# Controls – Solid-State Switching Devices

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# Introduction

## Overview


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| **SIRIUS solid-state switching devices** | | | |
| ***Solid-state relays*** | | | |
| **Solid-state relays 22.5 mm, Solid-state relays 45 mm** | • Widths of 22.5 mm and 45 mm<br>• Compact and space-saving design<br>• "Zero-point switching" version<br>• Mounting onto existing heat sinks | 3RF21,<br>3RF20<br>3RF22 | 4/7<br>4/13<br>4/17 |
| ***Solid-state contactors*** | | | |
| **Solid-state contactors** | • Complete units comprising a solid-state relay and an optimized heat sink, "ready to use"<br>• Compact and space-saving design<br>• Versions for resistive loads "zero-point switching" and inductive loads "instantaneous switching"<br>• Special versions "low noise" and "short-circuit resistant" | 3RF23<br>3RF24 | 4/23<br>4/31 |
| ***Function modules*** | For extending the functionality of the 3RF21 solid-state relays and the 3RF23 solid-state contactors for many different applications: | | |
| **Converters** | • For converting an analog input signal into an on/off ratio; can also be used on 3RF22 and 3RF24 3-phase switchgear | 3RF29 00-0EA18 | 4/42 |
| **Load monitoring** | • For load monitoring of one or more loads (partial loads) | 3RF29 20-0FA08,<br>3RF29 .0-0GA.. | 4/43 |
| **Heating current monitoring** | • For load monitoring of one or more loads (partial loads); remote teach | 3RF29 ..-0JA.. | 4/44 |
| **Power control regulators** | • For supplying the current by means of a solid-state switching device depending on a setpoint value. There is a choice of full-wave control and generalized phase control. | 3RF29 ..-0KA. | 4/45 |
| **Power controllers** | • For supplying the current by means of a solid-state switching device depending on a setpoint value. Closed-loop control: Full-wave control or generalized phase control | 3RF29 .0-0HA.. | 4/46 |

## Overview

***SIRIUS solid-state switching devices***

- Solid-state relays
- Solid-state contactors
- Function modules

### *SIRIUS – for almost unending activity*

Conventional electromechanical switching devices are often overtaxed by the rise in the number of switching operations. A high switching frequency results in frequent failure and short replacement cycles. However, this does not have to be the case, because with the latest generation of our SIRIUS solid-state switching devices we provide you with solid-state relays and contactors with a particularly long endurance - for almost unending activity even under the toughest conditions and under high mechanical load, but also in noise-sensitive areas.

### *Proved time and again in service*

SIRIUS solid-state switching devices have become firmly established in industrial applications. They are used above all in applications where loads are switched frequently – mainly with resistive load controllers, with the control of electrical heat or the control of valves and motors in conveyor systems. In addition to its use in areas with high switching frequencies, its silent switching means that SIRIUS is also ideally suited for use in noise-sensitive areas, such as offices or hospitals.

### *The most reliable solution for any application*

Compared to mechanical switchgear, our SIRIUS solid-state switching devices stand out due to their considerably longer service life. Thanks to the high product quality, their switching is extremely precise, reliable and above all insusceptible to faults. With its variable connection methods and a wide spread of control voltages, the SIRIUS family is universally applicable. Depending on the individual requirements of the application, our modular switching devices can also be quite easily expanded by the addition of standardized function modules.

### *Always on the sunny side with SIRIUS*

Because SIRIUS offers even more:

- The space-saving and compact side-by-side mounting ensures reliable operation up to an ambient temperature of +60 °C.
- Thanks to fast configuration and the ease of mounting and start-up, you save not only time but also expenses.

## General data

| Type | Solid-state relays | | | Solid-state contactors | | Function modules | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-phase | | 3-phase | 1-phase | 3-phase | Converters | Load monitoring | | Heating current monitoring | Power control regulators | Power controllers |
| | 22.5 mm | 45 mm | 45 mm | | | | Basic | Extended | | | |
| **Usage** | | | | | | | | | | | |
| Simple use of existing solid-state relays | ❑ | ✓ | ❑ | ❑ | ❑ | -- | -- | -- | -- | -- | -- |
| Complete unit "Ready to use" | ❑ | ❑ | ❑ | ✓ | ✓ | -- | -- | -- | -- | -- | -- |
| Space-saving | ✓ | -- | ✓ | ✓ | ✓ | ✓ | ✓ | -- | -- | -- | -- |
| Can be extended with modular function modules | ✓ | -- | ✓ | ✓ | ✓ | -- | -- | -- | -- | -- | -- |
| Frequent switching and monitoring of loads and solid-state relays/solid-state contactors | -- | -- | -- | -- | -- | -- | ✓ | ✓ | ✓ | ✓ | ✓ |
| Monitoring of up to 6 partial loads | -- | -- | -- | -- | -- | -- | ✓ | -- | ✓ | ✓ | -- |
| Monitoring of more than 6 partial loads | -- | -- | -- | -- | -- | -- | -- | ✓ | -- | -- | -- |
| Control of the heating power through an analog input | -- | -- | -- | -- | -- | ✓ | -- | -- | -- | ✓ | ✓ |
| Power control | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | ✓ |
| **Startup** | | | | | | | | | | | |
| Easy setting of setpoint values with "Teach" button | -- | -- | -- | -- | -- | -- | ✓ | ✓ | -- | ✓ | ✓ |
| "Remote Teach" input for setting setpoints | -- | -- | -- | -- | -- | -- | -- | -- | ✓ | -- | -- |
| **Mounting** | | | | | | | | | | | |
| Mounting onto mounting rails or mounting plates | -- | -- | -- | ✓ | ✓ | -- | -- | -- | -- | -- | -- |
| Can be snapped directly onto a solid-state relay or contactor | -- | -- | -- | -- | -- | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| For use with "Coolplate" heat sink | ✓ | ✓ | ✓ | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cable routing** | | | | | | | | | | | |
| Connection of load circuit as for controlgear | ✓ | -- | ✓ | ✓ | ✓ | -- | ✓ | ✓ | ✓ | ✓ | ✓ |
| Connection of load circuit from above | -- | ✓ | -- | -- | -- | -- | -- | -- | -- | -- | -- |

✓ Function is available

❑ Function is possible

## Design

There is no typical design of a load feeder with solid-state relays or solid-state contactors; instead, the great variety of connection methods and control voltages offers universal application opportunities. SIRIUS solid-state relays and solid-state contactors can be installed in fuseless or fused feeders, as required. There are special versions with which it is even possible to achieve short-circuit strength in a fuseless design.

## Function

### *Connection methods*

All SIRIUS solid-state switching devices are characterized by the great variance of connection methods. You can choose between the following connection methods:

Screw connection system

The screw connection system is the standard among industrial controls. Open terminals and a plus-minus screw are just two features of this technology. Two conductors of up to 6 $mm^2$ can be connected in just one terminal. As a result, loads of up to 50 A can be connected.

Spring-loaded terminal connection system

This innovative technology manages without any screw connection. This means that very high vibration resistance is achieved. Two conductors of up to 2.5 $mm^2$ can be connected to each terminal. As a result, loads of up to 20 A can be dealt with.

Ring terminal lug connection

The ring terminal lug connection is equipped with an M5 screw. Ring terminal lugs of up to 25 $mm^2$ can be connected. In this way it is possible to connect even high powers with current strengths of up to 90 A safely. Finger-safety is provided in this case too with a special cover.

### *Switching functions*

In order to guarantee an optimized control method for different loads, the functionality of our solid-state switching devices can be adapted accordingly.

The "**zero-point switching**" method has proved to be ideal for resistive loads, i.e. where the power semiconductor is activated at zero voltage.

For inductive loads, on the other hand, for example in the case of valves, it is better to go with "**instantaneous switching**". By distributing the ON point over the entire sine curve of the mains voltage, disturbances are reduced to a minimum.

### *Performance characteristics*

The performance of the solid-state switching devices is substantially determined by the type of power semiconductors used and the internal design. In the case of the SIRIUS solid-state contactors and solid-state relays, only thyristors are used in place of less powerful Triacs.

Two of the most important features of thyristors are the blocking voltage and the maximum load integral:

Blocking voltage

Thyristors with a high blocking voltage can also be operated without difficulty in networks with high interference voltages. Separate protective measures, such as a protective circuit with a varistor, are not necessary in most cases.

For example, thyristors with 800 V blocking voltage are fitted in the devices for operation in networks up to 230 V. Thyristors with up to 1600 V are used for power systems with higher voltages.

Maximum load integral

One of the purposes of specifying the maximum load integral ($I^2t$) is to determine the rating of the short-circuit protection. Only a large power semiconductor with a correspondingly high $I^2t$ value can be given appropriate protection against destruction from a short-circuit by means of a protective device matched to the application. However, the devices are also characterized by the optimum matching of the thyristors ($I^2t$ value) with the rated currents. The rated currents specified on the devices according to EN 60947-4-3 were confirmed by extensive testing.

You can find more information on the Internet at:

http://www.siemens.de/halbleiterschaltgeraete

## Integration

### *Notes on integration in the load feeders*

The SIRIUS solid-state switching devices are very easy to integrate into the load feeders thanks to their industrial connection method and design.

Particular attention must however be paid to the circumstances of the installation and ambient conditions, as the performance of the solid-state switching devices is largely dependent on these. Depending on the version, certain restrictions must be observed. Detailed information, for example in relation to solid-state contactors about the minimum spacing and to solid-state relays about the choice of heat sink, is given in the technical specifications and the product data sheets.

Despite the rugged power semiconductors that are used, solid-state switching devices respond more sensitively to short-circuits in the load feeder. Consequently, special precautions have to be taken against destruction, depending on the type of design.

Siemens generally recommends using SITOR semiconductor protection fuses. These fuses also provide protection against destruction in the event of a short-circuit even when the solid-state contactors and solid-state relays are fully utilized.

Alternatively, if there is lower loading, protection can also be provided by standard fuses or miniature circuit breakers. This protection is achieved by overdimensioning the solid-state switching devices accordingly. The technical specifications and the product data sheets contain details both about the solid-state fuse protection itself and about use of the devices with conventional protective equipment.

The SIRIUS solid-state switching devices are suitable for interference-free operation in industrial networks without further measures. If they are used in public networks, it may be necessary for conducted interference to be reduced by means of filters. This does not include the special solid-state contactors of type 3RF23..-.CA.. "Low Noise". These comply with the class B limit values up to a rated current of 16 A. If other versions are used, and at currents of over 16 A, standard filters can be used in order to comply with the limit values. The decisive factors when it comes to selecting the filters are essentially the current loading and the other parameters (operational voltage, design type, etc.) in the load feeder.

Suitable filters can be ordered from EPCOS AG.

You can find more information on the Internet at:

http://www.epcos.com

# General data

## Overview

### *Solid-state relays*

SIRIUS solid-state relays are suitable for surface mounting on existing cooling surfaces. Mounting is quick and easy, involving just two screws. The special technology of the power semiconductor ensures there is excellent thermal contact with the heat sink. Depending on the nature of the heat sink, the capacity reaches up to 88 A on resistive loads.

The solid-state relays are available in three different versions:

- 3RF21 single-phase solid-state relays with a width of 22.5 mm,
- 3RF20 single-phase solid-state relays with a width of 45 mm,
- 3RF22 three-phase solid-state relays with a width of 45 mm.

The 3RF21 and 3RF22 solid-state relays can be expanded with various function modules to adapt them to individual applications.

### *Version for resistive loads, "zero-point switching"*

This standard version is often used for switching space heaters on and off.

### *Version for inductive loads, "instantaneous switching"*

In this version the solid-state relay is specifically matched to inductive loads. Whether it is a matter of frequent actuation of the valves in a filling plant or starting and stopping small operating mechanisms in packet distribution systems, operation is carried out safely and noiselessly.

### *Single-phase solid-state relay with a width of 22.5 mm*

With its compact design, which stays the same even at currents of up to 88 A, the 3RF21 solid-state relay is the ultimate in space-saving construction, at a width of 22.5 mm. The logical connection method, with the power infeed from above and load connection from below, ensures tidy installation in the control cabinet.

### *Single-phase solid-state relay with a width of 45 mm*

The solid-state relays with a width of 45 mm provide for connection of the power supply lead and the load from above. This makes it easy to replace existing solid-state relays in existing arrangements. The connection of the control cable also saves space in much the same way as the 22.5 mm design, as it is simply plugged on.

### *Three-phase solid-state relay with a width of 45 mm*

With its compact design, which stays the same even at currents of up to 55 A, the 3RF22 solid-state relay is the ultimate in space-saving construction, at a width of 45 mm. The logical connection method, with the power infeed from above and load connection from below, ensures tidy installation in the control cabinet.

The three-phase solid-state relays are available with

- Two-phase control and
- Three-phase control.

## Function

### *3-phase solid-state switching devices*

Two-phase controlled version

A three-phase control system is not required for many three-phase current applications. Loads in a delta circuit or star circuit which have no connection to the neutral conductor can also be safely switched on and off using just two phases.

Nevertheless, the 3-phase 3RF22 and 3RF24 solid-state switching devices permit all three phases to be connected to the switching device, in which case the middle phase is looped directly through the device. Compared to a three-phase controlled device, the lower power loss allows more compact installations.

Three-phase controlled version

This version is used for three-phase current applications in which the system requires all phases to be switched on and off, or for loads in a star circuit with connection to the neutral conductor.

## Configuration

### *Selecting solid-state relays*

When selecting solid-state relays, in addition to information about the network, the load and the ambient conditions it is also necessary to know details of the planned design. The solid-state relays can only conform to their specific technical specifications if they are mounted with appropriate care on an adequately dimensioned heat sink.

The following procedure is recommended:

- Determine the rated current of the load and the mains voltage
- Select the relay design and choose a solid-state relay with higher rated current than the load
- Determine the thermal resistance of the proposed heat sink
- Check the correct relay size with the aid of the diagrams

You can find more information on the Internet at:

http://www.siemens.de/halbleiterschaltgeraete

## 3RF21 solid-state relays, single-phase, 22.5 mm

### Overview

***22.5 mm solid-state relays***

With its compact design, which stays the same even at currents of up to 88 A, the 3RF21 solid-state relay is the ultimate in space-saving construction, at a width of 22.5 mm. The logical connection method, with the power infeed from above and connection of the load from below, ensures tidy installation in the control cabinet.

### Technical specifications

| Type | | 3RF21 ..-1.... | 3RF21 ..-2.... | 3RF21 ..-3.... |
|---|---|---|---|---|
| **General data** | | | | |
| **Ambient temperature** | | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | | |
| • During storage | °C | -55 ... +80 | | |
| **Installation altitude** | m | 0 ... 1000; derating from 1000 | | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15/11 | | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | | |
| **Degree of protection** | | IP20 | | |
| **Electromagnetic compatibility** (EMC) | | | | |
| • Emitted interference | | | | |
| - Conducted interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | | |
| - Emitted, high-frequency interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | | |
| • Interference immunity | | | | |
| - Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3) | kV | Contact discharge 4; air discharge 8; behavior criterion 2 | | |
| - Induced RF fields according to IEC 61000-4-6 | MHz | 0.15 ... 80; 140 dBµV; behavior criterion 1 | | |
| - Burst according to IEC 61000-4-4 | kV | 2/5.0 kHz; behavior criterion 1 | | |
| - Surge according to IEC 61000-4-5 | kV | Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | | |
| **Connection type** | | **Screw connections** | **Spring-loaded terminal connections** | **Ring cable connections** |
| **Connection, main contacts** | | | | |
| • Conductor cross-section | | | | |
| - Solid | $mm^2$ | 2 x (1.5 ... 2.5)[1], 2 x (2.5 ... 6)[1] | 2 x (0.5 ... 2.5) | -- |
| - Finely stranded with end sleeve | $mm^2$ | 2 x (1 ... 2.5)[1], 2 x (2.5 ... 6)[1], 1 x 10 | 2 x (0.5 ... 1.5) | -- |
| - Finely stranded without end sleeve | $mm^2$ | - | 2 x (0.5 ... 2.5) | -- |
| - Solid or stranded, AWG conductors | | 2 x (AWG 14 ... 10) | 2 x (AWG 18 ... 14) | -- |
| • Terminal screw | | M4 | -- | M5 |
| • Tightening torque | NM<br>lb. in | 2 ... 2.5<br>7 ... 10.3 | --<br>-- | 2.5 ... 2<br>10.3 ... 7 |
| • Cable lug | | | | |
| - DIN | | -- | -- | DIN 46234 -5-2.5, -5-6, -5-10, -5-16, -5-25 |
| - JIS | | -- | -- | JIS C 2805 R 2-5, 5.5-5, 8-5, 14-5 |
| **Connection, auxiliary/control contacts** | | | | |
| • Conductor cross-section | mm<br>AWG | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>20 ... 12 | 0.5 ... 2.5<br>20 ... 12 | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>20 ... 12 |
| • Stripped length | mm | 7 | 10 | 7 |
| • Terminal screw | | M3 | -- | M3 |
| • Tightening torque | NM<br>lb. in | 0.5 ... 0.6<br>4.5 ... 5.3 | --<br>-- | 0.5 ... 0.6<br>4.5 ... 5.3 |

[1] If two different conductor cross-sections are connected to one clamping point, both cross-sections must lie in the range specified. If identical cross-sections are used, this restriction does not apply.

## 3RF21 solid-state relays, single-phase, 22.5 mm

| Type | $I_{max}$ [1] at $R_{thha}/T_u$ = 40 °C | | $I_e$ according to IEC 60947-4-3 at $R_{thha}/T_u$ = 40 °C | | $I_e$ according to UL/CSA at $R_{thha}/T_u$ = 50 °C | | Power loss at $I_{max}$ | Minimum load current | Leakage current |
|---|---|---|---|---|---|---|---|---|---|
| | A | K/W | A | K/W | A | K/W | W | A | mA |
| **Main circuit** | | | | | | | | | |
| **3RF21 20-.....** | 20 | 2.0 | 20 | 1.7 | 20 | 1.3 | 28.6 | 0.1 | 10 |
| **3RF21 30-1....** | 30 | 1.1 | 30 | 0.79 | 30 | 0.56 | 44.2 | 0.5 | 10 |
| **3RF21 50-1....** | 50 | 0.68 | 50 | 0.48 | 50 | 0.33 | 66 | 0.5 | 10 |
| **3RF21 50-2....** | 50 | 0.68 | 20 | 2.6 | 20 | 2.9 | 66 | 0.5 | 10 |
| **3RF21 50-3....** | 50 | 0.68 | 50 | 0.48 | 50 | 0.33 | 66 | 0.5 | 10 |
| **3RF21 70-1....** | 70 | 0.40 | 50 | 0.77 | 50 | 0.6 | 94 | 0.5 | 10 |
| **3RF21 90-1....** | 88 | 0.33 | 50 | 0.94 | 50 | 0.85 | 118 | 0.5 | 10 |
| **3RF21 90-2....** | 88 | 0.33 | 20 | 2.8 | 20 | 3.5 | 118 | 0.5 | 10 |
| **3RF21 90-3....** | 88 | 0.33 | 88 | 0.22 | 83 | 0.19 | 118 | 0.5 | 10 |

[1] $I_{max}$ provides information about the performance of the solid-state relay. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and cooling conditions.

*Note: The rate currents and Imax do not provide information about the full performance of the solid-state relay. The required heat sinks for the corresponding load currents can be determined from the characteristic curves, page 4/10. The minimum thickness values for the mounting surface must be observed.*

| Type | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|
| | A | $A^2s$ |
| **Main circuit** | | |
| **3RF21 20-.....** | 200 | 200 |
| **3RF21 30-..A.2** | 300 | 450 |
| **3RF21 30-..A.4** | 300 | 450 |
| **3RF21 30-..A.6** | 400 | 800 |
| **3RF21 50-.....** | 600 | 1800 |
| **3RF21 70-..A.2** | 1200 | 7200 |
| **3RF21 70-..A.4** | 1200 | 7200 |
| **3RF21 70-..A.5** | 1200 | 7200 |
| **3RF21 70-..A.6** | 1150 | 6600 |
| **3RF21 90-.....** | 1150 | 6600 |

| Type | | 3RF21 ..-....2 | 3RF21 ..-....4 | 3RF21 ..-....5 | 3RF21 ..-....6 |
|---|---|---|---|---|---|
| **Main circuit** | | | | | |
| **Rated operational voltage $U_e$** | V | 24 ... 230 | 48 ... 460 | 48 ... 600 | 48 ... 600 |
| • Operating range | V | 20 ... 253 | 40 ... 506 | 40 ... 660 | 40 ... 660 |
| • Rated frequency | Hz | 50/60 ±10 % | | | |
| **Rated insulation voltage $U_i$** | V | 600 | | | |
| **Blocking voltage** | V | 800 | 1.200 | | 1.600 |
| **Rage of voltage rise** | V/µs | 1.000 | | | |

| Type | | 3RF21 ..-...0. | 3RF21 ..-...2. | 3RF21 ..-...4. |
|---|---|---|---|---|
| **Control circuit** | | | | |
| **Method of operation** | | DC operation | AC operation | DC operation |
| **Rated control supply voltage $U_s$** | V | 24 according to EN 61131-2 | 110 ... 230 | 4 ... 30 |
| **Rated frequency** Of the control supply voltage | Hz | -- | 50/60 | -- |
| **Rated control voltage $U_c$** | V | 30 | 253 | 30 |
| **Typical actuating current** | mA | 20 | 15 | 20 |
| **Response voltage** | V | 15 | 90 | 4 |
| **Drop-out voltage** | V | 5 | 40 | 1 |
| **Operating times** | | | | |
| • ON-delay | ms | 1 + additional max. one half-wave[1] | 40 + additional max. one half-wave[1] | 1 + additional max. one half-wave[1] |
| • OFF-delay | ms | 1 + additional max. one half-wave | 40 + additional max. one half-wave | 1 + additional max. one half-wave |

[1] Only for zero-point-switching devices.

## 3RF21 solid-state relays, single-phase, 22.5 mm

### *Fused version with semiconductor protection (similar to type of coordination "2")*[1)]

The semiconductor protection for the SIRIUS controls can be used with different protective devices. This allows protection by means of LV HRC fuses of gG operational class or miniature circuit breakers. Siemens recommends the use of special SITOR semiconductor fuses. The table below lists the maximum permissible fuses for each SIRIUS control.

If a fuse is used with a higher rated current than specified, semiconductor protection is no longer guaranteed. However, smaller fuses with a lower rated current for the load can be used without problems.

For protective devices with gG operational class and for SITOR full range fuses 3NE1, the minimum cross-sections for the conductor to be connected must be taken into account.

| Type | All-range fuse | Semiconductor protection fuses | | | | Cable and line protection fuses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LV HRC design | Cylindrical design | | | LV HRC design | Cylindrical design | | | DIAZED |
| | LV HRC design gR/SITOR 3NE1 | aR/SITOR 3NE8 | 10 x 38 mm aR/SITOR 3NC1 0 | 14 x 51 mm aR/SITOR 3NC1 4 | 22 x 58 mm aR/SITOR 3NC2 2 | gG 3NA | 10 x 38 mm gG 3NW | 14 x 51 mm gG 3NW | 22 x 58 mm gG 3NW | Quick 5SB |
| **3RF21 2.-....2** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 803 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF21 2.-....4** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 016 | 3NC1 420 | 3NC2 220 | 3NA2 801 | -- | 3NW6 101-1 | -- | 5SB1 41 |
| **3RF21 3.-....2** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 803 | -- | 3NW6 103-1 | -- | 5SB311 |
| **3RF21 3.-....4** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 025[2)] | 3NC1 432 | 3NC2 232 | 3NA2 803 | -- | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF21 3.-....6** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 803-6 | -- | -- | -- | -- |
| **3RF21 5.-....2** | 3NE1 817-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 810 | -- | 3NW6 107-1 | 3NW6 207-1 | 5SB3 21 |
| **3RF21 5.-....4** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 807 | -- | -- | 3NW6 205-1 | 5SB3 11 |
| **3RF21 5.-....6** | 3NE1 803-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 807-6 | -- | -- | -- | -- |
| **3RF21 7.-....2**[3)] | 3NE1 820-0 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF21 7.-....4**[3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF21 7.-....5**[3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF21 7.-....6**[3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF21 9.-....2**[3)] | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 200 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF21 9.-....4**[3)] | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 280[2)] | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF21 9.-....6**[3)] | 3NE1 020-2[2)] | 3NE8 021-1 | -- | -- | 3NC2 280[2)] | 3NA2 812-6 | -- | -- | -- | -- |

Suitable fuse holders, fuse bases and switchgear can be found in Catalog LV 1, Chapter 19.

1) Type of coordination "2" according to EN 60947-4-1:
In the event of a short-circuit, the controls in the load feeder must not endanger persons or the installation. They must be suitable for further operation. For fused configurations, the protective device must be replaced.

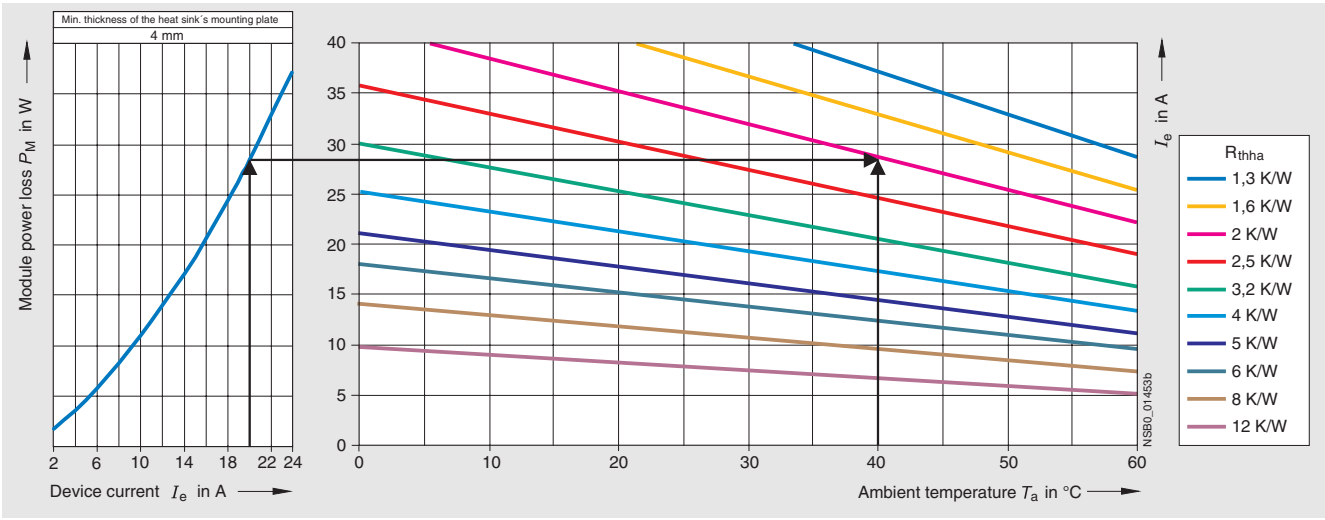
2) These fuses have a smaller rated current than the solid-state relays.

3) These versions can also be protected against short-circuits with miniature circuit breakers as described in the notes on "SIRIUS Solid-State Contactors → Special Version Short-Circuit Resistant".

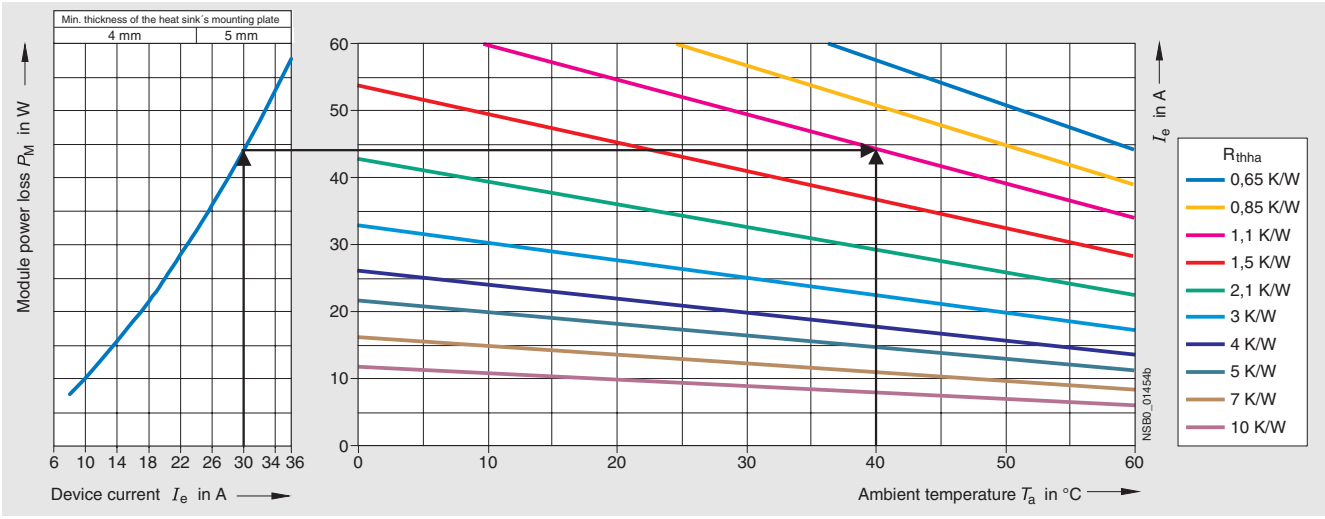
## 3RF21 solid-state relays, single-phase, 22.5 mm

### Characteristic curves

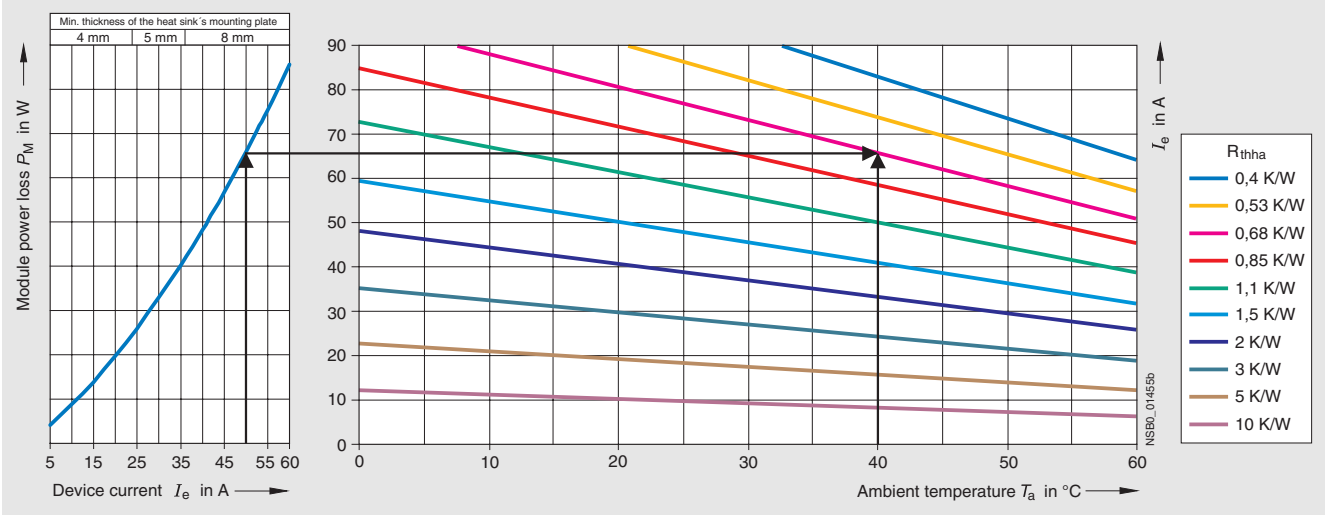
***Dependence of the device current $I_e$ on the ambient temperature $T_a$***




Type current 20 A (3RF21 20, 3RF20 20)[1)]

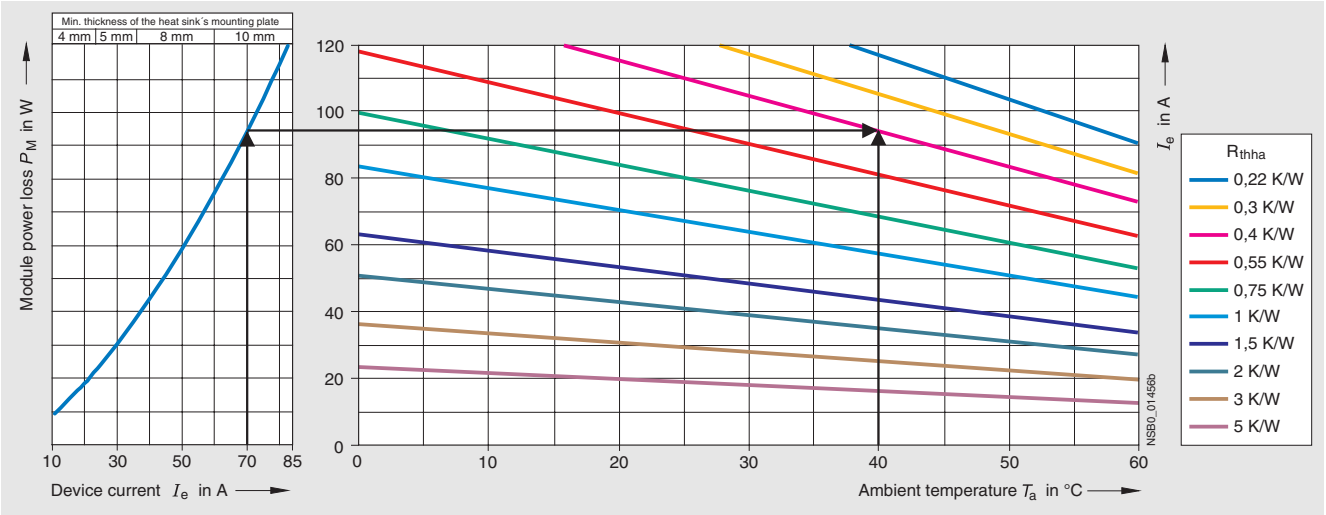



Type current 30 A (3RF21 30, 3RF20 30)

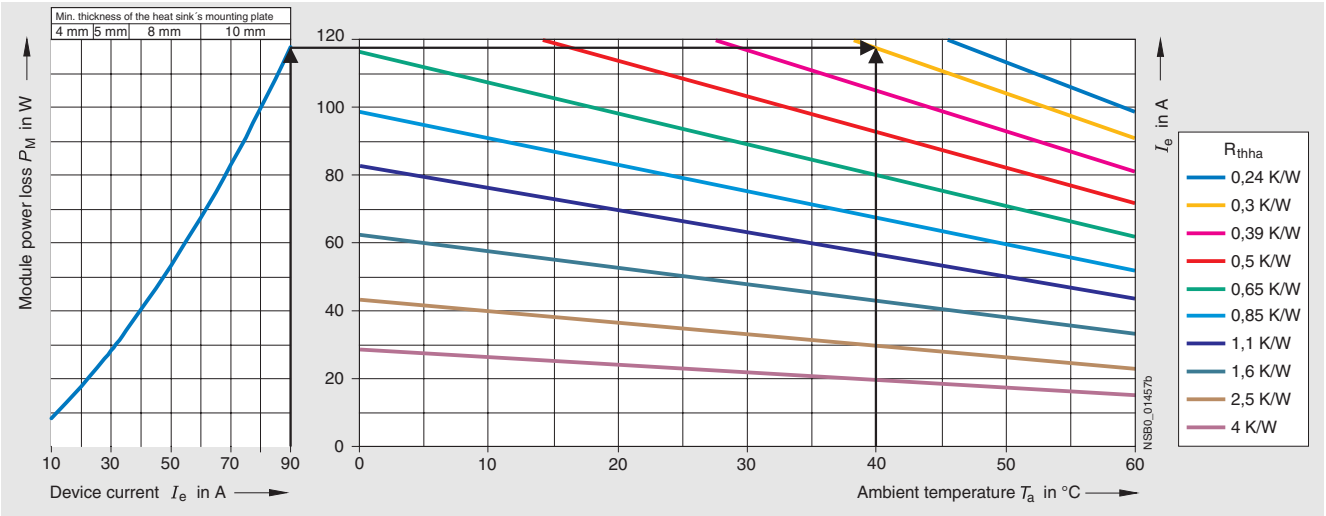



Type current 50 A (3RF21 50, 3RF20 50)

[1)] For arrangement example see next page.




Type current 70 A (3RF21 70, 3RF20 70)




Type current 90 A (3RF21 90, 3RF20 90)

Arrangement example

Given conditions: $I_e$ = 20 A and $T_a$ = 40 C. The task is to find the thermal resistance $R_{thha}$ and the heat sink overtemperature $dT_{ha}$.

From the diagram on the left → $P_M$ = 28 W,
from the diagram on the right → $R_{thha}$ = 2.0 K/W.

This results in:

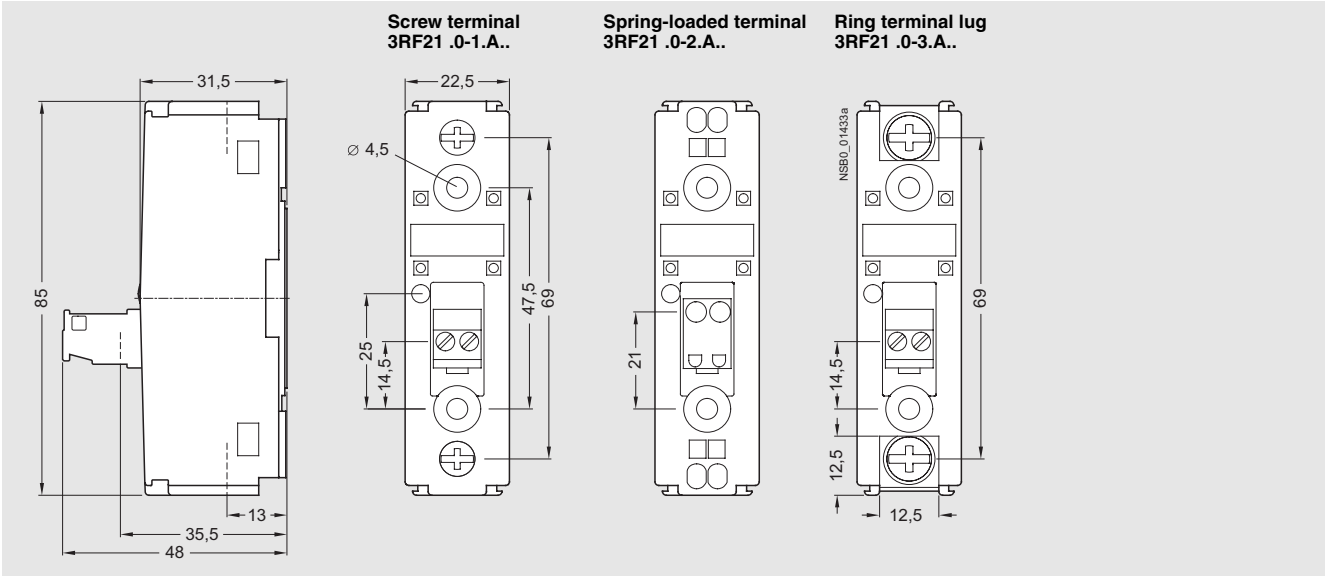
$dT_{ha} = R_{thha} \times PM = 2.0\ K/W \times 28\ W = 56\ K$.

At $dT_{ha}$ = 56 K the heat sink must therefore have an $R_{thha}$ = 2.0 K/W.

## 3RF21 solid-state relays, single-phase, 22.5 mm

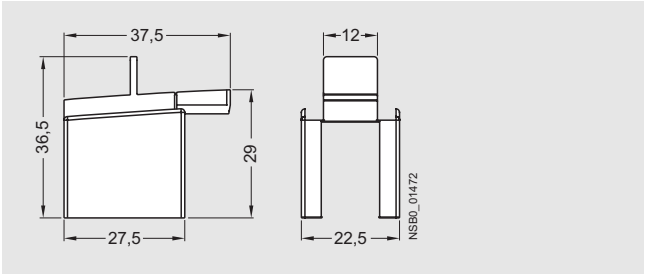
### Dimensional drawings

Solid-state relays



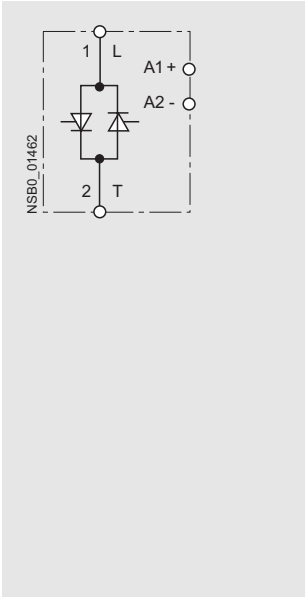

Terminal cover

3RF29 00-3PA88

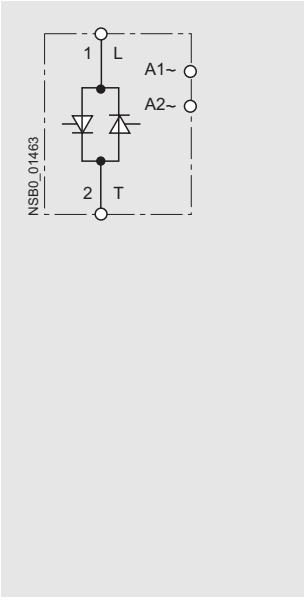



### Schematics

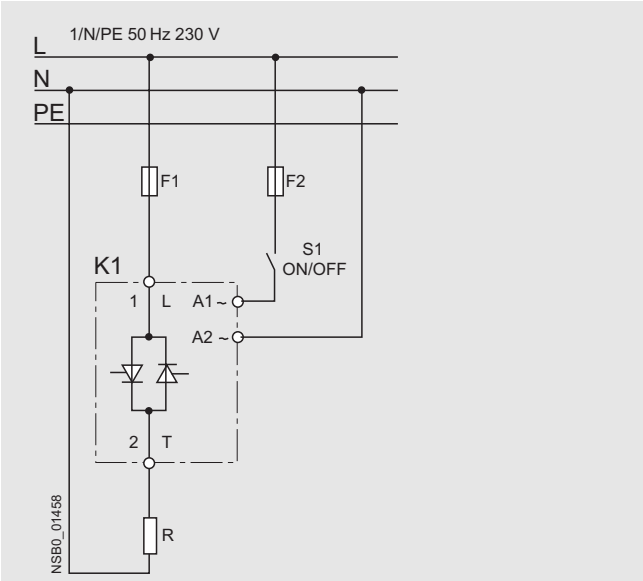
Version
DC control supply voltage




Version
AC control supply voltage




Switching example



## Overview

### *45 mm solid-state relays*

The solid-state relays with a width of 45 mm provide for connection of the power supply lead and the load from above. This makes it easy to replace existing solid-state relays in existing arrangements. The connection of the control cable also saves space in much the same way as the 22.5 mm design, as it is simply plugged on.

## Technical specifications

| Type | | 3RF20 ..-1.... | 3RF20 ..-4.... |
|---|---|---|---|
| **General data** | | | |
| **Ambient temperature** | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | |
| • During storage | °C | -55 ... +80 | |
| **Installation altitude** | m | 0 ... 1000; derating from 1000 | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15 /11 | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | |
| **Degree of protection** | | IP20 | |
| **Electromagnetic compatibility (EMC)** | | | |
| • Emitted interference | | | |
| - Conducted interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | |
| - Emitted, high-frequency interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | |
| • Interference immunity | | | |
| - Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3) | kV | Contact discharge 4; air discharge 8; behavior criterion 2 | |
| - Induced RF fields according to IEC 61000-4-6 | MHz | 0.15 ... 80; 140 dBµV; behavior criterion 1 | |
| - Burst according to IEC 61000-4-4 | kV | 2/5.0 kHz; behavior criterion 1 | |
| - Surge according to IEC 61000-4-5 | kV | Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | |
| **Connection type** | | **Screw connections** | **Spring-loaded terminal connections** |
| **Connection, main contacts** | | | |
| • Conductor cross-section | | | |
| - Solid | $mm^2$ | 2 x (1.5 ... 2.5)[1], 2 x (2.5 ... 6)[1] | -- |
| - Finely stranded with end sleeve | $mm^2$ | 2 x (1 ... 2.5)[1], 2 x (2.5 ... 6)[1], 1 x 10 | -- |
| - Solid or stranded, AWG conductors | | 2x (AWG 14 ... 10) | -- |
| • Terminal screw | | M4 | -- |
| • Tightening torque | NM<br>lb. in | 2 ... 2.5<br>7 ... 10.3 | --<br>-- |
| **Connection, auxiliary/control contacts** | | | |
| • Conductor cross-section | $mm^2$ | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0), AWG 20 ... 12 | 0.5 ... 2.5, AWG 20 ... 12 |
| • Stripped length | mm | 7 | 10 |
| • Terminal screw | | M3 | -- |
| • Tightening torque | NM<br>lb. in | 0.5 ... 0.6<br>4.5 ... 5.3 | --<br>-- |

[1] If two different conductor cross-sections are connected to one clamping point, both cross-sections must lie in the range specified. If identical cross-sections are used, this restriction does not apply.

## 3RF20 solid-state relays, single-phase, 45 mm

| Type | $I_{max}$ [1] at $R_{thha}/T_u$ = 40 °C | | $I_e$ according to IEC 60947-4-3 at $R_{thha}/T_u$ = 40 °C | | $I_e$ according to UL/CSA at $R_{thha}/T_u$ = 50 °C | | Power loss at $I_{max}$ | Minimum load current | Leakage current |
|---|---|---|---|---|---|---|---|---|---|
| | A | K/W | A | K/W | A | K/W | W | A | mA |
| **Main circuit** | | | | | | | | | |
| **3RF20 20-1.A..** | 20 | 2.0 | 20 | 1.7 | 20 | 1.3 | 28.6 | 0.1 | 10 |
| **3RF20 30-1.A..** | 30 | 1.1 | 30 | 0.79 | 30 | 0.56 | 44.2 | 0.5 | 10 |
| **3RF20 50-1.A..** | 50 | 0.68 | 50 | 0.48 | 50 | 0.33 | 66 | 0.5 | 10 |
| **3RF20 70-1.A..** | 70 | 0.40 | 50 | 0.77 | 50 | 0.6 | 94 | 0.5 | 10 |
| **3RF20 90-1.A..** | 88 | 0.33 | 50 | 0.94 | 50 | 0.85 | 118 | 0.5 | 10 |

[1] $I_{max}$ provides information about the performance of the solid-state relay. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and cooling conditions.

*Note: The rate currents and Imax do not provide information about the full performance of the solid-state relay. The required heat sinks for the corresponding load currents can be determined from the characteristic curves, page 4/10. The minimum thickness values for the mounting surface must be observed.*

| Type | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|
| | A | $A^2s$ |
| **Main circuit** | | |
| **3RF20 20-1.A..** | 200 | 200 |
| **3RF20 30-1.A.2** | 300 | 450 |
| **3RF20 30-1.A.4** | 300 | 450 |
| **3RF20 30-1.A.6** | 400 | 800 |
| **3RF20 50-1.A..** | 600 | 1800 |
| **3RF20 70-1.A.2** | 1200 | 7200 |
| **3RF20 70-1.A.4** | 1200 | 7200 |
| **3RF20 70-1.A.5** | 1200 | 7200 |
| **3RF20 70-1.A.6** | 1150 | 6600 |
| **3RF20 90-1.A..** | 1150 | 6600 |

| Type | | 3RF20 .0-1.A.2 | 3RF20 .0-1.A.4 | 3RF20 .0-1.A.5 | 3RF20 .0-1.A.6 |
|---|---|---|---|---|---|
| **Main circuit** | | | | | |
| **Rated operational voltage $U_e$** | V | 24 ... 230 | 48 ... 460 | 48 ... 600 | 48 ... 600 |
| • Operating range | V | 20 ... 253 | 40 ... 506 | 40 ... 660 | 40 ... 660 |
| • Rated frequency | Hz | 50/60 ±10 % | | | |
| **Rated insulation voltage $U_i$** | V | 600 | | | |
| **Blocking voltage** | V | 800 | 1200 | | 1600 |
| **Rage of voltage rise** | V/µs | 1000 | | | |

| Type | | 3RF20 .0-1.A0. | 3RF20 .0-1.A2. | 3RF20 .0-1.A4. |
|---|---|---|---|---|
| **Control circuit** | | | | |
| **Method of operation** | | DC operation | AC operation | DC operation |
| **Rated control supply voltage $U_S$** | V | 24 according to EN 61131-2 | 110 … 230 | 4 … 30 |
| **Rated frequency** of the control supply voltage | Hz | -- | 50/60 ±10 % | -- |
| **Rated control voltage $U_c$** | V | 30 | 253 | 30 |
| **Typical actuating current** | mA | 20 | 15 | 20 |
| **Response voltage** | V | 15 | 90 | 4 |
| **Drop-out voltage** | V | 5 | 40 | 1 |
| **Operating times** | | | | |
| • ON-delay | ms | 1 + additional max. one half-wave[1] | 40 + additional max. one half-wave[1] | 1 + additional max. one half-wave[1] |
| • OFF-delay | ms | 1 + additional max. one half-wave | 40 + additional max. one half-wave | 1 + additional max. one half-wave |

[1] Only for zero-point-switching devices.

## 3RF20 solid-state relays, single-phase, 45 mm

### *Fused version with semiconductor protection (similar to type of coordination "2")*[1)]

The semiconductor protection for the SIRIUS controls can be used with different protective devices. This allows protection by means of LV HRC fuses of gG operational class or miniature circuit breakers. Siemens recommends the use of special SITOR semiconductor fuses. The table below lists the maximum permissible fuses for each SIRIUS control.

If a fuse is used with a higher rated current than specified, semiconductor protection is no longer guaranteed. However, smaller fuses with a lower rated current for the load can be used without problems.

For protective devices with gG operational class and for SITOR full range fuses 3NE1, the minimum cross-sections for the conductor to be connected must be taken into account.

| Type | **All-range fuses** | **Semiconductor fuses** | | | | **Cable and line protection fuses** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LV HRC design | Cylindrical design | | | LV HRC design | Cylindrical design | | | DIAZED |
| | LV HRC design gR/SITOR 3NE1 | aR/SITOR 3NE8 | 10 x 38 mm aR/SITOR 3NC1 0 | 14 x 51 mm aR/SITOR 3NC1 4 | 22 x 58 mm aR/SITOR 3NC2 2 | gG 3NA | 10 x 38 mm gG 3NW | 14 x 51 mm gG 3NW | 22 x 58 mm gG 3NW | Quick 5SB |
| **3RF20 20-1.A.2** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 803 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF20 20-1.A.4** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 016 | 3NC1 420 | 3NC2 220 | 3NA2 801 | -- | 3NW6 101-1 | -- | 5SB1 41 |
| **3RF20 30-1.A.2** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 803 | -- | 3NW6 103-1 | -- | 5SB311 |
| **3RF20 30-1.A.4** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 025[2)] | 3NC1 432 | 3NC2 232 | 3NA2 803 | -- | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF20 30-1.A.6** | 3NE1 815-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 803-6 | -- | -- | -- | -- |
| **3RF20 50-1.A.2** | 3NE1 817-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 810 | -- | 3NW6 107-1 | 3NW6 207-1 | 5SB3 21 |
| **3RF20 50-1.A.4** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 807 | -- | -- | 3NW6 205-1 | 5SB3 11 |
| **3RF20 50-1.A.6** | 3NE1 803-0 | 3NE8 017-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 807-6 | -- | -- | -- | -- |
| **3RF20 70-1.A.2** [3)] | 3NE1 820-0 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF20 70-1.A.4** [3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF20 70-1.A.5** [3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF20 70-1.A.6** [3)] | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF20 90-1.A.2** [3)] | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 200 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF20 90-1.A.4** [3)] | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 280[2)] | 3NA2 812 | -- | -- | 3NW6 212-1 | 5SB3 21 |
| **3RF20 90-1.A.6** [3)] | 3NE1 020-2[2)] | 3NE8 021-1 | -- | -- | 3NC2 280[2)] | 3NA2 812-6 | -- | -- | -- | -- |

Suitable fuse holders, fuse bases and controls can be found in Catalog LV 1, Chapter 19.

1) Type of coordination "2" according to EN 60947-4-1:
In the event of a short-circuit, the controls in the load feeder must not endanger persons or the installation. They must be suitable for further operation. For fused configurations, the protective device must be replaced.

2) These fuses have a smaller rated current than the solid-state relays.

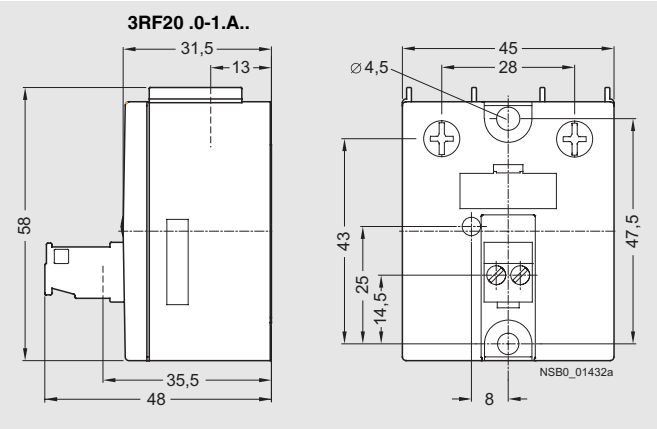
3) These versions can also be protected against short-circuits with miniature circuit breakers as described in the notes on "SIRIUS Solid-State Contactors → Special Version Short-Circuit Resistant".

### Characteristic curves

See 3RF21 solid-state relays, 22.5 mm.

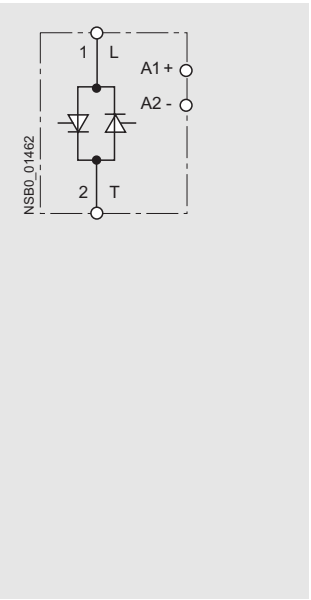
## 3RF20 solid-state relays, single-phase, 45 mm

### Dimensional drawings

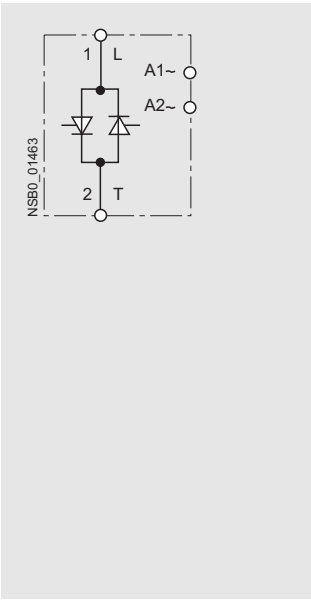



### Schematics

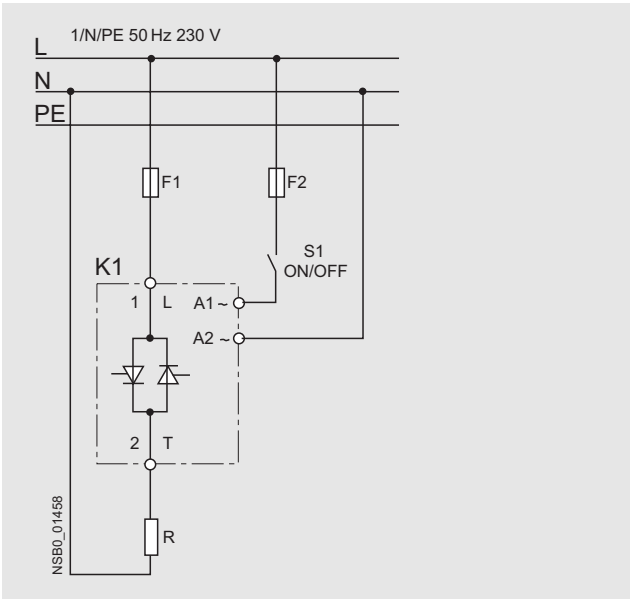
Version
DC control supply voltage




Version
AC control supply voltage




Switching example



## Overview

### *45 mm solid-state relays*

The 3RF22 solid-state relays with a width of 45 mm provide space advantages over solutions with single-phase versions. The logical connection method, with the power infeed from above and load connection from below, ensures tidy installation in the control cabinet.

Important features:
- LED display
- Variety of connection methods
- Plug-in control connection
- Degree of protection IP20
- Zero-point switching
- Two-phase of three-phase controlled

## Technical specifications

| Type | | 3RF22 ..-1.... | 3RF22 ..-2.... | 3RF22 ..-3.... |
|---|---|---|---|---|
| **General data** | | | | |
| **Ambient temperature** | | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | | |
| • During storage | °C | -55 ... +80 | | |
| **Installation altitude** | m | 0 ... 1000; > 1000 ask Technical Assistance | | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15/11 | | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | | |
| **Degree of protection** | | IP20 | | |
| **Insulation strength** at 50/60 Hz<br>(main/control circuit to floor) | V rms | 4000 | | |
| **Electromagnetic compatibility** (EMC) | | | | |
| • Emitted interference<br>- Conducted interference voltage according to IEC 60947-4-3 | | Class A for industrial applications[1] | | |
| - Emitted, high-frequency interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | | |
| • Interference immunity<br>- Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3) | kV | Contact discharge 4; air discharge 8; behavior criterion 2 | | |
| - Induced RF fields according to IEC 61000-4-6 | MHz | 0.15 ... 80; 140 dBµV; behavior criterion 1 | | |
| - Burst according to IEC 61000-4-4 | kV | 2/5.0 kHz; behavior criterion 1 | | |
| - Surge according to IEC 61000-4-5 | kV | Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | | |
| **Connection type** | | **Screw terminals** | **Spring-loaded terminal connections** | **Ring terminal end connections** |
| **Connection, main contacts** | | | | |
| • Conductor cross-section<br>- Solid | $mm^2$ | 2 x (1.5 ... 2.5)[2], 2 x (2.5 ... 6)[2] | 2 x (0.5 ... 2.5) | -- |
| - Finely stranded with end sleeve | $mm^2$ | 2 x (1 ... 2.5)[2], 2 x (2.5 ... 6)[2], 1 x 10 | 2 x (0.5 ... 1.5) | -- |
| - Finely stranded without end sleeve | $mm^2$ | -- | 2 x (0.5 ... 2.5) | -- |
| - Solid or stranded, AWG conductors | | 2 x (AWG 14 ... 10) | 2 x (AWG 18 ... 14) | -- |
| • Stripped length | mm | 10 | 10 | |
| • Terminal screw<br>- Tightening torque, Ø 5 ... 6 mm, PZ 2 | Nm<br>lb.in | M4<br>2 ... 2.5<br>18 ... 22 | -- | M5<br>2.5 ... 2<br>18 ... 22 |
| • Cable lug<br>- According to DIN 46234 | | -- | -- | |
| - According to JIS C 2805 | | | | 5-2.5 ... 5-25<br>R 2-5 ... 14-5 |
| **Connection, auxiliary/control contacts** | | | | |
| • Conductor cross-section, with or without end sleeve | mm<br>AWG | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>20 ... 12 | 0.5 ... 2.5<br>20 ... 12 | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>20 ... 12 |
| • Stripped length | mm | 7 | 10 | 7 |
| • Terminal screw<br>- Tightening torque, Ø 3.5, PZ 1 | Nm<br>lb.in | M3<br>0.5 ... 0.6<br>4.5 ... 5.3 | -- | M3<br>0.5 ... 0.6<br>4.5 ... 5.3 |

[1] These products were built as Class A devices. The use of these devices in residential areas could result in lead in radio interference. In this case these may be required to introduce additional interference suppression measures.

[2] If two different conductor cross-sections are connected to one clamping point, both cross-sections must lie in the range specified. If identical cross-sections are used, this restriction does not apply.

## 3RF22 solid-state relays, 3-phase, 45 mm

| Type | $I_{max}$ [1] at $R_{thha}/T_u$ = 40 °C | | $I_e$ acc. to IEC 60947-4-3 at $R_{thha}/T_u$ = 40 °C | | $I_e$ according to UL/CSA at $R_{thha}/T_u$ = 50 °C | | Power loss at $I_{max}$ | Minimum load current | Max. leakage current |
|---|---|---|---|---|---|---|---|---|---|
| | A | K/W | A | K/W | A | K/W | W | A | mA |
| **Main circuit** | | | | | | | | | |
| **3RF22 30-. AB..** | 30 | 0.57 | 30 | 0.57 | 30 | 0.44 | 81 | 0.5 | 10 |
| **3RF22 55-1AB..** | 55 | 0.18 | 50 | 0.27 | 50 | 0.19 | 151 | 0.5 | 10 |
| **3RF22 55-2AB..** | | | 20 | 1.83 | 20 | 1.58 | | | |
| **3RF22 55-3AB..** | | | 50 | 0.27 | 50 | 0.19 | | | |
| **3RF22 30-. AC..** | 30 | 0.33 | 30 | 0.33 | 30 | 0.25 | 122 | 0.5 | 10 |
| **3RF22 55-1AC..** | 55 | 0.09 | 50 | 0.15 | 50 | 0.1 | 226 | 0.5 | 10 |
| **3RF22 55-2AC..** | | | 20 | 1.19 | 20 | 1.02 | | | |
| **3RF22 55-3AC..** | | | 50 | 0.15 | 50 | 0.1 | | | |

[1] $I_{max}$ provides information about the performance of the solid-state relay. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and cooling conditions.

| Type | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|
| | A | $A^2s$ |
| **Main circuit** | | |
| **3RF22 30-....5** | 300 | 450 |
| **3RF22 55-....5** | 600 | 1800 |

| Type | | 3RF22 ..-.AB.5 | 3RF22 ..-.AC.5 |
|---|---|---|---|
| **Main circuit** | | | |
| **Controlled phases** | | Two-phase | Three-phase |
| **Rated operational voltage $U_e$** | V | 48 ... 600 | 48 ... 600 |
| • Operating range | V | 40 ... 660 | 40 ... 660 |
| • Rated frequency | Hz | 50/60 ±10 % | 50/60 ±10 % |
| **Rated insulation voltage $U_i$** | V | 600 | 600 |
| **Rated impulse withstand voltage $U_{imp}$** | kV | 6 | 6 |
| **Blocking voltage** | V | 1200 | 1200 |
| **Rage of voltage rise** | V/µs | 1.000 | 1.000 |

| Type | | 3RF22 ..-.AB4. | 3RF22 ..-.AC4. |
|---|---|---|---|
| **Control circuit** | | | |
| **Method of operation** | | DC operation | DC operation |
| **Rated control supply voltage $U_s$** | V | 4 ... 30 | 4 ... 30 |
| **Typical actuating current** | mA | 30 | 30 |
| **Response voltage** | V | 15 | 15 |
| **Drop-out voltage** | V | 1 | 1 |
| **Operating times** | | | |
| • ON-delay | ms | 1 + max. one half-wave | 1 + max. one half-wave |
| • OFF-delay | ms | 1 + max. one half-wave | 1 + max. one half-wave |

### *Fused version with semiconductor protection (similar to type of coordination "2")*[1]

The semiconductor protection for the 3RF22 controls can be used with different protective devices. Siemens recommends the use of special SITOR semiconductor fuses. The table below lists the maximum permissible fuses for each 3RF22 control.

If a fuse is used with a higher rated current than specified, semiconductor protection is no longer guaranteed. However, smaller fuses with a lower rated current for the load can be used without problems.

| Order No. | All-range fuses | Semiconductor fuses | | | | Cable and line protection fuses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LV HRC design | Cylindrical design | | | LV HRC design | Cylindrical design | | | DIAZED |
| | LV HRC design gR/SITOR 3NE1 | aR/SITOR 3NE8 | 10 x 38 mm aR/SITOR 3NC1 0 | 14 x 51 mm aR/SITOR 3NC1 4 | 22 x 58 mm aR/SITOR 3NC2 2 | gG 3NA | 10 x 38 mm gG 3NW | 14 x 51 mm gG 3NW | 22 x 58 mm gG 3NW | Quick 5SB |
| **Rated operational voltage $U_e$ up to 506 V** | | | | | | | | | | |
| **3RF22 30-.....** | 3NE1 814-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 430 | 3NC2 232 | 3NA3 803-6 | -- | 3NW6 101-1 | -- | 3SB1 17 |
| **3RF22 55-.....** | 3NE1 802-0 | 3NE8 020-1 | -- | 3NC1 450 | 3NC2 263 | 3NA3 807-6 | -- | -- | 3NW6 205-1 | 3SB3 11 |
| **Rated operational voltage $U_e$ up to 660 V** | | | | | | | | | | |
| **3RF22 30-.....** | 3NE1 814-0 | 3NE8 003-1 | 3NC1 025 | 3NC1 430 | 3NC2 232 | 3NA3 803-6 | -- | -- | -- | -- |
| **3RF22 55-.....** | 3NE1 803-0 | 3NE8 018-1 | -- | 3NC1 450 | 3NC2 250 | 3NA3 805-6 | -- | -- | -- | -- |

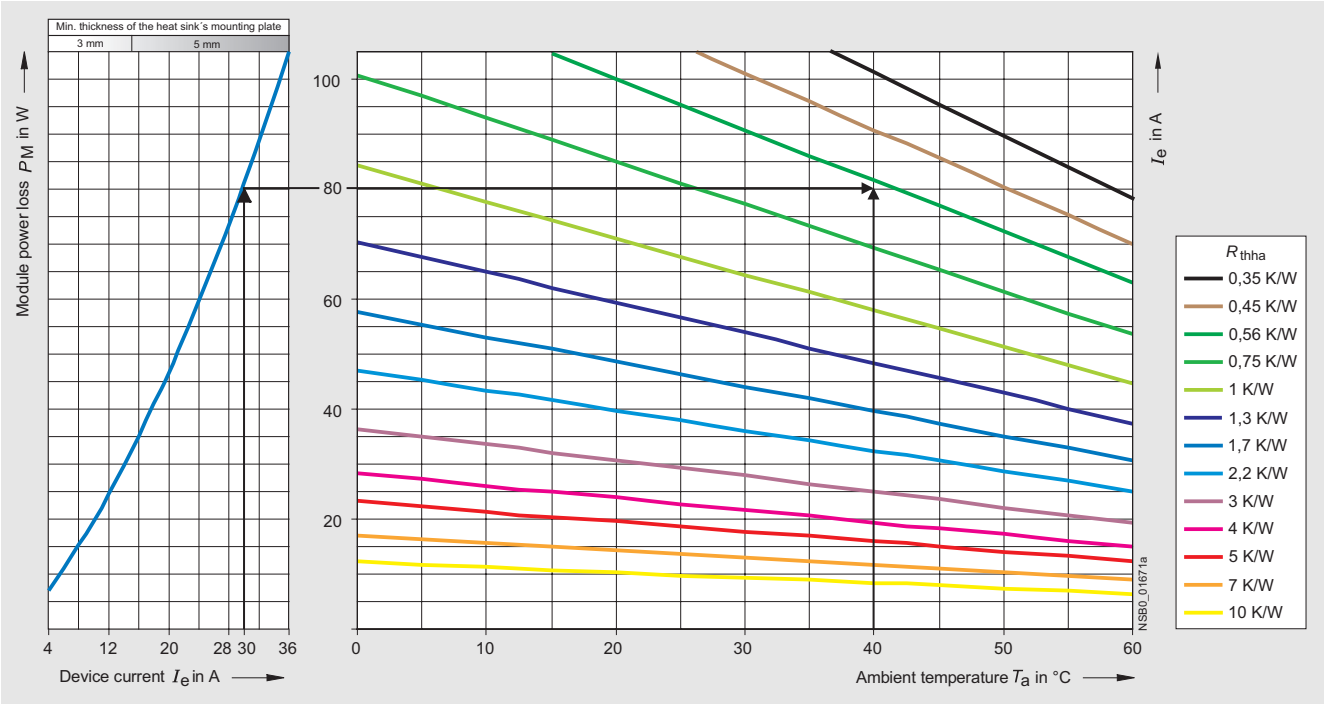
Suitable fuse holders, fuse bases and controls can be found in Catalog LV 1, Chapter 19.

[1] Type of coordination "2" according to EN 60947-4-1:

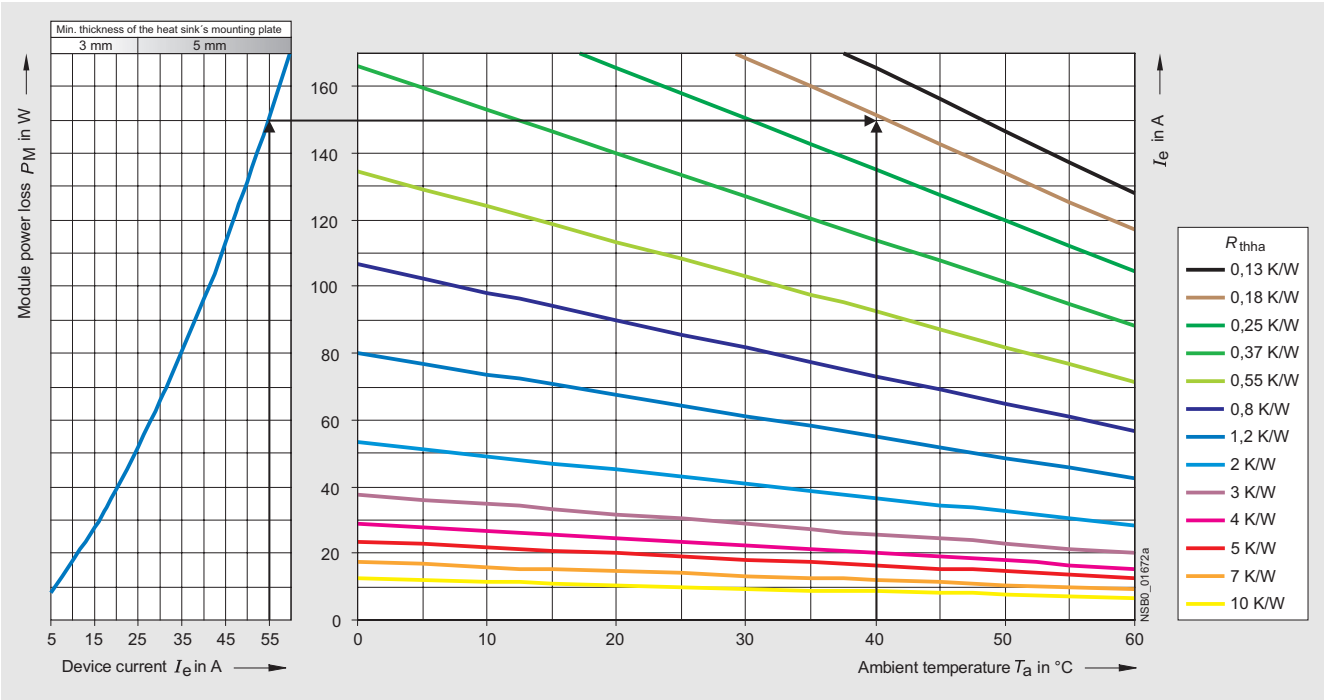
In the event of a short-circuit, the controls in the load feeder must not endanger persons or the installation. They must be suitable for further operation. For fused configurations, the protective device must be replaced.

## Characteristic curves

### *Dependence of the device current $I_e$ on the ambient temperature $T_a$ (two-phase controlled)*



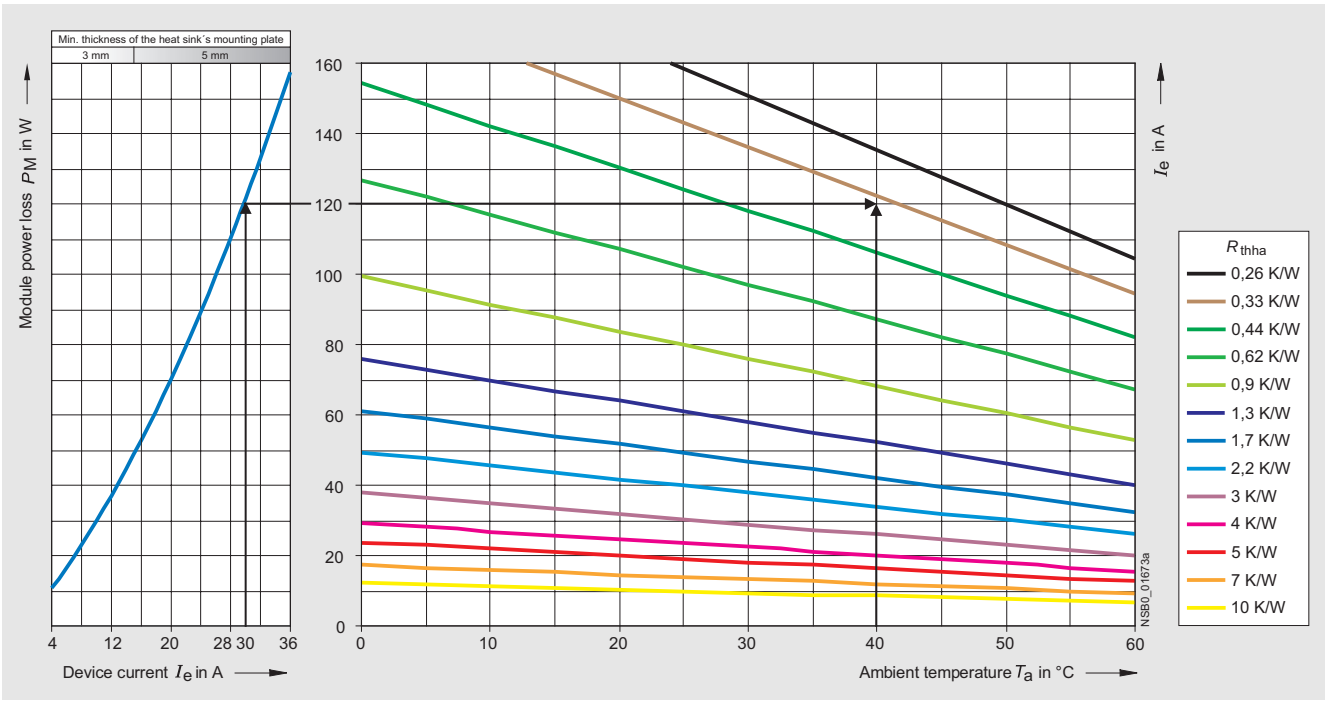

Type current 30 A (3RF22 30-.AB..)



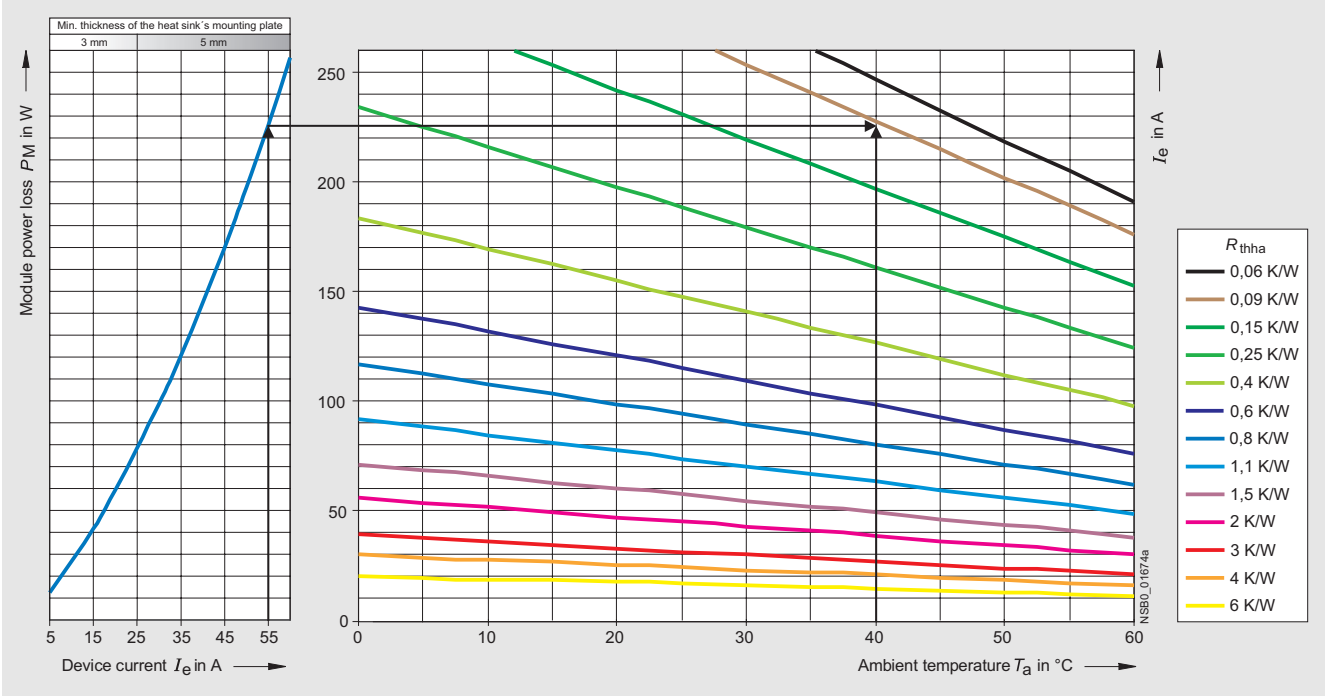

Type current 55 A (3RF22 55-.AB..)

## 3RF22 solid-state relays, 3-phase, 45 mm

### *Dependence of the device current $I_e$ on the ambient temperature $T_a$ (three-phase controlled)*




Type current 30 A (3RF22 30-.AC..)




Type current 55 A (3RF22 55-.AC..)

Arrangement example

Given conditions: $I_e$ = 55 A and $T_a$ = 40 C. The task is to find the thermal resistance $R_{thha}$ and the heat sink overtemperature $dT_{ha}$.

From the diagram on the left → $P_M$ = 227 W,
from the diagram on the right → $R_{thha}$ = 0.09 K/W.

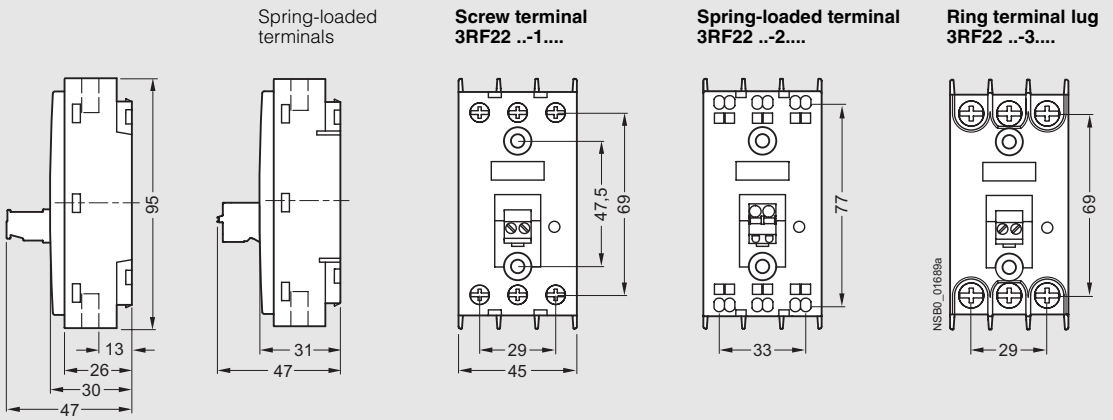
This results in:

$dT_{ha} = R_{thha} \times PM = 0.09\ K/W \times 227\ W = 20.4\ K$.

At $dT_{ha}$ = 20.4 K the heat sink must therefore have an $R_{thha}$ = 0.09 K/W.

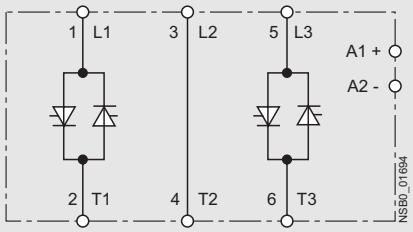
## Dimensional drawings

Solid-state relay

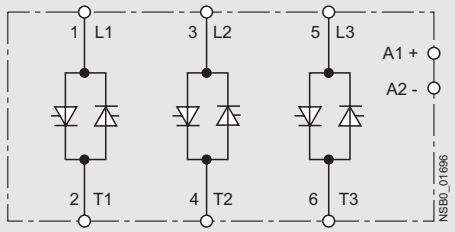



## Schematics

Two-phase controlled,
DC control supply voltage




Three-phase controlled,
DC control supply voltage



# General data

## Overview

The complete units consist of a solid-state relay plus optimized heat sink, and are therefore „ready to use“. They offer defined rated currents to make selection as easy as possible. Depending on the version, current strengths of up to 88 A are achieved. Like all of our solid-state switching devices, one of their particular advantages is their compact and space-saving design.

With their insulated mounting foot they can easily be snapped onto a standard mounting rail, or they can be mounted on carrier plates with fixing screws. This insulation enables them to be used in circuits with protective extra-low voltage (PELV) or safety extra-low voltage (SELV) in building engineering. For other applications, such as for extended personal safety, the heat sink can be grounded through a screw terminal.

The solid-state contactors are available in 2 different versions:

- 3RF23 Single-phase solid-state contactors
- 3RF24 3-phase solid-state contactors

### *Version for resistive loads, "zero-point switching"*

This standard version is often used for switching space heaters on and off.

### *Version for inductive loads, "instantaneous switching"*

In this version the solid-state contactor is specifically matched to inductive loads. Whether it is a matter of frequent actuation of the valves in a filling plant or starting and stopping small operating mechanisms in packet distribution systems, operation is carried out safely and noiselessly.

### *Special "Low Noise" version*

Thanks to a special control circuit, this special version can be used in public networks up to 16 A without any additional measures such as interference suppressor filters. As a result it conforms to limit value curve class B according to EN 60947-4-3 in terms of emitted interference.

### *Special "Short-circuit-resistant" version*

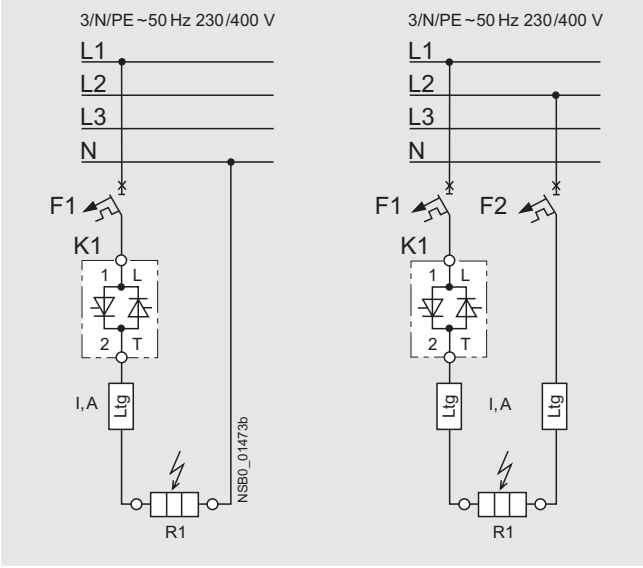
Skillful matching of the power semiconductor with the performance of the solid-state contactor means that "short-circuit strength" can be achieved with a standard miniature circuit breaker. In combination with a B-type MCB or a conventional fuse, the result is a short-circuit resistant feeder.

In order to achieve problem-free short-circuit protection by means of miniature circuit breakers, however, certain boundary conditions must be observed. As the magnitude and duration of the short-circuit current are determined not only by the short-circuit breaking response of the miniature circuit breaker but also the properties of the wiring system, such as the internal resistance of the input to the network and damping by controls and cables, particular attention must also be paid to these parameters. The necessary cable lengths are therefore shown for the main factor, the conductor resistance, in the table below.

The following miniature circuit breakers with a type B tripping characteristic and 10 kA or 6 kA breaking capacity protect the 3RF23..-.DA.. solid-state contactors in the event of short-circuits on the load and the specified conductor cross-sections and lengths:

| Rated current of the miniature circuit breaker | Example Type[1)] | Max. conductor cross-section | Minimum cable length from contactor to load |
|---|---|---|---|
| 6 A | 5SY4 106-6, 5SX2 106-6 | 1 mm$^2$ | 5 m |
| 10 A | 5SY4 110-6, 5SX2 110-6 | 1.5 mm$^2$ | 8 m |
| 16 A | 5SY4 116-6, 5SX2 116-6 | 1.5 mm$^2$ | 12 m |
| 16 A | 5SY4 116-6, 5SX2 116-6 | 2.5 mm$^2$ | 20 m |
| 20 A | 5SY4 120-6, 5SX2 120-6 | 2.5 mm$^2$ | 20 m |
| 25 A | 5SY4 125-6, 5SX2 125-6 | 2.5 mm$^2$ | 26 m |

[1)] The miniature circuit breakers can be used up to a maximum rated voltage of 480 V!




The setup and installation above can also be used for the solid-state relays with a $I^2t$ value of at least 6600 A$^2$s.

## More information

### *Selecting solid-state contactors*

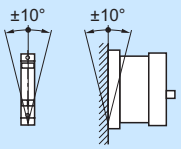
The solid-state contactors are selected on the basis of details of the network, the load and the ambient conditions. As the solid-state contactors are already equipped with an optimally matched heat sink, the selection process is considerably simpler than that for solid-state relays.

The following procedure is recommended:

- Determine the rated current of the load and the mains voltage
- Select a solid-state contactor with the same or higher rated current than the load
- Check the correct contactor size with the aid of the rated current diagram, taking account of the installation conditions

## Technical specifications

| Type | | 3RF23 ..-.A... | 3RF23 ..-.B... | 3RF23 ..-.C... | 3RF23 ..-.D... |
|---|---|---|---|---|---|
| **General data** | | | | | |
| **Ambient temperature** | | | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | | | |
| • During storage | °C | -55 ... +80 | | | |
| **Installation altitude** | m | 0 ... 1000; derating from 1000 | | | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15/11 | | | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | | | |
| **Degree of protection** | | IP20 | | | |
| **Electromagnetic compatibility (EMC)** | | | | | |
| • Emitted interference according to IEC 60947-4-3<br>- Conducted interference voltage<br>- Emitted, high-frequency interference voltage | | Class A for industrial applications | | Class A for industrial applications;<br>Class B for residential/ business/ commercial applications up to 16 A, AC51 Low Noise | Class A for industrial applications |
| • Interference immunity | | | | | |
| - Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3) | kV | Contact discharge 4; air discharge 8; behavior criterion 2 | | | |
| - Induced RF fields according to IEC 61000-4-6 | MHz | 0.15 ... 80; 140 dBµV; behavior criterion 1 | | | |
| - Burst according to IEC 61000-4-4 | kV | 2/5.0 kHz; behavior criterion 1 | | | |
| - Surge according to IEC 61000-4-5 | kV | Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | | | |

| Type | | 3RF23 ..-1.... | 3RF23 ..-2.... | 3RF23 ..-3.... |
|---|---|---|---|---|
| **General data** | | | | |
| **Connection type** | | **Screw terminals** | **Spring-loaded terminal connections** | **Ring terminal end connections** |
| **Connection, main contacts** | | | | |
| • Conductor cross-section | | | | |
| - Solid | $mm^2$ | 2 x (1.5 ... 2.5)[1], 2 x (2.5 ... 6)[1] | 2x (0.5 ... 2.5) | -- |
| - Finely stranded with end sleeve | $mm^2$ | 2 x (1 ... 2.5)[1], 2 x (2.5 ... 6)[1], 1 x 10 | 2x (0.5 ... 1.5) | -- |
| - Finely stranded without end sleeve | $mm^2$ | -- | 2x (0.5 ... 2.5) | -- |
| - Solid or stranded, AWG conductors | | 2 x (AWG 14 ... 10) | 2 x (AWG 18 ... 14) | -- |
| • Terminal screw | | M4 | -- | M5 |
| • Tightening torque | Nm<br>lb.in | 2 ... 2.5<br>7 ... 10.3 | --<br>-- | 2 ... 2.5<br>7 ... 10.3 |
| • Cable lug | | -- | -- | |
| - DIN | | | | DIN 46234<br>-5-2.5, -5-6, -5-10, -5-16, -5-25 |
| - JIS | | | | JIS C 2805 R 2-5, 5.5-5, 8-5, 14-5 |
| **Connection, auxiliary/control contacts** | | | | |
| • Conductor cross-section | mm<br>AWG | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>AWG 20 ... 12 | 0.5 ... 2.5<br>AWG 20 ... 12 | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>AWG 20 ... 12 |
| • Stripped length | mm | 7 | 10 | 7 |
| • Terminal screw | | M3 | -- | M3 |
| • Tightening torque | NM<br>lb.in | 0.5 ... 0.6<br>4.5 ... 5.3 | --<br>-- | 0.5 ... 0.6<br>4.5 ... 5.3 |
| **Permissible mounting positions** | |  | | |

[1] If two different conductor cross-sections are connected to one clamping point, both cross-sections must lie in the range specified. If identical cross-sections are used, this restriction does not apply.

| Type | | 3RF23 ..-....2 | 3RF23 ..-....4 | 3RF23 ..-....5 | 3RF23 ..-....6 |
|---|---|---|---|---|---|
| **Main circuit** | | | | | |
| **Rated operational voltage $U_e$** | V | 24 ... 230 | 48 ... 460 | 48 ... 600 | 48 ... 600 |
| • Operating range | V | 20 ... 253 | 40 ... 506 | 40 ... 660 | 40 ... 660 |
| • Rated frequency | Hz | 50/60 ±10 % | | | |
| **Rated insulation voltage $U_i$** | V | 600 | | | |
| **Blocking voltage** | V | 800 | 1200 | | 1600 |
| **Rage of voltage rise** | V/µs | 1000 | | | |

## 3RF23 solid-state contactors, single-phase

| Type | Type current AC-51[1] for $I_{max}$ at 40 °C | Type current AC-51[1] according to IEC 60947-4-3 for 40 °C | Type current AC-51[1] according to UL/CSA for 50 °C | Power loss at $I_{max}$ | Minimum load current | Leakage current | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|---|---|---|---|---|---|
| | A | A | A | W | A | mA | A | $A^2s$ |
| **Main circuit** | | | | | | | | |
| **3RF23 1.-.A..2** | 10.5 | 7.5 | 9.6 | 11 | 0.1 | 10 | 200 | 200 |
| **3RF23 1.-.A..4** | | | | | | | 200 | 200 |
| **3RF23 1.-.A..6** | | | | | | | 400 | 800 |
| **3RF23 2.-.A..2** | 20 | 13.2 | 17.6 | 20 | 0.5 | 10 | 600 | 1800 |
| **3RF23 2.-.A..4** | | | | | | 10 | 600 | 1800 |
| **3RF23 2.-.A..5** | | | | | | 10 | 600 | 1800 |
| **3RF23 2.-.A..6** | | | | | | 10 | 600 | 1800 |
| **3RF23 2.-.C..2** | | | | | | 25 | 600 | 1800 |
| **3RF23 2.-.C..4** | | | | | | 25 | 600 | 1800 |
| **3RF23 2.-.D..2** | | | | | | 10 | 1150 | 6600 |
| **3RF23 2.-.D..4** | | | | | | 10 | 1150 | 6600 |
| **3RF23 3.-.A..2** | 30 | 22 | 27 | 33 | 0.5 | 10 | 600 | 1800 |
| **3RF23 3.-.A..4** | | | | | | 10 | 600 | 1800 |
| **3RF23 3.-.A..6** | | | | | | 10 | 600 | 1800 |
| **3RF23 3.-.C..2** | | | | | | 25 | 600 | 1800 |
| **3RF23 3.-.D..4** | | | | | | 10 | 1150 | 6600 |
| **3RF23 4.-.A..2** | 40 | 33 | 36 | 44 | 0.5 | 10 | 1200 | 7200 |
| **3RF23 4.-.A..4** | | | | | | | 1200 | 7200 |
| **3RF23 4.-.A..5** | | | | | | | 1200 | 7200 |
| **3RF23 4.-.A..6** | | | | | | | 1150 | 6600 |
| **3RF23 5.-.A..2** | 50 | 36 | 45 | 54 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 5.-.A..4** | | | | | | | | |
| **3RF23 5.-.A..5** | | | | | | | | |
| **3RF23 5.-.A..6** | | | | | | | | |
| **3RF23 7.-.A..2** | 70 | 70 | 62 | 83 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 7.-.A..4** | | | | | | | | |
| **3RF23 7.-.A..5** | | | | | | | | |
| **3RF23 7.-.A..6** | | | | | | | | |
| **3RF23 9.-.A..2** | 88 | 88 | 80 | 117 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 9.-.A..4** | | | | | | | | |
| **3RF23 9.-.A..5** | | | | | | | | |
| **3RF23 9.-.A..6** | | | | | | | | |

[1] The type current provides information about the performance of the solid-state contactor. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and start-up conditions. For derating see the characteristic curves on page 4/26.

| Type | Type current AC-51[1] for $I_{max}$ at 40 °C | Type current AC-51[1] according to IEC 60947-4-3 for 40 °C | Type current AC-51[1] according to UL/CSA for 50 °C | Type current AC-15 10 x $I_e$ for 60 ms | Type current AC-15 Parameters | Power loss at $I_{max}$ | Minimum load current | Leakage current | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | A | A | A | | W | A | mA | A | $A^2s$ |
| **Main circuit** | | | | | | | | | | |
| **3RF23 1.-.B..2** | 10.5 | 7.5 | 9.6 | 6 | 1200 1/h 50 % ON-period | 11 | 0.1 | 10 | 200 | 200 |
| **3RF23 1.-.B..4** | | | | | | | | | 200 | 200 |
| **3RF23 1.-.B..6** | | | | | | | | | 400 | 800 |
| **3RF23 2.-.B..2** | 20 | 13.2 | 17.6 | 12 | 1200 1/h 50 % ON-period | 20 | 0.5 | 10 | 600 | 1800 |
| **3RF23 2.-.B..4** | | | | | | | | | | |
| **3RF23 2.-.B..6** | | | | | | | | | | |
| **3RF23 3.-.B..2** | 30 | 22 | 27 | 15 | 1200 1/h 50 % ON-period | 33 | 0.5 | 10 | 600 | 1800 |
| **3RF23 3.-.B..4** | | | | | | | | | | |
| **3RF23 3.-.B..6** | | | | | | | | | | |
| **3RF23 4.-.B..2** | 40 | 33 | 36 | 20 | 1200 1/h 50 % ON-period | 44 | 0.5 | 10 | 1200 | 7200 |
| **3RF23 4.-.B..4** | | | | | | | | | 1200 | 7200 |
| **3RF23 4.-.B..6** | | | | | | | | | 1150 | 6600 |
| **3RF23 5.-.B..2** | 50 | 36 | 45 | 25 | 1200 1/h 50 % ON-period | 54 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 5.-.B..4** | | | | | | | | | | |
| **3RF23 5.-.B..6** | | | | | | | | | | |
| **3RF23 7.-.B..2** | 70 | 70 | 62 | 27.5 | 1200 1/h 50 % ON-period | 83 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 7.-.B..4** | | | | | | | | | | |
| **3RF23 7.-.B..6** | | | | | | | | | | |
| **3RF23 9.-.B..2** | 88 | 88 | 80 | 30 | 1200 1/h 50 % ON-period | 117 | 0.5 | 10 | 1150 | 6600 |
| **3RF23 9.-.B..4** | | | | | | | | | | |
| **3RF23 9.-.B..6** | | | | | | | | | | |

[1] The type current provides information about the performance of the solid-state contactor. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and start-up conditions. For derating see the characteristic curves on page 4/26.

## 3RF23 solid-state contactors, single-phase

| Type | | 3RF23 ..-...0. | 3RF23 ..-...1. | 3RF23 ..-...2. | 3RF23 ..-...4. |
|---|---|---|---|---|---|
| **Control circuit** | | | | | |
| **Method of operation** | | DC operation | AC/DC operation | AC operation | DC operation |
| **Rated control supply voltage $U_s$** | V | 24 acc. to EN 61131-2 | 24 | 110 ... 230 AC | 4 ... 30 |
| **Rated frequency**<br>Of the control supply voltage | Hz | -- | AC 50/60 Hz / -- DC | 50/60 ±10 % | -- |
| **Actuating voltage, max.** | V | 30 | 26.5 AC / 30 DC | 253 | 30 |
| **Typical actuating current** | A | 20 | 20 | 15 | 20 |
| **Response voltage** | V | 15 | 14 AC / 15 DC | 90 | 4 |
| **Drop-out voltage** | V | 5 | 5 | 40 | 1 |
| **Operating times** | | | | | |
| • ON-delay | ms | 1 + additional max. one half-wave[1)] | AC: 40 + additional max. one half-wave[1)]<br>DC: 1 + additional max. one half-wave[1)] | 40 + additional max. one half-wave[1)] | 1 + additional max. one half-wave[1)] |
| • OFF-delay | ms | 1 + additional max. one half-wave | AC: 1 + additional max. one half-wave<br>DC: 1 + additional max. one half-wave | 40 + additional max. one half-wave | 1 + additional max. one half-wave |

1) Only for zero-point-switching devices.

### *Fused version with semiconductor protection (similar to type of coordination "2")*[1)]

The semiconductor protection for the SIRIUS controls can be used with different protective devices. This allows protection by means of LV HRC fuses of gG operational class or miniature circuit breakers. Siemens recommends the use of special SITOR semiconductor fuses. The table below lists the maximum permissible fuses for each SIRIUS control.

If a fuse is used with a higher rated current than specified, semiconductor protection is no longer guaranteed. However, smaller fuses with a lower rated current for the load can be used without problems.

For protective devices with gG operational class and for SITOR full range fuses 3NE1, the minimum cross-sections for the conductor to be connected must be taken into account.

| **Type** | **All-range fuses** | **Semiconductor fuses** | | | | **Cable and line protection fuses** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LV HRC design | Cylindrical design | | | LV HRC design | Cylindrical design | | | DIAZED |
| | LV HRC design<br>gR/SITOR<br>3NE1 | aR/SITOR<br>3NE8 | 10 x 38 mm<br>aR/SITOR<br>3NC1 0 | 14 x 51 mm<br>aR/SITOR<br>3NC1 4 | 22 x 58 mm<br>aR/SITOR<br>3NC2 2 | gG<br>3NA | 10 x 38 mm<br>gG<br>3NW | 14 x 51 mm<br>gG<br>3NW | 22 x 58 mm<br>gG<br>3NW | Quick<br>5SB |
| **3RF23 1.-....2** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 010 | 3NC1 410 | 3NC2 220 | 3NA2 803 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 41 |
| **3RF23 1.-....4** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 010 | 3NC1 410 | 3NC2 220 | 3NA2 801 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 41 |
| **3RF23 1.-....6** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 010 | 3NC1 410 | 3NC2 220 | 3NA2 803-6 | -- | -- | -- | -- |
| **3RF23 2.-....2** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 807 | 3NW6 007-1 | 3NW6 107-1 | 3NW6 207-1 | 5SB1 71 |
| **3RF23 2.-....4** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 807 | 3NW6 005-1 | 3NW6 105-1 | 3NW6 205-1 | 5SB1 71 |
| **3RF23 2.-....5** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 807-6 | -- | -- | -- | -- |
| **3RF23 2.-....6** | 3NE1 814-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 420 | 3NC2 220 | 3NA2 807-6 | -- | -- | -- | -- |
| **3RF23 3.-....2** | 3NE1 803-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 810 | -- | 3NW6 107-1 | 3NW6 207-1 | 5SB3 11 |
| **3RF23 3.-....4** | 3NE1 803-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 807 | -- | 3NW6 105-1 | 3NW6 205-1 | 5SB3 11 |
| **3RF23 3.-....6** | 3NE1 803-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 432 | 3NC2 232 | 3NA2 807-6 | -- | -- | -- | -- |
| **3RF23 4.-....2** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 440 | 3NC2 240 | 3NA2 817 | -- | 3NW6 117-1 | 3NW6 217-1 | 5SB3 21 |
| **3RF23 4.-....4** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 440 | 3NC2 240 | 3NA2 812 | -- | 3NW6 112-1 | 3NW6 212-1 | 5SB3 21 |
| **3RF23 4.-....5** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 440 | 3NC2 240 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 4.-....6** | 3NE1 802-0 | 3NE8 017-1 | -- | 3NC1 440 | 3NC2 240 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 5.-....2** | 3NE1 817-0 | 3NE8 018-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 817 | -- | 3NW6 117-1 | 3NW6 217-1 | 5SB3 21 |
| **3RF23 5.-....4** | 3NE1 817-0 | 3NE8 018-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 812 | -- | -- | 3NW6 210-1 | 5SB3 21 |
| **3RF23 5.-....5** | 3NE1 817-0 | 3NE8 018-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 812-6 | -- | -- | | |
| **3RF23 5.-....6** | 3NE1 817-0 | 3NE8 018-1 | -- | 3NC1 450 | 3NC2 250 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 7.-....2** | 3NE1 820-0 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF23 7.-....4** | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812 | -- | -- | 3NW6 210-1 | 5SB3 21 |
| **3RF23 7.-....5** | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 7.-....6** | 3NE1 020-2 | 3NE8 020-1 | -- | -- | 3NC2 280 | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 9.-....2** | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 200 | 3NA2 817 | -- | -- | 3NW6 217-1 | 5SB3 31 |
| **3RF23 9.-....4** | 3NE1 021-2 | 3NE8 021-1 | -- | -- | 3NC2 280 [2)] | 3NA2 812 | -- | -- | 3NW6 210-1 | 5SB3 21 |
| **3RF23 9.-....5** | 3NE1 020-2 [2)] | 3NE8 021-1 | -- | -- | 3NC2 280 [2)] | 3NA2 812-6 | -- | -- | -- | -- |
| **3RF23 9.-....6** | 3NE1 020-2 [2)] | 3NE8 021-1 | -- | -- | 3NC2 280 [2)] | 3NA2 812-6 | -- | -- | -- | -- |

Suitable fuse holders, fuse bases and controls can be found in Catalog LV 1, Chapter 19.

1) Type of coordination "2" according to EN 60947-4-1:
In the event of a short-circuit, the controls in the load feeder must not endanger persons or the installation. They must be suitable for further operation. For fused configurations, the protective device must be replaced.

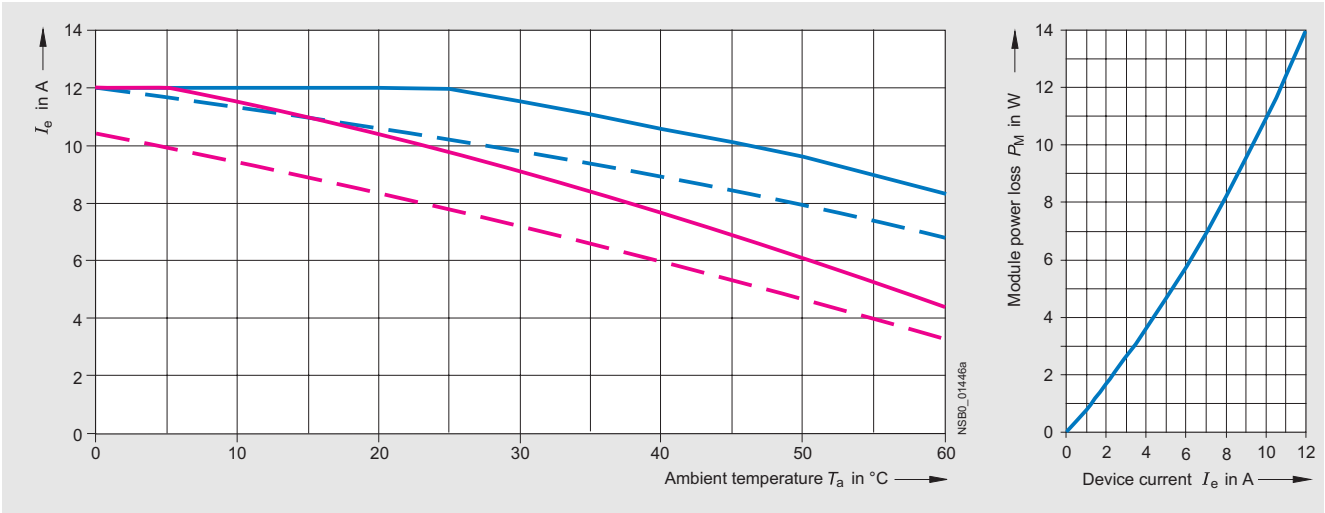
2) These fuses have a smaller rated current than the solid-state contactors.

## 3RF23 solid-state contactors, single-phase

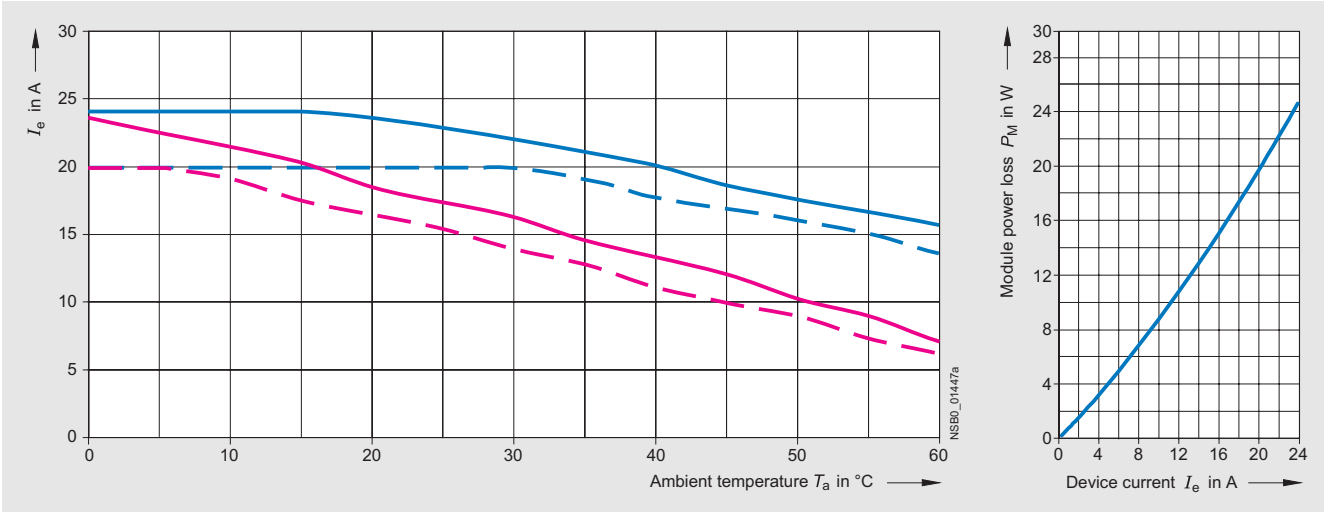
### Characteristic curves

***Derating curves***

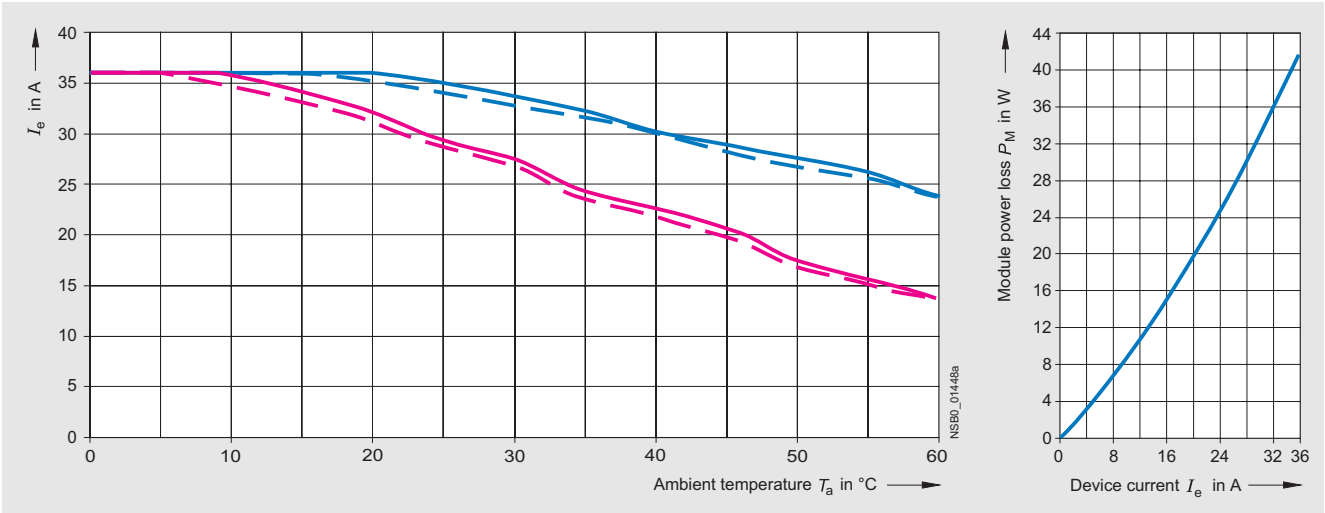
For designation of the characteristic curves see page 4/28.



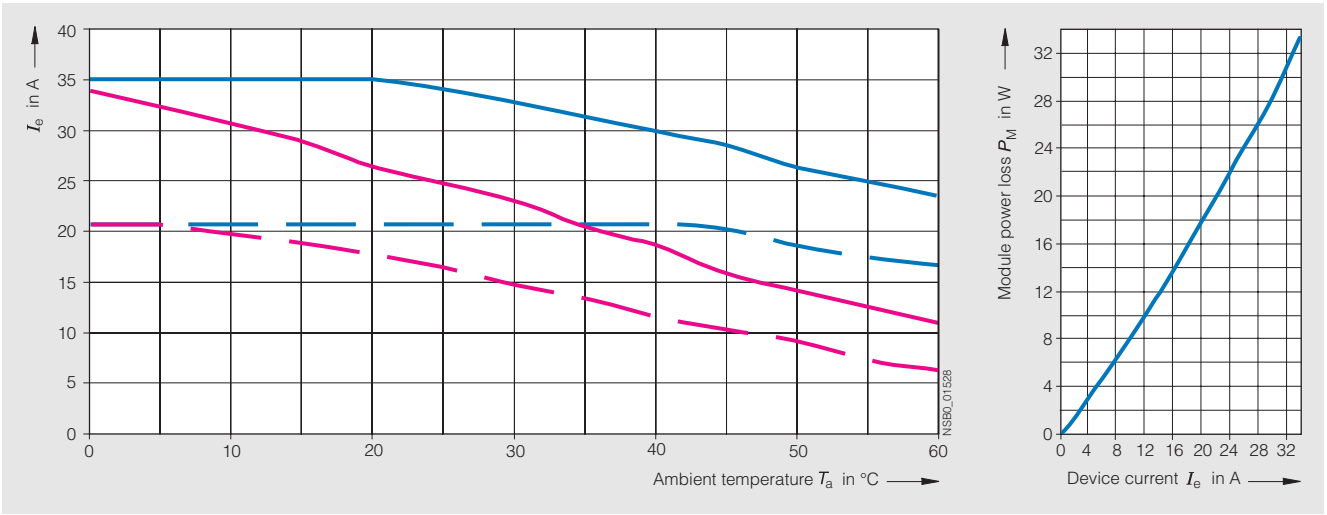

Type current 10.5 A (3RF23 10)



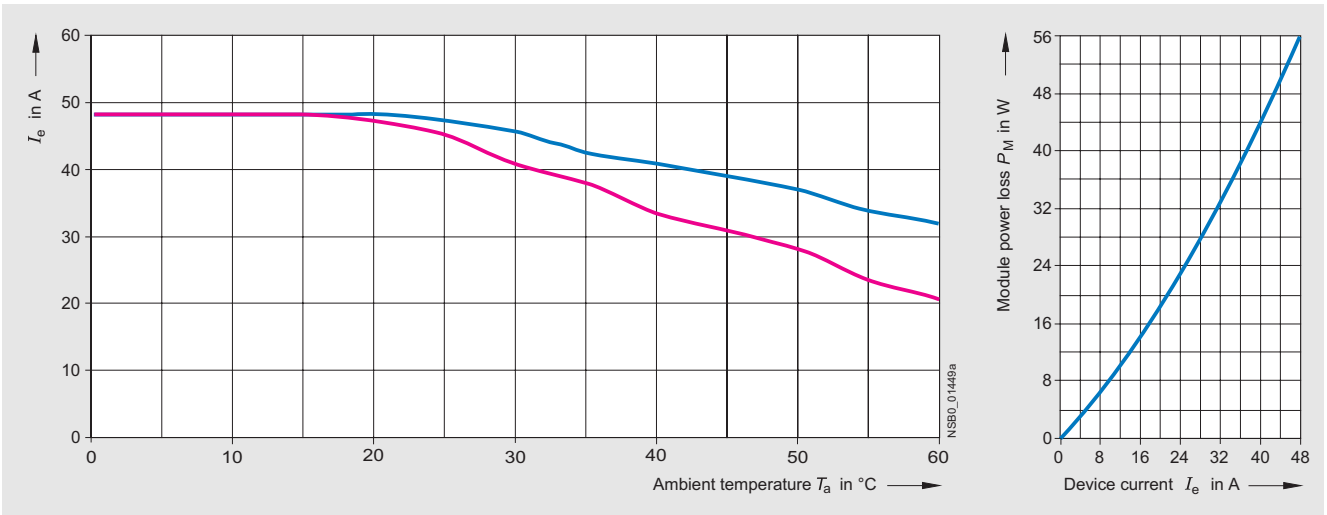

Type current 20 A (3RF23 20)



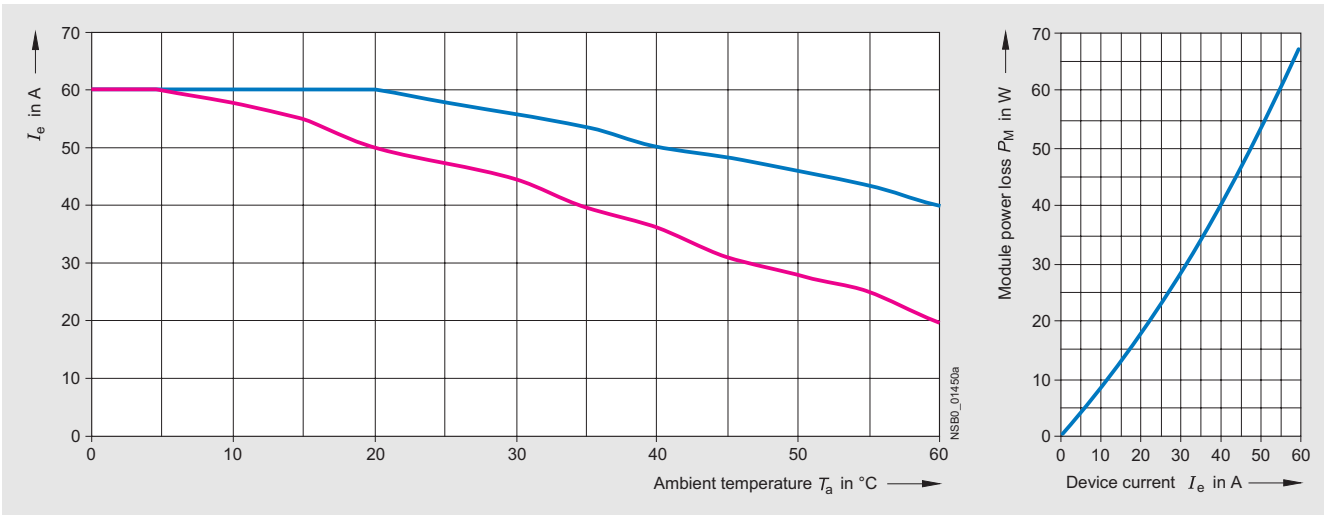

Type current 30 A (3RF23 30-.AA.., -.BA.., -.CA..)




Type current 30 A (3RF23 30-.DA..)

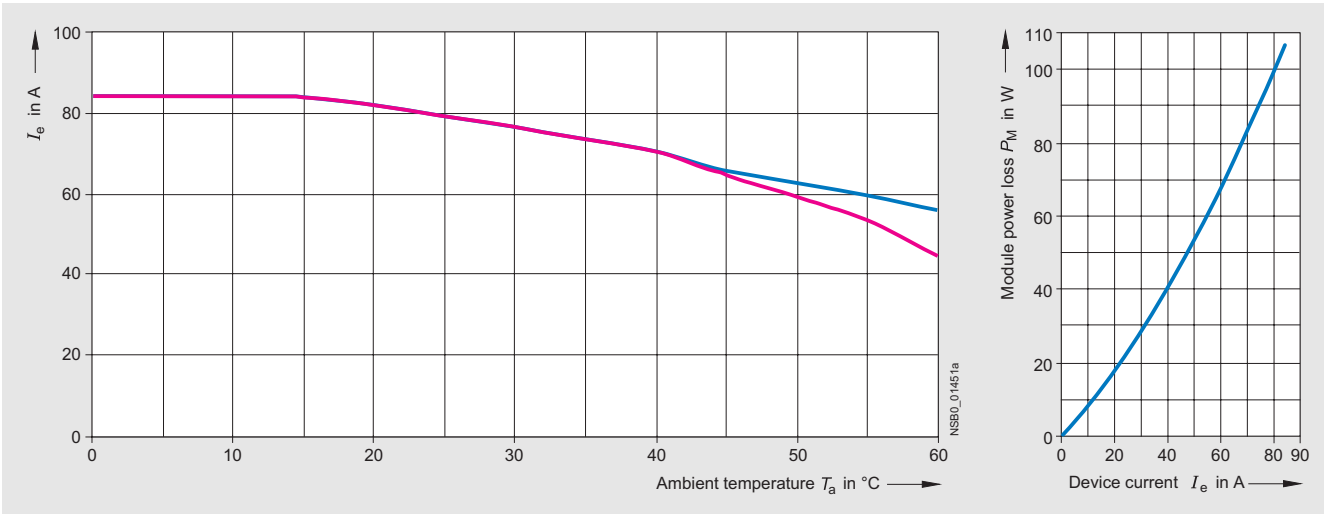



Type current 40 A (3RF23 40)[1)]

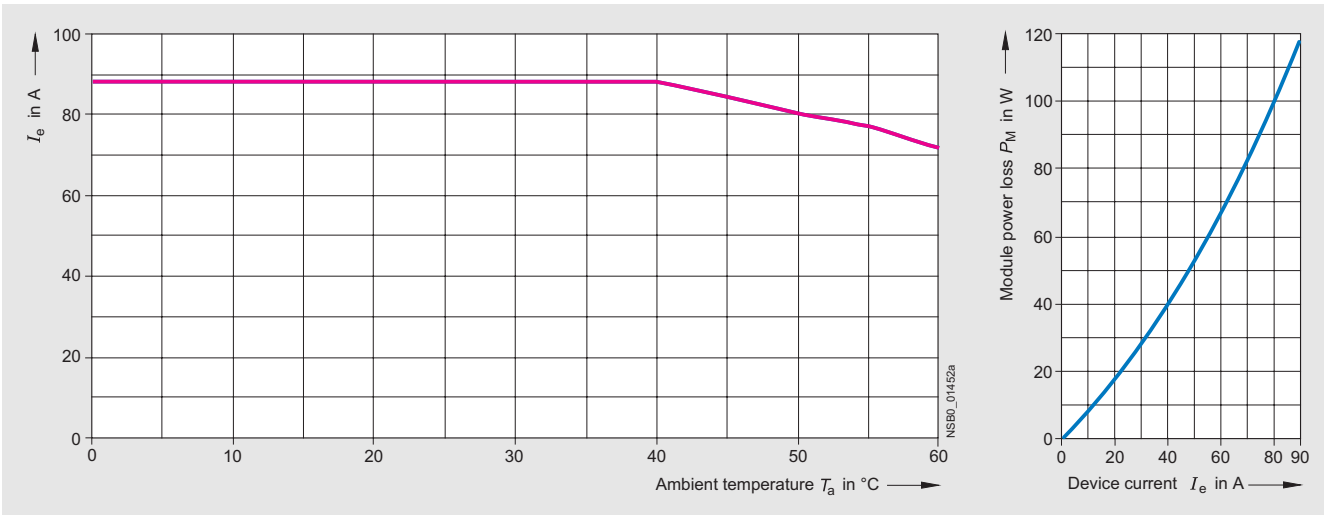



Type current 50 A (3RF23 50)[1)]

## 3RF23 solid-state contactors, single-phase



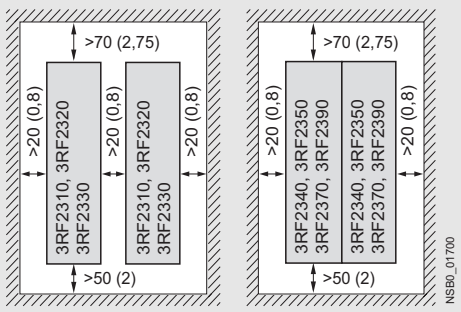

Type current 70 A (3RF23 70)[1)]




Type current 88 A (3RF23 90)[1)]

$I_{max}$ Thermal limit current for individual mounting
$I_{max}$ Thermal limit current for side-by-side mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for individual mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for side-by-side mounting

### Mounting regulations

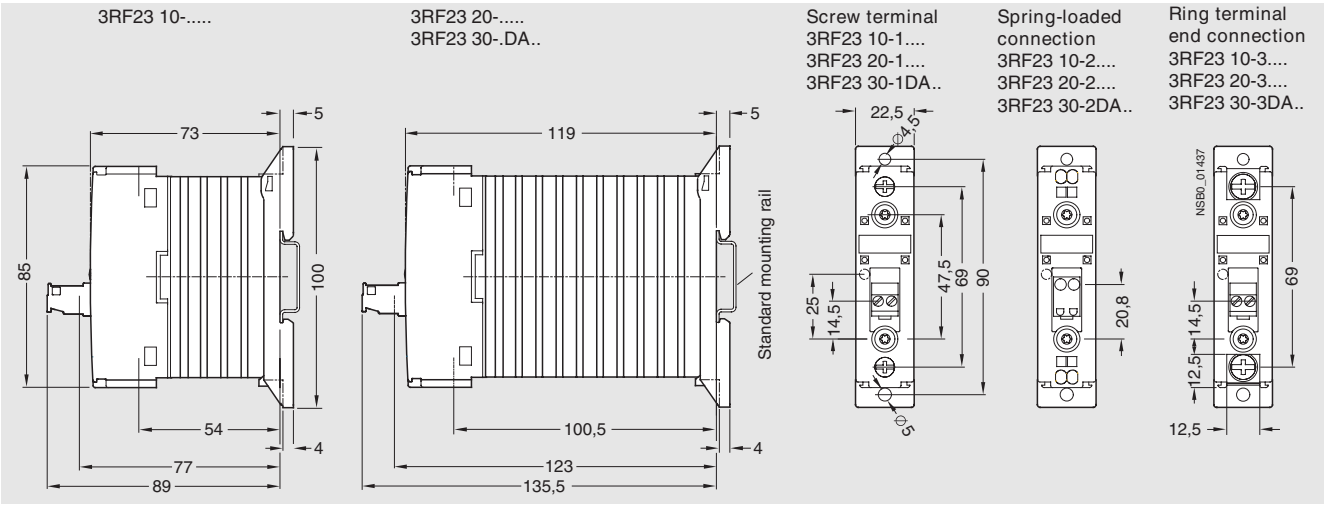



Clearances for stand-alone and side-by-side installation

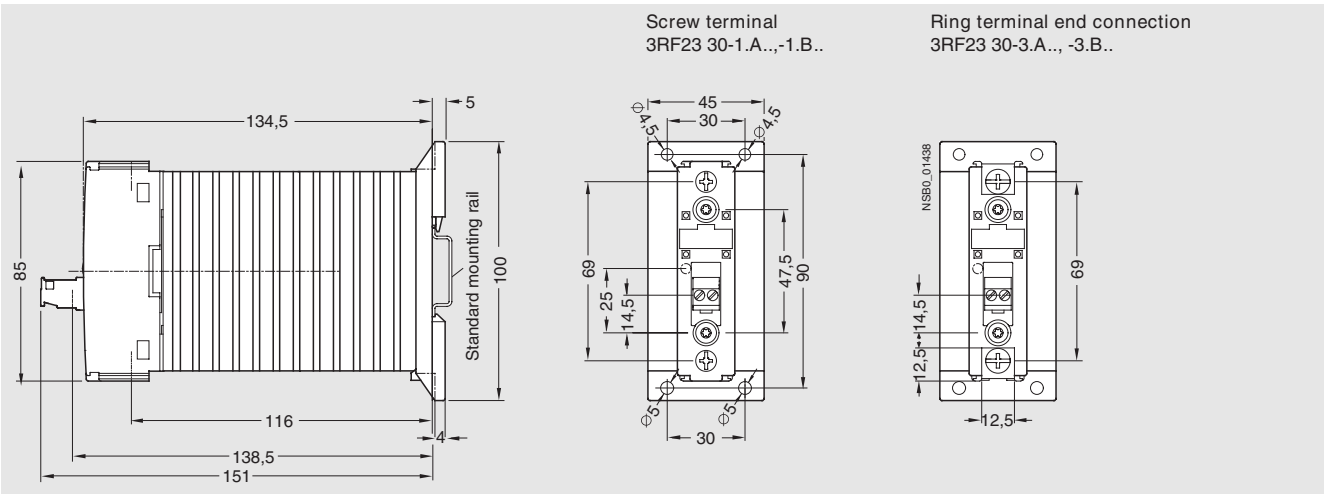
[1)] Identical current/temperature curves for stand-alone and side-by-side installation.

## Dimensional drawings

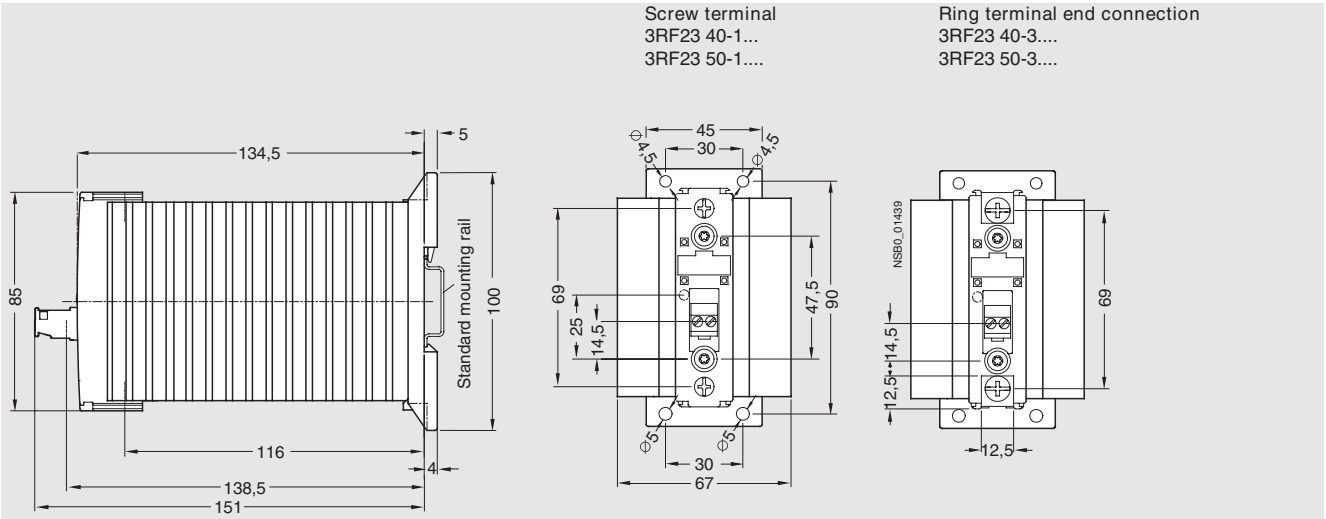
Type current 10.5 A and 20 A




Type current 30 A

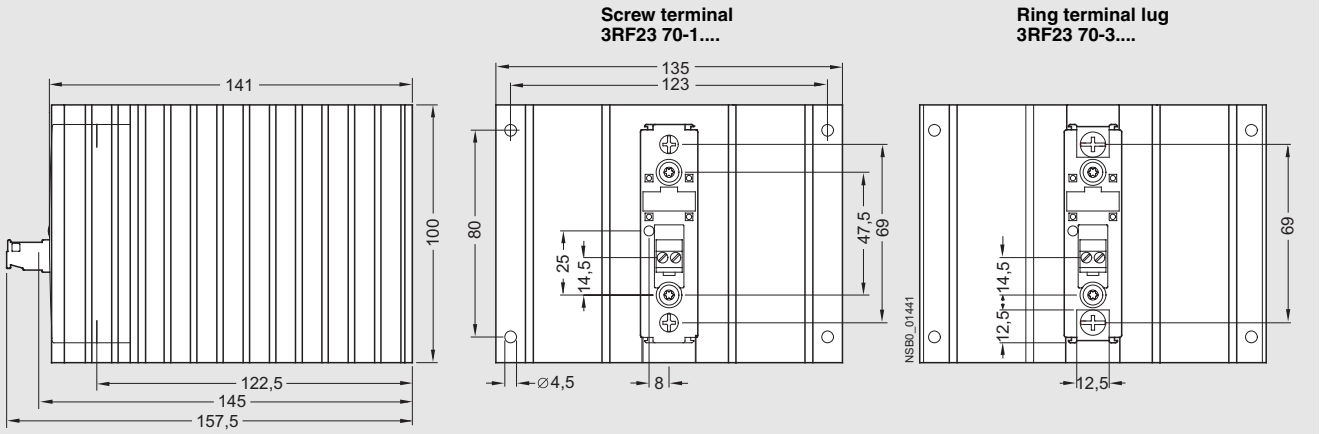



Type current 40 A and 50 A

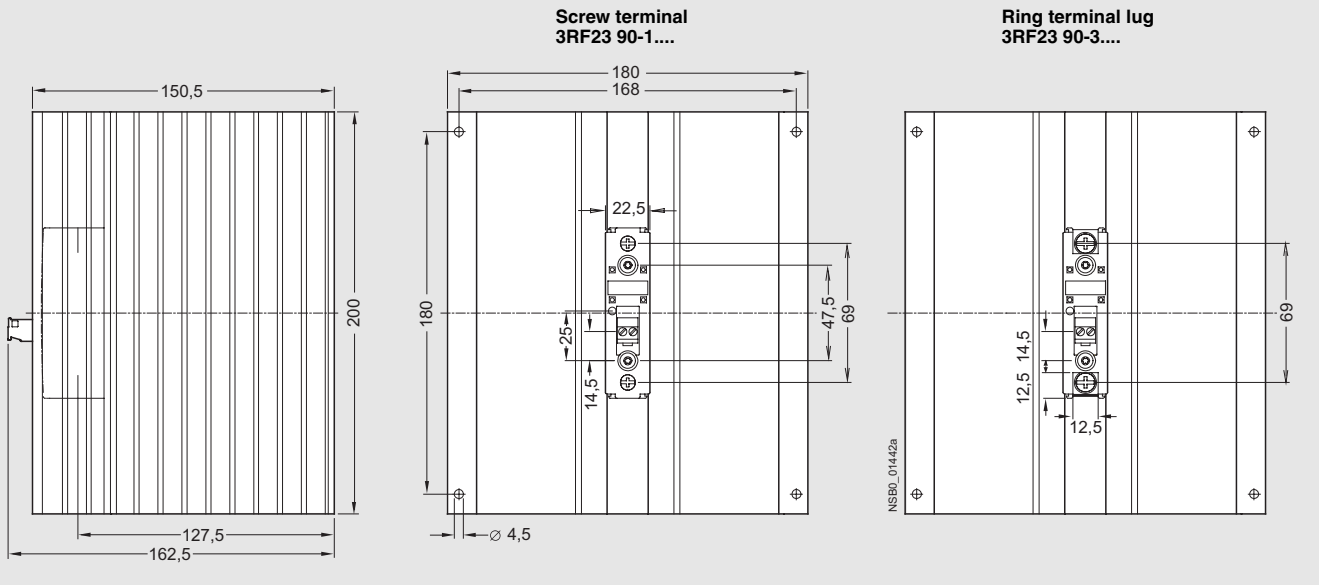


## 3RF23 solid-state contactors, single-phase

Type current 70 A

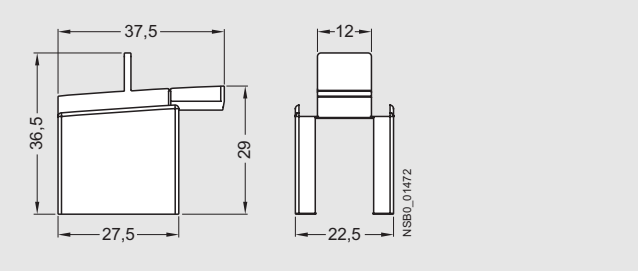



Type current 88 A



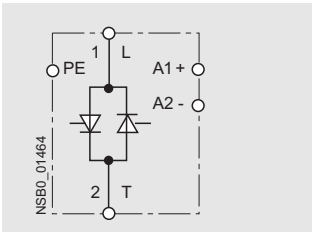

Terminal cover

3RF29 00-3PA88

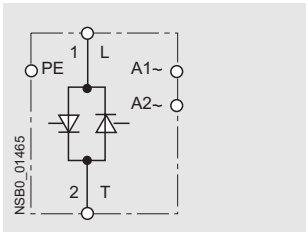



### Schematics

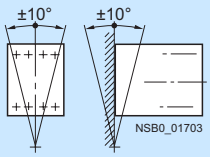
Version
DC control supply voltage




Version
AC control supply voltage



## Technical specifications

| Type | | 3RF24 ..-1.... | 3RF24 ..-2.... | 3RF24 ..-3.... |
|---|---|---|---|---|
| **General data** | | | | |
| **Ambient temperature** | | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | | |
| • During storage | °C | -55 ... +80 | | |
| **Installation altitude** | m | 0 ... 1000; derating from 1000 | | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15/11 | | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | | |
| **Degree of protection** | | IP20 | | |
| **Insulation strength** at 50/60 Hz<br>(main/control circuit to floor) | V rms | 4000 | | |
| **Electromagnetic compatibility (EMC)** | | | | |
| • Emitted interference<br>according to IEC 60947-4-3<br>- Conducted interference voltage<br>- Emitted, high-frequency interference voltage | | <br><br>Class A for industrial applications[1)]<br>Class A for industrial applications | | |
| • Interference immunity<br>- Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3)<br>- Induced RF fields according to IEC 61000-4-6<br>- Burst according to IEC 61000-4-4<br>- Surge according to IEC 61000-4-5 | <br>kV<br><br>MHz<br>kV<br>kV | <br>Contact discharge 4; air discharge 8; behavior criterion 2<br><br>0.15 ... 80; 140 dBµV; behavior criterion 1<br>2/5.0 kHz; behavior criterion 1<br>Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | | |
| **Connection type** | | **Screw connections** | **Spring-loaded terminal connections** | **Ring terminal end connections** |
| **Connection, main contacts** | | | | |
| • Conductor cross-section<br>- Solid<br>- Finely stranded with end sleeve<br>- Finely stranded without end sleeve<br>- Solid or stranded, AWG conductors | <br>$mm^2$<br>$mm^2$<br>$mm^2$<br> | <br>2 x (1.5 ... 2.5)[2)], 2 x (2.5 ... 6)[2)]<br>2 x (1 ... 2.5)[2)], 2 x (2.5 ... 6)[2)], 1 x 10<br>--<br>2 x (AWG 14 ... 10) | <br>2x (0.5 ... 2.5)<br>2x (0.5 ... 1.5)<br>2x (0.5 ... 2.5)<br>2 x (AWG 18 ... 14) | <br>--<br>--<br>--<br>-- |
| • Stripped length | mm | 10 | 10 | -- |
| • Terminal screw<br>- Tightening torque | <br>Nm<br>lb. in | M4<br>2 ... 2.5<br>18 ... 22 | -- | M5<br>2 ... 2.5<br>18 ... 22 |
| • Cable lug<br>- According to DIN 46234<br>- According to JIS C 2805 | | -- | -- | <br>5-2.5 ... 5-25<br>R 2-5 ,,, 14-5 |
| **Connection, auxiliary/control contacts** | | | | |
| • Conductor cross-section | mm<br>AWG | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>AWG 20 ... 12 | 0.5 ... 2.5<br>AWG 20 ... 12 | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0)<br>AWG 20 ... 12 |
| • Stripped length | mm | 7 | 10 | 7 |
| • Terminal screw<br>- Tightening torque, Ø 3.5, PZ 1 | <br>Nm<br>lb. in | M3<br>0.5 ... 0.6<br>4.5 ... 5.3 | -- | M3<br>0.5 ... 0.6<br>4.5 ... 5.3 |
| **Permissible mounting positions** | |  | | |

[1)] These products were built as Class A devices. The use of these devices in residential areas could result in lead in radio interference. In this case these may be required to introduce additional interference suppression measures.

[2)] If two different conductor cross-sections are connected to one clamping point, both cross-sections must lie in the range specified. If identical cross-sections are used, this restriction does not apply.

## 3RF24 solid-state contactors, 3-phase

| Type | Type current $I_{AC-51}$ at 40 °C | Rated operational current $I_e$ according to IEC 60947-4-3 for 40 °C | Rated operational current $I_e$ according to UL/CSA for 50 °C | Power loss at $I_{AC-51}$ | Minimum load current | Max. leakage current | Rated impulse withstand capacity $I_{tsm}$ | $I^2t$ value |
|---|---|---|---|---|---|---|---|---|
| | A | A | A | W | A | mA | A | $A^2s$ |
| **Main circuit** | | | | | | | | |
| **3RF24 10-.AB.5** | 10.5 | 7 | 7 | 23 | 0.1 | 10 | 200 | 200 |
| **3RF24 20-.AB.5** | 22 | 15 | 15 | 44 | 0.5 | 10 | 600 | 1800 |
| **3RF24 30-.AB.5** | 30 | 22 | 22 | 61 | 0.5 | 10 | 1200 | 7200 |
| **3RF24 40-.AB.5** | 40 | 30 | 30 | 80 | 0.5 | 10 | 1150 | 6600 |
| **3RF24 50-.AB.5** | 50 | 38 | 38 | 107 | 0.5 | 10 | 1150 | 6600 |
| **3RF24 10-.AC.5** | 10.5 | 7 | 7 | 31 | 0.1 | 10 | 300 | 450 |
| **3RF24 20-.AC.5** | 22 | 15 | 15 | 66 | 0.5 | 10 | 600 | 1800 |
| **3RF24 30-.AC.5** | 30 | 22 | 22 | 91 | 0.5 | 10 | 1200 | 7200 |
| **3RF24 40-.AC.5** | 40 | 30 | 30 | 121 | 0.5 | 10 | 1150 | 6600 |
| **3RF24 50-.AC.5** | 50 | 38 | 38 | 160 | 0.5 | 10 | 1150 | 6600 |

1) The type current provides information about the performance of the solid-state contactor. The actual permitted rated operational current $I_e$ can be smaller depending on the connection method and start-up conditions. For derating see the characteristic curves on page 4/34.

| Type | | 3RF24 ..-.AB.5 | 3RF24 ..-.AC.5 |
|---|---|---|---|
| **Main circuit** | | | |
| **Controlled phases** | | Two-phase | Three-phase |
| **Rated operational voltage $U_e$** | V | 48 ... 600 | 48 ... 600 |
| • Operating range | V | 40 ... 660 | 40 ... 660 |
| • Rated frequency | Hz | 50/60 ±10 % | 50/60 ±10 % |
| **Rated insulation voltage $U_i$** | V | 600 | 600 |
| **Rated impulse withstand voltage $U_{imp}$** | kV | 6 | 6 |
| **Blocking voltage** | V | 1200 | 1200 |
| **Rage of voltage rise** | V/µs | 1000 | 1000 |

| Type | | 3RF24 ..-...4. | 3RF24 ..-...5. |
|---|---|---|---|
| **Control circuit** | | | |
| **Method of operation** | | DC operation | AC operation |
| **Rated control supply voltage $U_s$** | V | 4 ... 30 | 190 ... 230 |
| **Rated frequency** Of the control supply voltage | Hz | -- | 50/60 ±10 % |
| **Actuating voltage, max.** | V | 30 | 253 |
| **Typical actuating current** | mA | 30 | 15 |
| **Response voltage** | V | 4 | 180 |
| **Drop-out voltage** | V | < 1 | < 40 |
| **Operating times** | | | |
| • ON-delay | ms | 1 + max. one half-wave | 40 + max. one half-wave |
| • OFF-delay | ms | 1 + max. one half-wave | 40 + max. one half-wave |

## *Fused version with semiconductor protection (similar to type of coordination "2")*[1)]

The semiconductor protection for the 3RF24 controls can be used with different protective devices. Siemens recommends the use of special SITOR semiconductor fuses. The table below lists the maximum permissible fuses for each 3RF24 controlgear.

If a fuse is used with a higher rated current than specified, semiconductor protection is no longer guaranteed. However, smaller fuses with a lower rated current for the load can be used without problems.

| Type | All-range fuses gR | Semiconductor fuses aR | | | | Cable and line protection fuses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LV HRC design | Cylindrical design | | | LV HRC design | Cylindrical design | | | DIAZED |
| | LV HRC design<br>SITOR<br>3NE1 | SITOR<br>3NE8 | 10 x 38 mm<br>SITOR<br>3NC1 0 | 14 x 51 mm<br>SITOR<br>3NC1 4 | 22 x 58 mm<br>SITOR<br>3NC2 2 | gG<br>3NA | 10 x 38 mm<br>gG<br>3NW | 14 x 51 mm<br>gG<br>3NW | 22 x 58 mm<br>gG<br>3NW | Quick<br>5SB |
| **Rated operational voltage $U_e$ up to 506 V** | | | | | | | | | | |
| **3RF24 10-.AB..** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 020 | 3NC1 415 | 3NC2 220 | 3NA3 801 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF24 10-.AC..** | 3NE1 814-0 | 3NE8 003-1 | 3NC1 032 | 3NC1 430 | 3NC2 232 | 3NA3 803 | 3NW6 001-1 | 3NW6 101-1 | -- | 5SB1 71 |
| **3RF24 20-.A...** | 3NE1 802-0 | 3NE8 020-1 | 3NC1 032 | 3NC1 450 | 3NC2 263 | 3NA3 805 | 3NW6 005-1 | 3NW6 105-1 | 3NW6 205-1 | 5SB3 11 |
| **3RF24 30-.A...** | 3NE1 818-0 | 3NE8 022-1 | 3NC1 032 | 3NC1 450 | 3NC2 200 | 3NA3 812 | -- | 3NW6 112-1 | -- | 5SB3 21 |
| **3RF24 40-.A...** | 3NE1 818-0 | 3NE8 022-1 | -- | 3NC1 450 | 3NC2 200 | 3NA3 812 | -- | 3NW6 112-1 | 3NW6 210-1 | 5SB3 21 |
| **3RF24 50-.A...** | 3NE1 818-0 | 3NE8 022-1 | -- | 3NC1 450 | 3NC2 200 | 3NA3 812 | -- | -- | 3NW6 210-1 | 5SB3 21 |
| **Rated operational voltage $U_e$ up to 660 V** | | | | | | | | | | |
| **3RF24 10-.AB..** | 3NE1 813-0 | 3NE8 015-1 | 3NC1 016 | 3NC1 420 | 3NC2 220 | -- | -- | -- | -- | -- |
| **3RF24 10-.AC..** | 3NE1 814-0 | 3NE8 003-1 | 3NC1 025 | 3NC1 430 | 3NC2 220 | -- | -- | -- | -- | -- |
| **3RF24 20-.A...** | 3NE1 803-0 | 3NE8 018-1 | 3NC1 032 | 3NC1 450 | 3NC2 250 | -- | -- | -- | -- | -- |
| **3RF24 30-.A...** | 3NE1 817-0 | 3NE8 021-1 | 3NC1 032 | 3NC1 450 | 3NC2 280 | -- | -- | -- | -- | -- |
| **3RF24 40-.A...** | 3NE1 817-0 | 3NE8 022-1 | -- | 3NC1 450 | 3NC2 280 | -- | -- | -- | -- | -- |
| **3RF24 50-.A...** | 3NE1 020-2 | 3NE8 022-1 | -- | 3NC1 450 | 3NC2 280 | -- | -- | -- | -- | -- |

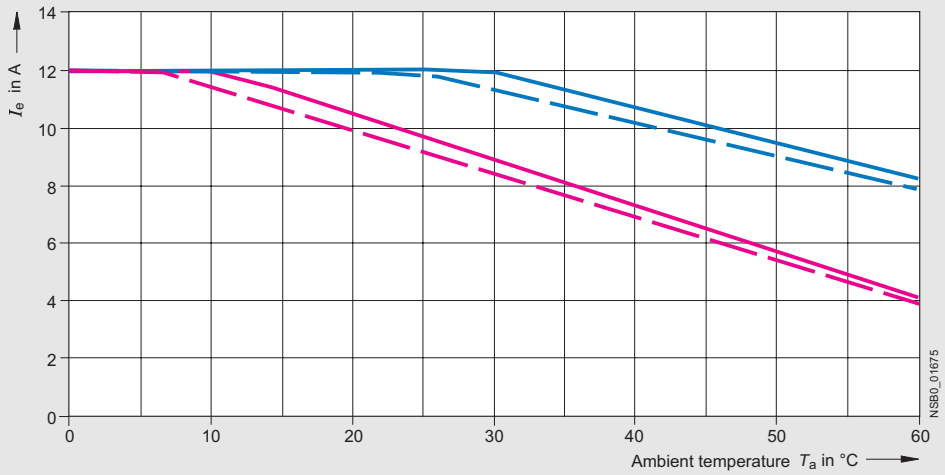
Suitable fuse holders, fuse bases and controls can be found in Catalog LV 1, Chapter 19.

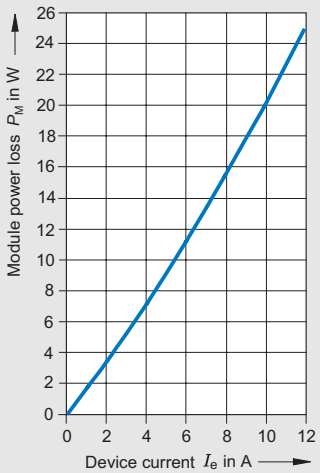
1) Type of coordination "2" according to EN 60947-4-1:
In the event of a short-circuit, the controls in the load feeder must not endanger persons or the installation. They must be suitable for further operation. For fused configurations, the protective device must be replaced.

## 3RF24 solid-state contactors, 3-phase

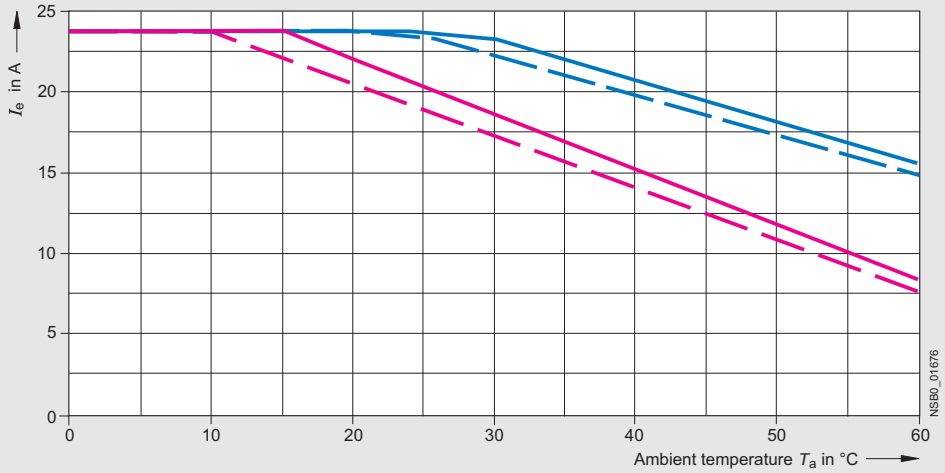
### Characteristic curves

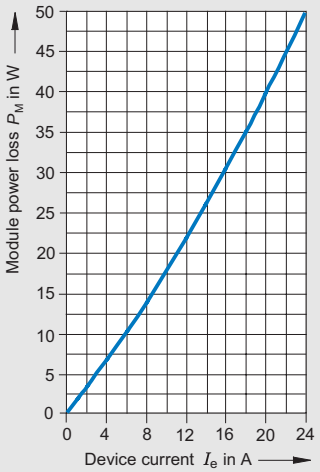
***Derating curves, two-phase controlled***



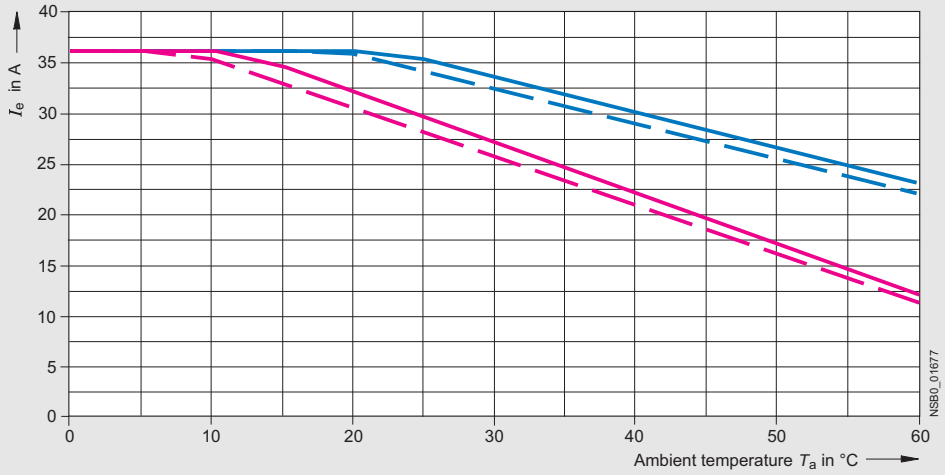



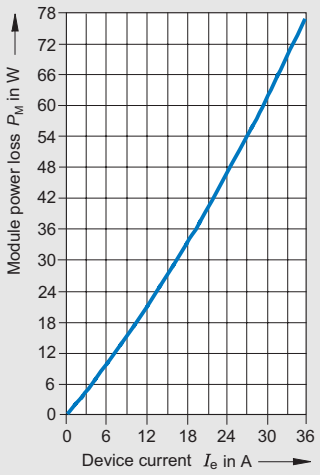

Type current 10.5 A (3RF24 10-.AB..)



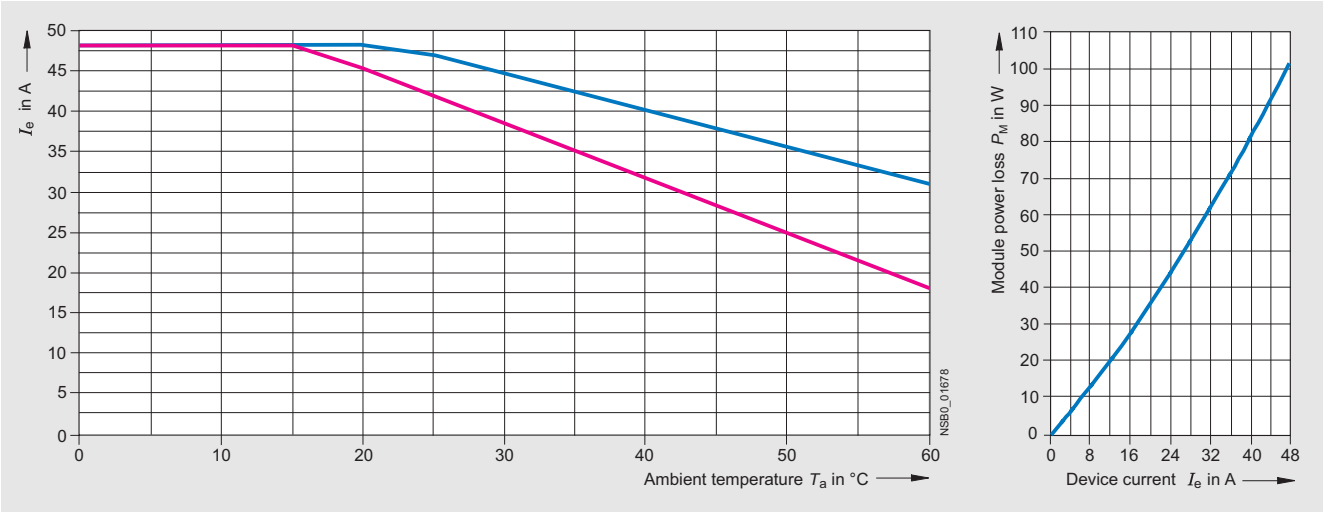




Type current 20 A (3RF24 20-.AB..)

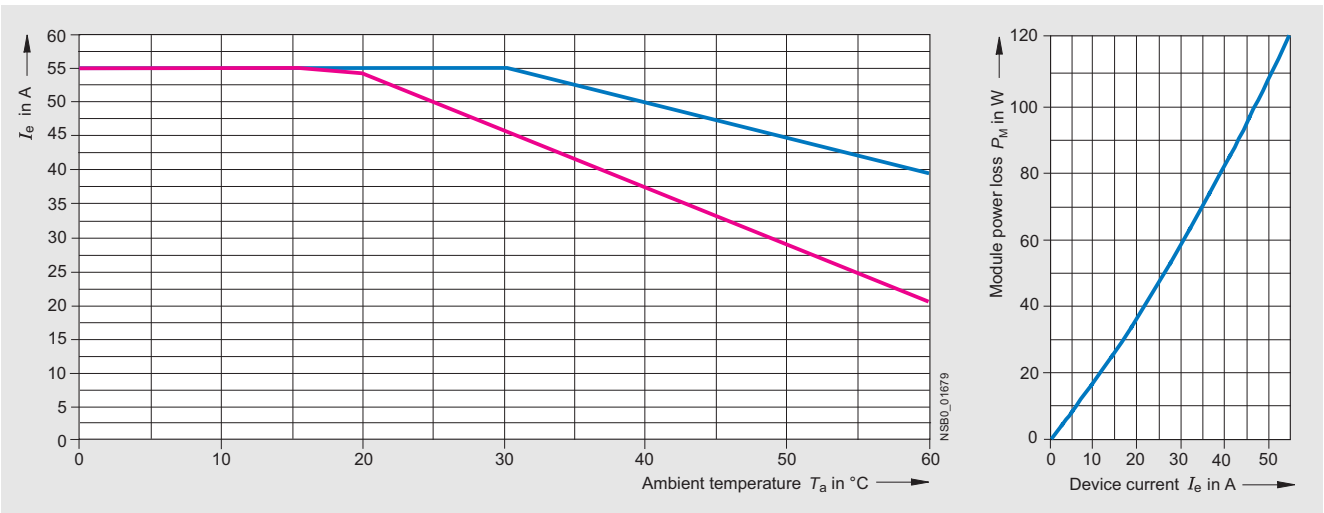



Type current 30 A (3RF24 30-.AB..)



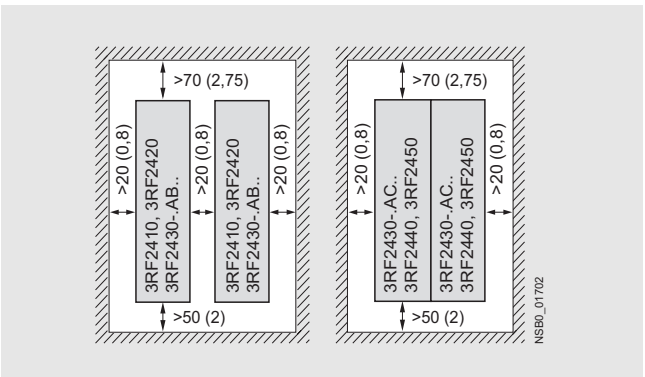

Type current 40 A (3RF24 40-.AB..)[1)]




Type current 50 A (3RF24 50-.AB..)[1)]

$I_{max}$ Thermal limit current for individual mounting
$I_{max}$ Thermal limit current for side-by-side mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for individual mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for side-by-side mounting

## Mounting regulations

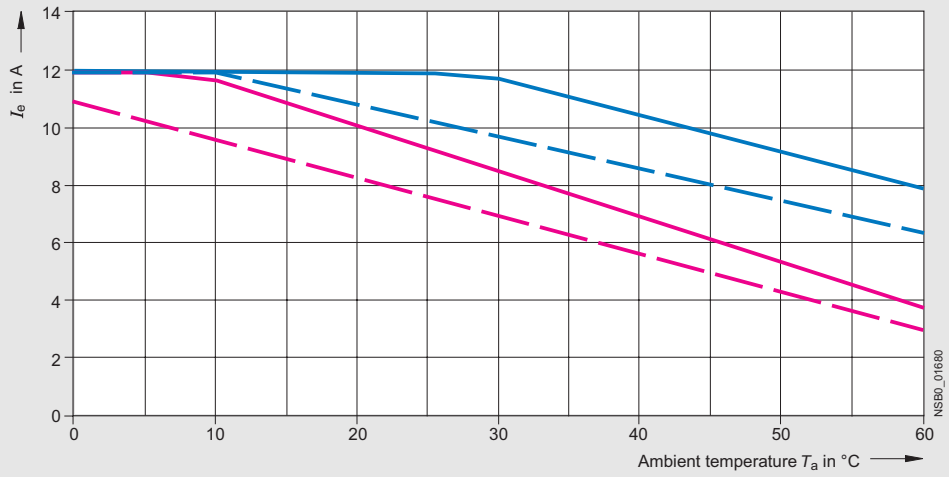


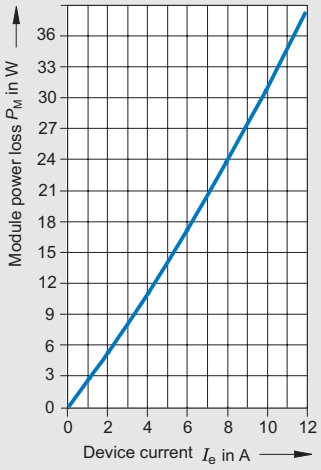

Clearances for stand-alone and side-by-side installation

[1)] Identical current/temperature curves for stand-alone and side-by-side installation.

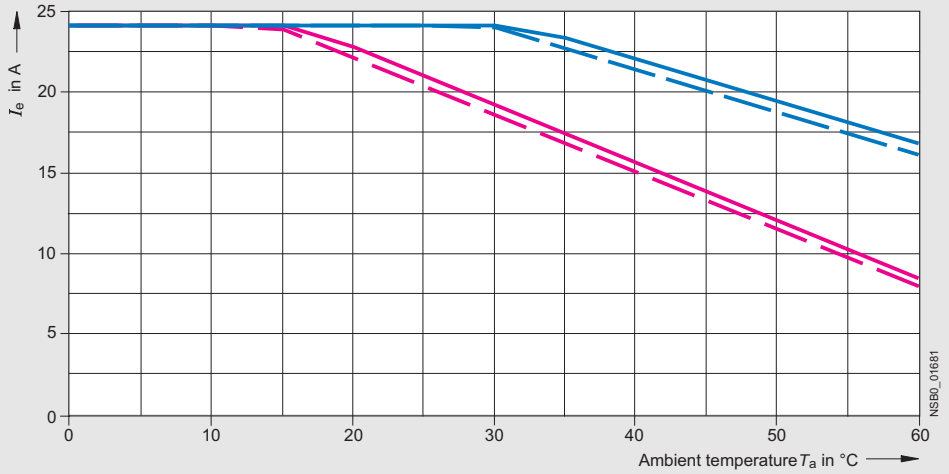
## 3RF24 solid-state contactors, 3-phase

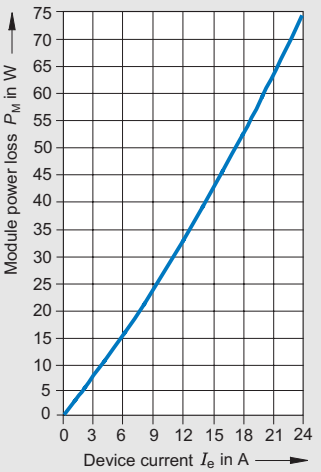
### *Derating curves, three-phase controlled*



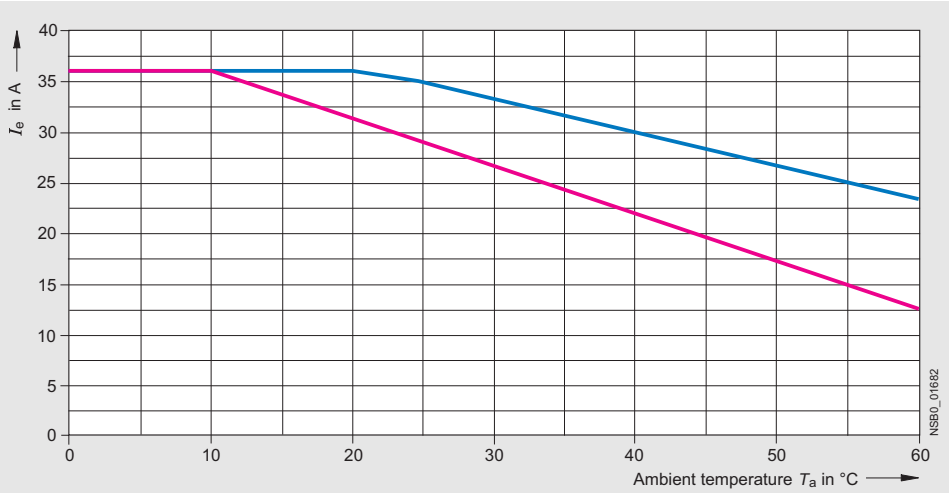

Type current 10.5 A (3RF24 10-.AC..)

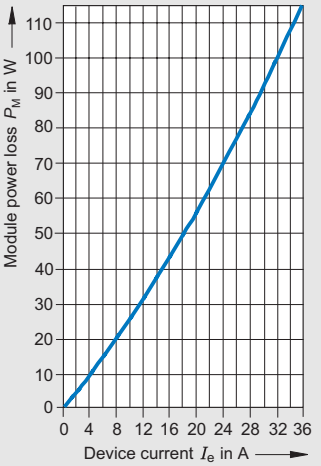



Type current 20 A (3RF24 20-.AC..)

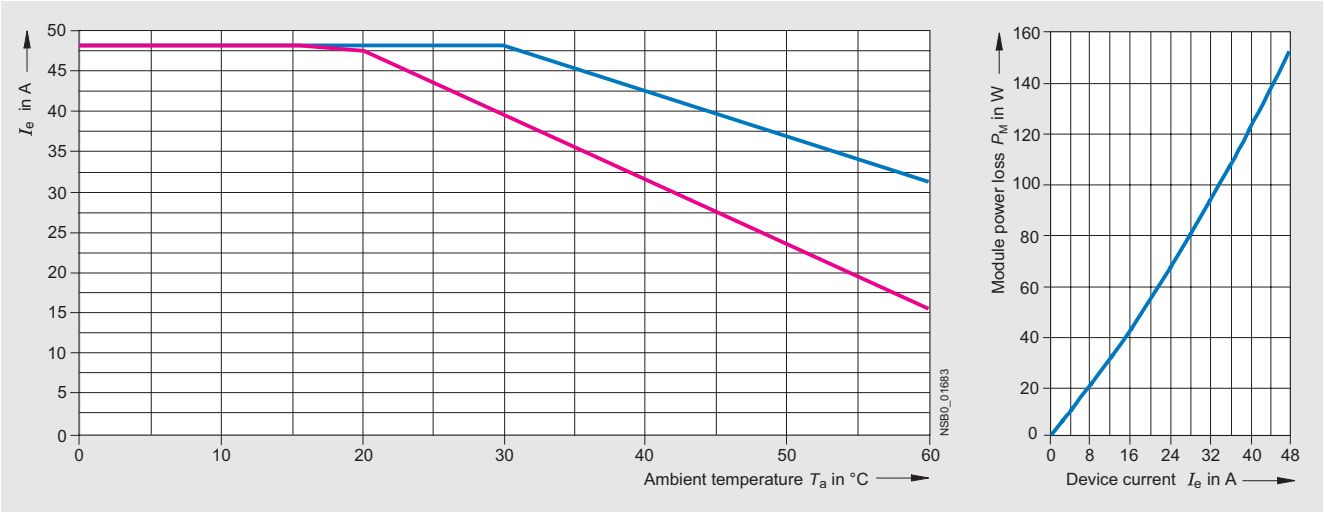
[1] Identical current/temperature curves for stand-alone and side-by-side installation.



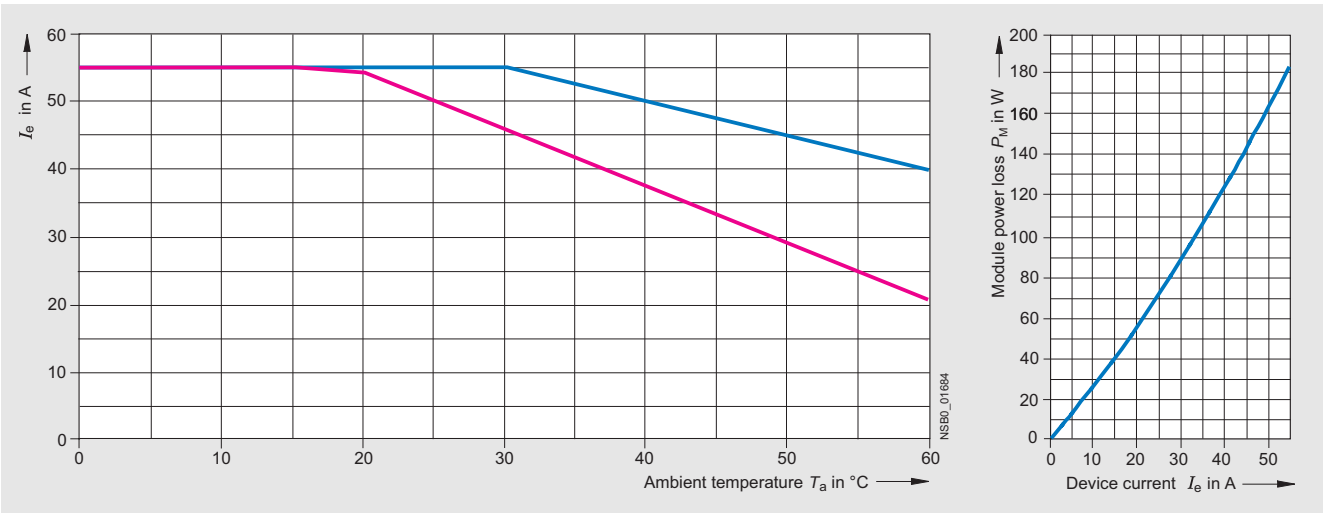




Type current 30 A (3RF24 30-.AC..)[1]

[1] Identical current/temperature curves for stand-alone and side-by-side installation.



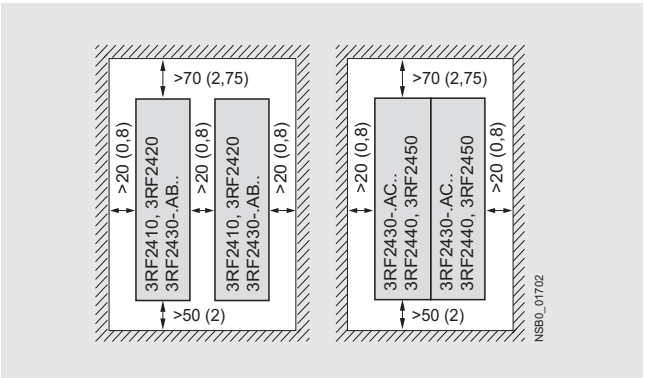

Type current 40 A (3RF24 40-.AC..)[1)]




Type current 50 A (3RF24 50-.AC..)[1)]

$I_{max}$ Thermal limit current for individual mounting
$I_{max}$ Thermal limit current for side-by-side mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for individual mounting
$I_{IEC}$ Current acc. to IEC 947-4-3 for side-by-side mounting

## Mounting regulations



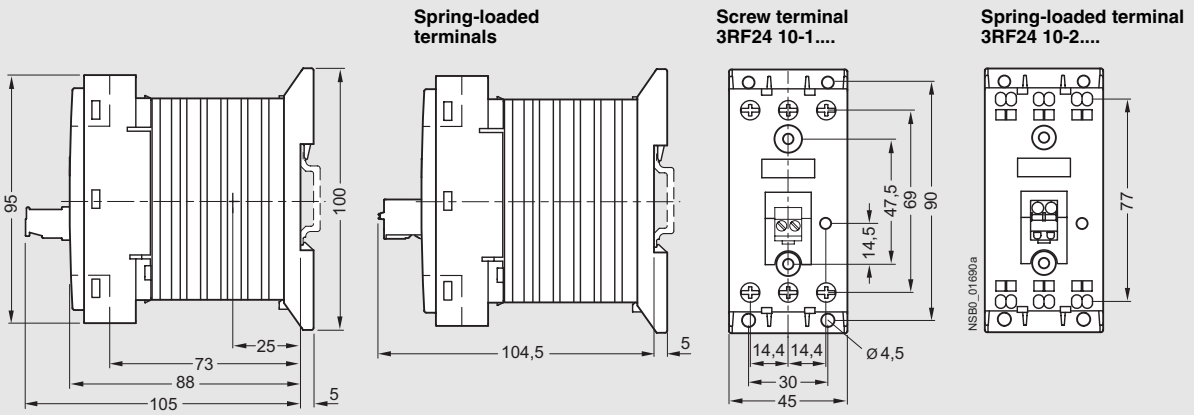

Clearances for stand-alone and side-by-side installation

[1)] Identical current/temperature curves for stand-alone and side-by-side installation.

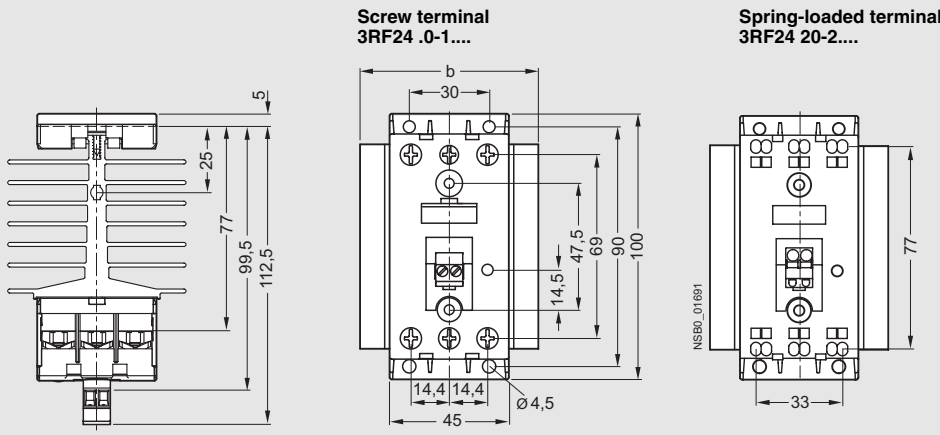
## 3RF24 solid-state contactors, 3-phase

### Dimensional drawings

Type current 10.5 A

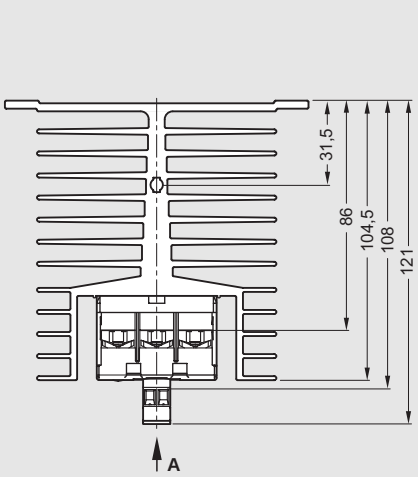



Type current 20 A; 30 A (two-phase controlled)

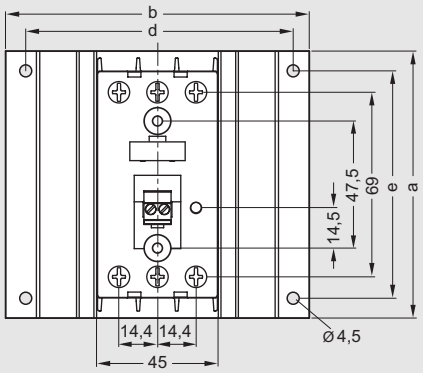



| | b |
|---|---|
| 3RF2420-.AB.. | 67 |
| 3RF2420-.AC..<br>3RF2430-.AB.. | 89,5 |

Type current 30 A (three-phase controlled); 40 A, 50 A

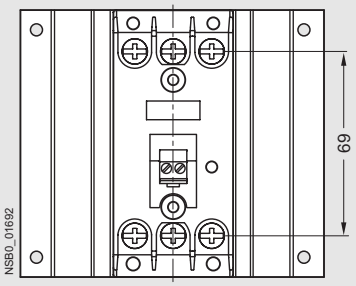



**Screw terminal**
**3RF24 .0-1....**




View A

**Ring terminal lug**
**3RF24 50-3....**

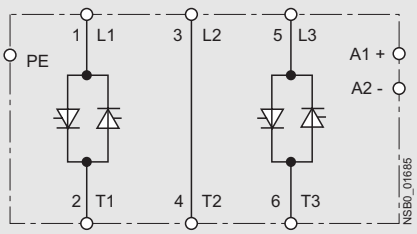



View A

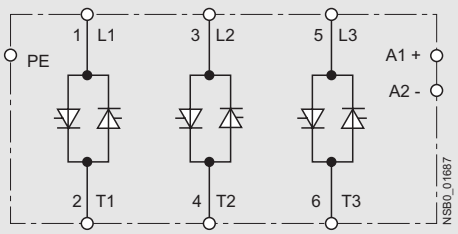
| | a | b | d | e |
|---|---|---|---|---|
| 3RF2430-.AC..<br>3RF2440-.AB.. | 100 | 113,5 | 100 | 85 |
| 3RF2440-.AC..<br>3RF2450-.AB.. | 100 | 157,5 | 146 | 80 |
| 3RF2450-.AC.. | 180 | 157,5 | 146 | 160 |

## Schematics

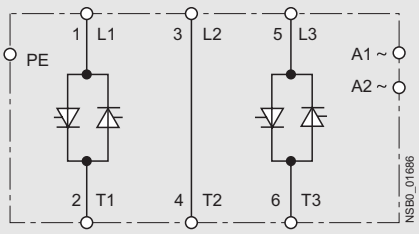
Two-phase controlled,
DC control supply voltage



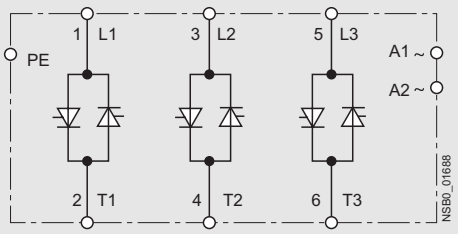

Three-phase controlled,
DC control supply voltage




Two-phase controlled,
AC control supply voltage




Three-phase controlled,
AC control supply voltage



# General data

## Overview

### *Function modules for SIRIUS 3RF2 solid-state switching devices*

A great variety of applications demand an expanded range of functionality. With our function modules, these requirements can be met really easily. The modules are mounted simply by clicking them into place; straight away the necessary connections are made with the solid-state relay or contactor. The plug-in connection to control the solid-state switching devices can simply remain in use.

The following function modules are available:

- Converters
- Load monitoring
- Heating current monitoring
- Power control regulators
- Power controllers

With the exception of the converter, the function modules can be used only with single-phase solid-state switching devices.

## Technical specifications

| Type | | 3RF29 ..-.E... | 3RF29 ..-.F... | 3RF29 ..-.G... | 3RF29 ..-.H... | 3RF29 ..-.J... | 3RF29 ..-.K... |
|---|---|---|---|---|---|---|---|
| **General data** | | | | | | | |
| **Ambient temperature** | | | | | | | |
| • During operation, derating from 40 °C | °C | -25 ... +60 | | | | | |
| • During storage | °C | -55 ... +80 | | | | | |
| **Installation altitude** | m | 0 ... 1000; derating from 1000 | | | | | |
| **Shock resistance**<br>According to IEC 60068-2-27 | *g*/ms | 15/11 | | | | | |
| **Vibration resistance**<br>According to IEC 60068-2-6 | *g* | 2 | | | | | |
| **Degree of protection** | | IP20 | | | | | |
| **Electromagnetic compatibility (EMC)** | | | | | | | |
| • Emitted interference | | | | | | | |
| - Conducted interference voltage according to IEC 60947-4-3 | | Class A for industrial applications[1)] | | | | | |
| - Emitted, high-frequency interference voltage according to IEC 60947-4-3 | | Class A for industrial applications | | | | | |
| • Interference immunity | | | | | | | |
| - Electrostatic discharge according to IEC 61000-4-2 (corresponds to degree of severity 3) | kV | Contact discharge 4; air discharge 8; behavior criterion 2 | | | | | |
| - Induced RF fields according to IEC 61000-4-6 | MHz | 0.15 ... 80; 140 dBµV; behavior criterion 1 | | | | | |
| - Burst according to IEC 61000-4-4 | | 2 kV/5.0 kHz; behavior criterion 1 | | | | | |
| - Surge according to IEC 61000-4-5 | kV | Conductor - ground 2; conductor - conductor 1; behavior criterion 2 | | | | | |
| **Connection, auxiliary/control contacts, screw terminal** | | | | | | | |
| • Conductor cross-section | $mm^2$ | 1 x (0.5 ... 2.5), 2 x (0.5 ... 1.0), 1 x (AWG 20 ... 12) | | | | | |
| • Stripped length | mm | 7 | | | | | |
| • Terminal screw | | M3 | | | | | |
| • Tightening torque | Nm<br>lb. in | 0.5 ... 0.6<br>4.5 ... 5.3 | | | | | |
| **Converter, feed-through opening** | mm | | | | | | |
| • Diameter | | -- | 7 | 17 | | | |

[1)] Note limitations for power controller function modules. These modules were built as Class A devices. The use of these devices in residential areas could result in lead in radio interference. In this case these may be required to introduce additional interference suppression measures.

## General data

| Type | | 3RF29 ..-.E..8 | 3RF29 ..-.F..8 | 3RF29 ..-.G..3 | 3RF29 ..-.G..6 |
|---|---|---|---|---|---|
| **Main circuit** | | | | | |
| **Rated operational voltage $U_e$** | V | -- [1] | | 110 ... 230 | 400 ... 600 |
| • Operating range | V | -- | | 93.5 ... 253 | 340 ... 660 |
| • Rated frequency | Hz | -- | | 50/60 | |
| **Rated insulation voltage $U_i$** | V | -- | | 600 | |
| **Voltage measuring** | | | | | |
| • Measuring range | V | -- | | 93.5 ... 253 | 340 ... 660 |
| **Mains voltage, fluctuation compensation** | % | -- | | 20 | |

[1] Versions are independent of the main circuit.

| Type | | 3RF29 ..-.H..3<br>3RF29 ..-.K..3 | 3RF29 ..-.H..6<br>3RF29 ..-.K..6 | 3RF29 ..-.J..3 | 3RF29 ..-.J..6 |
|---|---|---|---|---|---|
| **Main circuit** | | | | | |
| **Rated operational voltage $U_e$** | V | 110 ... 230 | 400 ... 600 | 110 ... 230 | 400 ... 600 |
| • Operating range | V | 93.5 ... 253 | 340 ... 660 | 93.5 ... 253 | 340 ... 660 |
| • Rated frequency | Hz | 50/60 | | | |
| **Rated insulation voltage $U_i$** | V | 600 | | | |
| **Voltage measuring** | | | | | |
| • Measuring range | V | 93.5 ... 253 | 340 ... 660 | 93.5 ... 253 | 340 ... 660 |
| **Mains voltage, fluctuation compensation** | % | 20 | | | |

| Type | | 3RF29 ..-...0. | 3RF29 ..-...1. | 3RF29 ..-...3. |
|---|---|---|---|---|
| **Control circuit** | | | | |
| **Method of operation** | | DC operation | AC/DC operation | AC operation |
| **Rated control supply voltage $U_s$** | V | 24 | 24 | 110 |
| Rated control current | mA | 15 | 15 | 15 |
| **Rated frequency** of the control supply voltage | Hz | -- | 50/60 | 50/60 |
| **Actuating voltage, max.** | V | 30 | 30 | 121 |
| **Rated control current** | mA | 15 | 15 | 15 |
| At maximum voltage | | | | |
| **Response voltage** | V | 15 | 15 | 90 |
| • For tripping current | mA | 2 | 2 | 2 |
| **Drop-out voltage** | V | 5 | 5 | 15 |

| Type | | 3RF29 20-0FA08 | 3RF29 20-0GA.. | 3RF29 50-0GA.. | 3RF29 90-0GA.. |
|---|---|---|---|---|---|
| **Current measurement** | | | | | |
| **Rated operational current $I_e$** | A | 20 | 20 | 50 | 90 |
| **Current measurement** | | | | | |
| • Teach range | A | 0.65 ... 20 | 0.56 ... 20 | 1.62 ... 50 | 2.93 ... 90 |
| • Measuring range | A | 0 ... 22 | 0 ... 22 | 0 ... 55 | 0 ... 99 |
| • Minimum partial load current | A | 0.65 | 0.65 | 1.6 | 2.9 |
| **Number of partial loads** | | 1 ... 6 | 1 ... 12 | | |

| Type | | 3RF29 20-0HA.. | 3RF29 50-0HA.. | 3RF29 90-0HA.. | 3RF29 16-0JA.. | 3RF29 32-0JA.. |
|---|---|---|---|---|---|---|
| **Current measurement** | | | | | | |
| **Rated operational current $I_e$** | A | 20 | 50 | 90 | 16 | 32 |
| **Current measurement** | | | | | | |
| • Teach range | A | 4 ... 20 | 10 ... 50 | 18 ... 90 | 0.42 ... 16 | 0.8 ... 32 |
| • Measuring range | A | 0 ... 22 | 0 ... 55 | 4 ... 99 | 0 ... 16 | 0 ... 32 |
| • Minimum partial load current | A | -- | | | 0.42 | 0.8 |
| **Number of partial loads** | | -- | | | 1 ... 6 | |

| Type | | 3RF29 04-0KA.. | 3RF29 20-0KA.. | 3RF29 50-0KA.. | 3RF29 90-0KA.. |
|---|---|---|---|---|---|
| **Current measurement** | | | | | |
| **Rated operational current $I_e$** | A | 4 | 20 | 50 | 90 |
| **Current measurement** | | | | | |
| • Teach range | A | 0.15 ... 4 | 0.65 ... 20 | 1.6 ... 50 | 2.9 ... 90 |
| • Measuring range | A | 0 ... 4 | 0 ... 22 | 0 ... 55 | 0 ... 99 |
| • Minimum partial load current | A | -- | 0.65 | 1.6 | 2.9 |
| **Number of partial loads** | | | 1 ... 6 | | |

# Converters

## Overview

### *Converters for 3RF2 solid-state switching devices*

These modules are used to convert analog control signals, such as those output from many temperature controllers for example, into a pulse-width-modulated digital signal. The connected solid-state contactors and relays can therefore regulate the output of a load as a percentage.

## Design

### *Mounting*

Easy snapping onto the 3RF21 solid-state relays or 3RF23 solid-state contactors establishes the connections to the solid-state switching devices. The connector on the solid-state switching devices from the control circuit can be plugged onto the converter without rewiring.

## Function

The analog value from a temperature controller is present at the 0 ... 10 V terminals. This controls the on-to-off period, as a function of voltage. The period duration is predefined at one second. Conversion of the analog voltage is linear in the voltage range from 0.1 to 9.9 V. At voltages below 0.1 V the connected switching device is not activated, while at voltages above 9.9 V the connected switching device is always activated.

## Overview

### *Load monitoring for 3RF2 single-phase solid-state switching devices*

Many faults can be quickly detected by monitoring a load circuit connected to the solid-state switching device, as made possible with this module. Examples include the failure of load elements (up to 6 in the basic version or up to 12 in the extended version), alloyed power semiconductors, a lack of voltage or a break in a load circuit. A fault is indicated by one or more LEDs and reported to the controller by way of a PLC-compatible output.

The principle of operation is based on permanent monitoring of the current strength. This figure is continuously compared with the reference value stored once during commissioning by the simple press of a button. In order to detect the failure of one of several loads, the current difference must be 1/6 (in the basic version) or 1/12 (in the extended version) of the reference value. In the event of a fault, an output is actuated and one or more LEDs indicate the fault.

## Design

### *Mounting*

Easy snapping onto the 3RF21 solid-state relays or 3RF23 solid-state contactors establishes the connections to the solid-state switching devices. Because of the special design, the straight-through transformer of the load monitoring module covers the lower main circuit connection. The cable to the load is simply pushed through and secured with the terminal screw.

## Function

The function module is activated when an "ON" signal is applied (IN terminal). The module constantly monitors the current level and compares this with the setpoint value.

### *Startup*

Pressing the Teach button or actuating the input IN2 switches the device on; the current through the solid-state switching device is detected and is stored as the setpoint value. During this process the two lower (red[1)]) LEDs flash alternately; simultaneous maintained light from the 3 (red[1)]) LEDs indicates the conclusion of the teaching process.

The Teach button can also be used to switch on the connected solid-state switching device briefly for test purposes. In this case the "ON" LED is switched on.

## Load monitoring

### *Partial load faults, "Basic" load monitoring*

If a deviation of at least 1/6 of the stored setpoint value is detected, a fault is signaled. The fault is indicated by a "Fault" LED and by activation of the fault signaling output.

| LED | OK | Fault | | |
|---|---|---|---|---|
| | | Partial load failure/ Load short-circuit | Thyristor defect | Mains failure/ Fuse rupture |
| ON/OFF | ✓ | ✓ | -- | ✓ |
| Current flowing | ✓ | ✓ | ✓ | -- |
| Group fault | -- | ✓ | ✓ | ✓ |

✓ LED is lit

-- LED is not lit

### *Partial load faults, "Extended" load monitoring*

Depending on the setting of the "response time" potentiometer, a deviation of at least 1/12 of the stored setpoint value after a response time of between 100 ms and 3 s is signaled as a fault. The fault is indicated by a "Load" LED and by activation of the fault signaling output.

The potentiometer can also be used to determine the response behavior of the fault signaling output. When delay values are set in the left-hand half, the fault signal is stored. This can only be reset by switching on and off by means of the control supply voltage.

When settings are made on the right-hand side, the fault output is automatically reset after the deviation has been corrected.

### *Voltage compensation, "Extended" load monitoring*

In addition to the current, the load voltage is also detected. This makes it possible to compensate for influences on the current strength resulting from voltage fluctuations.

### *Thyristor fault*

If a current greater than the leakage current of the controls is measured in the deenergized state, the device triggers a thyristor fault after the set delay time. This means that the fault output is activated and the "Fault" ("Thyristor"[1)]) LED lights up.

### *Supply fault*

If no current is measured in the energized state, the device triggers a supply fault after the set delay time. This means that the fault output is activated and the "Fault" ("Supply"[1)]) LED lights up.

[1)] Only "Extended" load monitoring

# Heating current monitoring

## Overview

### *Heating current monitoring for 3RF2 single-phase solid-state switching devices*

Many faults can be quickly detected by monitoring a load circuit connected to the solid-state switching device, as made possible with this module. Examples include the failure of up to 6 load elements, alloyed power semiconductors, a lack of voltage or a break in a load circuit. A fault is indicated by LEDs and reported to the controller by way of a relay output (NC contact).

The principle of operation is based on permanent monitoring of the current strength. This figure is continuously compared with the reference value stored once during commissioning. In order to detect the failure of one of several loads, the current difference must be 1/6 of the reference value. In the event of a fault, an output is actuated and the LEDs indicate the fault.

The heating current monitoring has a teach input and therefore differs from the load monitoring. This remote teaching function enables simple adjustment to changing loads without manual intervention.

## Design

### *Mounting*

Easy snapping onto the 3RF21 solid-state relays or 3RF23 solid-state contactors establishes the connections to the solid-state switching devices. Because of the special design, the straight-through transformer of the heating current monitoring module covers the lower main circuit connection. The cable to the load is simply pushed through and secured with the terminal screw.

## Function

The function module is activated when an "ON" signal is applied (IN1 terminal). The module constantly monitors the current level and compares this with the setpoint value.

### *Startup*

Actuating the input IN2 switches the device on; the current through the solid-state switching device is detected and is stored as the setpoint value. During this process the two lower (red) LEDs flash alternately; simultaneous maintained light from the 3 (red) LEDs indicates the conclusion of the teaching process.

### *Partial load faults*

Depending on the setting of the "response time" potentiometer, a deviation of at least 1/6 of the stored setpoint value after a response time of between 100 ms and 3 s is signaled as a fault. The fault is indicated by a "Load" LED and by activation of the fault signaling output.

The potentiometer can also be used to determine the response behavior of the fault signaling output. When delay values are set in the left-hand half, the fault signal is stored. This can only be reset by switching on and off by means of the control supply voltage.

When settings are made on the right-hand side, the fault output is automatically reset after the deviation has been corrected.

### *Voltage compensation*

In addition to the current, the load voltage is also detected. This makes it possible to compensate for influences on the current strength resulting from voltage fluctuations.

### *Thyristor fault*

If a current greater than the leakage current of the controls is measured in the deenergized state, the device triggers a thyristor fault after the set delay time. The fault output is activated and the "Thyristor" LED lights up.

### *Supply fault*

If no current is measured in the energized state, the device triggers a supply fault after the set delay time. The fault output is activated and the "Supply" LED lights up.

## Overview

### *Power control regulators for 3RF2 single-phase solid-state switching devices*

The power control regulator is a function module for the autonomous power control of complex heating systems and inductive loads, for the operation of loads with temperature-dependent resistors and for simple indirect control of temperature.

The power control regulator can be used on the instantaneously switching 3RF21 and 3RF23 solid-state switching devices (single-phase). If only the full-wave operating mode is used, the power control regulator can also be used on the "zero-point switching" solid-state relays and contactors.

The following functions have been integrated:

- **Power control regulator** for adjusting the power of the connected load. Here, the setpoint value is set with a rotary knob on the module as a percentage with reference to the 100 % power stored as a setpoint value.
- **Inrush current limitation:** With the aid of an adjustable voltage ramp, the inrush current is limited by means of phase control. This is useful above all with loads such as lamps or infrared lamps which have an inrush transient current.
- **Load circuit monitoring** for detecting load failure, partial load faults, alloyed power semiconductors, lack of voltage or a break in the load circuit.

### *Special versions*

3RF29 04-0KA13-0KC0

During the Teaching process the connected solid-state relay or contactor is not activated; i.e. no current flow takes place. No current reference value is stored. No part-load monitoring!

3RF29 04-0KA13-0KT0

No part-load monitoring!

## Design

### *Mounting*

Easy snapping onto the 3RF21 solid-state relays or 3RF23 solid-state contactors establishes the connections to the solid-state switching devices. Because of the special design, the straight-through transformer of the function module covers the lower main circuit connection. The cable to the load is simply pushed through and secured with the terminal screw.

## Function

### *Power control*

The power control regulator sets the load current of the solid-state switching device depending on a setpoint value as a percentage. It does not compensate for changes in the mains voltage or load resistance. The modulation, the On/Off ratio or the phase angle, remains unchanged according to the setpoint value. The autonomous power control is performed between 0 and 100 % of the setpoint selection

### *Full-wave control*

If the left potentiometer $t_R$ is set to 0 s (= far left), then the power control regulator operates according to the principle of full-wave control. The power set, be it internal or external, is converted into a pulse-width-modulated digital signal. The power control regulator controls the On and Off time of the solid-state switching device within a fixed period duration of 1 s so that the selected power is applied to the load. The "ON" LED flashes in the same rhythm as the solid-state switching device switches on and off.

### *Generalized phase control*

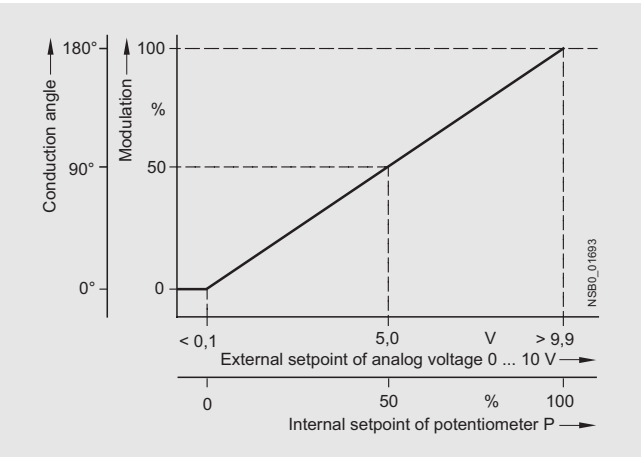
If the left potentiometer $t_R$ is set to greater than 0 s, then the power control regulator operates according to the principle of generalized phase control.

In order to observe the limit values of the conducted interference voltage for industrial networks, the load circuit must include a reactor with a rating of at least 200 µH.

### *Setpoint selection*

The setpoint selection is set either internally with the right-hand potiometer P to 0 ... 100 % on the module or externally using the analog input 0 ... 10 V.

In the case of full-wave control, 100 % corresponds to continuously On and, in the case of generalized phase control, to a conduction angle of 180° - and therefore maximum output.




Input characteristic

Internal setpoint selection

In the case of internal setpoint selection, the module is controlled over the IN terminal. Terminal 10 has no function.

External setpoint selection

With external setpoint selection (potentiometer P far left = 0 %) the module is actuated by applying the analog voltage 0 ... 10 V. 0 ... 10 V corresponds to 0 ... 100 % power. Conversion of the voltage is linear between 0.1 and 9.9 V. Below 0.1 V the switching device stays switched off; a voltage greater than 9.9 V corresponds to 100 % power.

### *Inrush current limitation*

The ramp time ($t_R$) for a voltage ramp on switching on is set with the left potentiometer for the purpose of inrush current limitation. The set time refers to a power of 100 %. If, for example, a ramp time of 10 s is set and the power setpoint selection is 60 %, then the power of 60 % will be reached after approx. 6 s.

### *Line, load and thyristor monitoring*

The power control regulator identifies partial load faults, mains failure and thyristor faults. The faults are indicated by the LEDs on the module and the fault output is actuated. The reference for the load monitoring is the taught value. A maximum of 6 partial loads can be monitored.

The response delay in the event of a fault amounts to approx. 100 ms in the case of full-wave control. In the case of generalized phase control and setpoint values > 50 % the response delay amounts to 500 ms from the end of the ramp time.

The detection of partial load faults takes place only in the control range from 20 to 100 %.

# Power controllers

## Overview

### *Power controllers for 3RF2 single-phase solid-state switching devices*

The power controller is a function module for the autonomous power control of complex heating systems, for the operation of loads with temperature-dependent resistors and for simple indirect control of temperature.

The power controller can be used on the 3RF21 and 3RF23 instantaneous switching solid-state switching devices (single-phase). If only the full-wave operating mode is used, the power controller can also be used on the zero-point-switching solid-state relays and contactors.

The following functions have been integrated:

- **Power control regulator with proportional-action control** for adjusting the power of the connected load. Here, the setpoint value is set with a rotary knob on the module as a percentage with reference to the 100 % power stored as a setpoint value. Changes in the mains voltage or in the load resistance are compensated in this case.
- **Inrush current limitation:** With the aid of an adjustable voltage ramp, the inrush current is limited by means of phase control. This is useful above all with loads such as lamps which have an inrush transient current.
- **Load circuit monitoring** for detecting load failure, alloyed power semiconductors, lack of voltage or a break in the load circuit.

## Design

### *Mounting*

Easy snapping onto the 3RF21 solid-state relays or 3RF23 solid-state contactors establishes the connections to the solid-state switching devices. Because of the special design, the straight-through transformer of the function module covers the lower main circuit connection. The cable to the load is simply pushed through and secured with the terminal screw.

## Function

### *Power control*

The power controller adjusts the current in the connected load by means of a solid-state switching device depending on a setpoint value. Changes in the mains voltage or in the load resistance are thus compensated by the power controller. The setpoint value can be predefined externally as a 0 to 10 V signal or internally by means of a potentiometer. Depending on the setting of the potentiometer ($t_R$), the adjustment is carried out according to the principle of full-wave control or generalized phase control.

### *Full-wave control*

In this operating mode the output is adjusted to the required setpoint value changing the on-to-off period. The period duration is predefined at one second.

### *Generalized phase control*

In this operating mode the output is adjusted to the required setpoint value by changing the current flow angle. The half-waves of the current are adjusted to produce the selected setpoint value of the power at the load.

In order to observe the limit values of the conducted interference voltage for industrial networks, the load circuit must include a reactor with a rating of at least 200 µH.

### *Setpoint selection*

The setpoint selection is set either internally with the right-hand potiometer P to 0 ... 100 % on the module or externally using the analog input 0 ... 10 V AC/DC.

External setpoint selection

At 0 % on the potentiometer the setpoint selection is set using an external 0 ... 10 V analog signal (terminals IN / 0 ... 10 V). The device is switched on and off via the power supply (terminals A1 / A2).

Internal setpoint selection

Above 0 % the setpoint is set using the potentiometer. To allow this, the potential at terminal A1 must additionally be applied at the IN terminal. After removal of the "ON" signal, the switching module is switched off.

### *Inrush current limitation*

The ramp time ($t_R$) for a voltage ramp on switching on is set with the left potentiometer for the purpose of inrush current limitation. If a time longer than 0 s is set, the device operates according to the generalized phase control principle. If 0 s is set, there is no voltage ramp and the device operates according to the principle of full-wave control.

### *Load fault*

If upon switching on with voltage applied the current flowing is not greater than the leakage current of the control, the device triggers a load fault. The fault relay is activated and the "Load" LED lights up.

### *Thyristor fault*

If a current greater than the leakage current of the control is measured in the deenergized state, the device triggers a thyristor fault. The fault relay is activated and the "Thyristor" LED lights up.

### *Supply fault*

If no current is measured in the energized state, the device triggers a supply fault. The fault relay is activated and the "Supply" LED lights up.

### *Startup*

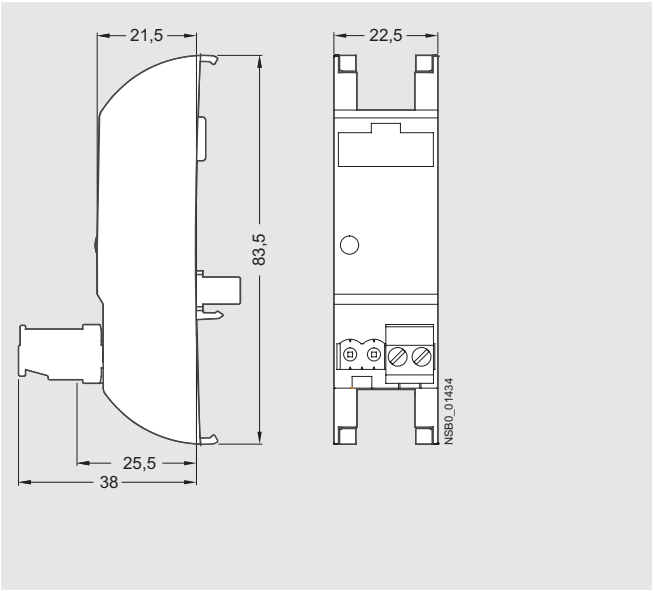
Pressing the "Teach" button switches the device on; the current through the solid-state switching device and the mains voltage are detected and stored. The resultant output is taken as the 100 % output for the setpoint selection. During this process the two lower red LEDs flash alternately. Simultaneous maintained light from the three red LEDs indicates the completion of the "Teach" process.

The "Teach" button can also be used to switch on the connected solid-state switching device briefly for test purposes. In this case the "ON" LED is switched on.

## Dimensional drawings

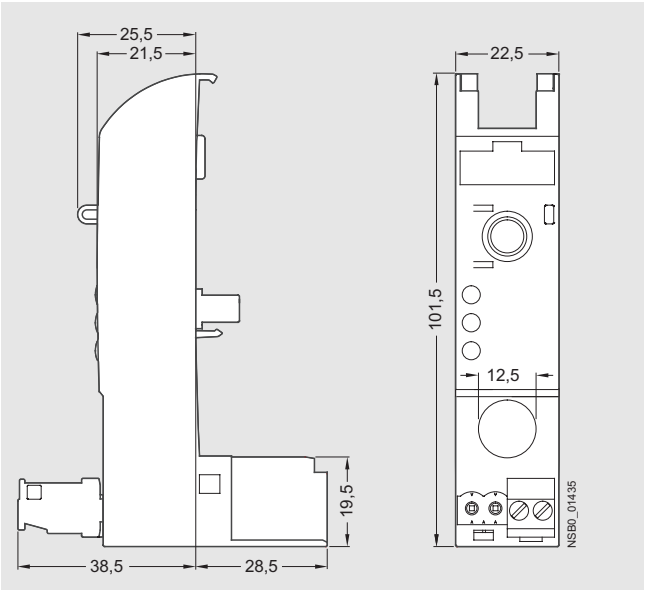
Converters

**3RF29 00-0EA18**



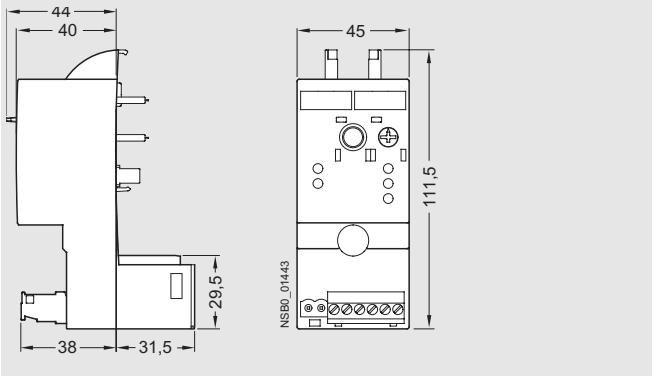

Basic load monitoring

**3RF29 ..-0FA08**



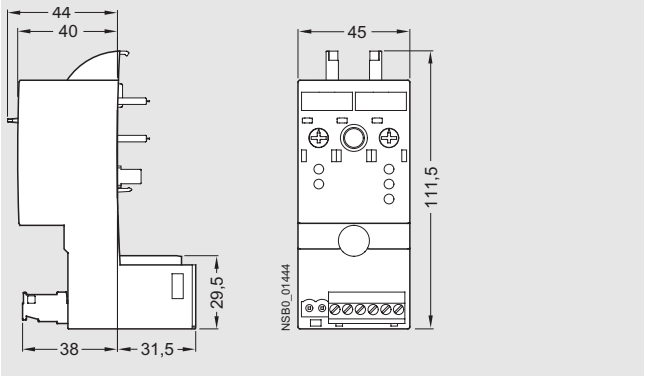

"Extended" load monitoring and heating current monitoring

**3RF29 ..-0GA.. and -0JA..**



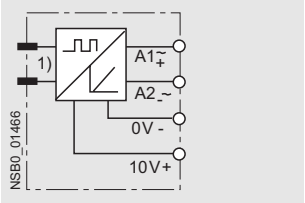

Power controllers

**3RF29 ..-0KA.., 3RF29 ..-0HA..**

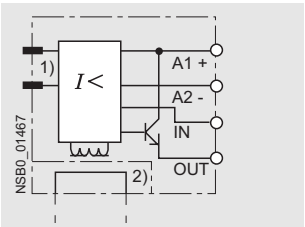



## Schematics

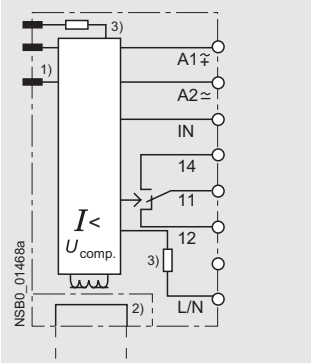
Converters



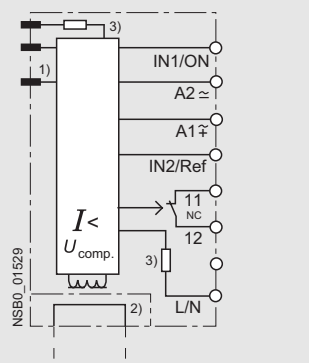

Basic load monitoring



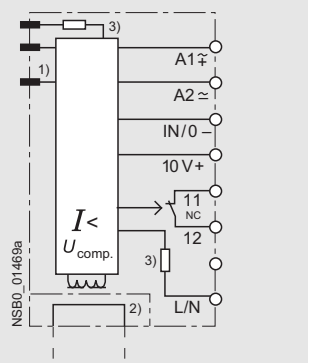

Extended load monitoring




Heating current monitoring




Power controllers

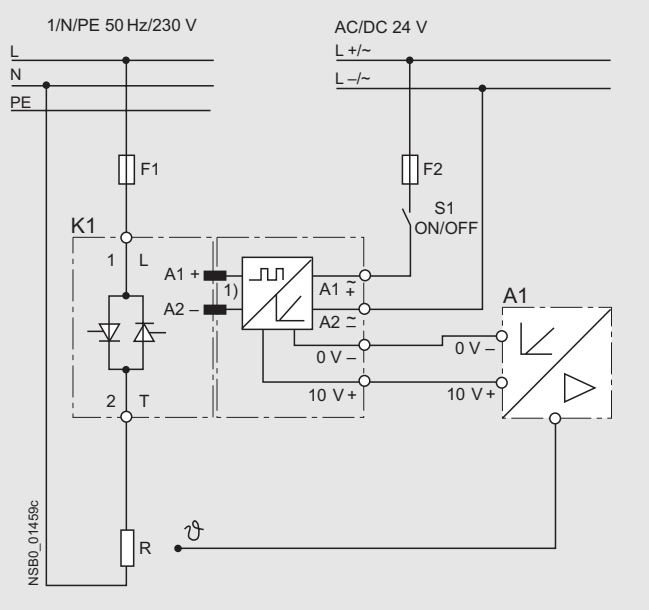



1) Internal connection.
2) Straight-through transformers.
3) Voltage measuring not electrically isolated (3 MΩ per path).

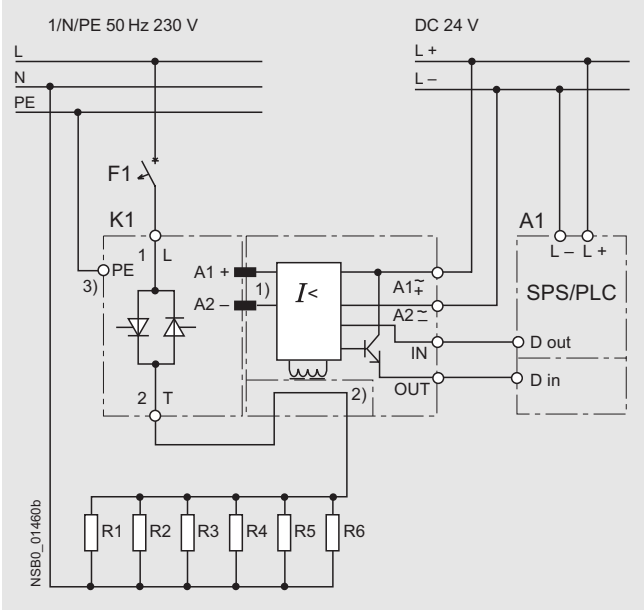
## Project planning aids

### *Switching examples*

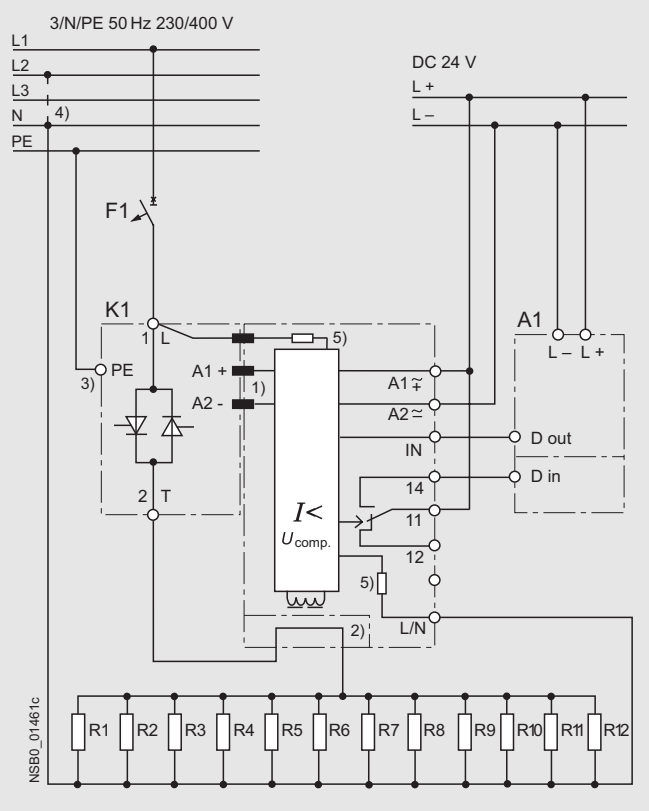
Converter



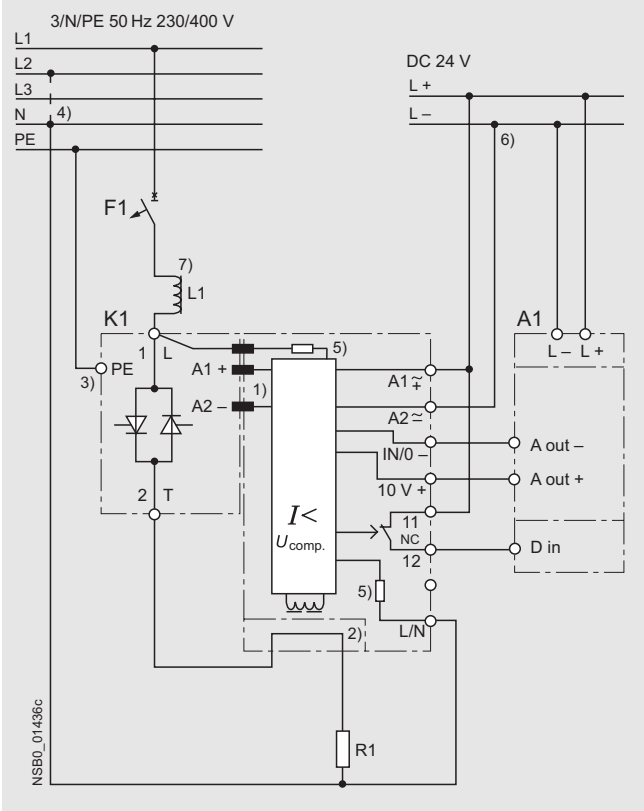

Basic load monitoring




Extended load monitoring




Power controllers




1) Internal connection to the solid-state relay/contactor.
2) Straight-through transformer.
3) Make PE/ground connection according to installation regulations.
4) Connection of L/N contact with:
- Load monitoring/power controller 3RF29 ..-0.A.**3** on neutral conductor N (e.g. 230 V),
- Load monitoring/power controller 3RF29 ..-0.A.**6** on a second phase (e.g. 400 V).
5) Voltage measuring not electrically isolated (3 MΩ per path).
6) Grounding of connection L- is recommended.
7) A 200 µH choke must be used when operating with leading-edge phase in order to observe the limit values of the conducted interference voltage according to Class A.