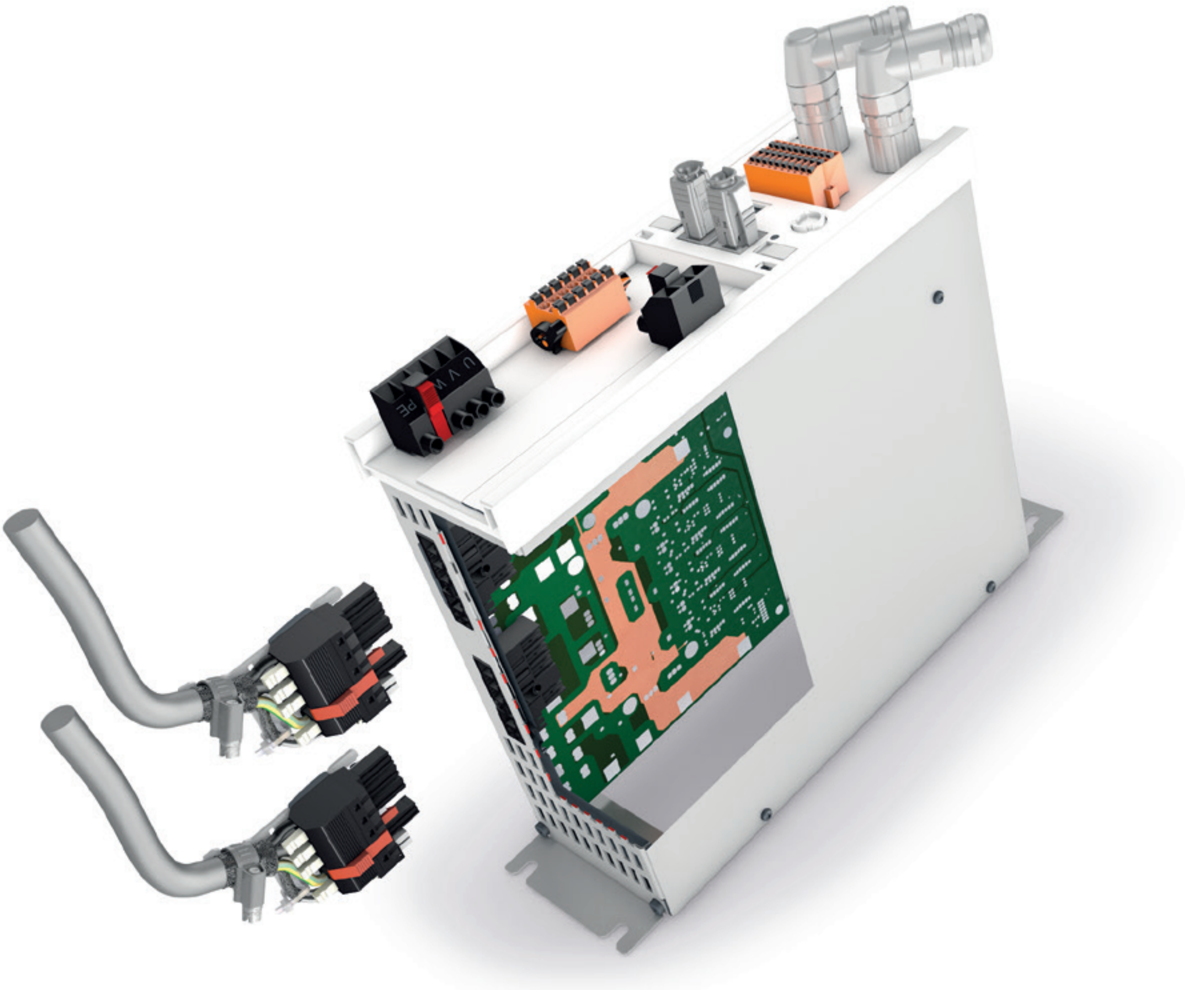
Design recommendations for connection systems and circuit boards in motor controllers

Whitepaper



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In recent years, semiconductor technology for performance electronics has been continuously developing. Increasingly complex drive controllers have been produced, for example for speed controllers or precise positioning systems. Perfect-fit, future-oriented connection and PCB technology on which the hardware developer can rely completely is essential. As a practical specialist in Industrial Connectivity, Weidmüller has in-depth know-how in connectivity for power electronics. Its technological partnership with Häusermann ensures expertise in design and production of high current and heat management PCBs. Both partners are familiar with the extreme requirements for servo-controllers or frequency converters that hardware developers are constantly faced with: voltages of 400 V to 690 V in accordance with IEC and 600 V in accordance with UL, and even up to 1000 V in direct current circuits are not uncommon. High electrical conductivity in the smallest possible space also plays an important role. Both Weidmüller and Häusermann support these kinds of complex requirements with impressive, innovative technologies.

Fig. 1: Device for controlling motors

Motor controller operation

A motor controller steplessly controls an alternating current motor based on a number of variables. To do this, they generate a pulse width-modulated alternating voltage with a variable frequency. The devices are split into various power classes. The white paper covers motor controllers with power output of up to 250 kW, i.e. devices that are typically used without discrete IGBTs.

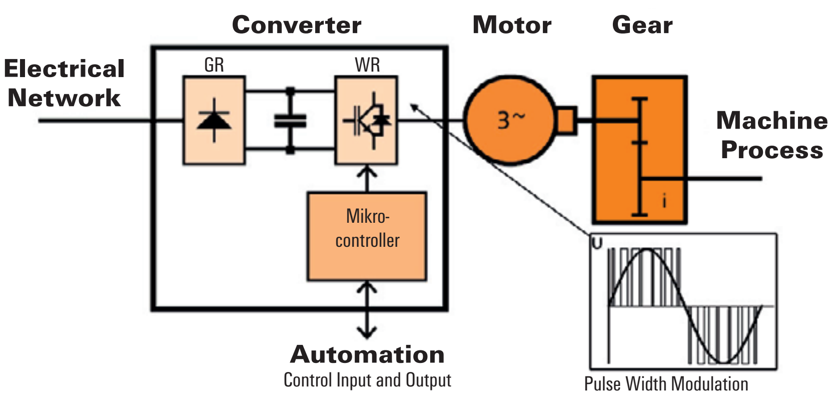


Fig. 2: Function circuit diagram for a motor controller

Function circuit diagram: As a rule, a motor controller consists of a controller element, the rectifier and the converter where the pulse width modulation takes place.

The power element requires considerably greater copper thicknesses on the PCB than the controller element, which is normally implemented with FR4 multi-layer PCBs with copper thicknesses of 35-70 µm. Despite the fact that FR4 conducts heat 10 times better than air, it is still necessary to achieve copper cross sections of up to 10 mm^2 for each phase. However, the increased space required when using standard copper layer thicknesses is often not available using state-of-the-art performance switches (MOSFETs) in SMD format. This basic problem is resolved by partially increasing the copper layer thickness from standard multi-layers to >500 µm for connections between the rectifier and inverter. The control and high-current elements can now be implemented on a single board. The unavoidable heat loss from the power switch can now also be efficiently led through the PCB to the cooling body.

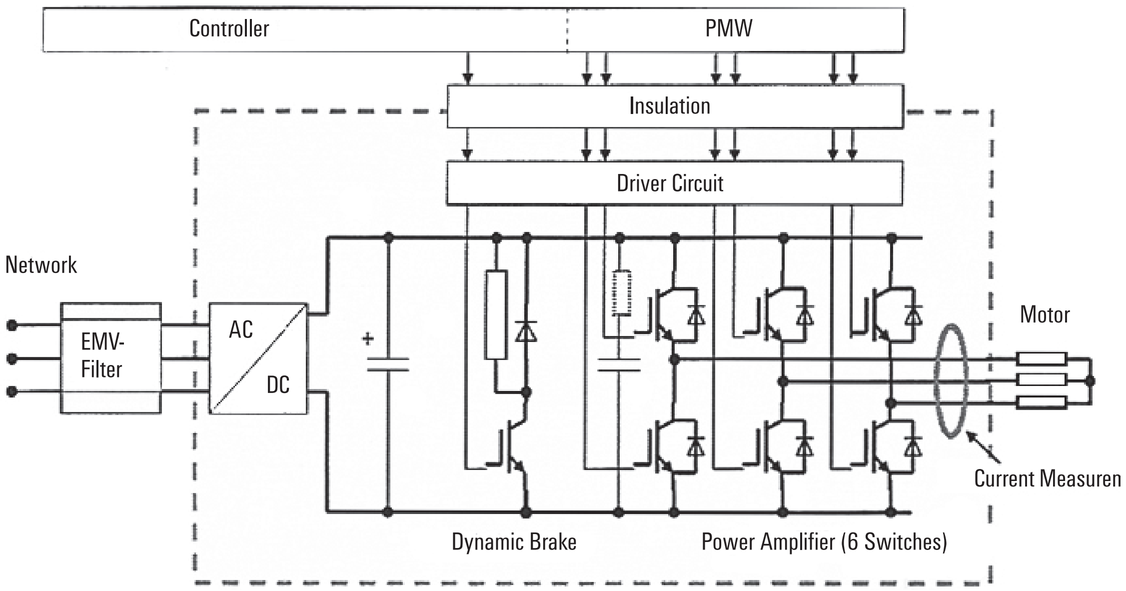


Fig. 3: Circuit diagram of a motor controller

Requirements of device connectivity for a motor controller

Power supply

A safe unit connection is indispensable for the given current and voltage requirements, in all power electronics applications. The terminals and plug-in connectors offer maximum safety. A separate connector face prevents the wrong connecting partners being connected accidentally. You can also further secure the plug-in connectors using clips, locks or screws. Depending on your application, you can choose between spring ("PUSH IN") or screw connections. There are connections with printable connection names to ensure error-free, maintenance free connection on site.

Standard and IT network plug-in connectors are suitable for connection cross-sections of 2.5 mm^2, 6 mm^2 and 16 mm^2. In power electronics applications, PCB terminals provide a robust direct connection for the power and voltage supplies required in a 10.16 mm, 12.7 mm or 15.0 mm size with connection capacities of up to 50 mm^2. In order to feed currents of different orders of magnitude through the device wall, panel feedthrough terminal blocks for 4 mm^2 to 95 mm^2 are used.

Interim circuit

Contact protection on both sides of the connection reduces the risk of reverse voltage at high voltages and complies with device approval in accordance with IEC 68100-5-1. Inverted bushes in conjunction with the relevant male connectors also provide touch safety on both sides even when disconnected. Special power connectors for IT networks simplify design-in and the approval process. For non plug-in connection solutions, the recommendation is for PCB terminals in sizes 10.16 mm, 12.7 mm and 15.0 mm with connection capacities of up to 25 mm^2 or terminals for device feedthrough for 4 mm^2 to 50 mm^2.

Motor connection

Connection of motor voltage, the internal temperature sensor and possibly also a mechanical brake are among the traditional requirements for this interface. Depending on the application, there is also a connection to an encoder or resolver. A hybrid motor plug connector combines energy, signals and cable shielding in one step, it saves space on the PCB and on the outside of the housing. Self-engaging one-handed locking also reduces installation and maintenance times. Specialist PCB plug connectors are available for devices on IT networks. The LSF PCB terminals in sizes 10.16 mm, 12.7 mm and 15.0 mm with a 50 mm^2 connection cross-section are a non-pluggable connection solution.

Safety circuit

Safety switchgear such as emergency off switches, light curtains and door switches communicate closely with drive controllers. In order to protect people and machinery, they ensure that the connected drive is stopped immediately if required. Signal plug connectors with a size of 5.08 mm with a screw or PUSH IN connection are used. The PCB terminals in size 5.08 mm work well as a non-pluggable connection solution.

Requirements for UL-compliant design of devices with device connectivity

Global certification of electronic components and devices

Before they are launched on the market, electronic components and devices are checked for safety. The leading global organisations for the certification of product safety are Underwriters Laboratories (UL) and the International Electrotechnical Commission (IEC). All products must be certified in accordance with the local applicable standards for the market in a given country. IEC standards apply in Europe and other areas of the world, while UL standards apply in USA and in Canada it is the Canadian Standards Association or CSA for short (cf. Fig. 4). There are substantial differences between the standards, which makes global product approval more difficult. In general, the requirements for UL are stricter than those for the IEC.

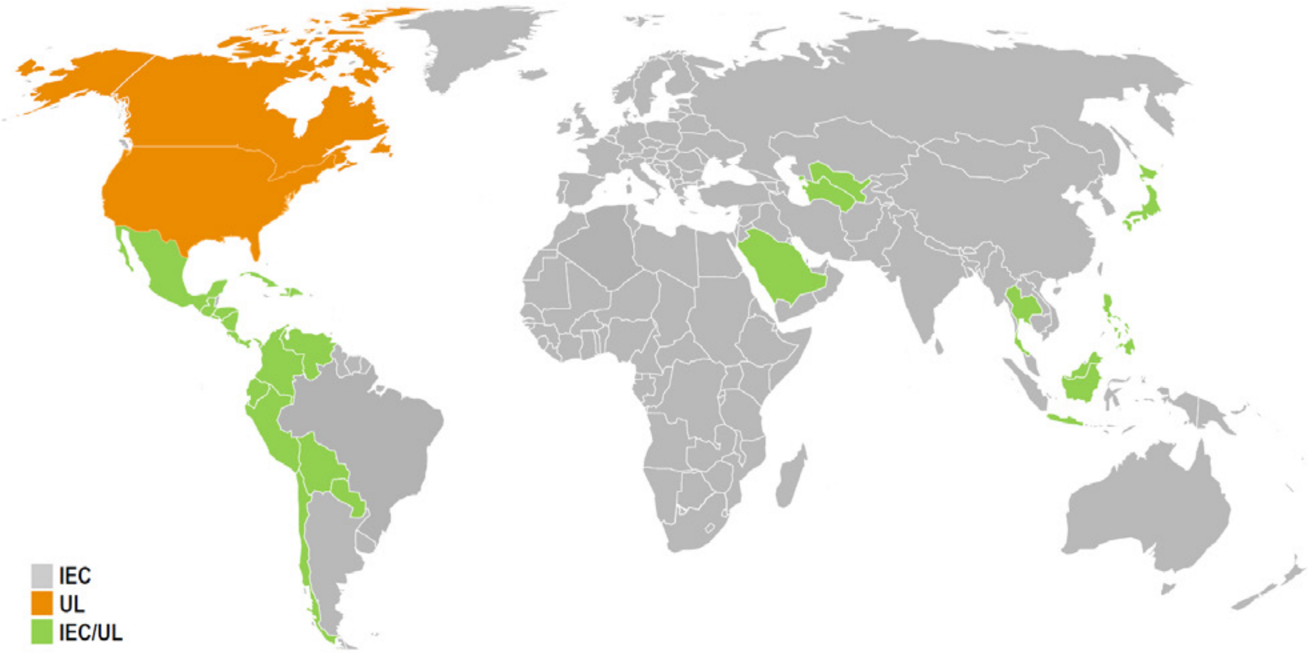


Fig. 4: Areas of application of IEC, UL and CSA standards, Source: Siemens

UL test mark for devices and components

The UL standard distinguishes between listed devices and registered components. A component (Fig. 5) is the smallest production unit, such as a terminal. Unlike a device, it is not given a UL listing, it is registered. Components may be fitted in control cabinets and used as passive elements. A device (Fig. 6) consists out of certified components which form a unit. It is an end product and can be used in the control cabinet as an active component. There are also different standards and test marks for devices and components, irrespective of where they are used.

In accordance with the CSA standard, there is no distinction between components and devices, the CSA test mark applies (Fig. 7). Product with a combined UL and CSA test mark (Fig. 5 - 7) can be sold in the USA and Canada.

Fig. 5 UL test mark for components

Fig. 6: UL test mark for devices

Fig. 7: CSA test mark

UL certification for components

When developing the device, device connectivity components are used as external connection components. Device connectivity components are subject to standard UL 1059. Depending on the purposes, this standard sets different requirements, specifically in terms of the length of the air and creep gaps. To do this, they are broken down into use groups (A, B, C and D) (Fig. 8). They are different in terms of the air and creep gaps required and the limits of the rated voltages. Standards UL 1059C and UL 1059D apply in industrial environments.
In the event of certification in accordance with Use Group D (Fig, 8), a maximum of 15 A cannot be exceeded at 51 V to 150 V, with 10 A for 151 to 300 V and 5 A for 301 V to 600 V, in order to guarantee safety despite reduced air and creep gaps compared to Use Group C.

Use Group	Explanation	max. Nominal Voltage (V)	Clearance (mm)	Creepage Distance (mm)
A	Control and operating panels, Control and monitor devices	150 300 600	12.7 19.1 25.4	19.1 31.8 50.8
B	Conduction-bound, non-fixed applications	150 300 600	1.6 2.4 9.5	1.6 2.4 12.7
C	All devices and equipment for industrial applications	150 300 600	3.2 6.4 9.5	6.4 9.5 12.7
D	All devices and equipment for industrial applications with limited current data	300 600	1.6 4.8	3.2 9.5
E	Connections in the range 601 - 1500 V	600 1500	14.0 17.8	21.6 30.5

Fig. 8: Extract from UL 1059 (Table 8.1), Source: UL

UL certification for devices

During device development, standard UL 1059 has little to say with respect to selecting suitable device connectivity. Exceptional regulations such as UL 508(C) (for Industrial Control Equipment) or UL 840 are applicable here. In terms of the certification of the connectivity of a device, the differentiation between field and factory wiring is relevant. Field wiring (Fig. 9) covers connectors and terminals with cables or lines for the connection of field components which can also be operated by non-specialists. These components are certified in accordance with UL 1059. Factory wiring components (Fig. 10) are fitted into an end device under factory conditions. Factory wiring components include plug connectors which are attached or soldered to a PCB and fitted into a device during the device manufacturing process. These are covered by the less strict device standards UL 508(C) and
UL 840.

Fig. 9: Field Wiring

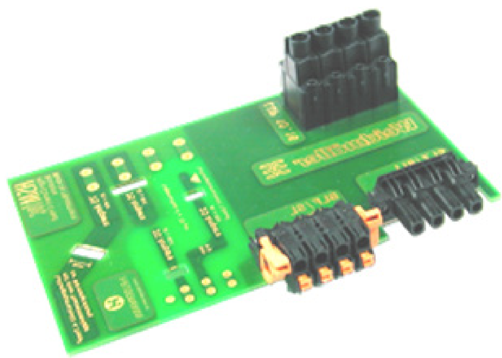


Fig. 10: Factory Wiring

Thanks to the differentiation between field and factory wiring, a male multipoint connector can be operated in a device above the maximum rated voltage specified by UL 1059. They must be part of this device and fitted under factory conditions (Fig. 11). In this case, the connection components must be certified in accordance with UL 1059, male multipoint connectors and PCB terminals must also be certified in accordance with device norm UL 508 (C) and UL 840 (Fig. 12), which set less strict requirements in terms of air and creep gaps.

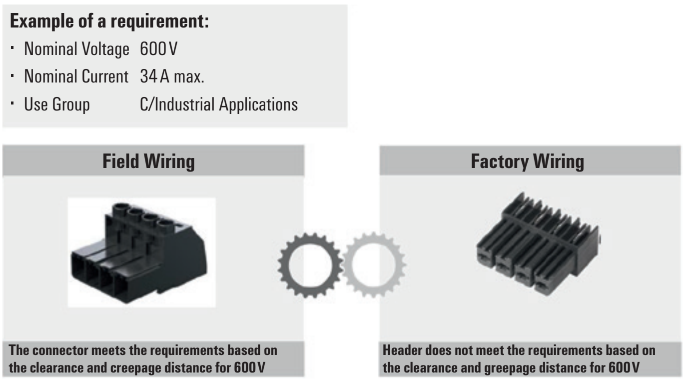


Fig. 11: Connector/male multipoint connector,
field or factory wiring

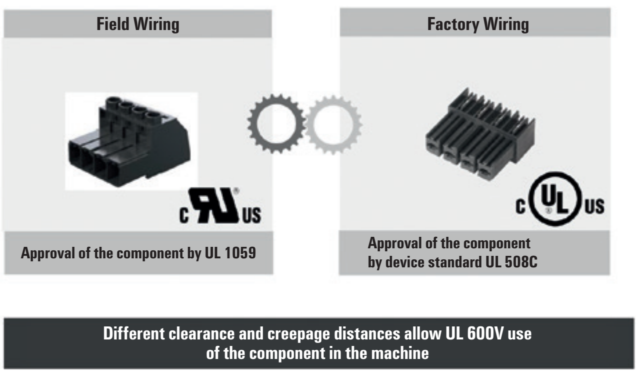


Fig. 12: Component, field or factory wiring

Effect device approval via UL 508C and UL 840

In order to certify a device in accordance with UL 508C and UL 840, the air and creep gaps must be evidenced in the multipoint male connector - they are a function of the level of contamination. For PCB terminals, in addition to evidence of the creep gap, evidence of the air gap must also be provided by carrying out an impact voltage test at 10.7 kV and connectivity with splice protection is also required. Requirements for air gaps for male multipoint connectors can be found in Table 8.1 of UL 840 and those for PCB terminals in Table 7.1 (A) of the same standard. Requirements for creep gaps can be found in Table 9.1 for both components. The creep gap is defined as a function of the material groups and the level of contamination.

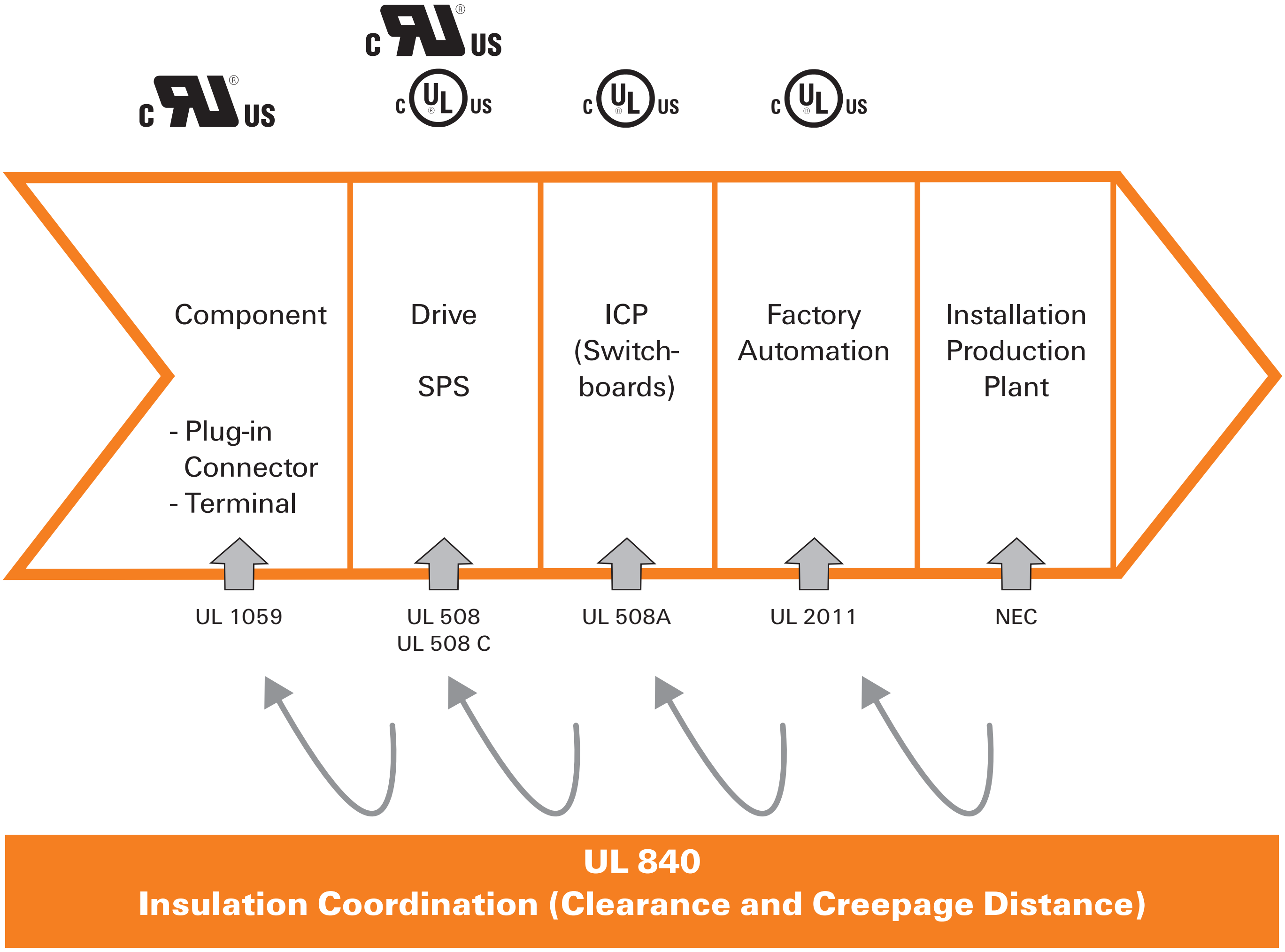


Fig. 13: UL certification process

Systematic procedures when selecting components for devices in accordance with UL 600V

Because the rules for UL certification are stricter than those for certification based on IEC standards, products should be developed to meet UL standards from the outset. By the same token, products which already have UL registration take priority.

Underwriters Laboratories (UL) has a service on their official website (http://ul.com/) whereby users can find out about the status (listed or unlisted) of a component free of charge. The manufacturer name and certificate (cURus) are required. At Weidmüller, this information can be found in the online catalogue under "nominal data as per UL 1059".

Touch safety for IT supply networks in accordance with UL/IEC 61800-5-1

UL/IEC 61800- 5-1

The standard IEC 61800 was adopted as a UL standard in 2012 and is now applicable worldwide. It describes the requirements of an electrical power drive system with adjustable speed, plus the power and monitoring units and motors. The standard restricts itself to a rated voltage of up to 1 kV or a rectified voltage of up to 35 kV at 50 Hz to 60 Hz respectively. Part 5-1 of IEC 61800 covers the safety requirements and thermal and energy requirements.

IT supply network

An IT network is a 3-line supply system with only a limited distribution. There is no intrinsic network earthing, so all housings and conductive equipment bodies must be earthed. A single insulation fault means the relevant external cable absorbs the earth potential. There is no risk of unauthorised contact voltage (Fig. 14). At the same time, a single fault does not lead to a network shutdown via a fuse, the second fault shuts the system down. In this case, two phases of the earthing, for a motor housing, for example, are connected together. This property is known as "single fault tolerance". In the event of a fault, it can be easily identified and resolved by the built-in insulation monitoring equipment in accordance with IEC 61557-8. This means IT networks are more reliable than earthed networks (TN-C network, etc.) where a short circuit causes an immediate shutdown by the safety equipment.

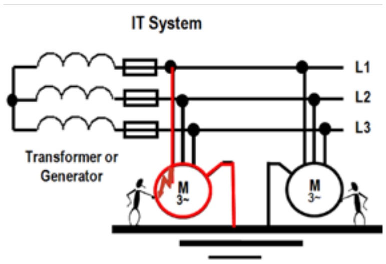


Fig. 14: IT network, single fault safety

Significance of UL/IEC 61800- 5-1 for device connectivity

In accordance with UL/IEC 61800-5-1, there is up to 400 V in contact with earth in an IT network. This means touch safety needs to be increased from, for example, 3 mm for 400 V TN networks for 5.5 mm for 400 V IT networks. It is crucial that these requirements are also met by the device connectivity components and elements (Fig. 15). Only then can they be certified in accordance with UL/IEC 61800-5-1. A test mark (Fig. 16) indicates that a product is certified.

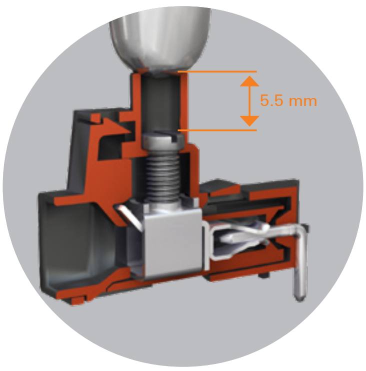


Fig. 15: Implementation of touch safety for device connectivity

Fig. 16: UL test mark 600 V

Approach to determining necessary touch safety

The first step is to determine the overvoltage category and system voltage of the system in question. UL/IEC 61800-5-1 Figure 17 also clarifies the impulse voltage based on the overvoltage category and the system voltage. The maximum overvoltage by time can also be seen. Based on the impulse voltages, the third thing which can be determined from UL/IEC 61800-5-1 Figure 18 is the norm-compliant minimum requirements based on the level of contamination.

System Voltage (4.3.6.2.1) (V)	Impulse Voltage (V)				Temporary Overvoltage (Crest Value/ r.m.s.) (V
	Overvoltage Category				
	I	II	III	IV	
≤ 50	330	500	800	1500	1770/1250
100	500	800	1500	2500	1840/1300
150	800	1500	2500	4000	1910/1350
300	1500	2500	4000	6000	2120/1500
600	2500	4000	6000	8000	2550/1800
1000	4000	6000	8000	12000	3110/2200

Fig. 17: UL/IEC 61800-5-1 - Insulation voltage for low voltage

Impulse Voltage (Tables 7, 8, 4.3.6.3)	Temporary Overvoltage (peak value) for determining the insulation between environments and circuits or working voltage (periodic peak value) for determining the operating insulation	Working voltage (periodic peak value) for determining the insulation between environments and circuits	Minimum Clearance mm Degree of Contamination		
V	V	V	1	2	3
N/A	≤ 110	≤ 71	0,01	0,20	0,80
N/A	225	141	0,01	0,20	0,80
330	340	212	0,01	0,20	0,80
500	530	330	0,04	0,20	0,80
800	700	440	0,10	0,20	0,80
1 500	960	600	0,50	0,50	0,80
2 500	1 600	1 000		1,5	
4 000	2 600	1 600		3,0	
6 000	3 700	2 300		5,5	
8 000	4 800	3 000		8,0	
12 000	7 400	4 600		14	
20 000	12 000	7 600		25	
40 000	26 000	16 000		60	
60 000	37 000	23 000		90	
75 000	48 000	30 000		120	
95 000	61 000	38 000		150	

Fig. 18: UL/IEC 61800-5-1 – Air gap/touch safety

Standards for PCB design

IPC guidelines for PCBs

The IPC guidelines (the Association Connecting Electronics Industries) for PCB design are second place of a four-position manufacturing which begins with "PCB and component design", "PCB production", "Component production" and "Repair and maintenance". For each group, there is a series of guidelines which describe, define and specify the individual processes or product groups. These specifications apply both to the manufacture and approval of PCBs.

Only a consistent system of guidelines from the design through to the delivery of a component which all those involved apply guarantees consistently high, reproducible quality.

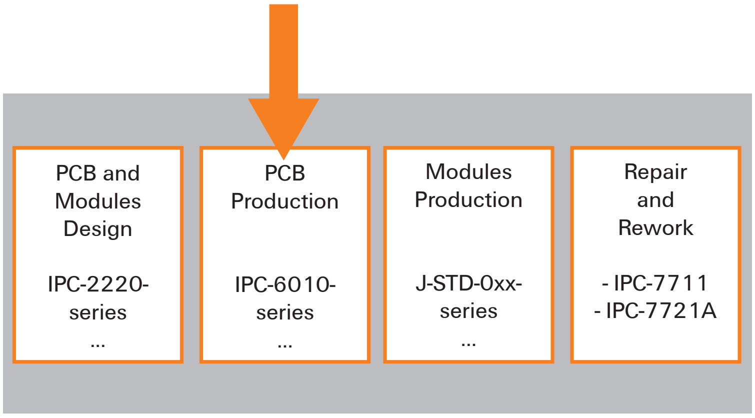


Fig. 19: Overview of IPC guidelines

Purpose of IPC 6010 series on "PCB production"

This series covers both the qualification and power specifications and the visual approval criteria for the PCBs. They are broken down into various technology groups.

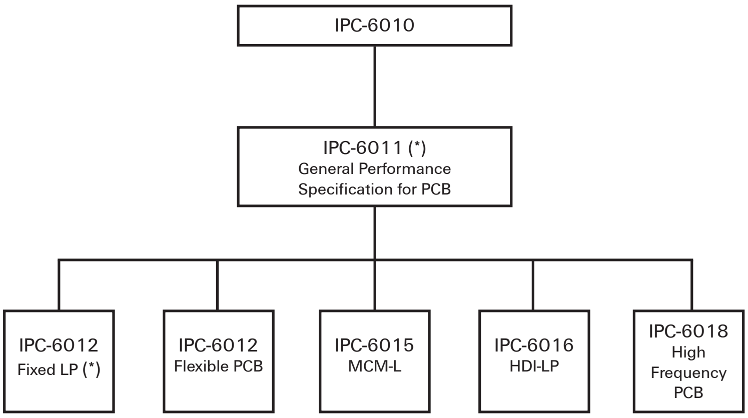


Fig. 20: Context of IPC guidelines

PCBs should always demonstrate the same high quality and meet the requirements of the IPC 6010 series.
The minimum requirements are defined in the IPC 6010 series Additional guidelines can be found in IPC-A-600x which includes a visual interpretation of the requirements.

Classification

The basic principle of IPC: quality is virtually mandatory, classification in three classes.

Class 1: general electronic products, consumer goods with low or undefined reliability requirements.
Class 2: general industrial electronics, electronics with specified applications, industry and control electronics with increased reliability requirements.
Class 3: high-performance electronics, electronics with extreme reliability requirements, including those under tough ambient conditions.

At the end of the day, the device manufacturer is responsible for determining which class the product is assigned to.

IPC 2152 Design guidelines to determine the conductivity of PCBs

As a general rule, it clarifies the relationships between current, cable dimensions and temperature and is used to define and evaluate copper cables on PCBs. The IPC 2152 design guidelines help to determine suitable cable sizes on a finished PCB as a function of the electrical conductivity required and the maximum temperature increase for the cable.

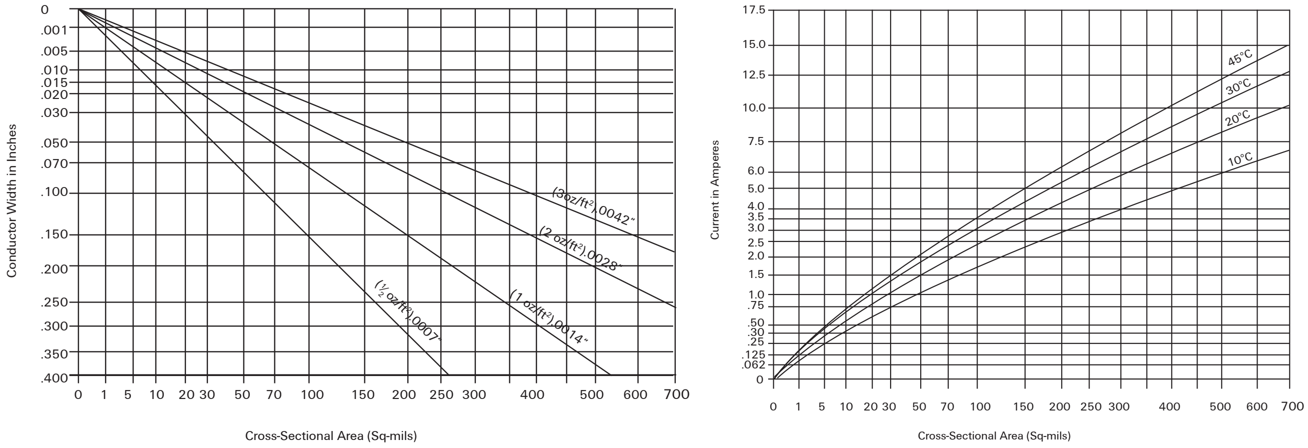


Fig. 21: Diagrams to determine the cable cross-section in accordance with IPC 2152

The diagrams in these guidelines extend to a maximum of 30 Amperes.

The following table serves as a guideline for currents over this and the use of copper profiles in the PCBs (HSMtec technology).

	Low Indirect Heat Splay					High Indirect Heat Splay				
Structure	FR4 160 mm x 100 mm x 1,6 mm					FR4 160 mm x 100 mm x 1,6 mm				
	Round Wire 0,5 mm	Cu-Profile 2 mm	Cu-Profile 4 mm	Cu-Profile 8 mm	Cu-Profile 12 mm	Round Wire 0,5 mm	Cu-Profile 2 mm	Cu-Profile 4 mm	Cu-Profile 8 mm	Cu-Profile 12 mm
Delta T [°C]	Ampere	Ampere	Ampere	Ampere	Ampere	Ampere	Ampere	Ampere	Ampere	Ampere
10	3,9	11,1	18,4	30,4	40,8	7,0	20,1	33,2	54,9	73,7
20	5,5	15,7	26,0	43,0	57,6	10,0	28,4	47,0	77,7	104,3
30	6,7	19,3	31,8	52,6	70,6	12,2	34,8	57,6	95,2	127,7
40	7,8	22,2	36,8	60,7	81,5	14,1	40,2	66,5	109,9	147,4
50	8,7	24,9	41,1	67,9	91,1	15,7	45,0	74,3	122,9	164,9
60	9,5	27,2	45,0	74,4	99,8	17,2	49,3	81,4	134,6	180,6
70	10,3	29,4	48,6	80,4	107,8	18,6	53,2	88,0	145,4	195,1
80	11,0	31,4	52,0	85,9	115,3	19,9	56,9	94,0	155,4	208,5
90	11,7	33,4	55,1	91,1	122,3	21,1	60,3	99,7	164,8	221,2
100	12,3	35,2	58,1	96,0	128,9	22,3	63,6	105,1	173,8	233,1

Fig. 22: Expansion of cable cross-sections for high currents

Häusermann provides a calculation tool for this on its website. The software calculates the necessary cable width for high current cable lines on an FR4 PCB. The result provides the recommended design width for a single high-current cable line on an HSMtec PCB and compares it to conventional PCB technology. http://www.haeusemann.at/de/node/642

UL listing/certification

Häusermann standard and HSMtec high-current PCBs are UL certified. The evidence that the recognised safety rules have been fulfilled is provided by UL listings, this applies to single and multi-layer PCBs plus rigid flexible PCBs and HSMtec PCBs. (UL file number for America E72795, UL file number for Canada E72795)

The most important threshold values, such as the minimum cable widths, min/max. cable height, cable distance to edge of PCB and copper area size are certified such that they satisfy all design and PCB layout guidelines. This is also checked when the CAM data is processed.

Seamless energy and control electronics

Power and control electronics on one PCB

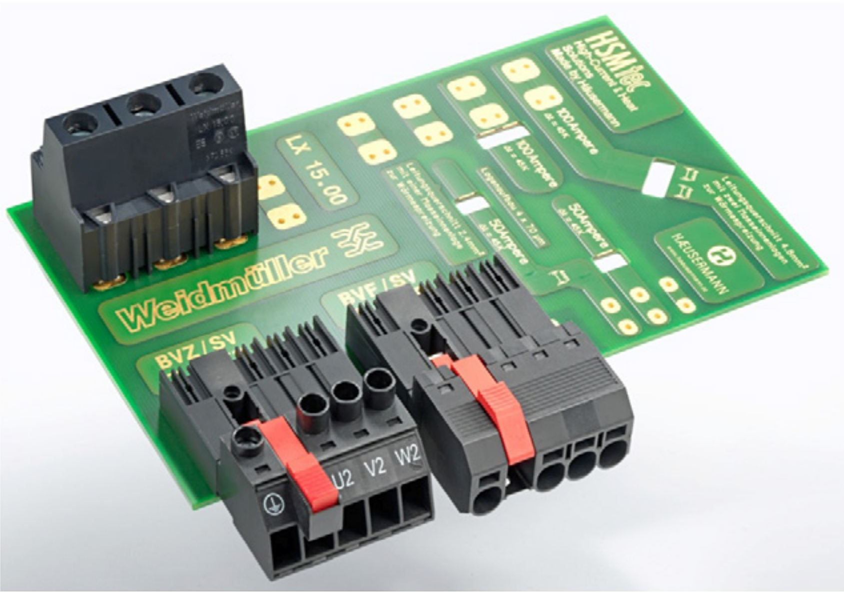


Fig. 23: PCB and connection technology for power electronics

When developing PCB technologies which require high currents and effective cooling options for power components, many options are dead ends because of the high costs of implementation. The conventional approach to designing a motor controller separates the control and power elements on two PCBs. Thick copper boards are first choice for the power section, linked via plug connectors. The disadvantages of this approach: increased space and volume requirements, reduced reliability and quality and the need for external components such as connectors, cables and power rails. The approach also requires more interfaces and does not provide optimised EMC behaviour.

Suitable PCB technologies which combine the control and power elements in a single PCB avoid these restrictions. The HSMtec technology developed by developed by Häusermann incorporates some large copper cross-section in profile or wire form into standard FR4 PCBs. This allows fine cable structures in combination with high-current connections and efficient heat management for power components can be simply and cost-effectively achieved on a single standard multi-layer board. The integration of partial copper elements also provides the optimum basis for the implementation of multi-dimensional PCB structures and reduces system costs.

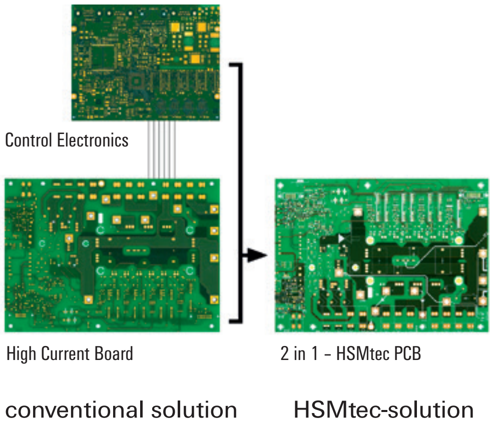


Fig. 24: Combination of control and power electronics on a single PCB

High current and fine cable structures on a motor controller PCB are no longer a contradiction. Currents of up to 400 Amperes per phase can now be combined with very fine cable structures on a single board. At the same time, the operating temperature of the power section is lower, which increases the conductivity of the component.

Profiles with a height of 500 µm with widths of 2 mm to 12 mm are currently available in various lengths. The 500 µm thick copper elements are connected rigidly to the etched circuit diagrams using ultrasound connection technology.
This can be implemented on any layer of a multi-layer based on FR4. HSMtec allows high currents and the heat development to be quickly curbed to approved partial and system temperatures.

HSMtec PCBs also provide the option of bending individual parts of the board by up to 90° on a one-off basis. Copper wires integrated into the bend points ensure mechanical stability and allow both signal high current and warmth connections to be established between individual PCB segments.

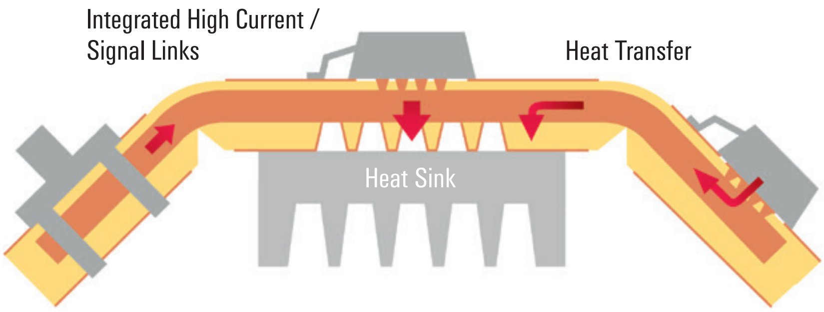


Fig. 25: Principle of heat deflection

Optimised heat management on the PCB

Feeding high currents of up to 400 A across the PCB requires efficient heat management. Modern MOSFET and IGBT components also carry the PCBs through the unavoidable power loss produced during the switching process. A solid copper cross section can be achieved in conventional PCBs by means of integrated control elements. This quickly distributes the heat among the components and reduces thermal resistance compared to standard multi-layer PCBs, such as thermal vias.

A glance at the specific heat conductivity shows the importance of the consistent metallic MOSFET or IGBT path to the sink. HSMtec technology is an attractive alternative to the metal core or ISM PCB, because copper deflects the heat at 300 W/mK, which is twice as quickly as aluminium. The copper and FR4 design allows specific thermal paths to be laid. And the combination of integrated copper profiles with the PCB technologies such as micro and thermal vias enables direct metallic contacting of the soldered areas (components, heatsinks) on the profiles while avoiding bottlenecks in the thermal path.

Material	Thermal conductivity λ [W/mK]
Copper RA	300
Aluminium alloy	150
Solder	51
Ceramic (LED)	24
FR4	0,25
Air (unforced)	0,026

Material	Thermal expansion coeff. X/Y [ppm/K]
Aluminum	24
Solder	≈ 22
Copper	16
FR4	13 – 17
Al_2O_3 (LED)	7
AIN (LED)	4

Fig. 26: Table of heat conductivity- and heat expansion coefficients

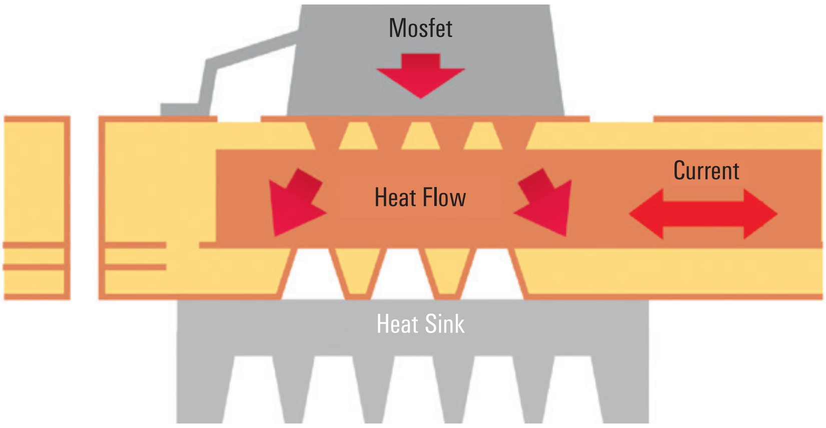


Table. 27: Principle of current and heat flow

Design rules for complex PCBs

Efficient heat management of the components on a PCB must be tailed to the relevant design of a motor controller. Other factors also need to be taken into consideration: this means it takes a great deal of experience to optimise heat removal with respect to economic and technical aspects. HSMtec has been qualified by independent testing bodies and is based on conventional FR4 material. It is produced using a standard manufacturing process and is simple to process further.

At the same time, there are some design rules to take into consideration to increase the longevity and reliability of the whole electronic component. The design of the PCB depends on factors such as cable structures, restrings, micro vias/blind holes, the BGA design and, in general, the quality of the layout data and the material. As well as handling, further processing and stability, the thickness of the material is also relevant to the diameter of the smallest whole diameter, as there must be a great enough thickness of copper of around 20 µm must be separated in the drill hole.

The conductivity of the cable lines must also be taken into consideration. As well as the position, other factors play a role in the load-bearing capacity of copper cables. The ratio between the cable line width and height, the ambient temperature and the arrangement of adjacent cable lines must also be taken into consideration. The maximum heating of the cable line through the flow of current is also an important factor. The solution using HSMtec goes way beyond the effect of mass layers in multi-layers, as the solid copper elements in the form of wires have an additional effect on the high current paths in the relevant layers and are connected with the actual cable lines electrically and thermally using an ultrasound welding process.

Convenient connectivity for power, signals and shielding

Well thought-out technical properties of connectivity

The optimum design of the connectivity at the interface between the device and the motor faces developers with challenges, as this is where the power and signals between the frequency converter and the motor need to be transferred. Because of the changing frequency ranges, there must also be consistent shielding of the cables between the device and the motor. The device developer needs to provide suitable, controllable device connections on the device for these functions. State-of-the-art technologies in the plug connector, PCB and cable production make it possible to implement power, signal and shield potential transfer in a product. Shielded cables, known as servo cables, with four wires for power transfer and two separate wires for control cables are available from manufacturers for applications all over the world.

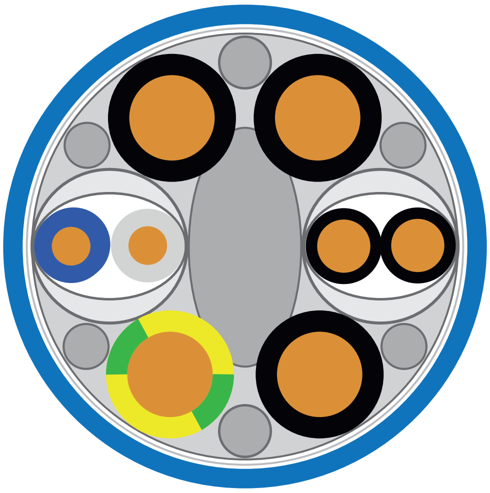


Fig. 28: Servo cable with built-in power and control cables

For connectivity, there are what are known as hybrid plug connectors which integrate power, signalling and shielding in a single product.

Motor connection in confined spaces with optimised connection time

Hybrid plug connectors allow power, signals and shielding to be connected in a single step. The connection can use PUSH-IN connectivity for cross-sections of up to 60 mm². Thanks to their design, the plug connectors comply with standards UL 1059 600 V, class c and IEC (UL) 61800-5-1 with increased touch safety, The signal cables are also connected using PUSH-IN technology for cable cross-sections of up to 1.2 mm². A shield plate secures the transfer of the shielding potential. This is where the shield of the cable is positioned and provides the spring contacts for a secure electrical connection to the metallic device housing.

Fig. 29: Secure connection of shield potential

Compact integrated functions are in line with the trend towards miniaturisation, even when it comes to power connectors. The pluggable solution reduces the space required up to 38 percent compared to conventional solutions.

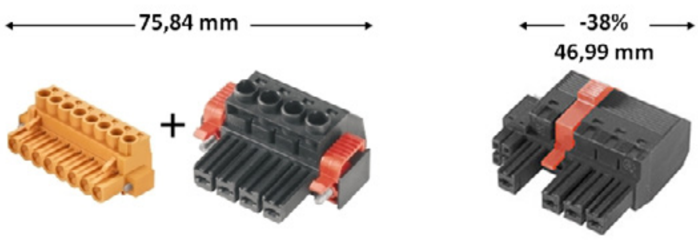


Fig. 30: Reduced space required thanks to hybrid plug connectors

As well as the correct electrical layout of the plug connectors, mechanical robustness is also a consideration when it comes to choosing connections. Modern connection components offer intrinsically safe and self-locking flange solutions. What sets them apart is the secure mechanical connection to the device and simple operation. Especially with relatively stiff connection lines, simple to use plug connectors are a real benefit, such as plug connectors which what are known as central flanges which can be operated with one hand.

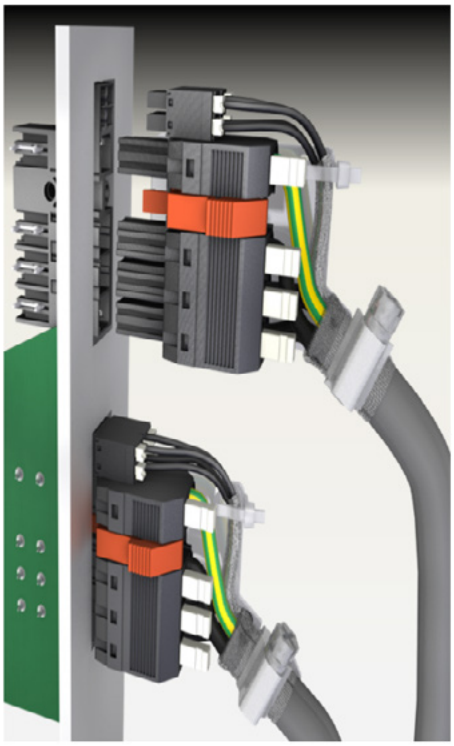


Fig. 31: Robust mechanical connection and simple operation thanks to central flange

Summary

The design of electronics for motor controllers faces hardware developers with the challenges of heat management and combining power and control electronics within confined spaces. Various layout and design regulations need to be taken into consideration: for the high-current and hybrid section of the PCB and for the plug connector PCB terminals in the input and output circuit, especially hybrid options. There are also standards for designing motor controllers which affect connectivity and PCBs in the same way.

Häusermann and Weidmüller offer innovative, highly reliable components for the development of seamless devices with both energy and control electronics. Innovative systems offer optimised heat management and convenient hybrid connectivity. Thanks to its high level of integration, an HSMtec PCB reduces space required and the weight and volume of the component. At the same time, the thermal, electric and mechanical properties in a single HSMtec PCB also lower the cost of the system as a whole. Added to this are cost-efficient standard processes in PCB production, PCB layout and fitting.

Today, the aim is to produce electronic products which meet the requirements for increasing packing density and complexity, use state-of-the-art technology and also meet the various regulations and requirements. Weidmüller and Häusermann support their customers not only by providing suitable, innovative components but also with extensive know-how and services relating to the design-in process. This means the two companies enable their customers to resolve the challenges of device development more efficiently.

OMNIMATE PCB components

As a leading manufacturer in the field of device connectivity, Weidmüller and its OMNIMATE PCB components offer a rounded product range of PCB terminals, PCB plug connectors and feedthrough terminals for industrial applications. This includes the OMNIMATE Signal and OMNIMATE Power product ranges which focus on signal processing and power electronics.

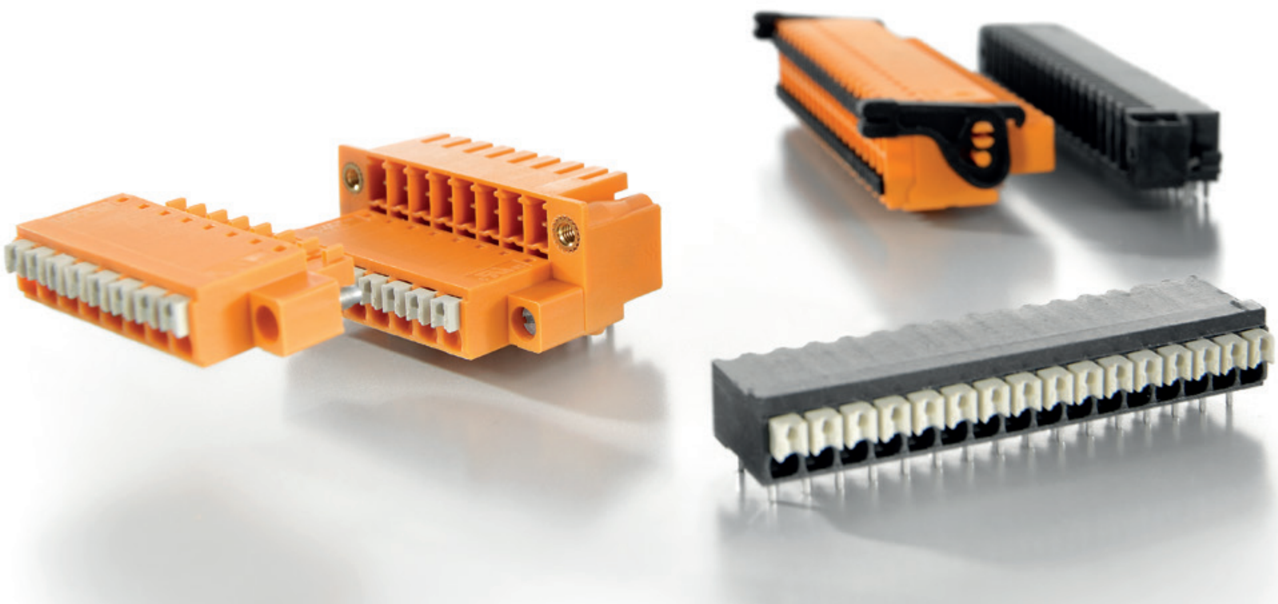
The hybrid PCB terminals and plug connectors are the real stars of the product range. They were developed to transfer signals and energy in a single plug connector in confined spaces. The hybrid products are also available with increased touch safety and optional pluggable shielding for use in IT networks. Figure Use of hybrid products

PCB terminals - OMNIMATE Signal
The universal, direct PCB connector for industrial electronics.

- Application-oriented connection technology from clamping-yoke screw connections to PUSH IN spring stop mechanisms in all the relevant cross-sectional areas
- Can be used universally in all standard pitches from 3.50 mm
- A wide range of reflow-compatible products for automated SMT processes
- Compact, multi-layer designs up to 72-pole

PCB connectors - OMNIMATE Signal
The pluggable PCB connection is the established standard in process and manufacturing automation as well as the measurement and control industry.

- 36 connections at 3.50 mm pitch, highest level of power reserves in 3.81 mm pitch and the largest application area in 5.08 mm pitch
- Application-oriented connection systems, from clamping-yoke screw connections to PUSH-IN spring connections
- A wide range of reflow-compatible products for automated SMT processes
- Multi-row and multi-layer designs up to 48-pole



PCB terminals - OMNIMATE Power
The sturdy, direct connection for extreme current and voltage requirements in all power electronics applications such as solar inverters, frequency converters, servo-controllers and power supplies.

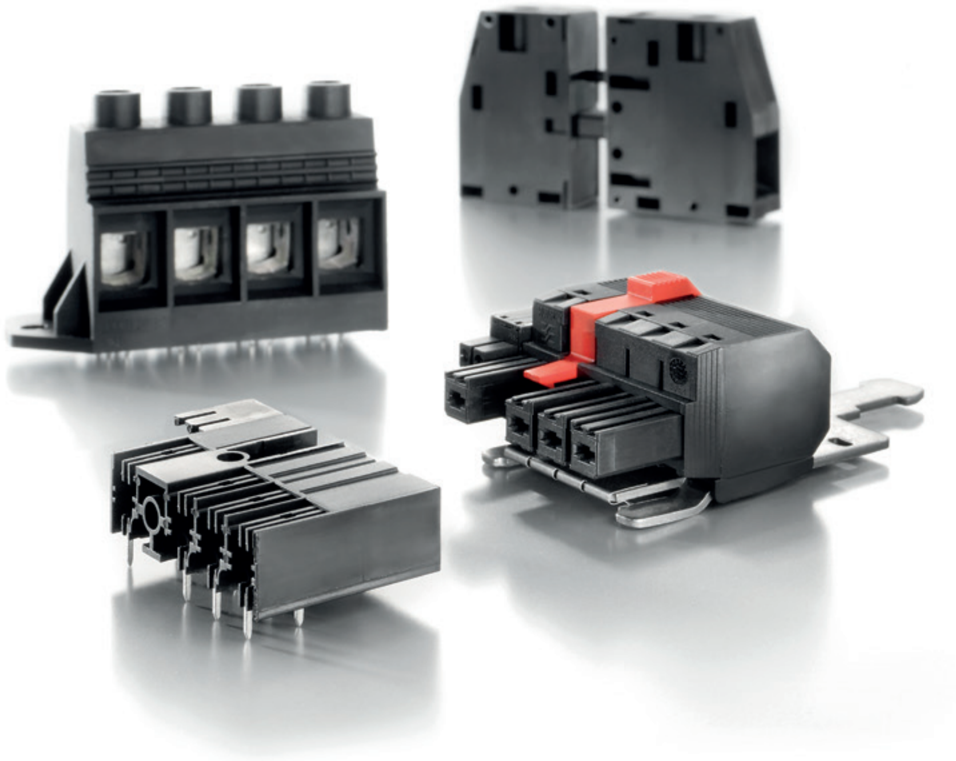
- High-power: 150 A / 1000 V (IEC) or 127 A / 600 V (UL)
- Application-oriented scalability: connection cross-sections from 16 mm² to 50 mm²
- Simple UL device approval up to 600 V
- Maintenance-free steel clamping yoke for vibration-resistant screw connections

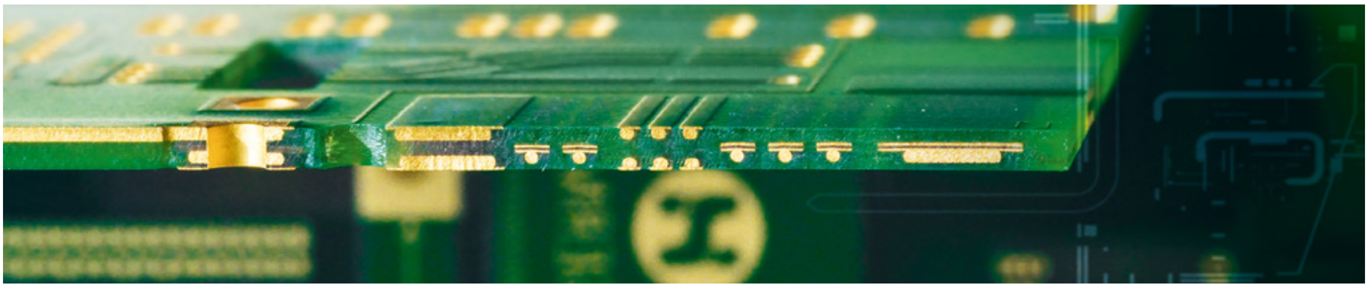
PCB connectors - OMNIMATE Power
The pluggable connections for power electronics - optimised for modern drive technologies, e.g. motor starters, frequency converters and servo-controllers.

- High-power: 150 A / 1000 V (IEC) or 127 A / 600 V (UL)
- Application-oriented scalability: connection cross-sections from 16 mm² to 50 mm²
- Simple UL device approval up to 600 V
- Maintenance-free steel clamping yoke for vibration-resistant screw connections

Feedthrough terminals for devices - OMNIMATE Power
The universal solution to feed power through housing walls. Ideally suited for applications such as an EMV filter or discretely built up converters for drive engineering and encapsulated equipment.

- A wide service portfolio for currents from 32 to 232 A and conductor cross-sections from 4 to 95 mm² (AWG 4/0)
- Different types of connections such as a castable soldering connection, cable lug bolt connection and service-free clamping yoke screw connection
- Designs for horizontal or vertical cable outlets





Häusermann Leiterplatten – Ein starker Partner

fehlende Info

PCBs for special requirements

Häusermann specialises in PCB with specialist requirements in terms of reliability. As well as established technologies, they also offer innovative solutions such as HSMtec with integrated copper elements for high-current and heat management PCBs. A flexible approach to the requirements and individual technical consultancy make them strong partners for challenging technology projects.

Their product range includes

- Single and double-sided PCBs
- Multi-layers up to 28 layers
- Impedance control
- Micro vias
- Buried vias
- SBU technology (sequential build up)
- Rigid flex (including UL listing)
- Semiflex
- Multi-dimensional HSMtec boards
- High-current (HSMtec boards)
- Heat management (HSMtec boards)
- LED-PCBs

HSMtec

HSMtec enables partial incorporation of large copper cross-sections in profile or wire format into standard FR4 PCBs. This allows fine cable structures to be achieved simply and cost-effectively in combination with high-current connections and efficient heat management for power components on a single board.

- High-current PCBs for up to 400 Amperes
- Heat management for power components (MOSFETs, IGBTs, etc.)
- LED-PCBs with excellent thermal performance
- Three-dimensional self-bearing PCBs

Tested quality to meet exacting requirements

- HSMtec PCBs comply with IPC A 600 Class 2 and 3
- Qualified process: DIN EN 60068-2-14; JEDEC A 101-A
- Audited for automotive and aviation
- Tested by independent institutions
- UL-listing file no.. E72795 for USA and Canada

Cost-efficient solutions with simple handling

- Reduction of system costs (logistics, procurement, production, quality assurance)
- Standard processes for manufacturing and further processing
- Simple implementation in standard layout process
- Increase the effectiveness and longevity of components
- Increased reliability by replacing plug and cable connections, power rails, etc.
- Reduced space requirement, weight and volume of the assembly

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