

## Certificate

### No. 0817 / FhG-ISE / 001

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**Manufacturer: phocos China Ltd.**  
**Charge regulator family: CXup**

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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 that are laid down in the measurement protocol (test report 17-08-04\_Phocos\_CXup\_v5.pdf) dated 04.08.2017 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 CXup charge controllers may require a repetition of some or all qualification tests to maintain type approval.

Freiburg,  
August, 04<sup>th</sup>, 2017

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is identical to the  
original document*



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## Test and Measurement Protocol - Charge Controllers -

Tests according to IEC 62 509:2010-12



Model/Type Phocos CXup 20
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DuT	Serial Number	Reference number	Date	Update
1	170310 0009	CXup_1-phc-0417	04.08.2017	
2	170310 0007	CXup_2-phc-0417		



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Overview Evaluation / Summary, page 1/2

DuT: Phocos CXup 20  
 Ref. nr.: CXup\_1-phc-0417  
 CXup\_2-phc-0417

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

General remarks, recommendations

The charge controller family CXup of phocos AG are professional manufactured charge controllers. The performance in all areas (efficiency, protection features, self-consumption etc.) is very high. The charge controllers are protected against short circuit and reversed polarity PV module, short circuited and reversed polarity battery using a reliable electronic fuse.

tested?	not tested (see comment)		value / claim <sup>1)</sup>	tolerance	measured value / result	requirements fulfilled?	comments
		IEC 62 509 requirements					
<b>Battery Lifetime Protection Tests</b>							
<input checked="" type="checkbox"/>	<input type="checkbox"/>	PV leakage current test	$\leq 0.1 \% I_N$	---	0 $\mu$ A	<input checked="" type="checkbox"/>	@ 12.6 V; R <sub>PVLoop</sub> = 30 Ohm
<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	BCC Mode (battery)					Vented battery
<input checked="" type="checkbox"/>	<input type="checkbox"/>	end of charge voltage boost mode	<b>14.4 V<sup>2,3</sup></b>	$\pm 1 \%$	14.40 V	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	end of charge voltage overcharge / equalization mode	<b>14.7 V to 15.3 V<sup>2</sup></b> <b>14.7 V<sup>3</sup></b>	$\pm 1 \%$	14.82 V	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	end of charge voltage floating mode	<b>14,1 V<sup>2</sup></b> <b>13.8 V<sup>3</sup></b>	$\pm 1 \%$	13.80 V	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	low voltage disconnect @ 0.1 x I <sub>10</sub>	<b>11.7 V to 12.0 V</b>	$\pm 2 \%$	11.50 V	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	temperature compensation HVD	<b>- 5 mV/cell/°C</b>	n. d.	-4.1 to -4.7 mV/cell/°C	<input checked="" type="checkbox"/>	From ISE perspective a range of -3 to -6 mV/cell/°C is o.k.!
<b>Energy Performance Tests</b>							
<input checked="" type="checkbox"/>	<input type="checkbox"/>	self-consumption (including lights / LCD)	0.1 % I <sub>N</sub>	n. d.	3.5 mA	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	charge efficiency	n. d.	n. d.	99.3 %	<input checked="" type="checkbox"/>	at max. current
<input checked="" type="checkbox"/>	<input type="checkbox"/>	discharge efficiency	n. d.	n. d.	99.2 %	<input checked="" type="checkbox"/>	at max. discharge current
<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>						
<input type="checkbox"/>	<input type="checkbox"/>	charging technology	PWM/two point				For information only

1) Values in **bold** are recommended values according to IEC 62 509  
 2) Vented battery  
 3) Sealed/VRLA battery

Overview Evaluation / Summary, page 2/2

tested?		not tested (see comment)	IEC 62 509 requirements	Value / claim	tolerance	measured value / result	requirements fulfilled?	comments
<b>Protection and Fail Safe Tests</b>								
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	protection against wrong polarity battery	compulsory	---	o.k.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	battery open circuit test	compulsory	---	o.k.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	protection against wrong polarity module	compulsory	---	o.k.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	protection against shorted load	compulsory	---	o.k.	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	PV overcurrent protection test	$1.25 \times I_N$ @ 25 °C	---	25.1 A	<input checked="" type="checkbox"/>	Remarks see 4.2.1
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Load overcurrent protection test	$1.25 \times I_N$ @ 25 °C	---	25.2 A	<input checked="" type="checkbox"/>	Remarks see 4.2.2
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Thermal performance test	$I_{PVmax}$ @ $T_{max}$ for 1 h	---	o.k.	<input checked="" type="checkbox"/>	test with max. currents at 40 °C ambient temperature for 1 hour
<b>User Interface Tests</b>								
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	display (charging, batt. charged, discharged)	charging	n. d.			Signalled by LCD pictograms
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		batt. charged	n. d.			Signalled by LCD pictograms
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		discharg. batt.	n. d.			Signalled by LCD pictograms
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input checked="" type="checkbox"/>	The availability of lettering/Labelling is not postulated by IEC 62 509. From Fraunhofer ISE perspective a labelling should be available. Visual test
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input checked="" type="checkbox"/>	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	CXup
Serial / Batch Nr.	(CXup_1-phc-0417) 170310 0007 (CXup_2-phc-0417)

### Mechanical data

Dimensions (l * w * h) [mm]	101*103*31
Weight [g]	205
Case material	plastic
Protection class (IP)	20
Case mounting	2 screws
Connection type (terminal)	screws
Cable stress relief	n.a.
Cable diameter [mm <sup>2</sup> ]	16
Label	yes

### Electrical data

At ambient temperature of [°C]	25 °C			
Rated voltage	<input checked="" type="checkbox"/> 12 V	<input checked="" type="checkbox"/> 24 V	<input type="checkbox"/> 48 V	
Automatic voltage adjustment	<input checked="" type="checkbox"/> yes		<input type="checkbox"/> no	
Max. module power [W]	n.a.			
Max. charge current [A]	10 to 40 depending on type			
Max. discharge current [A]	10 to 40 depending on type			
Type of controller	<input type="checkbox"/> shunt	<input checked="" type="checkbox"/> serial	<input type="checkbox"/> other:	
Technique of regulation	<input type="checkbox"/> two point	<input checked="" type="checkbox"/> PWM	<input type="checkbox"/> other:	
Self consumption [mA]	< 4 mA			
End of charge voltage [V]	13.8 / 27.6 (lead acid float voltage) 14.0 / 28.0 (LiFePO4)			
return switch-on voltage (two point regulation) [V]	---			
load disconnect warning on [% SOC]	n.s.			
load disconnect voltage [V]	11.5 / 23.0 / 46.0			
time delay at load shedding [s]	n.s.			
Reconnection voltage load [V]	12.8 / 25.6 (lead acid) 12.2 / 24.4 (LiFePO4)			
time delay at reconnection [s]	n.s.			
load reconnection manually [V]	n.s.			
operation temperature range [°C]	-30 up to +60°C			
display	<input type="checkbox"/> LED	<input checked="" type="checkbox"/> LCD	<input type="checkbox"/> LED & LCD	

**Information given by the manufacturer (continued)****Additional functions**

boost/gassing function	<input checked="" type="checkbox"/>	yes	<input type="checkbox"/>	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), 2h			
Temperature compensation	<input checked="" type="checkbox"/>	yes	<input type="checkbox"/>	no
temperature compensation [mV/K*cell]	-4.2			
Battery voltage sensor	<input type="checkbox"/>	yes	<input checked="" type="checkbox"/>	no
DC/DC-Converter (e.g. USB-Port)	<input checked="" type="checkbox"/>	yes	5.0 V, 1500 mA	
adjustable for different battery types	<input checked="" type="checkbox"/>	yes	<input type="checkbox"/>	no
adjustable thresholds	<input type="checkbox"/>	yes	<input checked="" type="checkbox"/>	no
end of charge [V]	--	min.	<input type="checkbox"/>	max.
load disconnect [V]	<input type="checkbox"/>	<input type="checkbox"/>	min.	<input type="checkbox"/>
selectable priority at load disconnection	<input type="checkbox"/>	yes	<input checked="" type="checkbox"/>	no
Protection against reversed battery polarity	<input checked="" type="checkbox"/>	yes <sup>1)</sup>	<input type="checkbox"/>	no
Protection against reversed PV polarity	<input checked="" type="checkbox"/>	yes <sup>1)</sup>	<input type="checkbox"/>	no
Others	Protection against Over-Current, Over-Voltage, Over-Temperature, short-circuit and wrong polarity.			
	2 years datalogger and serial communication interface			
	User friendly LC-Display and touch buttons			
	Programmable nightlight function. Ext. Temperatur sensor			

<sup>1)</sup> Electronic protection

**Others**

Interfaces	serial proprietary interface
Price	not available
Service	only manufacturer website
Warranty	no information

# 1 Pretests

## 1.2 Visual Inspection

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

### Lettering of the charge controller

Manufacturer	<input checked="" type="checkbox"/>	yes		no	
Model / type	<input checked="" type="checkbox"/>	yes		no	
Serial / batch number	<input checked="" type="checkbox"/>	yes		no	
Nominal voltage	<input checked="" type="checkbox"/>	yes		no	
Connectors	<input checked="" type="checkbox"/>	yes		no	
Fuse		yes		no	<input checked="" type="checkbox"/> n.a. <sup>1)</sup>
LED, displays	<input checked="" type="checkbox"/>	yes		no	
Comment labeling:	o.k.				

### Documentation

Data sheet	<input checked="" type="checkbox"/>	o.k.		not o.k.		not available
User manual						
Operating instructions	<input checked="" type="checkbox"/>	o.k.		not o.k.		not available
Troubleshooting guide	<input checked="" type="checkbox"/>	o.k.		not o.k.		not available
Safety instructions	<input checked="" type="checkbox"/>	o.k.		not o.k.		not available
Installation instructions	<input checked="" type="checkbox"/>	o.k.		not o.k.		not available
Calibration instructions		o.k.		not o.k.	<input checked="" type="checkbox"/>	not available
Others	user manuals in different languages (German, English, French, Spanish, Portugese, Chinese)					
Comment documentation	o.k.					

### Spare parts

Fuse		avaiable		<input checked="" type="checkbox"/>	not available <sup>1)</sup>
Mounting parts		avaiable		<input checked="" type="checkbox"/>	not available
Connectors		avaiable		<input checked="" type="checkbox"/>	not available
Others					
Comment spare parts	---				

### Support

Repair / Service address		avaiable		<input checked="" type="checkbox"/>	not available
Warranty		avaiable		<input checked="" type="checkbox"/>	not available
Others					
Comment support	a support address should be given				

<sup>1)</sup> Electronic protection

Is it possible to test the charge controller?  
IEC 62 509 requirements fulfilled?  
If failed, reason?

<input checked="" type="checkbox"/>	yes	<input type="checkbox"/>	no
<input checked="" type="checkbox"/>	passed	<input type="checkbox"/>	failed
-----			



## 2 Battery Lifetime Protection Tests

### 2.1 Leakage Current

Ambient temperature	28,0 °C
Rated voltage	12,0 V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	

Test	Behaviour / results		
	Revers current [µA]		
Protection against night discharge of the battery (leakage current)	0,0	p	leakage current was not measurable

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	27,5 °C
Rated voltage	12,0 V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	

Voltage thresholds	Specification (manufacturer) [V]	Measured [V]		p / f	Remarks
		DuT 1	DuT 2		
		reg. start	Cut-off		
End of charge voltage (floating)	13,8	13,76	13,80	p	
final voltage equalisation (gassing)	14,8	14,79	14,82	p	Only if vented battery is selected.
final voltage boost	14,4	14,35	14,40	p	
		LVD			
Deep discharging cut-off voltage		11,50		p	CC set to 11,5 V; mode = voltage
Reconnect voltage load		12,78		p	

Time delay load disconnect [s]	appr. 1 min.
Time delay load reconnect [s]	0
Type of controller	serial / PWM
equal to manufacturer data	<input checked="" type="checkbox"/> yes <input type="checkbox"/> 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?

<input checked="" type="checkbox"/>	passed	<input type="checkbox"/>	failed

## 2 Battery Lifetime Protection Tests

### 2.3 Temperature Compensation of the Set-points

Ambient temperature	see below	°C
Rated voltage	12,0	V

DuT	1
Reference	CXup_1-phc-0417
Inspector	NP

Voltage thresholds	ambient temperature [°C]				temp. comp [mV/K] / cell	DuT
	@ 25,0 °C		@ Temp. °C			
End of charge voltage (float) [V] <sup>1)2)</sup>	13,76		40,5	13,38	4,1	1
	13,80		40,5	13,36	4,7	1
Equalization voltage [V] <sup>1)2)</sup>						
Boost voltage [V] <sup>1)2)</sup>						
Deep discharging cut-off voltage [V]	11,50			11,52		1
Reconnect voltage [V]	12,78			12,70		1

<sup>1)</sup> PWM start

<sup>2)</sup> cut off

Remarks															
Used measurement equipment:	<table border="1"> <tr> <td>Vbat:</td> <td>Zimmer LMG 95</td> </tr> <tr> <td>Ibat:</td> <td>Zimmer LMG 95</td> </tr> <tr> <td>Vpv:</td> <td>Oscilloscope Agilent DSO-X-3014A</td> </tr> <tr> <td>Ipv:</td> <td>Zimmer LMG 95</td> </tr> <tr> <td>Vload:</td> <td>Zimmer LMG 95</td> </tr> <tr> <td>Iload:</td> <td>Zimmer LMG 95</td> </tr> <tr> <td>Ta:</td> <td>Maxim DS18S20</td> </tr> </table>	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
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?  passed  failed

If failed, reason?

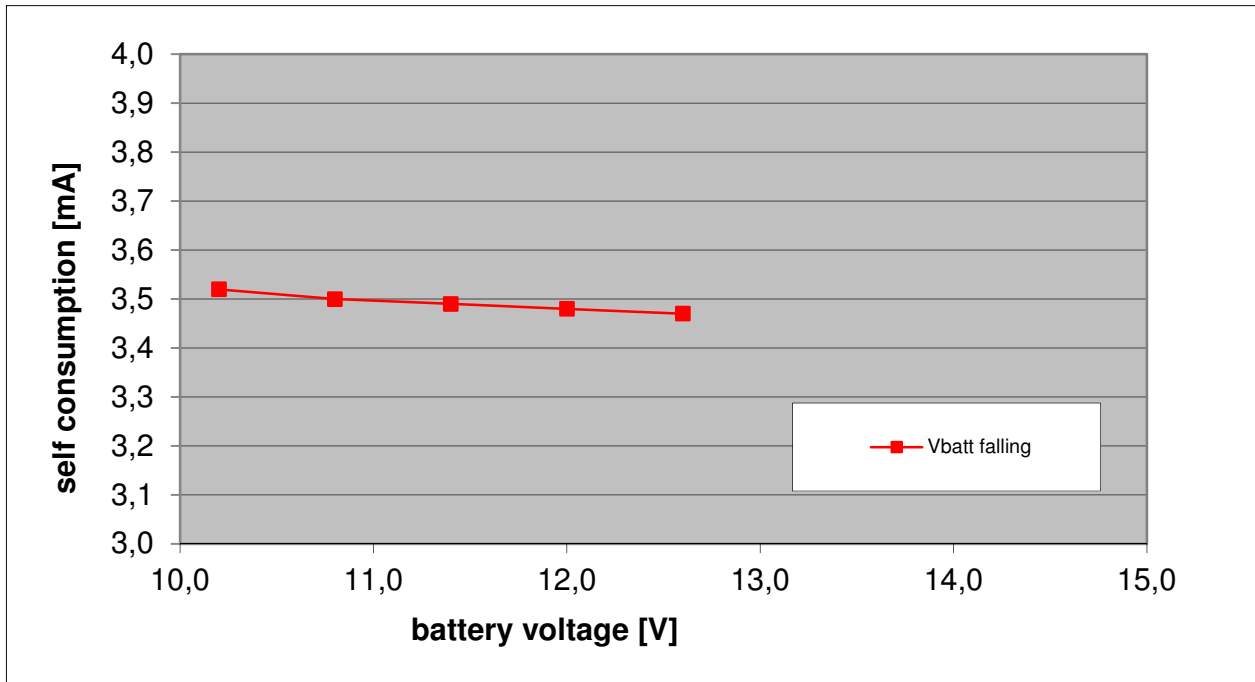
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### 3 Energy Performance Tests

#### 3.1 Self Consumption Tests

Ambient temperature	24,5 °C
Rated voltage	12,0 V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	



			DuT
max. selfconsumption	3,52	mA @ 10,2 V	1
average selfconsumption	3,49	mA	1

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

IEC 62 509 requirements?	<input checked="" type="checkbox"/>	passed	<input type="checkbox"/>	failed
If failed, reason?				

**Measured data**

Nr.	Batt. Volt. [V]	Self consumpt. [mA]	Self consumpt. [mW]	DuT	Comment
1	12,6	3,47	43,7	1	
2	12,0	3,48	41,8	1	
3	11,4	3,49	39,8	1	Deep discharge warning
4	10,8	3,50	37,8	1	
5	10,2	3,52	35,9	1	

### 3 Energy Performance Tests

#### 3.2 Efficiency Tests

Ambient temperature:	28,5	°C
Rated voltage:	12,0	V
Rated max. charge current:	20,0	A
Rated max. discharge current:	20,0	A

DuT	1	2
Reference	CXup_1-phc-0417	
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]	
13,239	1,95	25,8	13,207	1,95	25,8	99,8	0,032	1
13,305	4,04	53,8	13,259	4,04	53,6	99,7	0,046	1
13,323	6,53	87,0	13,259	6,53	86,6	99,5	0,064	1
13,370	8,02	107,2	13,295	8,02	106,6	99,4	0,075	1
13,333	10,61	141,5	13,239	10,61	140,5	99,3	0,094	1
13,380	12,10	161,9	13,276	12,10	160,6	99,2	0,104	1
13,440	13,99	188,0	13,322	13,99	186,4	99,1	0,118	1
13,510	16,19	218,7	13,376	16,19	216,6	99,0	0,134	1
13,575	18,20	247,1	13,425	18,20	244,3	98,9	0,150	1
13,647	20,39	278,3	13,479	20,39	274,8	98,8	0,168	1
						99,3		

##### 3.2.2 Discharging efficiency @ 100 % rated load current

Battery			Load			efficiency	Vbat-Vload	DuT
[V]	[A]	[W]	[V]	[A]	[W]	[%]	[V]	
13,222	20,08	265,5	13,118	20,08	263,41	99,2	0,104	1

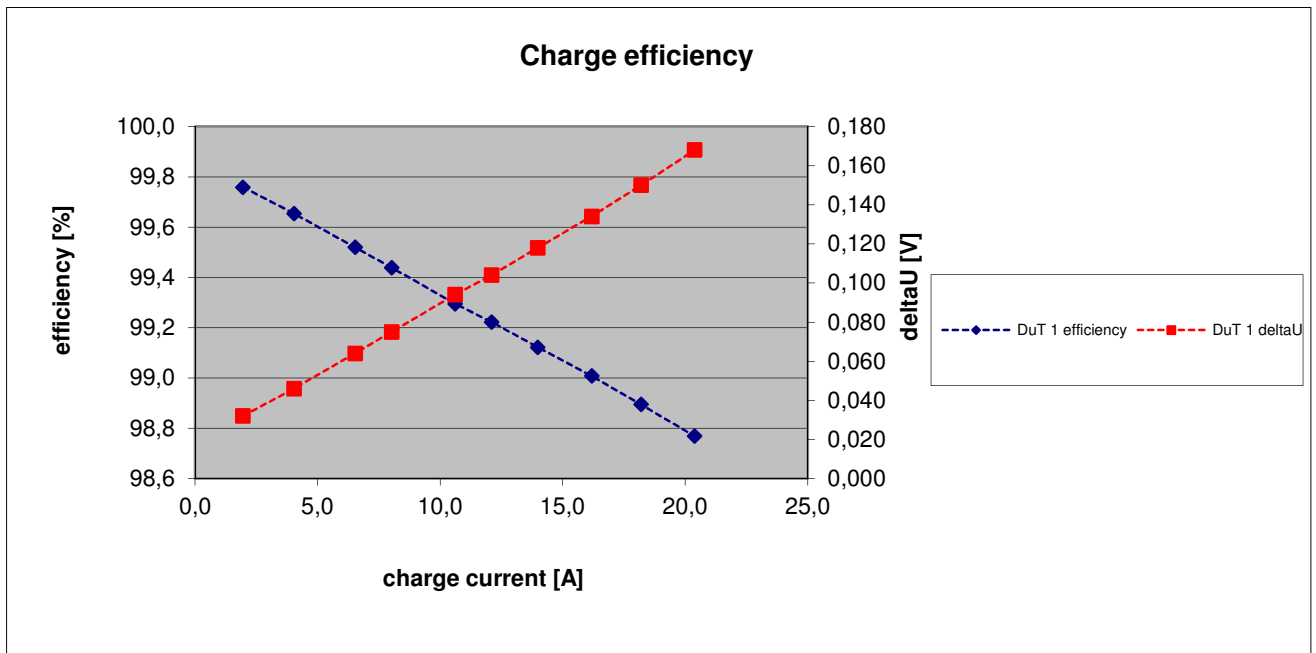
min. discharge efficiency [%]:

Remarks:

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?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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:	20 A
Rated max. discharge current:	20 A

DuT	1	
Reference	CXup_1-phc-0417	
Inspector:	NP	

#### Test at extended ambient temperature

time	PV-module		Battery		Load		T <sub>heatsink</sub>	T <sub>ambient</sub>	DuT	Comment
[min]	[V]	[A]	[V]	[A]	[V]	[A]	[°C]	[°C]		
1	13,3	20,5	13,2	0,1	13,1	20,4	45,2	45,0	1	
5	13,3	20,5	13,2	0,2	13,1	20,3	45,3	45,1	1	
10	13,2	20,6	13,1	0,1	13,1	20,5	45,5	45,2	1	
15	13,3	20,6	13,2	0,1	13,0	20,5	45,5	45,1	1	
20	13,3	20,4	13,2	0,1	13,1	20,3	45,5	45,0	1	
25	13,2	20,5	13,1	0,0	13,0	20,5	45,6	45,2	1	
30	13,3	20,6	13,2	0,1	13,1	20,5	45,4	45,1	1	
35	13,3	20,3	13,2	0,1	13,1	20,2	45,6	45,2	1	
40	13,2	20,5	13,1	0,1	13,0	20,4	45,6	45,1	1	
45	13,3	20,5	13,2	0,2	13,1	20,3	45,5	45,3	1	
50	13,3	20,5	13,2	0,1	13,0	20,4	45,6	45,2	1	
55	13,2	20,5	13,2	0,1	13,1	20,4	45,6	45,3	1	
60	13,2	20,5	13,1	0,1	13,0	20,4	45,7	45,3	1	

Remarks: According manual: max. ambient temperature @ rated currents is 45 °C  
 No problems occurred during test.

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	p		f



## 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 current:	20,0 A

DuT	1	
Reference	CXup_1-phc-0417	
Inspector:	NP	

#### 4.2.1 PV overcurrent protection test

time	PV-module		Battery		Remark	T <sub>heatsink</sub>	T <sub>ambient</sub>	DuT
[min]	[V]	[A]	[V]	[A]		[°C]	[°C]	
1	14,03	25,0	13,20	25,0	---	27,0	25,5	1
15	14,04	25,0	13,21	25,0		30,0	26,0	1
30	14,05	25,1	13,21	25,1		31,0	26,5	1
45	14,05	25,1	13,20	25,1		32,0	27,5	1
60	14,05	25,1	13,20	25,1		32,0	27,5	1

#### 4.2.2 Load overcurrent protection test

time	Remark	Battery		Load		T <sub>heatsink</sub>	T <sub>ambient</sub>	DuT
[min]		[V]	[A]	[V]	[A]	[°C]	[°C]	
1		12,05	25,2	11,91	25,2	28,0	27,5	1
5		12,04	25,2	11,90	25,2	29,0	27,5	1
15		12,03	25,2	11,91	25,2	30,5	28,0	1
30		12,02	25,3	11,91	25,3	31,0	28,5	1
45		12,02	25,3	11,91	25,3	32,0	29,0	1
60		12,0	25,3	11,91	25,3	33,0	30,0	1

No problems at all		
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	26,0 °C
Rated voltage	12,0 V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	

Test	Behaviour / results		remarks
	DuT 1	p/f	
Protection against short circuited PV <sup>1)</sup>	V <sub>pv</sub> = 12,03 V I <sub>pv</sub> = 2,2 A	p	DuT didn't suffer any damage.
Protection against reversed polarity PV Module	V <sub>pv</sub> = 22 V	p	DuT didn't suffer any damage. DuT didn't fed the reverse voltage to the load.
Protection against short circuited load <sup>1)</sup>	V <sub>load</sub> = 12,10 V I <sub>load</sub> = 2,1 A	p	DuT didn't suffer any damage.
Operation with reversed polarity battery		p	DuT didn't suffer any damage. Buzzer alarm

p/f: passed/failed

<sup>1)</sup> Not mandatory according to IEC 62 509

Remarks	The charge controller is protected against short circuited PV, reversed polarity PV module, 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?	<input checked="" type="checkbox"/>	passed	<input type="checkbox"/>	failed
If failed, reason?				

## 4 Protection and Fail-Safe Tests

### 4.4 Battery Open Circuit Test

Ambient temperature	25,3	°C
Rated voltage	12,0	V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	

Test	Behaviour / results	DuT
operating with disconnected battery	DuT didn't suffer any damage	1
	V load = 0,08 V    p    Passed/failed	
removing battery during normal operation	DuT didn't suffer any damage	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?				

## 5 User Interface Tests

### 5.1 Display

Ambient temperature	25,3
Rated voltage	12 V

DuT	1	
Reference	CXup_1-phc-0417	
Inspector	NP	

		DuT
charging indication	yes	1
battery charged indication (charge status)	yes	1
load cut off warning	yes /Buzzer	1
battery discharged indication (load disconnection)	yes / pictogram	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)**

<b>device</b>	<b>type</b>	<b>measured dimensions</b>	<b>reference number following DIN EN ISO 9001:2000</b>
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 in combination with Arduino Mega datalogging	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

