Motor Controllers
Dynamic Braking
Types RTC 40 HD12-./RTO 12..

- Control and output modules for dynamic braking of 3-phase induction motors
- Rated operational current: 18.5, 30 and 60 A DC
- Rated operational voltage: Up to 400 VACrms
- Control voltage: 10 to 32 VDC
- LED indication for line ON and brake ON

Product Description

Dynamic braking is achieved by introducing a DC current, rectified from the mains, through the motor windings. The control module RTC 40 HD-12-. is used in combination with the output module RTO 12.. to achieve dynamic braking of 3-phase induction motors with braking current up to 60 A. The desired braking time and the required brake current can be adjusted with the TIME and BRAKE CURRENT potentiometers. The control module, which is separately supplied from an external DC voltage source, has LED indications for LINE ON and BRAKE ON. The output signal from the control module is off 350 ms before the brake current is introduced. This signal can be used to take away the AC supply of the motor.

Ordering Key

RTC 40 HD 12 - 5

Solid State Relay
Dynamic braking
Control module
Output module
Rated operational voltage
Rated operational current
Control voltage
Non-rep. peak voltage
Rated op. frequency

RTO 1210

Type Selection

Type	Rated operational voltage	Control voltage	Non-rep. peak voltage	Rated operational frequency
C: Control module	40: 120/208 VACrms 230/400 VACrms	HD: 10 to 32 VDC	12: 1200 V_p	5: 50 Hz ± 3 Hz 6: 60 Hz ± 3 Hz

Type	Non-rep. peak voltage	Rated operational current
O: Output module	12: 1200 V_p	10: 2 x 18.5 A DC 25: 2 x 30 A DC 50: 2 x 60 A DC

Selection Guide

Control module	Rated operational frequency 50 Hz	60 Hz
230/400 VACrms	**RTC 40 HD-12-5**	**RTC 40 HD-12-6**

Non-rep. voltage	Rated operational current 18.5 A	30 A	60 A
1200 V_p	**RTO 1210**	**RTO 1225**	**RTO 1250**

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General Specifications Control Module

	RTC 40 HD12-5	RTC 40 HD12-6
Operational voltage range Line to line	190 to 440 VACrms	190 to 440 VACrms
Non-rep. peak voltage	≥ 1200 V_p	≥ 1200 V_p
Operational frequency range	47 to 52 Hz	57 to 63 Hz
Supply current @ RUN, no output @ BRAKE, no output	 ≤ 30 mA @ 32 VDC ≤ 110 mA @ 32 VDC	 ≤ 30 mA @ 32 VDC ≤ 110 mA @ 32 VDC
Approval	CSA	CSA
CE-marking	Yes	Yes

Control Input Specifications

Control voltage range	10 to 32 VDC
Motor running	≥ 8 VDC
Motor stopped	≤ 2 VDC
Adjust. braking current	Dependent on motor size
Adjust. braking time	1 to 40 s
Min. delay, stop to run	≥ 1 cycle
Remanence delay	≥ 350 ms

Thermal Specifications Control Mod.

Operating temperature	-20° to +80°C (-4° to +176°F)
Storage temperature	-40° to +100°C (-40° to +212°F)

Control Output Specifications

Minimum output voltage	Power supply less 3.5 VDC
Output current short-circuit protected	150 mA DC

Insulation Control Module

Rated insulation voltage Input to trigger outputs	≥ 4000 VACrms

Mode of Operation

The control module RTC 40 HD12-5 (50 Hz)/RTC 40 HD12-6 (60 Hz) is used with output module RTO 12.. to achieve dynamic braking of 3-phase induction motors.

Dynamic braking is achieved by passing direct current, rectified from the mains, through the motor windings. The DC-current will then produce a static field through the short-circuited rotor, and the induced rotor current will create a torque opposite to the direction of rotation.

Note:
This means that no braking takes place when the motor revolution is zero. The desired braking time can be set by means of the BRAKE TIME potentiometer. The braking current can be adjusted by means of the BRAKE CURRENT potentiometer to achieve motor stop within the desired time.

Note:
Avoid excessive braking current after the motor has been stopped, as this will create unnecessary heating of the motor.

Since the RTC/RTO configuration is only capable of braking the motor, a starting device is needed. Either a Solid State Relay, e.g. Carlo Gavazzi RZ, or a motor controller RSC 40 HD12-./RSO 12.. can be connected to the application.

To ensure safe operation the starting device must be controlled by the RTC output. When the control voltage (terminal C2) is removed, braking will take place.

The control module has LED indication for line ON and brake ON. The control module also features remanence delay. To avoid torque shock, a delay of min. 350 ms passes from the moment the motor contactor has been released until DC voltage is reapplied to the motor windings.

To measure the braking current, always use a true rms ammeter with DC range.

In order to define the size of the output module, it is necessary to find the resistance between the two terminals from the motor where the brake module will be connected. This resistance is a combination of the resistances of the motor windings and is dependent on how the motor is connected. In star connection it is a series connection of two windings (see top of next page). In delta connection it consists of two windings connected in parallel to the third winding (see top of next page).

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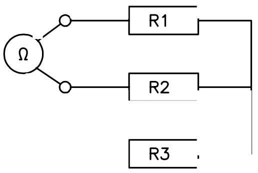
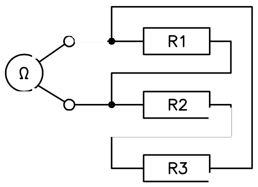
Mode of Operation (cont.)



Star



Delta

If the brake current is adjusted to max., full half waves are introduced to the motor, and the DC voltage is calculated as follows:

$$U_{DC} = \frac{U_{max}}{\pi} = \frac{U_n \times \sqrt{2}}{3.14}$$

$$= U_n \times 0.45$$

The max. current can be calculated as follows:

$$I_{max} = \frac{U_n \times 0.45}{\sum R}$$

where $\sum$ R is a combination of the windings mentioned above.

Example: The resistance of the motor winding is 5 Ω. The rated operational voltage is 400 VAC.

What is the max. current in star connection and in delta connection?

$\sum$ R star is R1 + R2 = 5 + 5 Ω = 10 Ω

$\sum$ R delta is R1 parallel to R2 + R3 = 3.3 Ω.

The current is:

$$\frac{400 \times 0.45}{10} = 18 \text{ A}$$

for the star connection, and

$$\frac{400 \times 0.45}{3.33} = 54 \text{ A}$$

for the delta connection.

The output module has to be selected accordingly (next higher power rating).

General Specifications Output Module

	RTO 1210	RTO 1225	RTO 1250
Operational voltage range Line to line	220 to 420 VACrms	220 to 420 VACrms	220 to 420 VACrms
Rated operational current	18.5 ADC	30 ADC	60 ADC
Approval	CSA	CSA	CSA
CE-marking	Yes	Yes	Yes

Output Specifications Output Module

	RTO 1210	RTO 1225	RTO 1250
Non-rep. peak voltage	$\geq$ 1200 V_p	$\geq$ 1200 V_p	$\geq$ 1200 V_p
Off-state leakage current	$\leq$ 10 mA	$\leq$ 10 mA	$\leq$ 10 mA
On-state voltage drop	$\leq$ 1.6 Vrms	$\leq$ 1.6 Vrms	$\leq$ 1.6 Vrms
I^2t for fusing t=1-10 ms	$\leq$ 130 A^2s	$\leq$ 450 A^2s	$\leq$ 1680 A^2s
Critical dI/dt	$\geq$ 50 A/µs	$\geq$ 50 A/µs	$\geq$ 50 A/µs
Non-rep. surge current t=10 ms	160 A_p	300 A_p	580 A_p

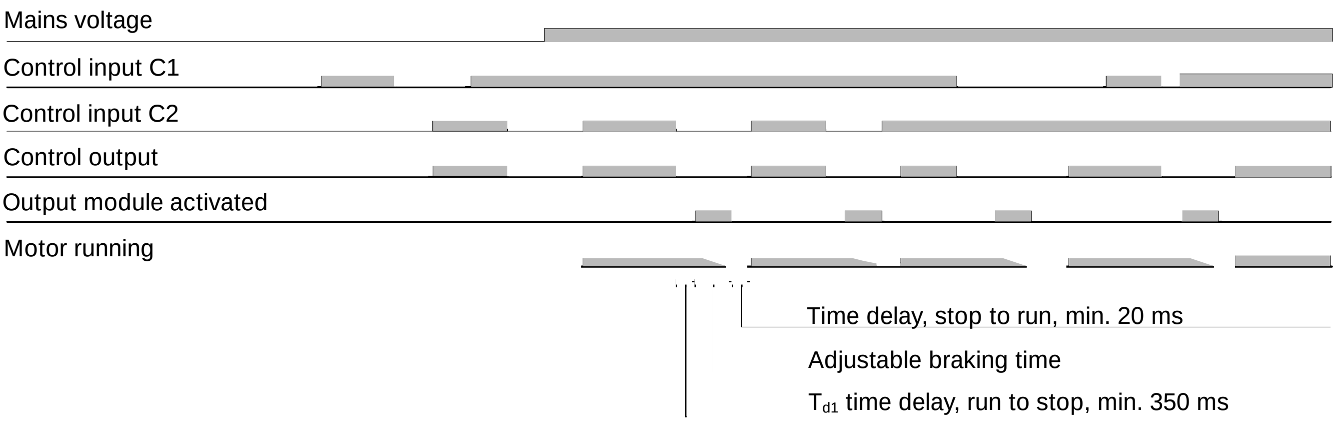
Thermal Specifications Output Module

	RTO 1210	RTO 1225	RTO 1250
Operating temperature	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)	-20° to +70°C (-4° to +158°F)
Storage temperature	-40° to +100°C (-40° to +212°F)	-40° to +100°C (-40° to +212°F)	-40° to +100°C (-40° to +212°F)
R_{th} junction to case	$\leq$ 1.4 K/W	$\leq$ 1.0 K/W	$\leq$ 0.5 K/W

Insulation Output Module

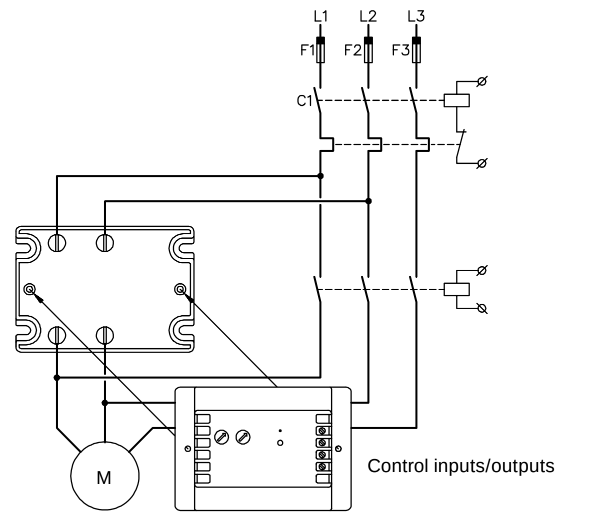
Rated insulation voltage Output to case	$\geq$ 4000 VACrms

Operation Diagram

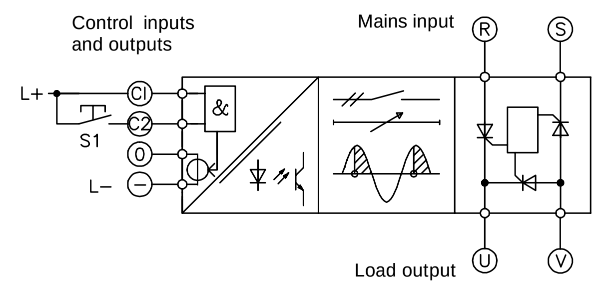


Wiring Diagram

Mounting and connection of control module and output module



Functional Diagram



Housing Specifications

Weight	Approx. 275 g
Housing material Colour	Noryl, glass-reinforced Black
Base plate	Aluminium, nickel-plated
Potting compound	Polyurethane, black
Relay Mounting scews Mounting torque	 M5 ≤ 1.5 Nm
Control terminal Mounting screws Mounting torque	 M3 ≤ 0.5 Nm
Power terminal Mounting screws Mounting torque	 M5 ≤ 1.5 Nm

Accessories

Heatsinks
Varistors
Fuses
Temperature limit switch
Power supply

For further information refer to “General Accessories”.

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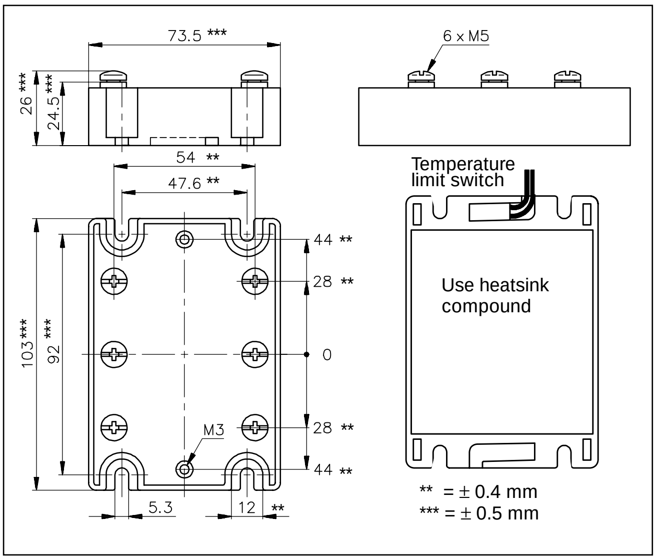
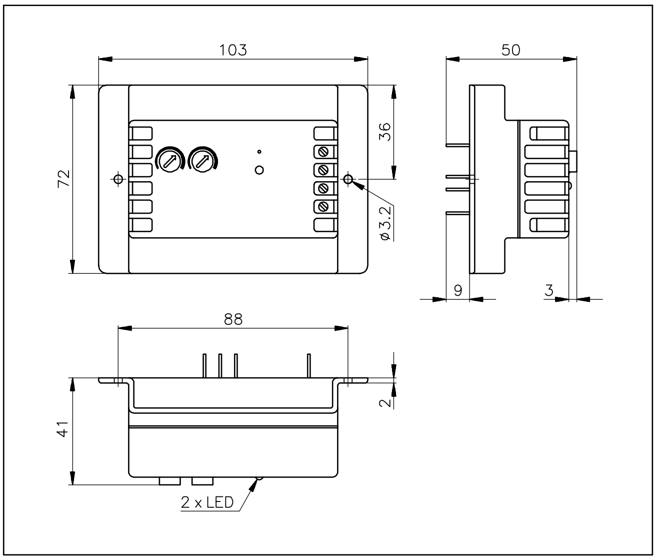
Dimensions

RTO 12..



All dimensions in mm

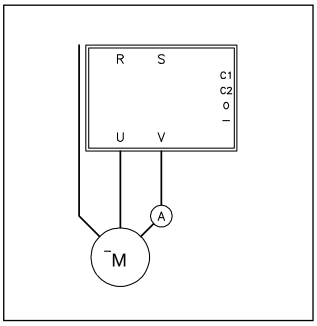
RTC 40 HD12-.



Applications

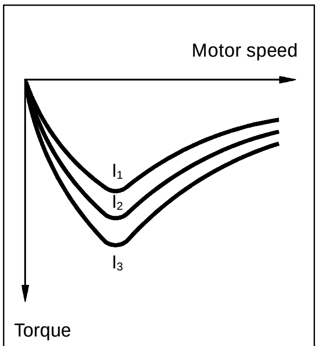
Measuring point for DC load current

Note: When using a clampmeter, be sure that it is capable of measuring DC-current.



Brake current

Typical behaviour of braking torque as a function of motor speed: As will be seen from the curve, the braking torque will be relatively low at nominal motor speed. As the revolution speed decreases, the braking torque increases until the speed approaches zero. Then, the braking torque decreases. With zero speed the braking torque is at zero.



Different settings of brake current $I_1 > I_2 > I_3$

Protection of the motor

A possible way of protecting the motor against overheating where dynamic braking is used is to mount a temperature sensor, PTC or Klixon, between the motor windings.

Thermal relays will normally be sensitive to the current asymmetry occuring while braking. The thermal relay may trip undesirably.

Connection to the mains

As this type of brake relay has a semiconductor between two phases, it is always recommended to protect it against high surge currents as well as possible voltage transients.

The protection consists of two elements:

1. A semiconductor fuse rated below the max. load integral (I^2t) for the output module.

2. A voltage-dependent resistor (MOV) to prevent voltages higher than the blocking voltage of the output modules. Without MOV, voltage transients might trigger the output module and subsequently cause undesirable fuse blowing.

Connection to 3-phase SSR

F1 - F3: Ultrafast fuses with I^2t rated lower than the I^2t value of the output module.
P1 - P5: Varistors for 420 V mains with a diameter of 20 mm.

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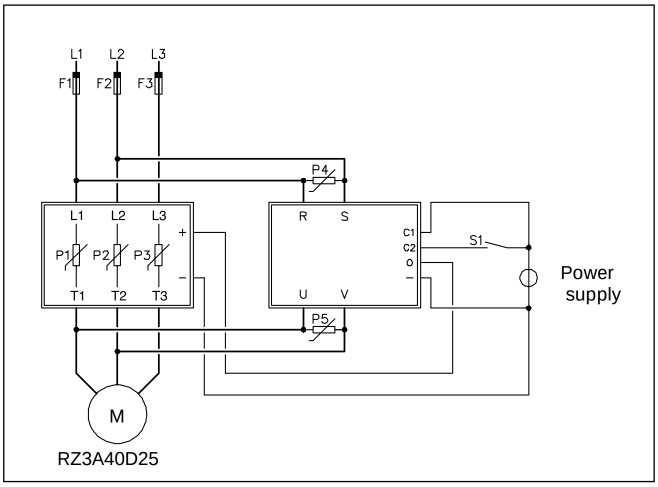
Applications (cont.)



S1 closed: The motor is running.
S1 opens: The adjusted current brakes the motor within the adjusted time.

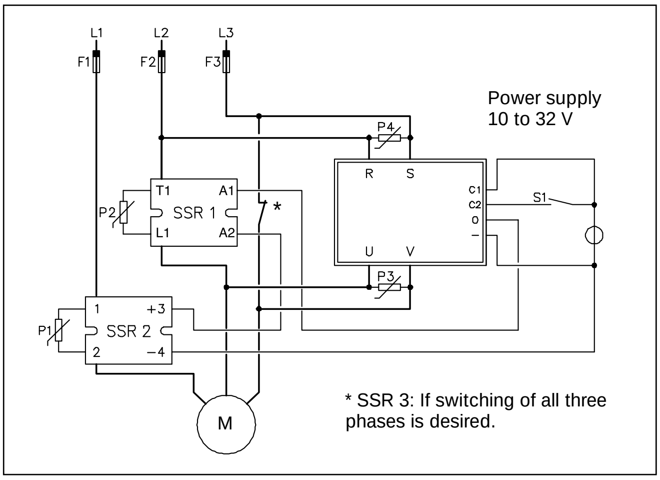
If S1 is closed before the end of a braking cycle, the relays will return to RUN mode within 0.1 s.

Connection to two 1-phase SSRs

Note: Motor protecting relay is not shown.

F1 - F3: Ultrafast fuses with I^2t rated lower than the I^2t value of the output.

P1 - P4: Varistors for 420 V mains with a diameter of 20 mm.



SSR 1, SSR 2: Carlo Gavazzi type RA 48 xx-D 12 (1200 V blocking voltage).
S1 closed: The motor is running.
S1 opens: The adjusted current brakes the motor within the adjusted time.

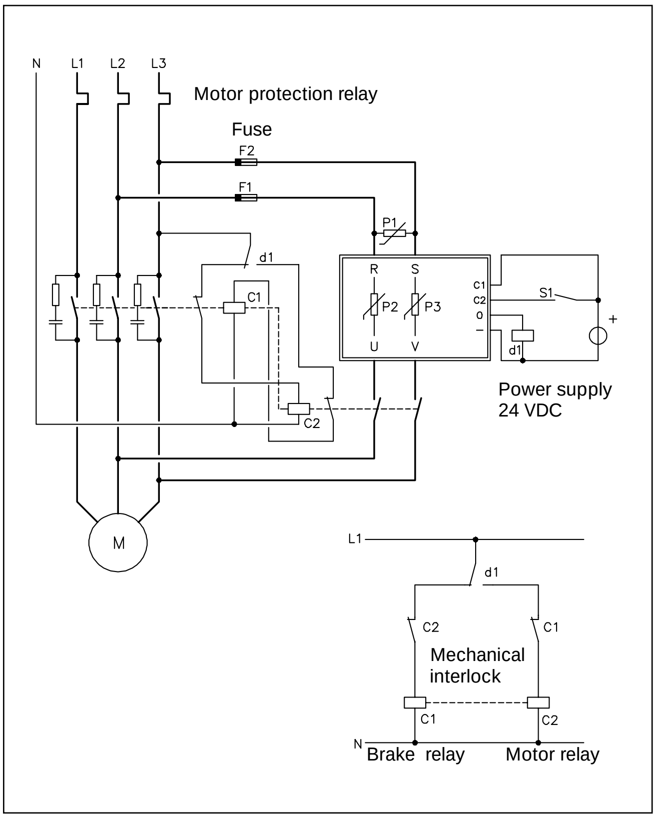
If S1 is closed before the end of a braking cycle, the relays will return to RUN mode within 0.1 s.

Connection to a 3-phase mechanical relay

Special precautions should be taken where the driving element is a mechanical contactor. The electrical voltage peaks from the contactor must be dampened by the use of RC snubbers.

Varistor: S20 K 420 Siemens
RC: PMR 209 Rifa 47Ω/0.1 µF
d1: Feme MZP
Fuse: See "General Accessories".

The output of the braking module is disconnected from the motor terminals when the motor is running and is connected only when the motor is in brake or stop mode. This feature together with a mechanical and electrical interlock (dotted line) between motor and brake relay will help to reduce the risk of malfunction.



F1 - F3: Ultrafast fuses with I^2t rated lower than the I^2t value of the output module. F3 is optional since there is no semiconductor in L3.
P1 - P3: Varistors for 420 V mains with a diameter of 20 mm.

When S1 is closed, the motor is running.

When S1 is opened, the motor brakes and stops.
Note: The max. allowable delay time for switching off is 350 ms. Do not use more than one auxiliary relay.

The d1 relay could also be a Solid State Relay, e.g. Carlo Gavazzi relay type RP1A23D3.

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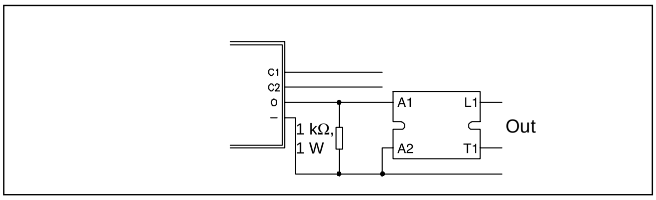
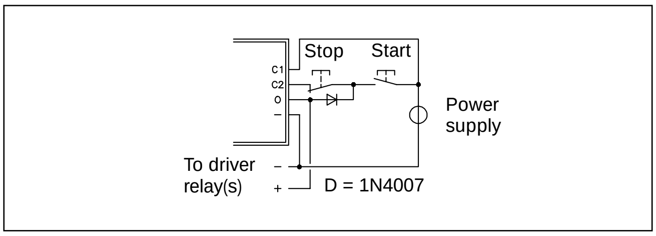
Applications (cont.)

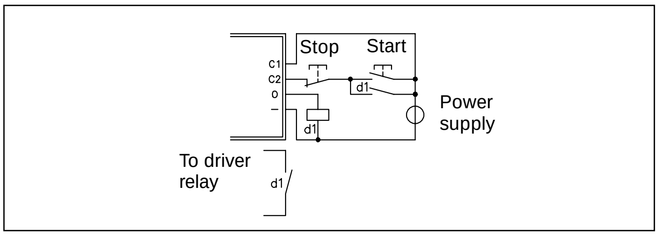
When using Solid State Relays, a resistor of 1 kΩ should be connected between output (0) and negative (-) on the RTC control unit to ensure that the output voltage from the RTC control unit is lower than the drop-out voltage for the Solid State Relay.



Start - stop function
(only control circuit is shown)

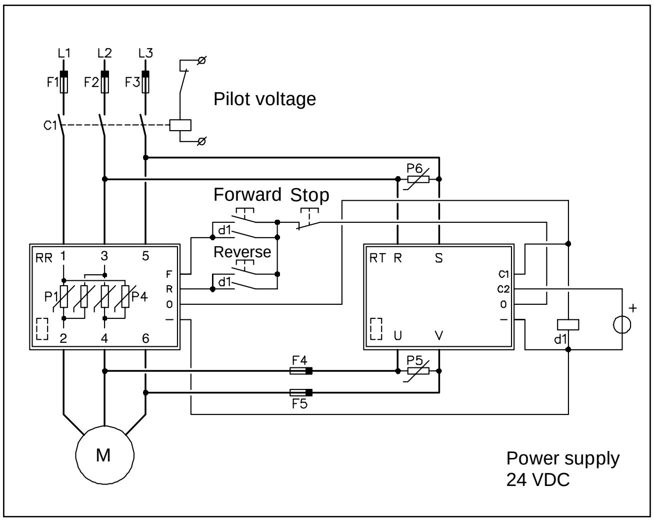


With auxiliary diode



With auxiliary relay

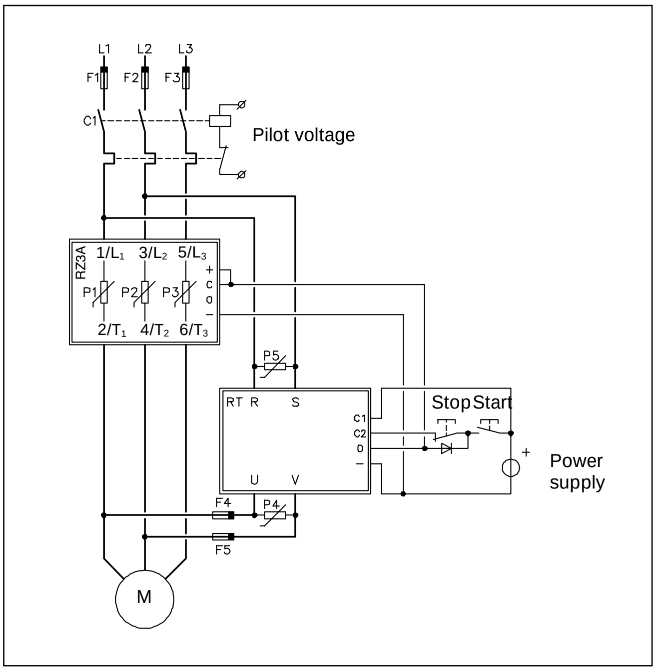
Interconnection of braking and reversing SSRs



F1 - F5: Ultrafast fuses with I^2t rated lower than the I^2t value of the relevant output modules.

P1 - P6: Varistors for 420 V mains with a diameter of 20 mm.

Interconnection of soft starting and braking SSRs



F1 - F5: Ultrafast fuses with I^2t rated lower than the I^2t value of the relevant output modules.

P1 - P5: Varistors for 420 V mains with a diameter of 20 mm.

Thermal considerations

Motor
Dynamic braking of 3-phase induction motors creates power dissipation in the motor. The DC current dissipates power in the stator windings, and the stored energy in the rotating machine is dissipated in the rotor during braking. Consequently, the best way of protecting the motor will be to install temperature sensors in the motor windings.

Solid State Relay
Due to the relatively high power dissipation in the motor the RUN and BRAKE mode ratio is normally less than 0.1.

$$\frac{\text{Brake time}}{\text{Run + Brake time}} < 0.1$$

This gives negligible power dissipation in the braking Solid State Relay. Under normal conditions it will be sufficient to mount the relay on to the chassis. If no metal backplate is available, a heatsink must be used:

RTO 1210 R_{th} = 2.5 K/W
RTO 1225 R_{th} = 2.5 K/W
RTO 1250 R_{th} = 1 K/W

The heatsinks are sufficient for ambient temperatures up to 60°C (140°F).