

POWER  
COMBICON

The full range  
for power electronics

## UL standards Technical information on the PCB connection

### 1) UL Product Standards

#### UL 1059 "Terminal blocks"

The recognition of printed circuit terminal blocks and PCB plug connectors by UL is based primarily on the UL standard 1059 "Terminal blocks". Recognition in acc. with this standard allows terminal blocks and plug connectors to be used universally in almost all fields of application as external connection terminal blocks, so-called Field Wiring Terminal Blocks. In order for Phoenix Contact products to be able to be used in industrial applications without restrictions, they are generally tested and recognized in acc. with UL 1059.

**UL 1977 "Component connectors for use in data, signal, control and power applications"**  
This standard specifies requirements designed solely for plug connectors for use in factory assembled

devices and systems (Factory Wiring Terminal Blocks). If a plug connector is to be certified in acc. with UL 1977, the following conditions must be fulfilled:

1. It must be guaranteed that the plug connector is preassembled under factory conditions!
2. The plug connector must be constructed in such a manner as to rule out the possibility of the poles being confused as a result of incorrect installation.
3. The possibility of confusing the individual contacts during mounting must be ruled out.

**UL 486 E "Equipment wiring terminals for use with aluminum and/or copper conductors"**  
This standard defines the requirements for terminal points for use with aluminum and/or copper conductors.

### 2) UL Online Certification Directory

Terminal blocks and plug connectors are recognized by UL as individual components (recognition). In the end application, the components undergo final evaluation and are approved for operation together with the device:



Recognition of the terminal blocks and plug connectors is confirmed by a UL report. This contains various details on the product, such as connection data (ratings), air and creepage distances, materials, dimensions and conditions of acceptability for applications.

Details for equipment certification not listed here can be found in the corresponding UL standards or, if necessary, clarified directly with the UL certification centers.

Together with the article designations, the connection data are documented in the so-called Yellow Cards or in the UL Online Certification Directory as proof of certification. UL has set up an Internet site under [www.ul.com/database](http://www.ul.com/database) making these data generally available and providing explanations. The site offers various different search options, such as "Company Name" or "UL File Number".

**Caution:** UL current and voltage values are listed in the UL Online Certification Directory as maximum values only. These values are not subdivided into individual Use Groups!

Data series and certifications for all COMBICON articles are listed in **COMBICON Select** [www.select.phoenixcontact.com](http://www.select.phoenixcontact.com) and under [www.phoenixcontact.com](http://www.phoenixcontact.com).

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### 3) UL Use Groups

The Use Group describes the later field of application of the finished device. The following table lists the air and creepage distances required:

Use Group	Definition	Max. voltage [V]	Required distances [mm]	
			Air distance	Creepage distance
A	Operating elements, panels and similar.	150	12.7	19.1
		300	19.1	31.8
		600	25.4	50.8
B	Conventional devices, including office and electronic data processing equipment and similar.	150	1.6	1.6
		300	2.4	2.4
		600	9.5	12.7
C	Industrial applications, without restrictions	150	3.2	6.4
		300	6.4	9.5
		600	9.5	12.7
D	Industrial applications, Electrical equipment with limited rating	300	1.6	3.2
		600	4.8	9.5

The possible UL voltage thus depends on the Use Group and the prevailing air and creepage distances. Let us assume the following values in a product example:

Article	Existing distances [mm]		Resulting UL voltage [V]
	Air distance	Creepage distance	
Plug	11.0	13.1	600
Headers	9.2	11.8	300

From this can be seen that in the Use Group C, there is a UL voltage of 600 V for the plug and a possible voltage of just 300 V for the matching header. Additional measures, such as coating the PCB with an insulating material (conformal coating) or slits in the PCB increase the air and creepage distances. It is thus possible to attain 600 V suitability at full current for the pin strip too.

The corresponding COMBICON products are marked overleaf with \*. Under point 4), application standard UL 840 is listed. The lower requirements with respect to air and creepage distances also allow certification of the terminal block with higher voltages.

### 4) UL Application Standards

#### UL 508 "Industrial control equipment"

Terminal blocks recognized according to UL 1059 can also be used directly as Field Wiring Terminal Blocks for devices in accordance with the UL 508 series of standards.

#### UL 508 C "Power conversion equipment"

UL 508 C applies in particular to motor controllers (frequency converters etc.). The section 35.9.3 exception allows the alternative rating of field wiring terminal blocks according to UL 840.

#### UL 840 "Insulation coordination including clearances and creepage distances for electrical equipment"

If there are space problems on the PCB, the

alternative air and creepage distance rating in accordance with UL 840 using the section 35.9.3 exception (in acc. with UL 508 C – 2nd Edition) can be used to achieve a reduction in the distance requirements for connection terminals. Certification in acc. with UL 840 requires the following conditions to be fulfilled:

1. The clamping technology fulfills the requirements of section 35.9.3 (in acc. with UL 508 C – 2nd Edition)
2. Proof of air distance: The surge voltage test in acc. with UL 840 is passed.
3. Proof of creepage distance: The minimum requirements for creepage distances in acc. with UL 840 (identical to IEC 664 (A) and VDE 0110, Table 4) are fulfilled.

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INNOVATION IN INTERFACE

## POWER COMBICON Printed circuit terminal blocks

The high-performance printed circuit terminal blocks from Phoenix Contact provide connection options for conductors with cross sections of 0.2 to 35 mm<sup>2</sup>. The use of a tension sleeve or spring-cage makes connecting the conductor a convenient matter. Complex and costly special aids with ring cable lugs, up front mounting rails or packages of modular terminal block can thus be dispensed with. The particularly powerful screw printed circuit terminal block, MKDSP 25, is designed for currents up to 125 amps and has unlimited UL rating up to 600V or up to 1000V in acc. with IEC / DIN VDE. It is connected to the PCB fast and securely with the wave soldering process. The high current terminal block is typically used wherever high currents flow on printed circuit boards, e.g. in high-capacity frequency converters, power supplies and chargers.

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[www.select.phoenixcontact.com](http://www.select.phoenixcontact.com)

Rated voltage in acc. with IEC / DIN VDE

Load current in acc. with IEC / DIN VDE

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### 500 V

Spring-cage connection	
ZFKDS 4-7.5 [V] [A]	300 30
UL Use Group B	300 30
UL Use Group C	150 30
UL Use Group D	300 10

### 630 V

Spring-cage connection	
ZFKDS 4-10 [V] [A]	300 30
UL Use Group B	300 30
UL Use Group C	150 30
UL Use Group D	300 10

### 690 V

Spring-cage connection	
MKDS 5 HW...9.52-2** [V] [A]	600 30
UL Use Group B	600 30
UL Use Group C	400 30
UL Use Group D	400 5

### 800 V

Spring-cage connection		Spring-cage connection	
MKDS 5 HW...9.52 [V] [A]	300/600* 30	MKDSV 5 HW...9.52** [V] [A]	300/600* 30
UL Use Group B	300/600* 30	UL Use Group B	300/600* 30
UL Use Group C	300/600* 30	UL Use Group C	300/600* 30
UL Use Group D	400 5	UL Use Group D	400 5

Voltage and current values listed in acc. with IEC / DIN VDE for surge voltage category III and degree of contamination 3.

\* For 600V UL applications, additional insulation is necessary on the solder pins (conformal coating).

\*\* "Z pinning" allows unretrofit 600V UL rating.

\*\*\* For 2-pin connections, polarization pins are recommended.

### 320 V

Spring-cage connection	
ZFKDS 10-10.00 [V] [A]	300 57
UL Use Group B	300 57
UL Use Group C	In preparation
UL Use Group D	In preparation

### 690 V

Spring-cage connection		Spring-cage connection	
MKDS 10...10.16 [V] [A]	300 57	MKDS 10 HW...10.16 [V] [A]	300/600* 57
UL Use Group B	300 57	UL Use Group B	300/600* 57
UL Use Group C	300 57	UL Use Group C	300/600* 57
UL Use Group D	600 5	UL Use Group D	600 5

### 1000 V

Spring-cage connection	
MKDS 10 HW...12.7 [V] [A]	600 57
UL Use Group B	600 57
UL Use Group C	400 57
UL Use Group D	400 5

### 1000 V

Spring-cage connection		Spring-cage connection	
MKDS 25...15.00 [V] [A]	600 115	MKDS 25...15.00-F [V] [A]	600 115
UL Use Group B	600 115	UL Use Group B	600 115
UL Use Group C	600 115	UL Use Group C	600 115
UL Use Group D	600 115	UL Use Group D	600 115

Voltage and current values listed in acc. with IEC / DIN VDE for surge voltage category III and degree of contamination 3.

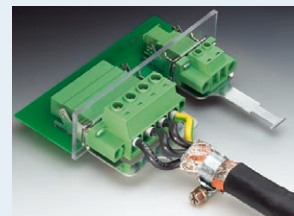
\* For 600V UL applications, additional insulation is necessary on the solder pins (conformal coating).

\*\* "Z pinning" allows unretrofit 600V UL rating.

\*\*\* For 2-pin connections, polarization pins are recommended.

## POWER COMBICON Plug connectors

The power spectrum of Phoenix Contact power plug connectors starts in the lower segment with the "High Current" HC range. Highly conductive materials make it possible for the HC contact system to attain a current carrying capacity of 16 amps. The conductors are connected with the proven tension sleeve principle or using spring-cage. If you need to get currents of up to 20 amps to the PCB, the PC 4 is the best choice. The POWER COMBICON classic has a convincing and compact design with a 7.62 mm pitch and UL certifications up to 600V. In addition to the standard variants, there are additional products available for rail-mounting and panel feed-through. PC 6 and PC 16 are high-performance plug connectors with an enormous safety reserve. If a 16 mm<sup>2</sup> conductor is connected, the PC 16 contact system allows a current carrying capacity of 76 amps. Power electronics go pluggable and easy to service.



POWER COMBICON with integrated shielding function

### 250 V

Spring-cage connection		Spring-cage connection	
MSTB 2.5 HCL...ST(F)... [V] [A]	300 16	MSTBT 2.5 HCL...ST [V] [A]	300 16
UL Use Group B	300 16	UL Use Group B	300 16
UL Use Group C	300 10	UL Use Group C	300 10
UL Use Group D	300 10	UL Use Group D	300 10

### 250 V

Spring-cage connection		Spring-cage connection	
MSTBR 2.5 HCL...ST(F)... [V] [A]	300 16	MSTBRW 2.5 HCL...ST(F)... [V] [A]	300 16
UL Use Group B	300 16	UL Use Group B	300 16
UL Use Group C	300 10	UL Use Group C	300 10
UL Use Group D	300 10	UL Use Group D	300 10

### 250 V

Spring-cage connection		Spring-cage connection	
FKC 2.5 HCL...ST(F)... [V] [A]	300 16	FKC 2.5 HCL...ST(F)... [V] [A]	300 16
UL Use Group B	300 16	UL Use Group B	300 16
UL Use Group C	300 10	UL Use Group C	300 10
UL Use Group D	300 10	UL Use Group D	300 10

### 250 V

Spring-cage connection		Spring-cage connection	
MSTBA 2.5 HCL...G(F)... [V] [A]	300 16	MSTBAW 2.5 HCL...G(F)... [V] [A]	300 16
UL Use Group B	300 16	UL Use Group B	300 16
UL Use Group C	300 10	UL Use Group C	300 10
UL Use Group D	300 10	UL Use Group D	300 10

Voltage and current values listed in acc. with IEC / DIN VDE for surge voltage category III and degree of contamination 3.

\* For 600V UL applications, additional insulation is necessary on the solder pins (conformal coating).

\*\* For 600V UL applications, the insulation requirements of the individual device specification for the connection points must be observed.

### 400 V

Spring-cage connection		Spring-cage connection	
PC 4...ST(F)-7.62 [V] [A]	300 20	PC 4...G(F)-7.62 [V] [A]	300/600* 20
UL Use Group B	300 20	UL Use Group B	300/600* 20
UL Use Group C	300 20	UL Use Group C	300/600* 20
UL Use Group D	600 5	UL Use Group D	600 5

### 400 V

Spring-cage connection		Spring-cage connection	
PCV 4...G(F)-7.62 [V] [A]	300/600* 20	DFK-PC 4...G-F-7.62 [V] [A]	300/600* 20
UL Use Group B	300/600* 20	UL Use Group B	300/600* 20
UL Use Group C	300/600* 20	UL Use Group C	300/600* 20
UL Use Group D	600 5	UL Use Group D	600 5

### 500 V

Spring-cage connection		Spring-cage connection	
DFK-PC 4...G-F-7.62-FS [V] [A]	300/600* 20	PCV 4-7.62 [V] [A]	300 20
UL Use Group B	300/600* 20	UL Use Group B	300 20
UL Use Group C	300/600* 20	UL Use Group C	300 20
UL Use Group D	600 5	UL Use Group D	600 5

### 500 V

Spring-cage connection		Spring-cage connection	
PC 4 HW...ST(F)-7.62 [V] [A]	600 20	PCV 4 HW...ST(F)-7.62 [V] [A]	600 20
UL Use Group B	600 20	UL Use Group B	600 20
UL Use Group C	600 20	UL Use Group C	600 20
UL Use Group D	600 5	UL Use Group D	600 5

Voltage and current values listed in acc. with IEC / DIN VDE for surge voltage category III and degree of contamination 3.

\* For 600V UL applications, additional insulation is necessary on the solder pins (conformal coating).

\*\* For 600V UL applications, the insulation requirements of the individual device specification for the connection points must be observed.

### 1000 V

Spring-cage connection		Spring-cage connection	
PC 4...ST(F)-10.16 [V] [A]	600 50	PCV 4...STD-10.16 [V] [A]	600 50
UL Use Group B	300/600* 50	UL Use Group B	300/600* 50
UL Use Group C	600 50	UL Use Group C	600 50
UL Use Group D	600 50	UL Use Group D	600 50

### 630 V

Spring-cage connection		Spring-cage connection	
PC 6-16...G(F)-10.16 [V] [A]	300/600* 50	PCV 6-16...G(F)-10.16 [V] [A]	300/600* 50
UL Use Group B	300/600* 50	UL Use Group B	300/600* 50
UL Use Group C	300/600* 50	UL Use Group C	300/600* 50
UL Use Group D	600 5	UL Use Group D	600 5

### 1000 V

Spring-cage connection		Spring-cage connection	
PC 16...ST(F)-10.16 [V] [A]	600 115	PCV 16...ST(F)-10.16 [V] [A]	600 115
UL Use Group B	600 115	UL Use Group B	600 115
UL Use Group C	In preparation	UL Use Group C	In preparation
UL Use Group D	In preparation	UL Use Group D	In preparation

### 1000 V

Spring-cage connection		Spring-cage connection	
IPC 16...ST(F)-10.16 [V] [A]	600 115	IPC 16...ST(F)-10.16 [V] [A]	600 115
UL Use Group B	600 115	UL Use Group B	600 115
UL Use Group C	In preparation	UL Use Group C	In preparation
UL Use Group D	In preparation	UL Use Group D	In preparation

Voltage and current values listed in acc. with IEC / DIN VDE for surge voltage category III and degree of contamination 3.

\* For 600V UL applications, additional insulation is necessary on the solder pins (conformal coating).

\*\* For 600V UL applications, the insulation requirements of the individual device specification for the connection points must be observed.

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