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The current terms of delivery and payment apply. Further information is available at www.woehner.com under the heading "Media/ Downloads".

Wöhner worldwide

Information to the Wöhner subsidiaries and agencies are available at www.woehner.com under the heading "Contact".

General technical information

Wöhner busbar systems and components are the result of expert development based on many years of experience. They have been exhaustively tested and hold many approvals. The correct selection of busbars and components is the responsibility of the system designer. For parts used in "low-voltage switching device assemblies" as defined by the IEC or EN 61439 standards, the planning, construction requirements and the required design verification are mandatory. In order to safely exclude risks to people and property when handling electrical power, expert handling of the equipment and compliance with the applicable regulations are fundamental requirements.

In particular, installation, maintenance, modifications and additions must only be carried out by qualified personnel in accordance with the general construction and safety regulations applicable to high-current electrical systems. Technical standards must be observed and the interaction

of the components must be taken into account. It is essential that all accessible parts are electrically isolated during installation and maintenance. All connections must be correctly tightened with the specified torque (M_d), correct gauges must be used and components that provide protection against accidental contact with live parts must be fitted. After transportation, all connections must be checked and, if necessary, re-tightened.

Products are to be used and operated correctly in the manner intended.

The technical information contained in the Manual and the installation instructions should be observed and retained for future modifications, maintenance or additions to the installation. Wöhner reserves the right to make modifications to its components, as the result of developments and technical advances.

Operating conditions

Unless special instructions are given, the information contained in the documentation applies for the recommended mounting position and the ambient conditions of indoor installation (contamination level 3; 2 in exceptional cases) according to IEC/EN 61439-1/-2/-3. The user must inform the manufacturer about any special operating conditions that deviate from this standard!

Plant-specific reduction factors must be considered, depending on the exact conditions of use. The rated loading factors listed below represent guide values and refer to a maximum +35 °C temperature of the air directly surrounding the products.

Number of main circuits	Rated diversity factor	
	to IEC / EN 61439-2	to IEC / EN 61439-3
2 and 3	0.9	0.8
4 and 5	0.8	0.7
6 to 9 inclusive	0.7	0.6
10 and more	0.6	0.5

IEC / EN 61439
Part 2: Power switchgear and controlgear assemblies, table 101
Part 3: Installation distributor for operation by lay people, table 101

In products intended to hold fuse-links, please observe the requirements governing connected cross-sections from the relevant product standards. Comply with the stated temperature specifications of all plastics used. Some of the material properties described here refers to several products. In isolated cases, values may exceed the levels stated.

Further information for each article are available at **www.woehner.com** under the heading "Products".

We recommend vertically mounting the device on a horizontal busbar system. All information and test values for busbar systems refer to the use of flat copper bars according to EN 13601:2013 or section busbars according to EN 13605:2013. For further information, see section "Use of busbars".

The fixing handle must be placed on top for switchgears mounted vertically. For this mounting position, the rated load factors shown in table 101 apply for the components with the worst-case permissible power dissipation and the ambient conditions as per IEC / EN 61439-2 / -3, section 7.1.1.1.

In case of deviating mounting positions and conditions, all influencing factors are on maximum temperature must be accounted for by applying additional correction factors.

Requirements for the dimensioning of parallel main circuits in a switchgear and controlgear assembly

When planning a switchgear and controlgear assembly, the interactions of the devices in parallel current paths must be considered.

The standard takes account of this situation by means of a switchgear assemblies rated diversity factor (RDF). This states the factor of the rated current to which all power circuits of a power distribution unit in a switchgear assembly can be permanently and simultaneously subjected. Here, the values from the table in the section "Operating conditions" apply, in accordance with IEC / EN 61439-2 / -3.

If, for example, a SECUR®60Classic PowerLiner is equipped with 35 A - D02 fuses in a power distribution unit, the switchgear device will be able to carry its nominal current of 35 A continuously on its own. However, this value must be reduced through thermal interaction with neighbouring devices. The rated diversity factors must always be selected in conformity with the application of the switch fuse unit, in accordance with IEC / EN 61439-2 / -3. See table in section "Operating conditions".

For example:

- power dissipation of the fuse-links and the devices in operation
 - simultaneous full and partial load cycles
 - arrangement in the system, mutual influence of the devices
 - busbar cross-section, conductor cross-section
 - ambient temperature, flow conditions, ventilation or cooling
- Mounting positions are prohibited where gravity and direction of mounting are opposed.

Air and creepage distances must be calculated in compliance with IEC / EN 60664-1 (VDE 0110 part 1). For values of 12 mm and greater, these requirements are automatically satisfied up to 690 V AC in compliance with IEC. Additional specifications, such as the minimum distance to earthed parts, must be observed. This is especially relevant for applications in compliance with UL.

Detrimental effects from chemical substances during storage, processing and operation must be prevented.

In order to ease the locking of the busbar components and the insertion of the NH fuse units, the spring clips will be lubricated with special grease during manufacturing. On other parts, especially on screw threads, it must be ensured that no supplementary change of the friction coefficient takes place.

It must always be ensured that the rated load factor applies to the fuse being used and not the rated current of the switch-disconnector or fuse-holder. It is also advisable to use fuse-links with silver-plated contacts. The size of the copper conductors is determined on the basis of the applicable product standard, e.g. IEC / EN 60947-3 for SECUR®60Classic PowerLiner.

Non-compliance with these reduction factors leads to unacceptably high temperatures in switchgear assemblies. This may in turn result in damaged or incorrectly triggered switchgear devices. Both fuse-links and cable insulation age when exposed to high temperatures.

For the correct design and layout of conductors, accumulation – as well as the ambient temperature – need to be taken into consideration. Here too, mutual thermal influence leads to raised temperatures and so to lower permitted currents. It is important to consider size and the corresponding factors.

Conductor connections

Specifications regarding conductor connection terminals apply for all copper conductors. The maintenance-free resistance to ageing for selected connections has been verified by testing.

The contact positions need to be checked, taking the operating conditions and applicable application-related specifications into account.

In the case of unfavourable operating conditions or frequent temperature fluctuations at the contact positions, shorter inspection intervals may be necessary. Temperature measurement strips that record the maximum values can be placed in the immediate vicinity of the contact positions and used for objective assessment during the regular tests.

All contact positions are suitable for connecting one conductor, unless expressly otherwise indicated on the device, in the installation instructions or in the technical description on our website. Devices with dual-function terminals have two separate contact positions.

The tightening torques specified on the device, in the installation instructions or in the technical description on our website must always be applied. Where no limits are specified, the tolerance on the tightening torque M_d of screw and clamp connections may be a maximum of $\pm 20\%$ of the nominal value.

If no range is specified for terminal cross-sections, the terminal range is limited downwards to the next two smaller cross-sections. If no information about the conductor type is present on the device, this can be found in the installation instructions or the technical description on our website.

The relationships between conductor cross-sections in mm^2 and AWG / MCM sizes are listed below:

0.75 mm^2	AWG 18 = 0.82 mm^2
1.5 mm^2	AWG 16 = 1.3 mm^2
2.5 mm^2	AWG 14 = 2.1 mm^2
4 mm^2	AWG 12 = 3.3 mm^2
6 mm^2	AWG 10 = 5.3 mm^2
10 mm^2	AWG 8 = 8.4 mm^2
16 mm^2	AWG 6 = 13.3 mm^2
25 mm^2	AWG 4 = 21.2 mm^2
35 mm^2	AWG 2 = 33.6 mm^2
50 mm^2	AWG 0 = 53.5 mm^2
70 mm^2	AWG 2 / 0 = 67.4 mm^2
95 mm^2	AWG 3 / 0 = 85.0 mm^2
120 mm^2	250 MCM = 127 mm^2
150 mm^2	300 MCM = 152 mm^2
185 mm^2	350 MCM = 177 mm^2
240 mm^2	500 MCM = 253 mm^2
300 mm^2	600 MCM = 304 mm^2

Conductor types are designated as follows:

Description	Short name	Standard designation
solid round	re	Class 1 (IEC / EN 60228)
stranded round	rm	Class 2 (IEC / EN 60228)
solid sectored	se	Class 1 (IEC / EN 60228)
stranded sectored	sm	Class 2 (IEC / EN 60228)
flexible	f	Class 5 (IEC / EN 60228)
stranded	str	Class B (UL 486E)

The following abbreviations are also used:

Laminated copper busbar	lam. Cu
Wire-end ferrule	AE

Wire-end ferrules are only permitted for applications in compliance with IEC / EN standards. Wöhner has tested the use of wire end ferrules. This does not result in a general approval for different ferrules and crimping methods. The maximum conductor cross-sections may need to be reduced. Conductor connections are to be set up with consideration given to the requirements as per IEC / EN 60999-1 / -2. Conductor connections are to be set up such that no load tension and no alternating bending load occur in the application.

Additional information on aluminium conductor connections

Optimum routing and fastening of the cables is achieved through the shaping and dimensioning of the contact pieces in the contact position. The contours present in the contact pieces enable an electrical connection with low contact resistance. Any impurity layers present to a limited extent following the proper pretreatment of aluminium conductors are penetrated by special crimping contours. When the specified tightening torques are observed, the required contact force is applied to the contact positions. Due to the elastic behaviour of the connection terminals, periodic retightening of the clamping screws is not necessary. Retightening of the clamping screws of the connection terminal during maintenance is expressly not recommended and can result in degradation of the clamp.

To achieve a high-quality connection of aluminium conductors with low contact resistances, proper pretreatment is essential. In addition, immediately after shortening and stripping, the surfaces on the ends of the conductors are to be freed of all impurity or oxide layers. The impurity layers are to be removed with a suitable knife or a suitable wire brush; it is essential to prevent deposits of metal residues. Immediately thereafter, the surfaces of the conductor ends must be protected against further oxidation by a generous application of a suitable grease (acid- and alkali-free) or an aluminium contact paste. The proper and – with sectored conductors – position-oriented connection in the contact positions must be performed immediately thereafter. Proper positioning of the conductor ends in the contact positions is to be ensured; the clamping screws are to be tightened once to the specified tightening torque.

Tests of electrical resistance to ageing were performed to verify the resistance to ageing of connection terminals for aluminium conductors. The aluminium conductors were pretreated prior to starting the tests according to the relevant recommendations for the removal of impurity and oxide layers. Immediately thereafter, the surfaces on the conductor ends were protected against further oxidation by means of grease and connected in the contact positions. The clamping screws were tightened to the respective, specified tightening torque. During the conducted test certifications, the maximum temperatures that occur in normal operation were taken into account. The clamping screws of the test objects were not retightened at any point during the entire loading period. Each of the cyclical current loads was performed under constant test conditions.

To ensure proper operation of switching device combinations, inspections must be performed at defined intervals. The necessary intervals between these inspections depend largely on the given installation and operating conditions. The inspections of contact positions with aluminium conductors are, for practical reasons, performed by way of visual examinations and, if necessary, temperature measurements. A high contact quality is ensured by observing the specifications for the proper connection of aluminium conductors. In addition to selecting appropriate connection terminals for the aluminium conductors with respect to conductor cross-sections and conductor types, the specifications for the pretreatment of aluminium conductors must be observed. Make certain that the required work steps up to tightening of the clamping screws to the specified tightening torques are performed in immediate succession. Subsequent tightening of the clamping screws results in no improvement of the contact quality and may even have a negative impact.

Special requirements for sizing AC string collectors

When AC string collectors are used, a few strings supply one inverter. The power of several string inverters is pooled on the alternating current side, e.g. via a 60 mm busbar system.

When dimensioning components for a busbar system of this kind, the direction of the energy – which is inverted to that of industrial applications – is unimportant. The same types of fuse (gG) are also used. It is the cables and leads going to the inverter that have to be protected from overload and short circuit. However, the rated diversity factor of the switch-gear and the simultaneity factor (=1) of this application do not match.

This means, for example, that from 10 devices or more, the SECUR®60Classic PowerLiner (rated current 63 A) with side-mounted module and 35 A fuse-links may be operated at 21 A maximum. Here, the rated current of the fuse is reduced to 60 %. If the maximum current of the inverter does not exceed this value, and if fuse protection at 35 A is permitted by the wiring and the inverter datasheet, the dimensions are correct. If higher power ratings with correspondingly higher currents need to be pooled, there are two choices for adaptation:

With the right conductor dimensions, the nominal current of the fuse-links can be increased. However, this must fit in with the requirements for inverter fuse protection. In this example the use of a 50 A fuse permits a maximum current of 30 A.

Alternatively, the thermal influence of the switchgear is reduced by modifying the layout. With the SECUR®60Classic PowerLiner fuse-switch-disconnector, in a test with 6 power circuits, a distance equal to the width of two devices (54 mm) between the switchgear devices increased the rated diversity factor from 0.7 to 0.9. This is only possible because the distance considerably reduces the thermal influence of the fuse-links. Based on the example with the 35 A fuse, the new arrangement would enable an inverter current of 31 A.

If the conductors to the inverters in the AC string collector are routed in a cable duct (routing method F), and ambient temperatures of 50 °C are anticipated there, when 6 conductors are used the permitted current capacity reduces to less than 50 % of the nominal current.

When cables and fuses have the correct dimensions, they also produce less dissipation, and therefore less waste heat. This in turn makes both cabinet selection and thermal management easier.

NH (busbar mounted) fuse-switch-disconnectors and NH in-line fuse-switch-disconnectors

NH fuses are only intended for use by authorized electricians or trained electrical personnel, see IEC / EN 60269-2.

When switching devices observe the following instructions:

- only electricians or personnel trained in electrical engineering are permitted to operate the equipment (disconnect, switch on, switch off or change fuses) in accordance with VDE 0105-100

- quick activation of fuse lid using the relevant operating handle
- before switching on, care must be taken that the fuse lid is located correctly in the open position
- the specifications for the IP protection class only apply when the fuse lid is closed

Use of busbars

To ensure safe mounting and connection of the single and multi-pole busbar components, the busbars used must comply with the adjacent tolerances. The busbars supplied by Wöhner meet these requirements.

Tensile strength: min. 300 N / mm²

Permitted tolerances:

Radius R 0.3 ... 0.7

Width: + 0.1 / - 0.5

Thickness: + 0.1 / - 0.1

Centre distance:

+ 0.5 / - 0.5 (60 mm system)

+ 1.0 / - 1.0 (100 mm system, 185 mm system)

Deviation in the contact level: 0.4

Use of comb-type busbars

A range of Wöhner fuse-holders and switches are suitable for use with comb-type busbars. We recommend the use of the comb-type busbars listed at the relevant places in the current Wöhner Manual (pollution degree 2 in accordance with IEC/EN 61439-1/-2). Ensure that the required air and creepage distances left in standard installation positions are

observed (comb-type busbars are angled towards the operator). Power must be supplied via the connection terminals sold separately by Wöhner. The additional connection terminal is not required for Wöhner products with double-function terminals. Connect terminals using the maximum torque stated on the fuse-holder.

Machining and use of plastic sections

The sections listed in the Wöhner Manual as covers for busbars or busbar systems and bottom troughs have been optimised with regard to their mechanical, thermal and electrical properties. Take particular care when mechanically cutting the profiles to avoid the formation of cracks (narrow saw blade, high speed of cutting, low tooth advance and strong saw guiding).

The cutting of profiles with a circular saw and an AKE circular saw blade for plastics is reliable with the following specific values:

D = 300 mm, B = 2.2 mm, Z = 120 W
with 5° negative tooth change (w),
cutting speed of 50 - 65 m/s,
tooth feed 0.05 - 0.1 mm.

The plastic parts must be clamped in order to exclude vibrations.

When processing and using plastic profiles, contact with oil, grease and other chemicals must be avoided.

Dimensions

All specified length dimensions are always in mm unless otherwise indicated. Mounting rails of adapters and clip-on fixings generally comply with IEC/EN 60715.

CE marking

In association with the 2006/95/EG low voltage directive, Wöhner products are subject to the CE marking commitment. The CE mark is applied via the label on the packaging and on the products themselves in compliance with the provisions of the Low Voltage Directive. Wöhner thus confirms its compliance with the directive.

The corresponding EU Declarations of Conformity for each article are available at www.woehner.com under the heading "Products".

Additional requirements in accordance with UL



Components that have also been tested for feeder circuits up to 600 V AC in compliance with UL 508 A are labelled in the approval overview.

Directives

RoHS Directive

Currently, Wöhner products do not come under the scope of RoHS Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment, or WEEE Directive 2012/19/EU governing waste electrical and electronic equipment. Irrespective of these directives, measures have been initiated, which ensure that the use of pollutant-free plastics complies with the RoHS Directive. The metallic surface coatings shall correspond to the substance ban in accordance with the RoHS Directive. Fuse-links may contain function-specific components which do not comply with the RoHS Directive.

REACH Regulation

Our products are “products” within the meaning of the REACH Regulation (EC) No. 1907/2006. The information requirements under Article 33 regarding substances in products applies only to so-called substances of very high concern which meet the criteria listed Article 57. Wöhner reviews and updates the REACH Regulation in accordance with Annex VII of the Candidate List (SVHC list).

WEEE Directive

The products from Wöhner are marked accordingly with the crossed-out dustbin symbol.

Certificates are available at www.woehner.com under the heading “Media/Downloads”.

Insulation coordination

All specifications apply for overvoltage category III in accordance with IEC/EN 61439-1. The usability for other overvoltage categories can be derived based on the rated impulse withstand voltage U_{imp} . The following clearances must be maintained:

Rated impulse withstand voltage U_{imp}	Minimum clearance
4 kV	3.0 mm
6 kV	5.5 mm
8 kV	8.0 mm
12 kV	14 mm

All specifications apply for pollution degree 3 in accordance with IEC/EN 61439-1 (Wöhner uses insulating parts made from materials in material class IIIa).

The following creepage distances must be maintained:

Rated insulation impulse withstand voltage U_i	Creepage distance
400 V AC/DC	6.3 mm
500 V AC/DC	8.0 mm
690 V AC/DC	10.0 mm
800 V AC/DC	12.5 mm
1000 V AC/DC	16.0 mm
1250 V DC	20.0 mm
1500 V DC	25.0 mm

The user is responsible for maintaining the proper clearances and creepage distances, taking the installation conditions into account. The maximum permitted power dissipation of the fuse-links must be taken into account with components having fuses. Short circuit data for DC applications is available upon request.

You can find an overview of the applicability of Wöhner products in terms of the operation voltage (according to IEC standards) at www.woehner.com/en/insulation_coordination