpv:	Oscilloscope for controling PWM behaviour
	Ipv:	Zimmer LMG 95
	Vload:	Zimmer LMG 95
	Iload:	Zimmer LMG 95
	Ta:	Tinsley 5885A

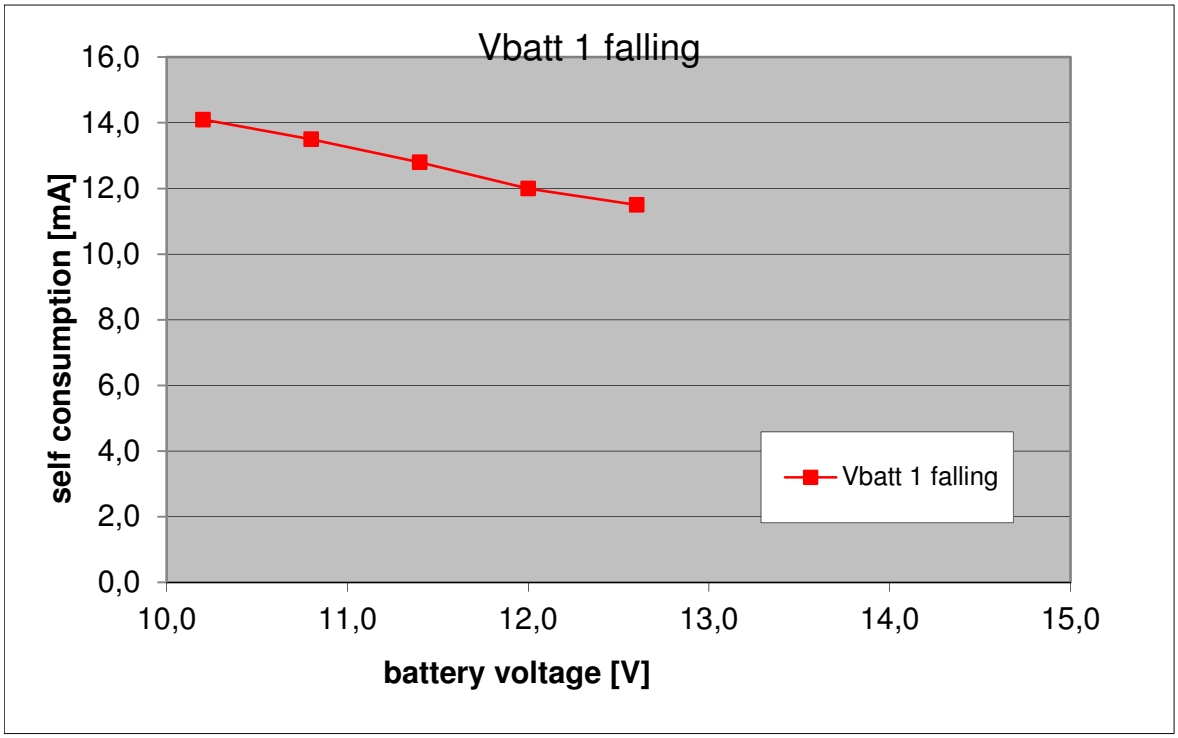
IEC 62 509 requirements?	x	passed		failed
Model/Type				

3 Energy Performance

3.1 Self Consumption Tests

Ambient temperature	24,9	°C
Rated voltage	12,0	V

DuT	1	2
Reference	CIS201-phc-1405	
Inspector	fs	



				DuT
max. selfconsumption	14,1	mA @	10,2 V	1
average selfconsumption	12,8	mA @	12.6 - 10.2 V	1

Comment		
Used measurement equipment	Ibat:	HP 34401A
	Ubat:	Zimmer LMG 95
	Ta:	Tinsley 5885A

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

Measured data

Nr.	Batt. Volt. [V] ↑ ↓	Self consumpt. [mA] ↓	Self consumpt. [mW] ↓	DuT
1	12,6	11,5	144,9	1
2	12,0	12,0	144,0	1
3	11,4	12,8	145,9	1
4	10,8	13,5	145,8	1
5	10,2	14,1	143,8	1
6				

3 Energy Performance

3.2 Efficiency Tests

Ambient temperature:	25,3	°C
Rated voltage:	12,0	V
Rated max. charge current:	20,0	A
Rated max. discharge current:	20,0	A

DuT	3	
Reference	CIS203-phc-1405	
Inspector:	fs	

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]	
41,08	0,70	28,59	13,20	2,00	26,40	92,3	27,88	3
40,63	1,39	56,48	13,20	4,06	53,59	94,9	27,43	3
40,06	2,10	84,09	13,23	6,02	79,62	94,7	26,83	3
39,56	2,81	111,16	13,25	8,00	106,00	95,4	26,31	3
38,95	3,54	137,88	13,20	10,00	132,00	95,7	25,75	3
38,90	4,29	166,88	13,21	12,00	158,52	95,0	25,69	3
38,80	5,00	194,00	13,21	14,08	185,95	95,9	25,59	3
38,64	5,81	224,50	13,18	16,09	212,07	94,5	25,46	3
38,40	6,56	251,90	13,19	18,00	237,42	94,3	25,21	3
38,44	7,30	280,61	13,19	20,02	264,06	94,1	25,25	3

3.2.2 Discharging efficiency @ 100 % rated load current

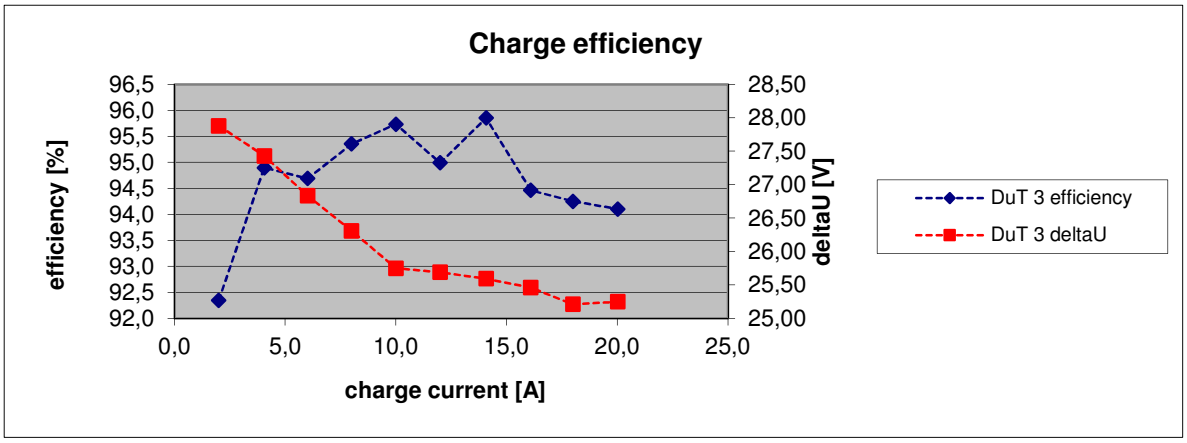
Battery			Load			efficiency	Vbat-Vload	DuT
[V]	[A]	[W]	[V]	[A]	[W]	[%]	[V]	
12,60	20,00	252,00	12,37	19,95	246,70	97,9	0,23	3
13,01	20,01	260,33	12,76	19,96	254,69	97,8	0,25	3

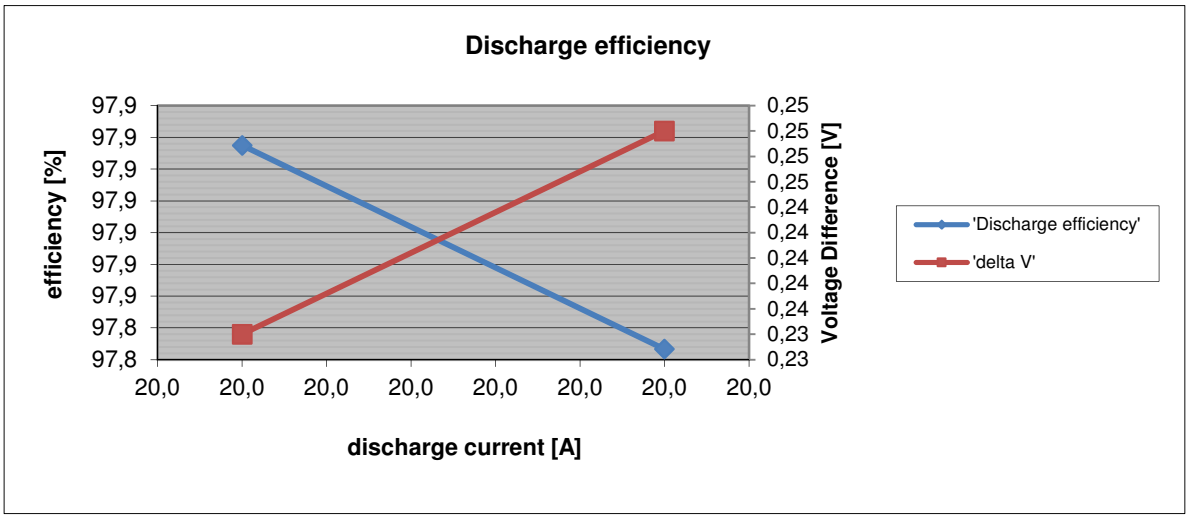
min. discharge efficiency [%]: 97,9 +/- 0,4

Remarks: 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:	Tinsley 5885A

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

Charge and discharge efficiencies





4 Protection and Fail-safe Tests

4.1 Thermal Performance Tests

Ambient temperature:	see below
Rated voltage:	12 V
Rated max. charge current:	20A
Rated max. discharge current:	20A

DuT	3	2
Reference	CIS203-phc-1405	
Inspector:	fs	

Test at extented ambient temperature

time	PV-module		Battery		load		T_{case}	$T_{ambient}$	DuT	Comment
[min]	[V]	[A]	[V]	[A]	[V]	[A]	[°C]	[°C]		
0	38,2	7,2	12,8	20,0	12,9	0,0	60,2	60,0	3	
15	38,3	7,2	12,8	20,0	12,8	0,0	62,7	60,5	3	
30	38,3	7,2	12,8	20,0	12,8	0,0	64,2	60,7	3	
45	38,3	7,2	12,8	20,0	12,8	0,0	64,8	60,4	3	
60	38,3	7,2	12,8	20,0	12,8	0,0	65,7	60,5	3	

Remarks: As per manual, at 60°C CIS-MPPT 85/20 can only have full current on panel or load, not simultaneously. Therefore only the PV input was set to max. power which results in a battery current of 20A

Used measurement equ	Vbat	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vloa	Zimmer LMG95
	Iload	Zimmer LMG95
	Ta:	Tinsley 5885A
	Tc:	Tinsley 5885A

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	20,0	A
Rated max. discharge curre	20,0	A

DuT	3	
Reference	CIS203-phc-1405	
Inspector:	fs	

4.2.1 PV Overcurrent Protection Test [1)]

time	PV-module		Battery		Remark		$T_{heatsink}$	$T_{ambient}$	DuT
[min]	[V]	[A]	[V]	[A]			[°C]	[°C]	
0	37,6	8,2	13,2	21,9	charging current is limitted to 21,9A		27,0	26,6	3
15	37,8	8,2	13,2	21,9			34,0	27,7	3
30	37,9	8,2	13,2	21,8			39,1	27,9	3
45	37,9	8,1	13,2	21,8			43,2	28,1	3
60	37,9	8,2	13,2	21,8			46,0	27,5	3

4.2.2 Load Overcurrent Protection Test [1)]

time	Remark		Battery		load [2)]		$T_{heatsink}$	$T_{ambient}$	DuT
[min]			[V]	[A]	[V]	[A]	[°C]	[°C]	
0	after 2 minutes the current gets limited by PWM. After another minute the the load is reconnectod for 2 minutes again. This cycle continues, it was stopped after 30 minutes by FS		11,0	25,0	10,7	25,0	28,2	28,5	3
2			16,2	10,3	2,3	5,2	28,2	28,8	3
3			11,0	25,0	10,7	25,0	28,9	29,0	3

Used measurement equipn	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Tinsley 5885A
	Tc:	Tinsley 5885A

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

4 Protection and Fail-Safe Tests

4.3 Protection Against Reversed Polarity and Short Circuits

Ambient temperature	25,2	°C
Rated voltage	12,0	V

DuT	3	
Reference	CIS203-phc-1405	
Inspector	fs	

Test	Behaviour / results DuT 2	p/f	remarks	
Protection against short circuited PV[1)]	test ok	p		
Protection against reversed polarity PV Module	test ok	p		
Protection against transient overvoltage (diodes, varistors)[1)]			protection via varistor according to manufacturer	
Protection against short circuited load[1)]	test ok	p		
Operation with reversed polarity battery	test not ok	p[2)]	the reverse voltage was fed to the load. The charge controller didn't suffer any damage.	

p/f: passed/failed

[1)] Not mandatory according to IEC 62 509

[2)] Manual clearly warns that load can be destroyed under those operating conditions --> pass

Remarks	the charge controller is protected against short circuited PV, reversed polarity PV Module, short circuited load, overload and reversed	
Used measurement equipment	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Tinsley 5885A

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

4 Protection and Fail-Safe Tests

4.4 Battery Open Circuit Test

Ambient temperature	25,6	°C
Rated voltage	12,0	V

DuT	1	
Reference	CIS203-phc-1405	
Inspector	fs	

Test	Behaviour / results			DuT
operating with disconnected battery	Load will be switched off;			3
	V load = 0,0 V	p	Passed/failed	
removing battery during normal operation				3
	V load = 0,0 V	p	Passed/failed	

Remarks	test with connected PV voltage (VOC = 42,5 V)	
Used measurement equipment	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Tinsley 5885A

IEC 62 509 requirements?	x	passed		failed
I/Typ If failed, reason?				

5 User Interface Tests

5.1 Display

Ambient temperature	25,7	°C
Rated voltage	12,0	V

DuT	1	2
Reference		CIS203-phc-1405
Inspector		fs

Charge Controler is equipped with a LC-Display

		DuT
charging indication	yes, blinking LED	3
battery charged indication (charge status)	no	3
load cut off warning	no	3
battery discharged indication (load disconnection)	yes, 1 red LED on	3

Remarks:		
Used measurement equipment:	Vbat:	Zimmer LMG95
	Ibat:	Zimmer LMG95
	Vpv:	Zimmer LMG95
	Ipv:	Zimmer LMG95
	Vload:	Zimmer LMG95
	Iload:	Zimmer LMG95
	Ta:	Tinsley 5885A

IEC 62 509 requirements?	x	passed		failed
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
Agilent 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 20 A, power	421-DC-16 421-DC-25 421-LI-5
Tinsley 5885A	multi channel temperature measurement device	temperatures	421-DC-24
Temperature sensors	Pt 100	temperatures in conjunction with Tinsley 5885A	421-DC-24.1 421-DC-24.2
Agilent DSO-X 3014A	4-channel-digital oszilloscope	control of PWM behaviour	
Fluke 87	multimeter	voltage, current, resistor	421-DC-17 / 421-DC-18

Certificate DE07/3874

The management system of

Fraunhofer-Institut für Solare Energiesysteme ISE

Heidenhofstraße 2
DE-79110 Freiburg

has been assessed and certified as meeting the requirements of

ISO 9001:2008

For the following activities

Research, development and service in the fields of thermal and electrical solar energy application, building services and hydrogen technology

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001:2008 requirements may be obtained by consulting the organization

This certificate is valid from 30/04/2013 until 29/04/2016
Issue 5. Certified since March 2001

Authorised by

Mark Piekereit
Managing Director

Christian Rathje
Head Of Certification Body

Deutscher Akkreditierungs Rat
TGA-ZM-17-93-00

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