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12V busbar test result

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12V busbar test result
OpenRack Standard Specification

The specifications stipulate that warming should be limited to a maximum of Δ30° .

4.0 IT Interconnect to 12V BUSBAR

4.2 Electrical

Contact Resistance	<0.5mΩ	EIA-364-6
Temperature Rise	30C Max @ rated current	EIA-364-70, Method II
Insertion force	< 40N	EIA-364-13
Float	>2mm	
Contact retention	140N	EIA-364-29
Salt Spray	48 hours, with a 5% solution salt spray, at 35 +1/-2°C	
Vibration	0.5g, 1.5mm amplitude, 5-500 Hz, 10 sweeps @ 1 octave/minute in all orthogonal axes with no discontinuities > 1 microsecond	
Shock	50G half-sine@ 11ms for 3 orthogonal axes	EIA-364-27, Method A.
Regulatory		UL94V0

OpenRackStandardV2.0 (p.25)

12V busbar test result

test setup

One half of the splitted busbar was tested

Test equipment

Test device	Manufacturer	Type	Serial no.	Test device no.	Calibrated until
Temperature measurment system	IO-Tech	DaqBook 200	126900	62830247	01/.19
Temperature sensor	Telemeter	PT 100	--	--	--
Clamp-on ammeter	Fluke	353	10340097	67530229	07/.18
High-current plant	Zimmermann	0-2000A	--	--	--

The condition of the testing devices was verified prior to testing and approved.

Estimation of the measuring inaccuracies

The estimated measurement inaccuracy is approximately $T_{MU} < 2,1K$ according to current calculations.

12V busbar test result

test setup

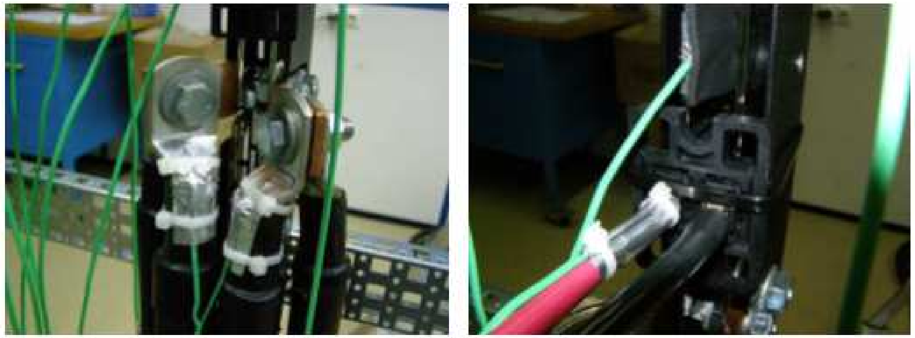
Temperature rise test

The specimen was positioned in the test field in free air and was connected at each side from the busbar with 1 cable 240mm² and 1 cable 185mm². (see fig. 1 and 2)

Fig. 1 and 2: test specimen

The sensors have been arranged and numbered from the bottom (power supply, see fig. 3) to the top (in test #3 short circuit) and on the cable (connector) also from the bottom to the top.

Fig. 3 und 4



The testing lasted until a steady state, $\Delta T \leq 1K$ per hour, was achieved.
The testing current was several times readjusted during the test.

12V busbar test result

test result

Test #1.1: Temperature rise test with 6 connectors and with I = 300A

That means, that every connector charged with I = 50 ± 1A.

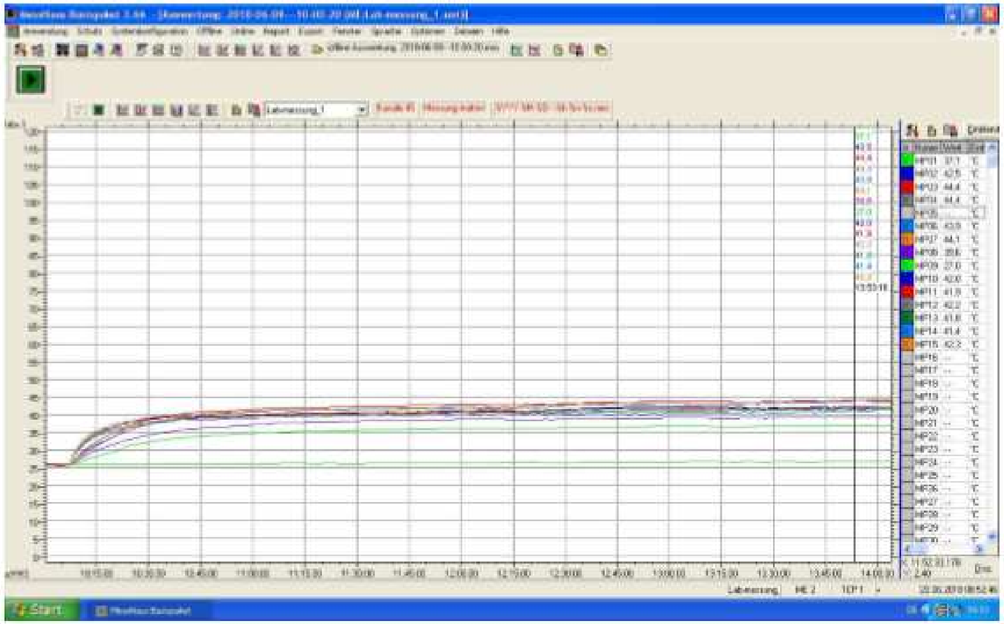
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp. in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	37,1	10,1
2	Busbar	↓	Al	30[1]	42,5	15,5
3	Busbar		Al	30[1]	44,4	17,4
4	Busbar		Al	30[1]	44,4	17,4
6	Busbar		Al	30[1]	43,9	16,9
7	Busbar	top	Al	30[1]	44,1	17,1
8	2. Terminal supply (right side)		Cu	30[1]	39,6	12,6
9	Ambient				27,0	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	42,0	15,0
11	Outgoing (cable)	↓	Cu/PVC	30[1]	41,9	14,9
12	Outgoing (cable)		Cu/PVC	30[1]	42,2	15,2
13	Outgoing (cable)		Cu/PVC	30[1]	41,8	14,8
14	Outgoing (cable)		Cu/PVC	30[1]	41,4	14,4
15	Outgoing (cable)	top	Cu/PVC	30[1]	42,3	15,3

[1] manufacturer instruction

$\Delta T<30°$

Diagram 1



12V busbar test result

test result

Test #1.2: Temperature rise test with 6 connectors and with I = 550A

That means, that every connector charged with I = 92 ± 1A.

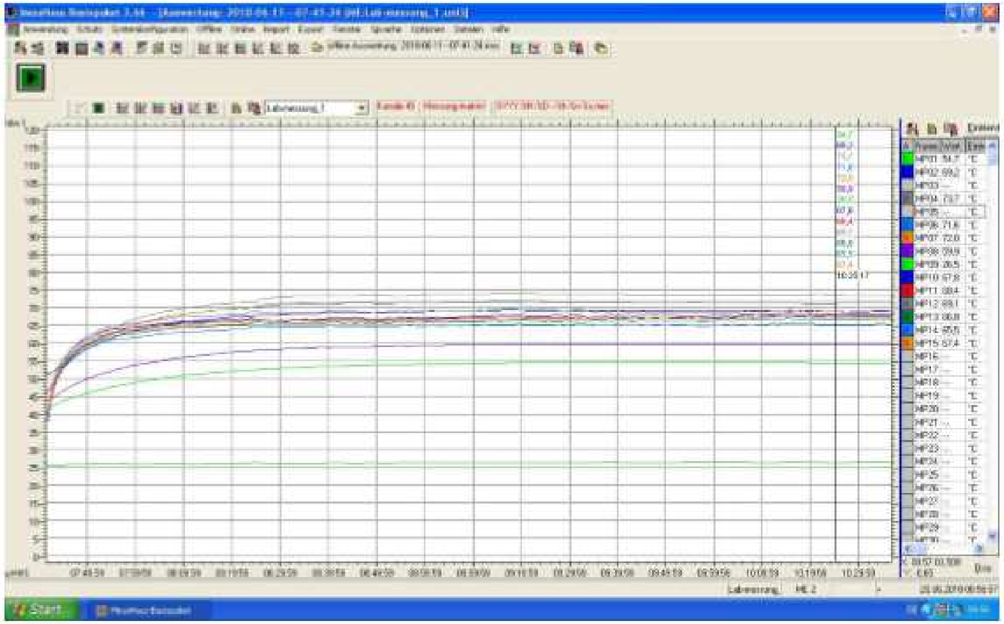
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1)]	54,7	28,2
2	Busbar	↓	Al	30[1)]	69,2	42,7
3	Busbar		Al	30[1)]	def.	
4	Busbar		Al	30[1)]	73,7	47,2
6	Busbar		Al	30[1)]	71,6	45,1
7	Busbar	top	Al	30[1)]	72,0	45,5
8	2. Terminal supply (right side)		Cu	30[1)]	59,9	33,4
9	Ambient				26,5	
10	Outgoing (cable)	bottom	Cu/PVC	30[1)]	67,8	41,3
11	Outgoing (cable)	↓	Cu/PVC	30[1)]	68,4	41,9
12	Outgoing (cable)		Cu/PVC	30[1)]	69,1	42,6
13	Outgoing (cable)		Cu/PVC	30[1)]	66,8	40,3
14	Outgoing (cable)		Cu/PVC	30[1)]	65,5	39,0
15	Outgoing (cable)	top	Cu/PVC	30[1)]	67,4	40,9

[1)] manufacturer instruction

ΔT>30°

Diagram 2



12V busbar test result

test result

Test #1.3: Temperature rise test with 6 connectors and with I = 625A

That means, that every connector charged with I = 104 ± 1A.

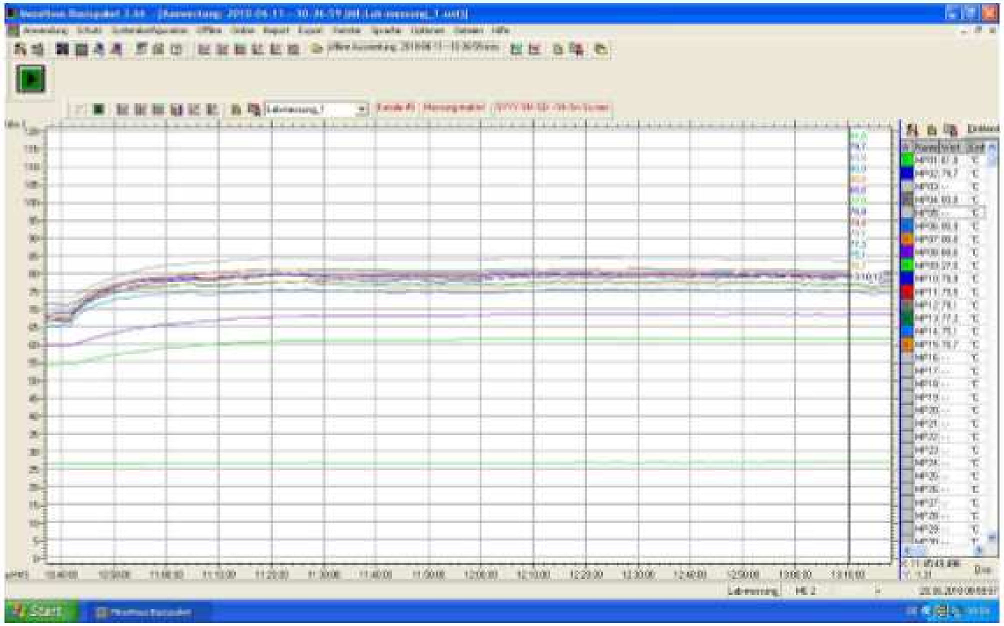
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	61,8	34,8
2	Busbar	↓	Al	30[1]	79,7	52,7
3	Busbar		Al	30[1]	def.	
4	Busbar		Al	30[1]	83,8	56,8
6	Busbar		Al	30[1]	80,9	53,9
7	Busbar	top	Al	30[1]	80,8	53,8
8	2. Terminal supply (right side)		Cu	30[1]	68,6	41,6
9	Ambient				27,0	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	78,9	51,9
11	Outgoing (cable)	↓	Cu/PVC	30[1]	79,5	52,5
12	Outgoing (cable)		Cu/PVC	30[1]	79,1	52,1
13	Outgoing (cable)		Cu/PVC	30[1]	77,3	50,3
14	Outgoing (cable)		Cu/PVC	30[1]	75,1	48,1
15	Outgoing (cable)	top	Cu/PVC	30[1]	76,7	49,7

[1] manufacturer instruction

ΔT>30°

Diagram 3



12V busbar test result

test result

Test #1.4: Temperature rise test with 6 connectors and with I = 750A

That means, that every connector charged with I = 125 ± 1A.

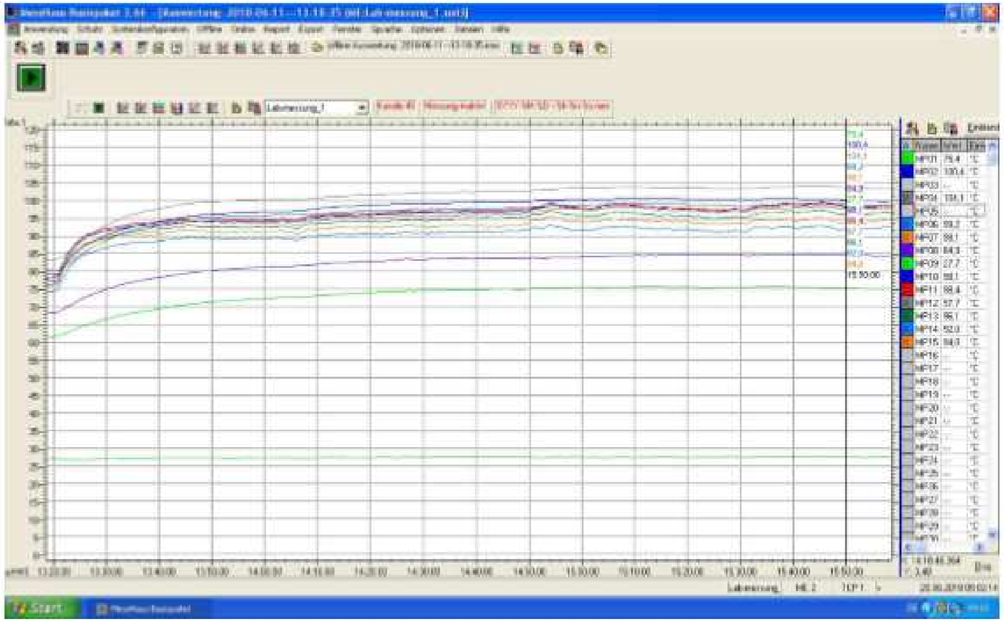
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp. in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	75,4	47,7
2	Busbar	↓	Al	30[1]	100,4	72,7
3	Busbar		Al	30[1]	def.	
4	Busbar		Al	30[1]	104,1	76,4
6	Busbar		Al	30[1]	99,2	71,5
7	Busbar	top	Al	30[1]	98,1	70,4
8	2. Terminal supply (right side)		Cu	30[1]	84,9	57,2
9	Ambient				27,7	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	98,1	70,4
11	Outgoing (cable)	↓	Cu/PVC	30[1]	98,4	70,7
12	Outgoing (cable)		Cu/PVC	30[1]	97,7	70,0
13	Outgoing (cable)		Cu/PVC	30[1]	96,1	68,4
14	Outgoing (cable)		Cu/PVC	30[1]	92,0	64,3
15	Outgoing (cable)	top	Cu/PVC	30[1]	94,0	66,3

[1] manufacturer instruction

ΔT>30°

Diagram 4



12V busbar test result

test result

Test #2.1: Temperature rise test with 11 connectors and with I = 300A

That means, that every connector charged with I = 27 ± 1A.

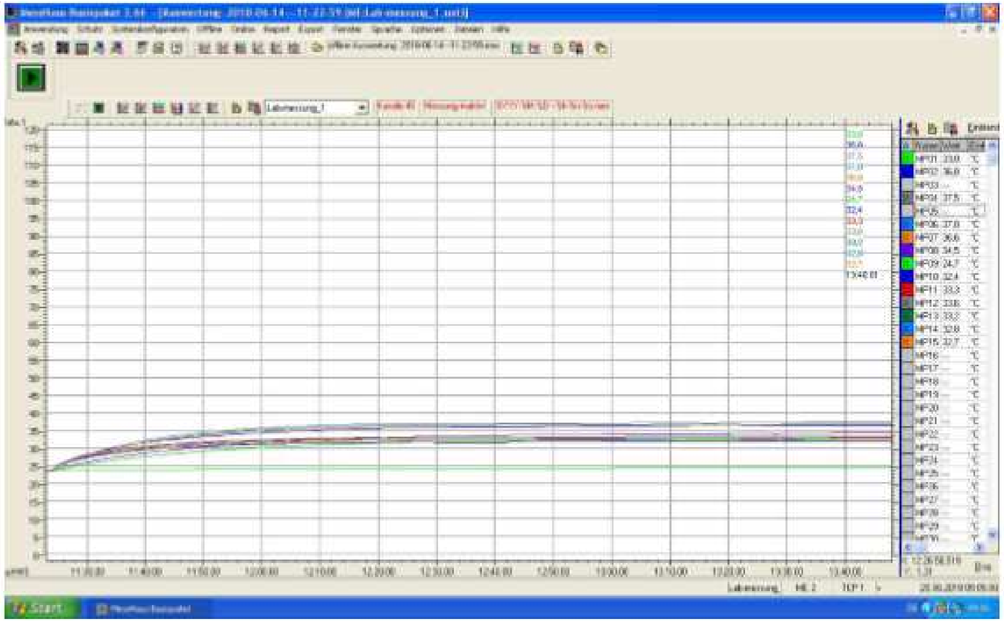
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	33,0	8,3
2	Busbar		Al	30[1]	36,8	12,1
3	Busbar		Al	30[1]	def.	
4	Busbar		Al	30[1]	37,5	12,8
6	Busbar		Al	30[1]	37,0	12,3
7	Busbar	top	Al	30[1]	36,6	11,9
8	2. Terminal supply (right side)		Cu	30[1]	34,5	9,8
9	Ambient				24,7	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	32,4	7,7
11	Outgoing (cable)		Cu/PVC	30[1]	33,3	8,6
12	Outgoing (cable)		Cu/PVC	30[1]	33,6	8,9
13	Outgoing (cable)		Cu/PVC	30[1]	33,2	8,5
14	Outgoing (cable)		Cu/PVC	30[1]	32,8	8,1
15	Outgoing (cable)	top	Cu/PVC	30[1]	32,7	8,0

[1] manufacturer instruction

$\Delta T<30^\circ$

Diagram 5



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12V busbar test result

test result

Test #2.2: Temperature rise test with 11 connectors and with I = 550A

That means, that every connector charged with I = 50 ± 1A.

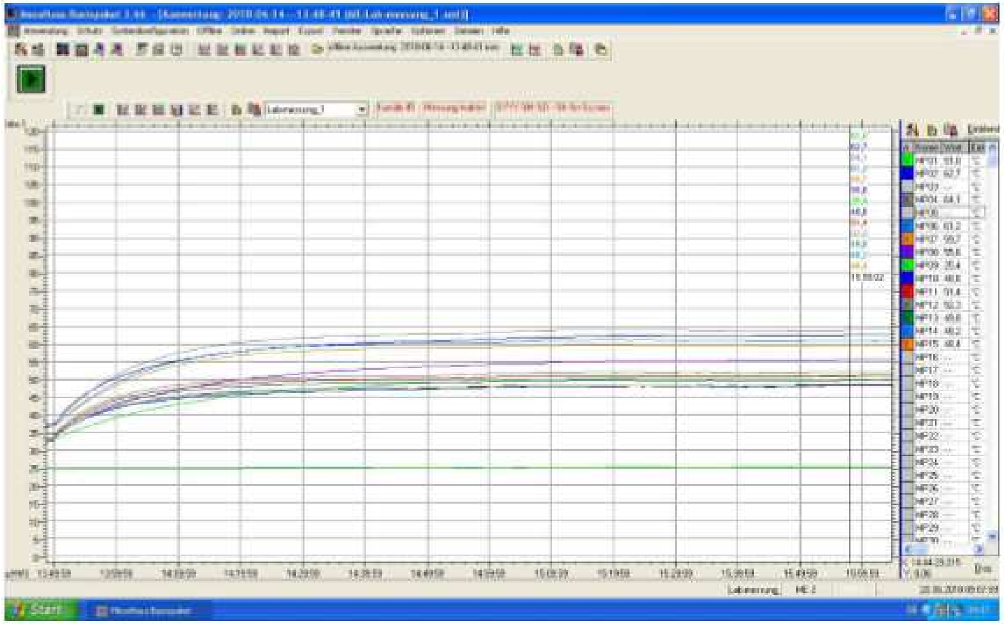
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	51,0	25,6
2	Busbar	↓	Al	30[1]	62,7	37,3
3	Busbar		Al	30[1]	def.	
4	Busbar		Al	30[1]	64,1	38,7
6	Busbar		Al	30[1]	61,2	35,8
7	Busbar	top	Al	30[1]	59,7	34,3
8	2. Terminal supply (right side)		Cu	30[1]	55,6	30,2
9	Ambient				25,4	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	48,6	23,2
11	Outgoing (cable)	↓	Cu/PVC	30[1]	51,4	26,0
12	Outgoing (cable)		Cu/PVC	30[1]	52,3	26,9
13	Outgoing (cable)		Cu/PVC	30[1]	49,8	24,4
14	Outgoing (cable)		Cu/PVC	30[1]	48,2	22,8
15	Outgoing (cable)	top	Cu/PVC	30[1]	48,4	23,0

[1] manufacturer instruction

ΔT>30°

Diagram 6



12V busbar test result

test result

Test #2.3: Temperature rise test with 11 connectors and with I = 625A

That means, that every connector charged with I = 57 ± 1A.

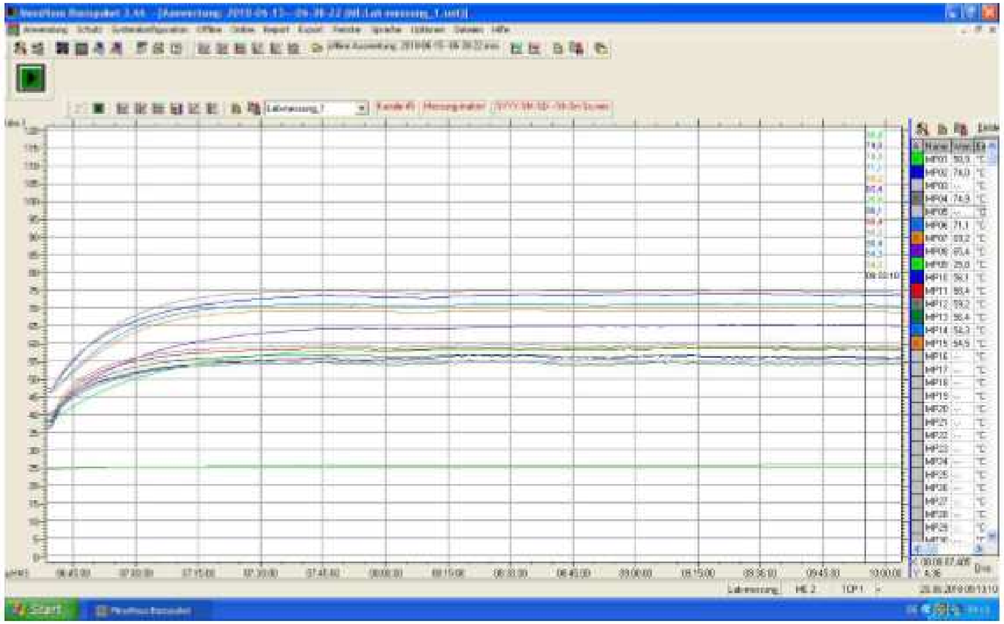
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./	Final overtemp in °C / K
1	1. Terminal supply (left side)	bottom	Cu	30[1]	58,9	33,1
2	Busbar	↓	Al	30[1]	74,0	48,2
3	Busbar	↓	Al	30[1]	def.	
4	Busbar	↓	Al	30[1]	74,9	49,1
6	Busbar	↓	Al	30[1]	71,1	45,3
7	Busbar	top	Al	30[1]	69,2	43,4
8	2. Terminal supply (right side)		Cu	30[1]	65,4	39,6
9	Ambient				25,8	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	56,1	30,3
11	Outgoing (cable)	↓	Cu/PVC	30[1]	58,4	32,6
12	Outgoing (cable)	↓	Cu/PVC	30[1]	59,2	33,4
13	Outgoing (cable)	↓	Cu/PVC	30[1]	56,4	30,6
14	Outgoing (cable)	↓	Cu/PVC	30[1]	54,3	28,5
15	Outgoing (cable)	top	Cu/PVC	30[1]	54,5	28,7

[1] manufacturer instruction

$\Delta T > 30°$

Diagram 7



12V busbar test result

test result

Test #2.4: Temperature rise test with 11 connectors and with I = 750A

That means, that every connector charged with I = 68 ± 1A.

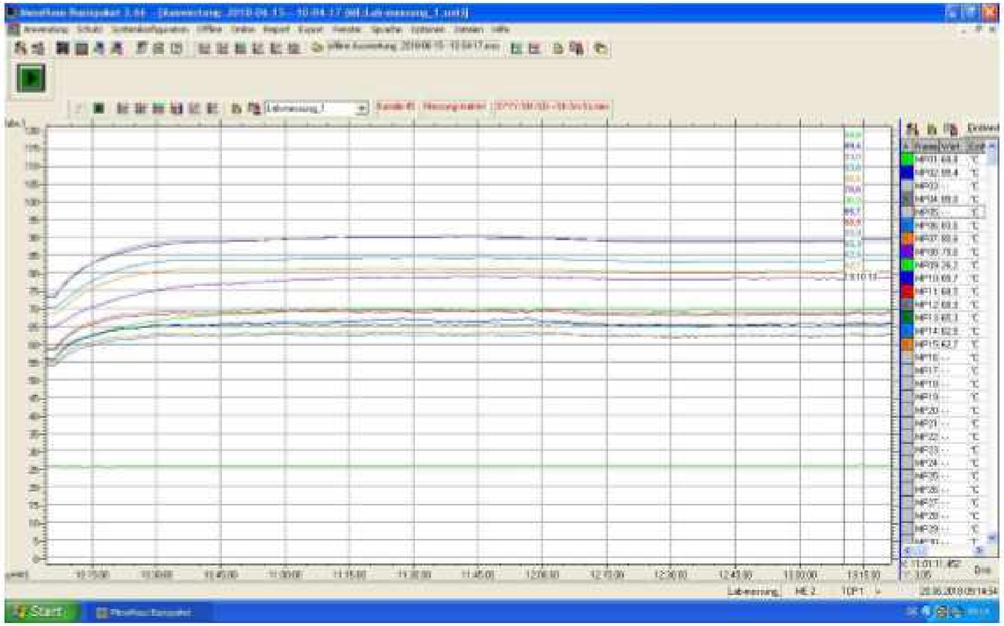
Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1]	69,8	43,6
2	Busbar		Al	30[1]	89,4	63,2
3	Busbar		Al	30[1]	def.	
4	Busbar		Al	30[1]	89,0	62,8
6	Busbar		Al	30[1]	83,6	57,4
7	Busbar	top	Al	30[1]	80,6	54,4
8	2. Terminal supply (right side)		Cu	30[1]	78,6	52,4
9	Ambient				26,2	
10	Outgoing (cable)	bottom	Cu/PVC	30[1]	65,7	39,5
11	Outgoing (cable)		Cu/PVC	30[1]	68,5	42,3
12	Outgoing (cable)		Cu/PVC	30[1]	68,9	42,7
13	Outgoing (cable)		Cu/PVC	30[1]	65,3	39,1
14	Outgoing (cable)		Cu/PVC	30[1]	62,5	36,3
15	Outgoing (cable)	top	Cu/PVC	30[1]	62,7	36,5

1) manufacturer instruction

$\Delta T > 30°$

Diagram 8



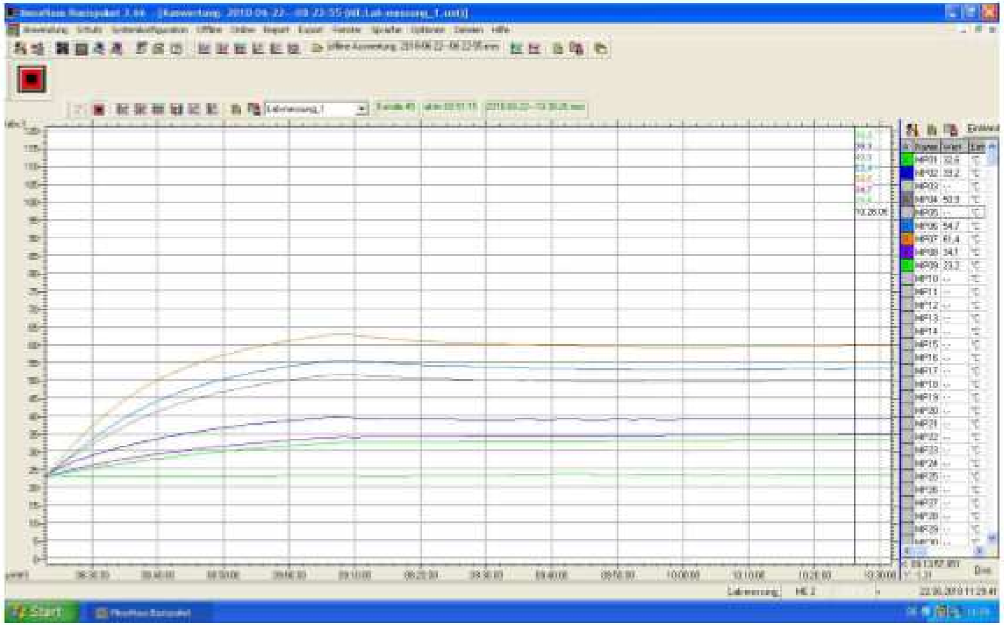
12V busbar test result

test result

Test #3: Temperature rise test without connectors (short circuit, see fig. 5) and with I = 300A

Fig. 5: short circuit

Diagram 9



Final values of temperature

Sensor	Designation of the part		Material	Permissible overtemperature at a max. ambient temperature of 35°C in K OpenRack Standard V2.0 / EN62368	Final temp./ Final overtemp in °C / K	
1	1. Terminal supply (left side)	bottom	Cu	30[1)]	32,6	9,4
2	Busbar	↓	Al	30[1)]	39,2	16,0
3	Busbar		Al	30[1)]	def.	
4	Busbar		Al	30[1)]	50,9	27,7
6	Busbar		Al	30[1)]	54,7	31,5
7	Busbar	top	Al	30[1)]	61,4	38,2
8	2. Terminal supply (right side)		Cu	30[1)]	34,1	10,9
9	Ambient				23,2	

[1)] manufacturer instruction

ΔT>30°

12V busbar test result

test result

Conclusion

1. Temperature rise test:
The requirement of the OCP V2 specification for a maximum temperature rise of Δ = 30K will be achieved with a test current I = 300A. (6 / 11 clips)
This value should be supposed for a maximum temperature-rise of Δ = 30K independent on number of connectors.
But it won't be achieved without any connectors (short circuit) by a test current of I = 300A.

12V busbar test result

test result - analysis

main points:

- Which factors have an effect on the temperature rise?
- How can the temperature rise be counteracted?
- Does the Open Rack specification meet the real situation?
- Suggestion for handling the Open Rack specification

12V busbar test result

test result - analysis

Which factors have an effect on the temperature rise?

Level of current:

In principle, the level of current is the main factor for the temperature increase. How strong this effect is depends, among other things, on the ratio of current to conductive material. The recommended bus bar current density, in the OpenRackStandardV2.0, at full load is 3.5 Amps / mm2 (or lower) ..

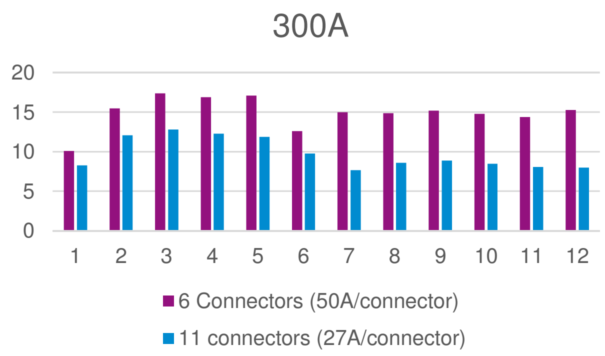
> The busbar(s) in an Open Rack Compliant system:
> ...
> SHOULD be sized for a current density at full load not higher than 5 Amps / mm2. The recommended bus bar current density at full load is 3.5 Amps / mm2 (or lower) which will limit the conduction losses and also guarantee optimum dynamic performances of the bus bar pair during heavy dynamic loads.
>
> OpenRackStandardV2.0 ; 3.1 12V Open Rack Electrical Requirements

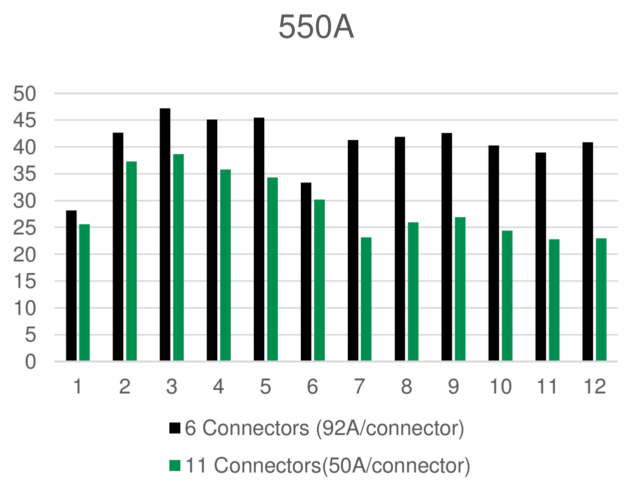
12V busbar test result

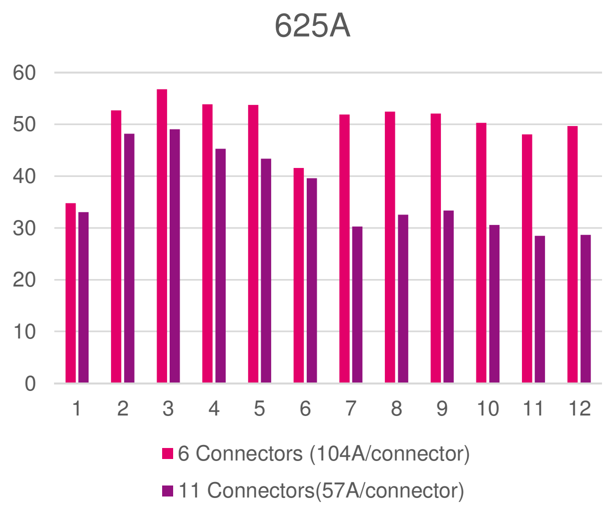
test result - analysis

Numbers of connectors:

Another factor is the number of connectors connected to the busbar. The more connectors are connected, the lower the temperature rise.







12V busbar test result

test result - analysis

How can the temperature rise be counteracted?

Current desity:

To reduce the current density and thus counteract the temperature rise, the profile of the busbar can be increased. A value of 2-2,5 Amps / mm2 would be desirable

Material:

Since the critical point is the connection from busbar to connector, a change of material at the contact area would be worth considering to reduce the thermal contact resistance.

Numbers of connectors

As shown, the numbers of connectors decrease the temperature rise, so a integration with a higher number of connectors is preferable.

12V busbar test result

test result - analysis

Does the Open Rack specification meets the real situation?

The difficulty is that the contact points are not statically loaded with the busbar, so it is possible that the specifications are exceeded and undershot at the same time onthe same busbar.
In addition, the temperature rise above Δ30° also depends on factors that can vary with each application like the numbers of connectors.

It is therefore almost impossible to know whether the individual components (busbar and connector) meet the open rack specifications within the application without knowing the direct application.
With this background it is difficult to characterize these standard components and to offer them independent of the application.

12V busbar test result

test result - analysis

Suggestion for handling the Open Rack specification

To support the standardization of the individual components (busbar/connectors), it would make sense to adjust the OpenRack specification.

- I would suggest to specify the components only at constant factors that are independent of the different applications.

- These factors should be calculated with an appropriate safety value to take dynamic loads into account.

- In order to prevent excessive heating, a regulation for the installation and the load of the individual connectors would have to be found.

Thank you.