

# Motor Controllers

## 3-Phase Analog Power Controller

### Types RSC-AAM60/RSO .....

CARLO GAVAZZI



- Control and output modules for analogue control of 3-phase induction motors or heaters
- Rated operational current: 3 x 10, 25, 50, 90, 110 AACrms
- Rated operational voltage: Up to 600 VACrms
- Supply voltage range: 10 to 32 VDC
- Control current range: 0 to 20 mA/4 to 20 mA
- LED-indication for line ON and load ON
- Varistor protection
- Approvals: CE, CCC, UL, CSA

### Product Description

The micro processor based control module RSC-AAM60 is used with output modules RSO... to achieve a voltage controlled soft start/soft stop of 3-phase motors and a possibility for energy reduction when e.g. a fan is running with a variable capacity. This function is achieved by controlling the control module with a current between 4 and 20 mA (0 and 20 mA). The output mod-

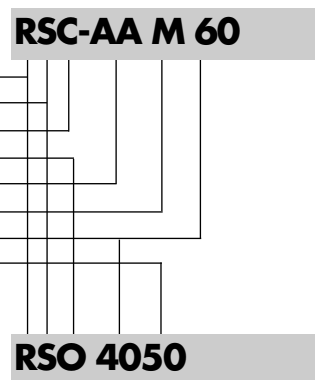
ule can be selected according to the rated operational voltage and the size of the load.

This phase angle controlled soft-start unit can be used for pumps, fans, heaters, lights and many other applications.

LED indications for line ON and load ON gives a clear status indication.

### Ordering Key

- Solid State Relay
- Soft starting/stopping
- Control module
- Output module
- Control input type
- Multivoltage
- Rated operational voltage
- Rated operational current



### Type Selection, Control Module

| Control current | Mains        | Max. operational voltage | Type Number |
|-----------------|--------------|--------------------------|-------------|
| 0-20 mA/4-20 mA | Multivoltage | 600 VAC                  | RSC-AA M 60 |

### Type Selection, Output Module

| Rated operational voltage | Rated operational current |          |          |          |           |
|---------------------------|---------------------------|----------|----------|----------|-----------|
|                           | 10 A                      | 25 A     | 50 A     | 90 A     | 110 A     |
| 3 x 220 VAC               | RSO 2210                  | RSO 2225 | RSO 2250 | RSO 2290 | RSO 22110 |
| 3 x 400 VAC               | RSO 4010                  | RSO 4025 | RSO 4050 | RSO 4090 | RSO 40110 |
| 3 x 480 VAC               | RSO 4810                  | RSO 4825 | RSO 4850 | RSO 4890 | RSO 48110 |
| 3 x 600 VAC               |                           |          | RSO 6050 | RSO 6090 | RSO 60110 |

### General Spec., Control Module

|  |                     |
|--|---------------------|
| Operational voltage range<br>Line to line                      | 150 to 660 VACrms   |
| Operational frequency range                                    | 45 to 65 Hz         |
| Supply current<br>@ no output current<br>@ max. output current | < 30 mA<br>< 180 mA |
| Supply voltage range   | 10 to 32 VDC        |
| CE-marking   | Yes                 |
| Approvals  | UL, CSA, CCC        |

### Control Specifications

|   |                          |
|---|--------------------------|
| Minimum output voltage                    | Power supply minus 8 VDC |
| Output current<br>short-circuit protected | ≤ 150 mA DC              |

### Thermal Specifications

|                       |                                 |
|-----------------------|---------------------------------|
| Operating temperature | -20° to +70°C (-4° to +158°F)   |
| Storage temperature   | -40° to +100°C (-40° to +212°F) |

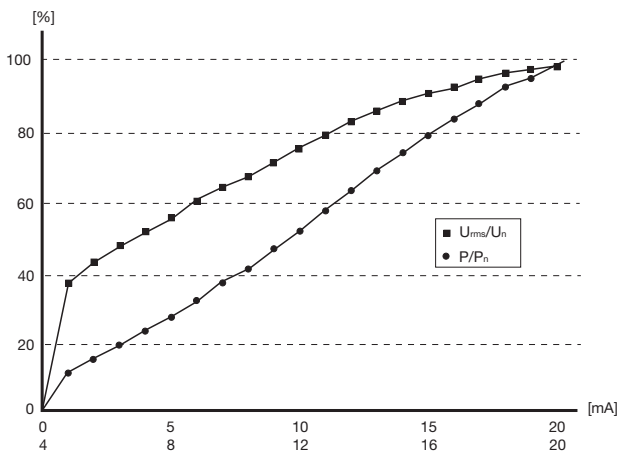
## Control Input Specifications

|   |                |
|---|----------------|
| Control current                             |                |
| A-input                                     | 0 to 20 mA     |
| B-input                                     | 4 to 20 mA     |
| Input impedance                             | 250 $\Omega$   |
| Power supply reset time                     | $\leq$ 300 ms  |
| Response time<br>(input to trigger outputs) | $\leq$ 1 cycle |

## Isolation Control Module

|   |                    |
|---|--------------------|
| Rated isolation voltage<br>Input to trigger outputs | $\geq$ 4000 VACrms |
|---|--------------------|

## Operation Diagram



Output as a function of control current @cos( $\phi$ ) = 0.9

## Mode of Operation

The control module RSC-AAM60 is used with the output module RSO..... to achieve analog control of 3-phase induction motors.

Soft starting is achieved by increasing the motor voltage in accordance with the input current. Soft stopping is achieved by decreasing the motor voltage in accordance with the input current.

When the motor is running idle, the motor voltage can be reduced by lowering the input current, whereby energy is saved.

Heating elements can also be controlled with the RSC/RSO with the use of appropriate filters.

## General Specifications, Output Module

|   | RSO 22...           | RSO 40...           | RSO 48...           | RSO 60...           |
|---|---------------------|---------------------|---------------------|---------------------|
| Operational voltage range<br>Line to line | 150 to 250 VACrms   | 220 to 420 VACrms   | 400 to 510 VACrms   | 400 to 625 VACrms   |
| Blocking voltage                          | 1200 V <sub>p</sub> | 1200 V <sub>p</sub> | 1200 V <sub>p</sub> | 1600 V <sub>p</sub> |
| Varistor voltage                          | 275 VAC             | 420 VAC             | 510 VAC             | 625 VAC             |
| CE-marking                                | Yes                 | Yes                 | Yes                 | Yes                 |

## Output Specifications, Output Module

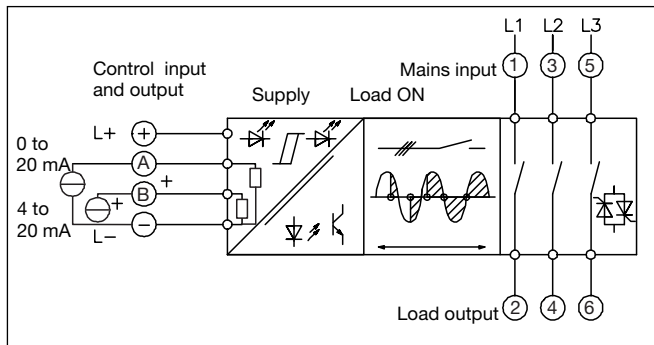
|   | RSO ..10                     | RSO ..25                     | RSO ..50                      | RSO ..90                      | RSO ..110                      |
|---|------------------------------|------------------------------|-------------------------------|-------------------------------|--------------------------------|
| IEC and CCC<br>Rated Operational Current<br>AC 51       | 16 Arms                      | 25 Arms                      | 50 Arms                       | 90 Arms                       | 110 Arms                       |
| IEC and CCC rated<br>operational current<br>AC 53a      | 3 Arms                       | 5 Arms                       | 15 Arms                       | 30 Arms                       | 40 Arms                        |
| Number of starts/hr @40°C                               | 7*                           | 7*                           | 7*                            | 50*                           | 50*                            |
| Overload cycle according to<br>EN/ IEC 60947-4-2 @ 40°C | 3A: AC53a:<br>4 - 4:100 - 7* | 3A: AC53a:<br>4 - 4:100 - 7* | 3A: AC53a:<br>4 - 4: 100 - 7* | 3A: AC53a:<br>4 - 4:100 - 50* | 3A: AC53a:<br>4 - 4: 100 - 50* |
| Off-state leakage current                               | $\leq$ 10 mArms              | $\leq$ 10 mArms              | $\leq$ 10 mArms               | $\leq$ 25 mArms               | $\leq$ 25 mArms                |
| On-state voltage drop                                   | $\leq$ 1.6 Vrms              | $\leq$ 1.6 Vrms              | $\leq$ 1.6 Vrms               | $\leq$ 1.8 Vrms               | $\leq$ 1.8 Vrms                |
| I <sup>2</sup> t for fusing t=10 ms                     | $\leq$ 130 A <sup>2</sup> s  | $\leq$ 525 A <sup>2</sup> s  | $\leq$ 1800 A <sup>2</sup> s  | $\leq$ 6600 A <sup>2</sup> s  | $\leq$ 18000 A <sup>2</sup> s  |
| Non-rep. surge current<br>t=10 ms                       | 160 A <sub>p</sub>           | 325 A <sub>p</sub>           | 600 A <sub>p</sub>            | 1150 A <sub>p</sub>           | 1900 A <sub>p</sub>            |

\* Mounted on RHS 301

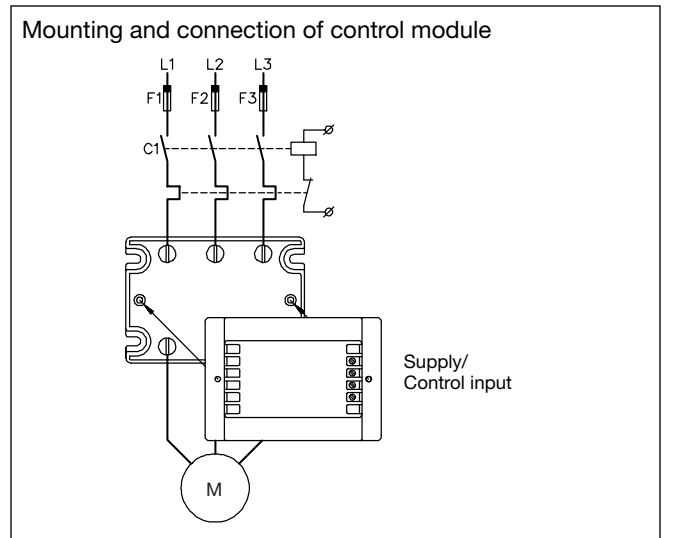
## Thermal Specifications Output Module

|                                  | RSO ..10                           | RSO ..25                           | RSO ..50                           | RSO ..90                           | RSO ..110                          |
|----------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| Operating temperature            | -20° to +70°C<br>(-4° to +158°F)   | -20° to +70°C<br>(-4° to +158°F)   | -20° to +70°C<br>(-4° to +158°F)   | -20° to +70°C<br>(-4° to +158°F)   | -20° to +70°C<br>(-4° to +158°F)   |
| Storage temperature              | -40° to +100°C<br>(-40° to +212°F) | -40° to +100°C<br>(-40° to +212°F) | -40° to +100°C<br>(-40° to +212°F) | -40° to +100°C<br>(-40° to +212°F) | -40° to +100°C<br>(-40° to +212°F) |
| Junction temperature             | ≤ 125°C                            | ≤ 125°C                            | ≤ 125°C                            | ≤ 125°C                            | ≤ 125°C                            |
| R <sub>th</sub> junction to case | ≤ 0.7 K/W                          | ≤ 0.5 K/W                          | ≤ 0.25 K/W                         | ≤ 0.1 K/W                          | ≤ 0.09 K/W                         |

## Functional Diagram



## Wiring Diagram

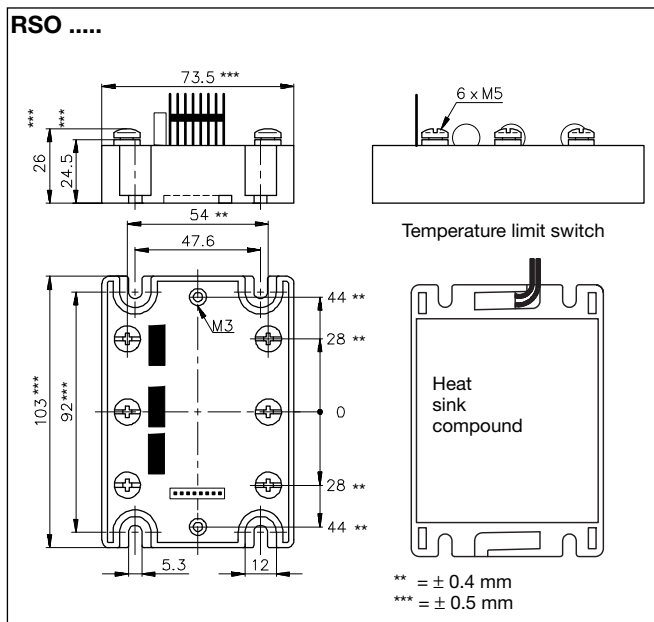


## Accessories

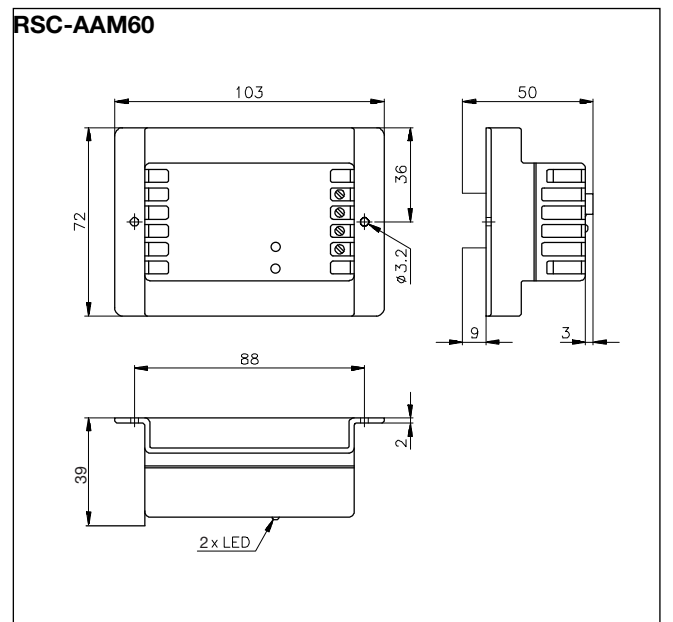
- Heatsinks
- Fuses
- Temperature limit switch
- Power supply

For further information refer to "General Accessories".

## Dimensions



All dimensions in mm



All dimensions in mm



## Heatsink Dimensions (load current versus ambient temperature)

**RSO ..10**

| Load current [A] | Thermal resistance [K/W] |      |      |      |      | Power dissipation [W] | Temp. protection [°C] |
|------------------|--------------------------|------|------|------|------|-----------------------|-----------------------|
| 16               | 0.97                     | 0.81 | 0.65 | 0.48 | 0.32 | 62                    | 80°C                  |
| 15               | 1.1                      | 0.88 | 0.71 | 0.53 | 0.35 | 57                    |                       |
| 14               | 1.2                      | 0.97 | 0.77 | 0.58 | 0.39 | 52                    |                       |
| 13               | 1.3                      | 1.1  | 0.85 | 0.64 | 0.43 | 47                    |                       |
| 12               | 1.4                      | 1.2  | 0.95 | 0.71 | 0.47 | 42                    |                       |
| 11               | 1.6                      | 1.3  | 1.1  | 0.80 | 0.53 | 38                    |                       |
| 10               | 1.8                      | 1.5  | 1.2  | 0.90 | 0.60 | 33                    |                       |
| 9                | 2.1                      | 1.7  | 1.4  | 1    | 0.69 | 29                    |                       |
| 7                | 2.8                      | 2.3  | 1.9  | 1.4  | 0.93 | 21                    |                       |
| 5                | 4.2                      | 3.5  | 2.8  | 2.1  | 1.4  | 14                    |                       |
| 3                | 7.4                      | 6.2  | 4.9  | 3.7  | 2.5  | 8                     |                       |
| 1                | 23.8                     | 19.8 | 15.9 | 11.9 | 7.9  | 3                     |                       |
|                  | 20                       | 30   | 40   | 50   | 60   | T <sub>A</sub>        | Ambient temp. [°C]    |

**RSO ..25**

| Load current [A] | Thermal resistance [K/W] |      |      |      |      | Power dissipation [W] | Temp. protection [°C] |                    |
|------------------|--------------------------|------|------|------|------|-----------------------|-----------------------|--------------------|
| 25               | 0.66                     | 0.55 | 0.44 | 0.33 | 0.22 | 91                    | 80°C                  |                    |
| 22.5             | 0.76                     | 0.63 | 0.51 | 0.38 | 0.25 | 79                    |                       |                    |
| 20               | 0.88                     | 0.74 | 0.59 | 0.44 | 0.29 | 68                    |                       |                    |
| 17.5             | 1.1                      | 0.87 | 0.70 | 0.52 | 0.35 | 57                    |                       |                    |
| 15               | 1.3                      | 1.1  | 0.85 | 0.63 | 0.42 | 47                    |                       |                    |
| 12.5             | 1.6                      | 1.3  | 1.1  | 0.79 | 0.53 | 38                    |                       |                    |
| 10               | 2.1                      | 1.7  | 1.4  | 1    | 0.69 | 29                    |                       |                    |
| 7.5              | 2.9                      | 2.4  | 1.9  | 1.4  | 0.96 | 21                    |                       |                    |
| 5                | 4.5                      | 3.8  | 3    | 2.3  | 1.5  | 13                    |                       |                    |
| 2.5              | 9.4                      | 7.8  | 6.3  | 4.7  | 3.1  | 6                     |                       |                    |
|                  | 20                       | 30   | 40   | 50   | 60   | T <sub>A</sub>        |                       | Ambient temp. [°C] |

**RSO ..50**

| Load current [A] | Thermal resistance [K/W] |      |      |      |      | Power dissipation [W] | Temp. protection [°C] |
|------------------|--------------------------|------|------|------|------|-----------------------|-----------------------|
| 50               | 0.33                     | 0.28 | 0.22 | 0.16 | 0.11 | 181                   | 80°C                  |
| 45               | 0.38                     | 0.32 | 0.25 | 0.19 | 0.13 | 158                   |                       |
| 40               | 0.44                     | 0.37 | 0.29 | 0.22 | 0.15 | 136                   |                       |
| 35               | 0.52                     | 0.43 | 0.35 | 0.26 | 0.17 | 116                   |                       |
| 30               | 0.63                     | 0.52 | 0.42 | 0.31 | 0.21 | 96                    |                       |
| 25               | 0.78                     | 0.65 | 0.52 | 0.39 | 0.26 | 77                    |                       |
| 20               | 1                        | 0.84 | 0.67 | 0.50 | 0.34 | 60                    |                       |
| 15               | 1.4                      | 1.2  | 0.93 | 0.69 | 0.46 | 43                    |                       |
| 10               | 2.2                      | 1.8  | 1.4  | 1.1  | 0.72 | 28                    |                       |
| 5                | 4.5                      | 3.8  | 3    | 2.3  | 1.5  | 13                    |                       |
|                  | 20                       | 30   | 40   | 50   | 60   | T <sub>A</sub>        | Ambient temp. [°C]    |

**RSO ..90, RSO ..110**

| Load current [A] | Heatsink/Thermal resistance [K/W] |      |      |      |      | Power dissipation [W] | Temp. protection [°C] |
|------------------|-----------------------------------|------|------|------|------|-----------------------|-----------------------|
| 90               | 0.13                              | 0.10 | 0.07 | 0.04 | -    | 304                   | 80°C                  |
| 80               | 0.19                              | 0.15 | 0.12 | 0.08 | 0.04 | 260                   |                       |
| 70               | 0.27                              | 0.22 | 0.18 | 0.13 | 0.09 | 219                   |                       |
| 60               | 0.33                              | 0.28 | 0.22 | 0.17 | 0.11 | 181                   |                       |
| 50               | 0.41                              | 0.35 | 0.28 | 0.21 | 0.14 | 145                   |                       |
| 40               | 0.54                              | 0.45 | 0.36 | 0.27 | 0.18 | 111                   |                       |
| 30               | 0.75                              | 0.63 | 0.50 | 0.38 | 0.25 | 80                    |                       |
| 20               | 1.2                               | 0.99 | 0.79 | 0.59 | 0.39 | 51                    |                       |
| 10               | 2.5                               | 2.1  | 1.7  | 1.2  | 0.83 | 24                    |                       |
|                  | 20                                | 30   | 40   | 50   | 60   | T <sub>A</sub>        |                       |

## Heatsink Selection

| Carlo Gavazzi Heatsink (see Accessories) | Thermal resistance      |
|--|-------------------------|
| No heatsink required                     | $R_{th\ s-a} > 8.0$ K/W |
| RHS 300 Assy or backplate                | 5.0 K/W                 |
| RHS 301 Assy                             | 0.8 K/W                 |
| RHS 301 F Assy                           | 0.25 K/W                |
| Consult your distributor                 | $< 0.25$ K/W            |

Compare the value found in the load current versus temperature chart with the standard heatsink values and select the heatsink with the next lower value.

It is recommended to protect the solid state relay against overheating. Therefore the chart also states the maximum switching temperature (70, 80 or 90 °C) for the optional temperature limit switch.

## Housing Specifications

|  |   |   |                    |
|--|---|---|--------------------|
| <b>Weight</b><br>RSO ..10, ..25, ..50<br>RSO ..90, ..110 | Approx. 275 g<br>Approx. 385 g                    | <b>Relay</b><br>Mounting screws<br>Mounting torque            | M5<br>≤ 1.5 Nm     |
| <b>Housing material</b><br>Colour                        | Noryl, glass-reinforced<br>Black                  | <b>Control terminal</b><br>Mounting screws<br>Mounting torque | M3<br>≤ 0.5 Nm     |
| <b>Base plate</b><br>@ ≤ 50 A<br>@ ≥ 90 A                | Aluminium, nickel-plated<br>Copper, nickel-plated | <b>Power terminal</b><br>Mounting screws<br>Mounting torque   | M5 x 6<br>≤ 1.5 Nm |
| <b>Potting compound</b>                                  | Polyurethane, black                               |   |                    |

## Applications

The output module RSO ..110 is recommended for motors up to 22 kW @ 400 V. The RSO ..110 is designed for use in applications with high surge current conditions. Care must be taken to ensure proper heat-sinking when the relays are to be used at high nominal currents. Adequate electrical connection between relay terminals and cable must be ensured.

**Example 1:**  
**Power dissipation - RSO 40110:**

$I_{load} = 40 \text{ Arms} = 111 \text{ W}$   
See previous page.

**Example 2:**  
Motor: 3 kW, 4 HP  
3 x 400 VAC, 4-pole  
 $T_A: 50^\circ\text{C}$   
Starting time: ≤ 5 s

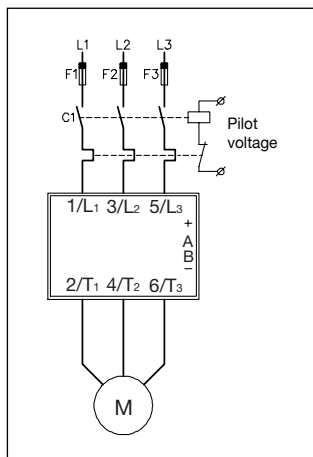
For this application RSC-AAM60 must be used. The output module RSO4025 is selected according to the Selection Guide.

The smallest heatsink required is 1 K/W, and the power dissipation is 25 W.

This gives:  
Control module:  
RSC-AAM60  
Output module: RSO 4025  
Heatsink: 1K/W

**Connection to the mains**  
Since no motor protective circuitry is included in the RSC/RSO, the motor must be protected in the usual way, i.e. either by a thermal relay, a PTC-resistor or a Klixon bimetal temperature switch near the motor windings.

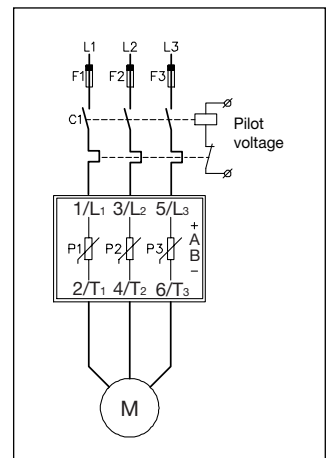
If short circuit protection is required, fuses F1 to F3 should be ultrafast and selected according to the load integral ( $I^2t$ ) of the RSO output module and the motor load.



Overload protection by thermal relay

**Transient voltage protection**  
With an unfiltered main supply, voltage transient may occur. Since these transients could have a high energy content, it is advisable to use varistors to protect the output module.

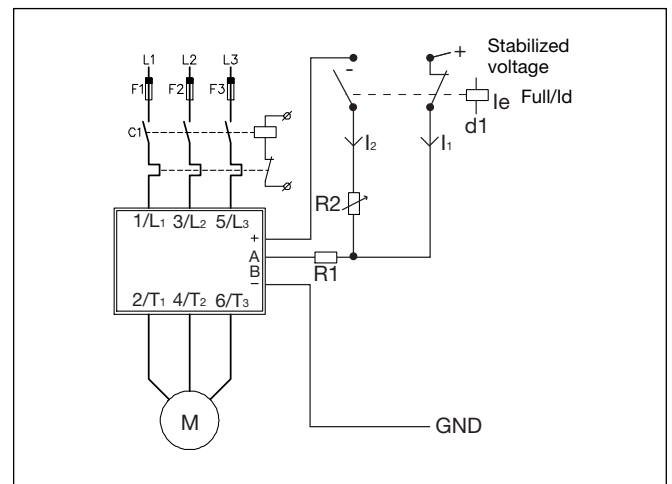
The varistors are already mounted in the RSO output module and they are selected according to the rated operational voltage.



**Energy saving for motors in idle mode**

When motors are running idle, it not necessary to maintain a full magnetic field, as is the case when the motor has to produce full torque. By lowering the motor voltage, power losses inside the motor are also reduced.

When the motor is idle, d1 will switch the control current from  $I_1 > 20 \text{ mA}$  to  $I_2$ , which is adjusted to a value at which the motor is still running at full speed, but at a lower voltage. Please remark that this type of phase-angle controlled voltage reduction, demands additional filtering to fulfill EMC regulations.





## Applications (cont.)

In order to achieve a 4 to 20 mA signal from a 12 or 24 VDC source, a resistor and a potentiometer should be connected in series with the voltage source and the RSC controller.

We define the  $I_{max}$  to be e.g. 24 mA, which means that the series resistors must be:

$$R_1 (12 V) = U/I - R_{int} = 12 V/24 mA - 250 \Omega = 250 \Omega$$

$$R_1 (24 V) = U/I - R_{int} = 24 V/24 mA - 250 \Omega = 750 \Omega$$

If the minimum current is defined to be e.g. 2.4 mA and the 250  $\Omega$   $R_{int}$  input resistance of the RSC is also calculated in:

$$R_2 (12 V) = U/I - R_1 - R_{int} = 12/2.4 - 250 - 250 = 4500 \Omega$$

$$R_2 (24 V) = U/I - R_1 - R_{int} = 24/2.4 - 750 - 250 = 9000 \Omega$$

### Selection Guide

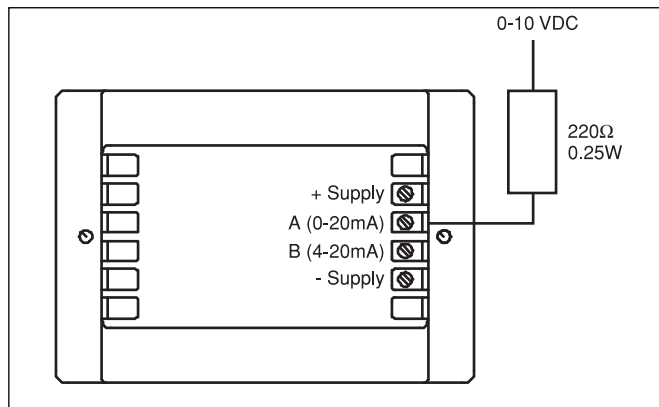
#### 400 VACrms and 480 VACrms motors

| Output module   | RSO ..10    | RSO ..25  | RSO ..50    | RSO ..90    | RSO ..110   |
|-----------------|-------------|-----------|-------------|-------------|-------------|
| Max. motor size | 3 HP/2.2 kW | 5 HP/4 kW | 15 HP/11 kW | 20 HP/15 kW | 30 HP/22 kW |

#### 600 VACrms motors

| Output module   |  |  | RSO 6050 | RSO 6090 | RSO 60110 |
|-----------------|--|--|----------|----------|-----------|
| Max. motor size |  |  | 15 HP    | 30 HP    | 40 HP     |

## Wiring Diagram (0-10 VDC control)



## Short circuit Protection (according to EN/IEC 60947-4-2)

Type of coordination: 2  
Rated short circuit current

| RSO...25<br>RSO...10   | RSO...50   | RSO...90   | RSO...110  |
|--|--|--|--|
| 5kA when protected by semiconductor fuses. Ferraz Shawmut 25A, Class URQ Art. No. 6.9 CP gRC 14.51/ 25 | 5kA when protected by semiconductor fuses. Ferraz Shawmut 63A, Class URQ Art. No. 6.921 CP URQ 27 x 60/ 63 | 5kA when protected by semiconductor fuses. Ferraz Shawmut 80A, Class URQ Art. No. 6.921 CP URQ 27 x 60/ 80 | 5kA when protected by semiconductor fuses. Ferraz Shawmut 100A, Class URQ Art. No. 6.921 CP URQ 27 x 60/ 100 |