

# MC4 & MC4-Evo 2 for low-voltage DC applications up to 100 A

Stäubli Description Report

## MC4

### Connector



PV-KBT4...



PV-KST4...

### Receptacle



PV-ADBP4-S2...



PV-ADSP4-S2...

## MC4-Evo 2

### Connector



PV-KBT4-EVO 2/...-UR



PV-KST4-EVO 2/...-UR

### Receptacle



PV-ADB4-EVO 2



PV-ADS4-EVO 2

Consumer electronics

Communications equipment

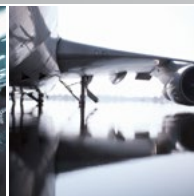
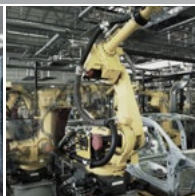
Automation and robotics

Automotive

Aerospace and Defense

Medtech

Other industries



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## 1. Information on standards and certifications

MC4 & MC4-Evo 2 connectors and panel receptacles offer a cost-effective, high-quality solution for low voltage DC applications up to 1500 V, 100 A and 10 mm<sup>2</sup>/8 AWG cable.

This description report offers technical information for non-PV application of:

connectors: PV-KBT4/... assembly instructions: MA231



PV-KBT4-EVO 2/... MA275



panel receptacles: PV-ADBP4-S2/... MA273



PV-ADB4-EVO 2/... MA285



The following information describes possible cable types on which the connectors might be used in low-voltage DC applications regarding cable stranding, diameter range and limiting temperatures. Further, current ratings with respect to ambient temperature (derating diagrams) are given. The products' assembly instructions (as listed above) are valid for non PV cables as well and have to be followed.

**For general low-voltage DC applications the products fulfill the requirements of IEC 61984:2008 (Connectors – Safety requirements and tests).**

Further, the technical performance of the connectors is TÜV certified according to IEC 62852:2014 (Connectors for DC-application in photovoltaic systems - Safety requirements and tests). At UL, the connectors are certified according to UL 6703:2014 (Standard for Connectors for Use in Photovoltaic Systems). This high-level PV certification outperforms the general industry level requirements of IEC 61984:2008, UL 1977 and is beyond most known general industry level standards (UL 2237, UL 2238, UL 486A/B, etc.). **These TÜV and UL certifications, however, are only valid when the respective PV cables are mounted.** Also the UR sign on the connectors is only valid for certified PV cables attached as described in the assembly instructions (MA231, MA275, MA273, MA285).

### Summary:

- The connectors are suitable for use with other cable types in lieu of PV cables
- For the use in systems outside of photovoltaics, no PV-specific certification is applicable
- In this case connectors perform according to IEC 61984:2008 (Connectors - Safety requirements and tests).

## 2. Cable stranding possible to connect

		MC4	MC4-Evo 2
Range mm <sup>2</sup> /AWG		2.5 mm <sup>2</sup> -10 mm <sup>2</sup> 14 AWG-8 AWG	
Stranding range	2.5 mm <sup>2</sup> /14 AWG	19-49	19-49
	4 mm <sup>2</sup> /12 AWG	19-56	19-56
	6 mm <sup>2</sup> /10 AWG	19-78	19-105
	10 mm <sup>2</sup>	56-78	19-168
	8 AWG	7-168	19-168

Cables in the range of 2.5 mm<sup>2</sup>-10 mm<sup>2</sup> (12 AWG-8 AWG) can be applied for such application. Cable stranding must be Class 5 according to IEC 60228.

## 3. Untinned copper strands

Tinned copper strands can be connected with all metal parts.

Untinned copper strands:

For untinned copper strands of 10 mm<sup>2</sup>/8 AWG, the round crimp MC4 PV-KXT4/8II-UR shall be used (cables of other diameters need to have tinned copper strands in order to be connected to the respective metal parts).

In case of blanc, i.e. untinned, copper strands, it has to be assured that the crimping area on the cable strands is free of oxides and dirt when crimping.

To ensure long-term stable crimping, please submit the cable specification to the Stäubli Electrical Connectors Engineering team for evaluation. We offer support in qualifying cable for customer applications.

## 4. Cable insulation-outer diameter ranges (regarding the cable gland)

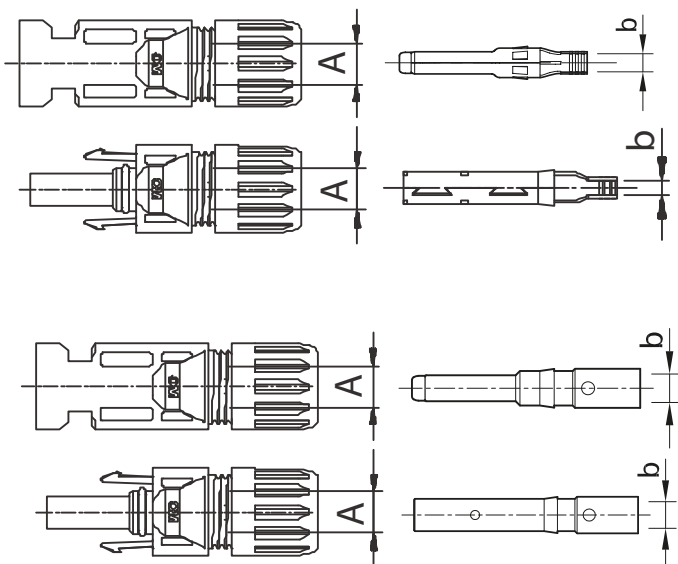
The following table shows the outer diameter ranges for connectable cables as well as the respective sealing element of the connector.

	MC4	MC4-Evo 2
Cable outer diameter range	DZER6: 4.7 mm-6.2 mm DZER7: 5.7 mm-7.4 mm DZER9: 6.0 mm-8.8 mm	Seal DI: 4.7 mm-6.4 mm Seal DII: 6.4 mm-8.4 mm

### 4.1 MC4

#### Selection of connector configuration

A: $\varnothing$ range of the cable [mm]	Conductor cross section				
	1.5/2.5 mm <sup>2</sup> 14 AWG	4 mm <sup>2</sup> 12 AWG	6 mm <sup>2</sup> 10 AWG	10 mm <sup>2</sup>	8 AWG
Strandings	19-49	19-56	19-78	56-78	7-168
4.7-6.2	PV-K...T4/2,5I	PV-K...T4/6I	PV-K...T4/6I		
5.7-7.4	PV-K...T4/2,5X	PV-K...T4/6X	PV-K...T4/6X		
6.0-8.8	PV-K...T4/2,5II	PV-K...T4/6II	PV-K...T4/6II	PV-K...T4/8II	PV-K...T4/8II
b: Control dimension	~3 mm	~5 mm		~4.4 mm	

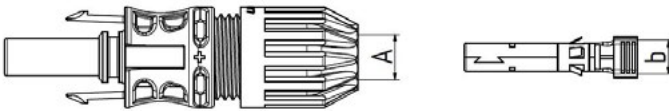
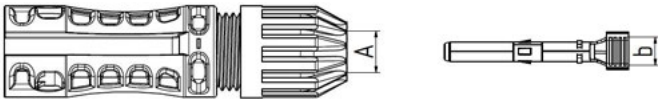


## 4.2 MC4-Evo 2

### Selection of the connector type

Chose the isolation and connector type that is suitable for your application.

b: Control measure	Conductor cross section	A: $\varnothing$ range of the cable (mm)	
		4.7-6.4	6.4-8.4
mm	mm <sup>2</sup> AWG	Type	
~ 3	1.5-2.5 14	PV-K...T4-EVO 2/2,5I	PV-K...T4-EVO 2/2,5II
~ 5	4-6 12/10	PV-K...T4-EVO 2/6I	PV-K...T4-EVO 2/6II
~ 7.2	8 10		PV-K...T4-EVO 2/10II
		DI Maroon	DII Grey
		Usable seals	



## 5. PVC cable applications

For safety reasons Stäubli prohibits the use of PVC cables. Cables made from PVC can be connected to MC4-Evo 2 since the insulation material of the connector (Polyamide) is suitable to



PV-KBT4-EVO 2/...

Example:

H07VK according to EN 50525-2-31:2011, Part 2-31:

Power cables for general applications - Conductor and wiring lines with thermoplastic PVC insulation.

be connected to PVC. PVC cables usually have an upper limiting temperature of 70 °C, in fixed installations sometimes 80 °C.



PV-KST4-EVO 2/...

Exemplary application areas of PVC cables:

- Control devices, e. g. machine tools
- Flow and assembly lines, conveyor systems, production lines
- Plant engineering, switchgear cabinet construction, control engineering
- Communication technology equipment, data processing
- Electrical engineering, installation and packaging technology
- Iron and steel production industry, chemical industry, textile
- Automotive industry, automation technology, press and mold construction
- Printing and paper machine construction
- Household appliances

## 6. Rubber cable applications

Rubber cable (usual upper limiting temperature: 90 °C) can be connected to MC4 or MC4-Evo 2.

For example: NSGAFÖU cable according to VDE 0250 T 602

with nominal voltage of at least U0/U: 1.8/3 kV (short circuit safe and grounded wiring up to 1000 V according to VDE 0100 T520 and VDE 0298 T 3).

### 6.1. 10 mm<sup>2</sup> / 8 AWG

The round crimp metal part of the MC4 named PV-KST/KBT4/8II-UR is suitable for 8 AWG or 10 mm<sup>2</sup> cables. The max. outer diameter of the cable insulation is limited by the sealing to 8.8 mm.

(A H07RNF 10mm<sup>2</sup> according to DIN EN 50525-2-21 / VDE 0285-525-2-21:2012-01 is 9.7 mm outer diameter, so H07RNF can only be used up to 6 mm<sup>2</sup>)



PV-KBT4/8II-UR



PV-KST4/8II-UR

### 6.2. 2,5 mm<sup>2</sup>, 4mm<sup>2</sup>, 6 mm<sup>2</sup> / 10-14 AWG

2.5/4/6 mm<sup>2</sup> (10-14 AWG) rubber cable (usual upper limiting temperature: 90 °C) can be connected to MC4 or MC4-Evo 2. e. g. NSGAFÖU cable according to VDE 0250 T 602 with nominal voltage of at least U0/U: 1.8/3 kV (short circuit safe and

earthing safe wiring up to 1000 V according to VDE 0100 T520 and VDE 0298 T 3) or H07RNF according to DIN EN 50525-2-21 / VDE 0285-525-2-21:2012-01).



PV-KBT4-EVO2/...



PV-KST4-EVO2/...

or



PV-KBT4/2,5.../PV-KBT4/6...



PV-KST4/2,5.../PV-KST4/6...



## 7. Maximum currents and temperatures - the derating diagram

The derating diagram is valid for the

connectors: assembly instructions

PV-KBT4/... MA231

PV-KBT4-EVO 2/... MA275

panel receptacles:

PV-ADBP4-S2/... MA273

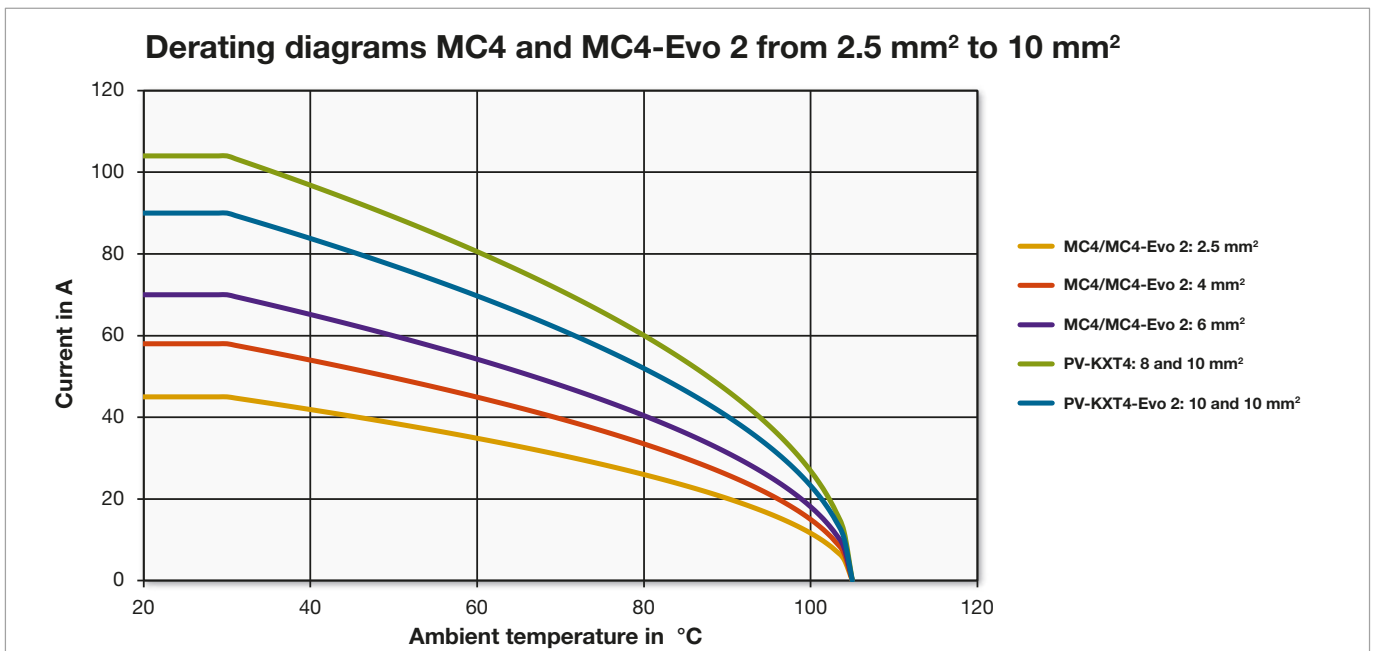
PV-ADB4-EVO 2/... MA285

The current capacity has been evaluated according to IEC 60512-5-2:2002 (with a derating factor of 0,9) and IEC 60364-5-52:2009.

The derating diagram specifies the maximum current at respective ambient temperatures. Operation of the connector is limited by a maximum component temperature (ambient temperature plus heating from current flow). This maximum admissible temperature is 105 °C inside of the connector.

Typical ambient temperatures in industrial applications are between 30 °C and 50 °C.

Beware: Hot surfaces of the connector and attached cables are possible (> 65 °C maximum temperature of touchable surfaces). Please note that in some switchgear applications the maximum temperature of touchable surfaces is limited to 65 °C (touchable/susceptible to manipulation) according to IEC 60947-1 (Low-voltage switchgear and control gear - Part 1: General rules). Depending on the application, it has to be checked whether this requirement applies.



The derating diagram is valid for attached cables with 90 °C admissible temperature or higher. If cables with a temperature rating < 90 °C is used, the derating of the cable has to be considered.

Possible examples of cables:

- PVC cable: H07V-K 10 mm<sup>2</sup>: 70 °C
- Rubber cable: NSGAFÖU 1.8/3 kV 10 mm<sup>2</sup>: 90 °C
- PV cable: FLEX-SOL-EVO-DX 10 mm<sup>2</sup>: 120 °C

The current values of the diagram for 2.5 mm<sup>2</sup>, 4mm<sup>2</sup> und 6mm<sup>2</sup> are shown in the following table:

Rated currents at respective ambient temperatures for MC4 and MC4-EVO 2			
Ambient temperature	cable cross section		
	2.5 mm <sup>2</sup>	4 mm <sup>2</sup>	6 mm <sup>2</sup>
30 °C	42	55	70
40 °C	39	51	65
50 °C	36	47	60
60 °C	32	43	54
70 °C	28	38	48
80 °C	24	32	40
90 °C	19	25	31

The following table shows rated currents with respect to cross sections and cable types:

Maximum admissible current in Ampere for T <sub>AMB</sub> = 30 °C for 2.5 mm <sup>2</sup> to 10 mm <sup>2</sup>				
Max admissible temperature of attached cable	70 °C cable		90 °C cable or higher	
	MC4	MC4-Evo 2	MC4	MC4-Evo 2
2.5 mm <sup>2</sup> / 14 AWG	32 A		42 A	
4.0 mm <sup>2</sup> / 12 AWG	42 A		55 A	
6.0 mm <sup>2</sup> / 10 AWG	54 A		70 A	
10 mm <sup>2</sup> / 8 AWG	85 A*	80 A	104 A*	90 A

\* 8II-UR version for 10 mm<sup>2</sup>/8 AWG: measured derating, smaller diameters calculated according to IEC 60364-5-52:2009

The following tables display the rated currents for MC4 and for MC4-Evo 2 for the largest possible cable -10 mm<sup>2</sup>/8 AWG- at different temperatures with respect to cable temperature rating

70 °C or > 90 °C, and for keeping touchable surfaces cooler than 65 °C. Note: Maximum ambient temperature for the connectors is specified to 85 °C.

MC4 PV-KXT4/8	Maximum admissible current in Ampere for		
	Touchable surface < 65 °C	70 °C cable	90 °C cable or higher
Ambient temperature			
30 °C	80	85	104
40 °C	65	74	95
50 °C	41	58	88
60 °C	14	30	81
65 °C	0	15	77
70 °C		0	72
80 °C			61
90 °C			41

MC4-Evo 2	Maximum admissible current in Ampere for			
	Touchable surface < 65 °C	70 °C cable	90 °C Cable	120 °C cable or higher
Ambient temperature				
30 °C	86	80	90	90
40 °C	72	68	83	83
50 °C	53	58	76	77
60 °C	18	30	67	70
65 °C	0	15	63	67
70 °C		0	59	63
80 °C			47	51
90 °C			27	31

## 8. Technical characteristics

MC4 (PV-KBT4/... and PV-ADBP4-S2/...)

Rated voltage	1000 V DC
Rated current (30 °C)	2.5 mm <sup>2</sup> / 14 AWG: 39 A 4.0 mm <sup>2</sup> / 12 AWG: 51 A 6.0 mm <sup>2</sup> / 10 AWG: 65 A 10.0 mm <sup>2</sup> / 8 AWG: 104 A
Rated surge voltage	12 kV
Ambient temperature range	-40 °C...+85 °C
Upper limiting temperature	105 °C
Mating cycles	100
Degree of protection, mated	IP65
unmated	IP2X
Overvoltage category / Pollution degree	CATIII/3
Contact resistance of plug connectors	≤ 0.35 mΩ
Locking system	snap-in/locking type
Safety class	II
Contact system	MULTILAM
Type of termination	Crimping
Contact material	Tin-plated copper
Warning	Do not disconnect under load
Insulation material	PC/PA
Flame class	UL94-V0

MC4-Evo 2 (PV-KBT4-EVO 2/... and PV-ADB4-EVO 2/...)

Rated voltage	1500 V DC
Rated current (30 °C)	2.5 mm <sup>2</sup> / 14 AWG: 39 A 4.0 mm <sup>2</sup> / 12 AWG: 51 A 6.0 mm <sup>2</sup> / 10 AWG: 65 A 10.0 mm <sup>2</sup> / 8 AWG: 90 A
Rated surge voltage	16 kV
Ambient temperature range	-40 °C...+ 85 °C
Upper limiting temperature	115 °C
Mating cycles	100
Degree of protection, mated	IP65
unmated	IP2X
Overvoltage category / Pollution degree	CATIII / 3
Contact resistance of plug connectors	≤ 0.35 mΩ
Locking system	snap-in/locking type
Safety class	II
Contact system	MULTILAM
Type of termination	Crimping
Contact material	Tin-plated copper
Warning	Do not disconnect under load
Insulation material	PA
Flame class	UL94-V0

## 9. Norms and standards

IEC 61984:2008 Connectors - Safety requirements and tests

IEC62852:2014 Connectors for DC-application in photovoltaic systems. Safety requirements and tests

IEC60664: Insulation coordination for equipment within low-voltage systems

IEC 60512-5-2:2002 Connectors for electronic equipment - Tests and measurements - Part 5-2: Current-carrying capacity tests- Test 5b: Current-temperature derating

IEC 60364-5-52:2009 Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems

IEC 60947-1 (Low-voltage switchgear and control gear-Part 1: General rules).

UL 6703:2014 Standard for Connectors for Use in Photovoltaic Systems

UL 1977:2016 Standard for Component Connectors for Use in Data, Signal, Control and Power Applications

UL 2237:2018 Outline of Investigation for Multi-Point Interconnection Power Cable Assemblies For Industrial Machinery

UL 2238:2011 Standard for Cable Assemblies and Fittings for Industrial Control and Signal Distribution

UL 486a,b: wire connectors

EN 50525-2-31:2011, Part 2-31: Power cables for general applications - Conductor and wiring lines with thermoplastic PVC insulation

DIN VDE 0100-520:2013-06 Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems (IEC 60364-5-52:2009, modified + Corrigendum Feb. 2011); German implementation HD 60364-5-52:2011

DIN VDE 0298-3:2006-06: Verwendung von Kabeln und isolierten Leitungen für Starkstromanlagen-Teil 3: Leitfaden für die Verwendung nicht harmonisierter Starkstromleitungen Application of cables and cords in power installations- Part 3: Guide to use of non-harmonized cables

EN 50525-2-21:2011 Kabel und Leitungen- Starkstromleitungen mit Nennspannungen bis 450/750 V ( $U_0/U$ )- Teil 2-21: Starkstromleitungen für allgemeine Anwendungen- Flexible Leitungen mit vernetzter Elastomer-Isolierung; Electric cables-Low voltage energy cables of rated voltages up to and including 450/750 V ( $U_0/U$ )-Part 2-21: Cables for general applications-Flexible cables with crosslinked elastomeric insulation;

DIN VDE 0250-602:1985-03 Cables, wires and flexible cords for power installation; special rubber-insulated single-core cables