Power Electronics

MINISTART
Softstarter with braking function
BL 9028

- According to IEC/EN 60 947-4-2
- IEC/EN 60 947-8 (motor protection with variant /_1_)
- 2-phase motor control
- For motors up to 11 kW at 3 AC 400 V
- Separate settings for start and brake time, as well as starting and braking torque
- No braking contactor necessary
- Function test of brake circuit before softstart
- With automatic standstill detection
- Current monitoring
  - to protect the power semiconductors
  - for device protection at stalled motor
- Maintenance- and wearfree
- Auxiliary DC 24 V
- Monitors undervoltage and phase sequence
- With input to detect motor temperature via PTC (variant /_1_)
- 3 relay outputs for indication of status and fault with LED-indication
- Width: 112.5 mm

Applications
- Motor with gear, belt or chain drive
- Fans, pumps, conveyor systems, compressors
- Woodworking machines, centrifuges
- Packing machines, door-drives

The devices slowly ramps up the current on two phases, therefore allowing the motor torque to build up slowly. This reduces the mechanical stress on the machine and prevents damage to conveyed material.

Start/Stop switch
When the motor is on full speed after the starting with start/stop switch S the semiconductors are bridged with internal relay contacts to prevent internal power losses and heat built up. When stopping the motor via start/stop switch S braking is started. The braking current flows until the motor standstill is detected but not longer (max. 20 s) through the motor windings.

Monitoring relay 1 (contact 13-14)
The relay energizes at the end of the softstart ramp and de-energizes at the beginning of the braking cycle. (operation with bridged semiconductors). When a failure occurs the relay de-energizes when the semiconductors switch off.

Monitoring relay 2 (contact 13-24)
This relay energizes as soon as the unit is ready for operation after connecting it to power. If any error occurs the monitoring relay 2 will be de-energized immediately. The power output will be switched off.

Monitoring relay 4 (contact 43-44)
This relay is energized when motor standstill is detected. It will be reset by starting the motor. The monitoring relay 4 is de-energized if an error occurs.

Input P1 / P2 / P3 to monitor the motor temperature (variant /_1_)
To monitor overtemperature on the motor a bimetallic contact can be connected to P1 / P2. When overtemperature is detected the power semiconductors switch off and all relays de-energize. On P1 / P2 up to 6 PTC sensors can be connected. On detection of over-temperature, short circuit or broken wire (in sensor circuit) the power semiconductors switch off and all relays de-energise. The fault is reset by disconnecting the power supply temporarily after the temperature on the motor is down again.
If standstill is not detected, the braking cycle is interrupted after 20 s. The brake current switches off after 0.5 sec standstill detection. After activation of the start input mains frequency, phase sequence and presence of all 3 phases is checked. Internal temperature monitoring protects the thyristors. By switching on or off of the power supply this fault can be reset after the temperature has dropped. To protect the power circuit the current is monitored in L1-T1. If the fixed settings are exceeded, the device switches off and a failure indication is displayed by a red LED.

Monitoring of phases and phase shift protects the motor or the system. After removing the fault this error can be reset switching the power supply ON and OFF again.

External bimetallic switches or PTC-thermo sensors are used to monitor motors on thermal overload. (variant /_1_). Overload results in disconnection of the motor and failure indication via the red error LED. After a cooling down period for the motor, the failure can be reset switching the power supply OFF and ON again.

Variation of speed is not possible with this device. Without load a softstart cannot be achieved. It is recommended that the softstart is protected by superfast semiconductor fuses rated as per the current rating of the soft-start or motor. However, standard line and motor protection is acceptable, but for high starting frequencies motor winding temperature monitoring is recommended. The softstarter must not be operated with capacitive load e.g. power factor compensation on the output.

In respect to safety of persons and plant only qualified staff is allowed to work on this device.

Green LED: perm. on: - When auxiliary supply connected or bypass relay energized flasher light: - While starting and breaking

Monitoring relay 1
Yellow LED: perm. on: - When contact 13-14 switched on

Monitoring relay 2
Yellow LED: perm. on: - When contact 13-24 switched on

Monitoring relay 4
Yellow LED: perm. on: - When contact 43-44 switched on
Red LED: steady flashing: - Motor current is > 3 x device current
Red LED: flasher light : - Error
1*: - Overtemperature on thyristor (internal)
2*: - Overtemperature on motor or broken wire in sensor circuit P1/P2 or bi-metal contact at sensor circuit P2/P3 has tripped (oopen)
3*: - Short circuit on sensor circuit P1/P2
4*: - Phase failure
5*: - Incorrect phase sequence, exchange connections on L1 and L2
6*: - Incorrect frequency
7*: - Incorrect brake circuit
10*: - Incorrect RAM
13*: - Overcurrent
14*: - Brake current to high
15*: - Overcurrent at end of ramp up

1-15* = Number of flashing pulses in short sequence

Monitoring Features
- If standstill is not detected, the braking cycle is interrupted after 20 s.
- The brake current switches off after 0.5 sec standstill detection.
- After activation of the start input mains frequency, phase sequence and presence of all 3 phases is checked.
- Internal temperature monitoring protects the thyristors. By switching on or off of the power supply this fault can be reset after the temperature has dropped.
- To protect the power circuit the current is monitored in L1-T1. If the fixed settings are exceeded, the device switches off and a failure indication is displayed by a red LED.
- Monitoring of phases and phase shift protects the motor or the system. After removing the fault this error can be reset by switching the power supply on and off.
- External bimetallic switches or PTC-thermo sensors are used to monitor motors on thermal overload. (variant /_1_). Overload results in disconnection of the motor and failure indication via the red error LED. After a cooling down period for the motor, the failure can be reset switching the power supply OFF and ON again.

Notes
Variation of speed is not possible with this device. Without load a softstart cannot be achieved. It is recommended that the softstart is protected by superfast semiconductor fuses rated as per the current rating of the soft-start or motor. However, standard line and motor protection is acceptable, but for high starting frequencies motor winding temperature monitoring is recommended. The softstarter must not be operated with capacitive load e.g. power factor compensation on the output.

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<table>
<thead>
<tr>
<th>Terminal designation</th>
<th>Signal description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1, X2</td>
<td>Start-/Stop-Signal</td>
</tr>
<tr>
<td>13, 14</td>
<td>Monitoring relay 1 bridging operation</td>
</tr>
<tr>
<td>13, 24</td>
<td>Monitoring relay 2 Ready</td>
</tr>
<tr>
<td>43, 44</td>
<td>Monitoring relay4 Standstill</td>
</tr>
<tr>
<td>A1(+), A2</td>
<td>Auxiliary voltage DC 24 V</td>
</tr>
<tr>
<td>L1, L2, L3</td>
<td>Phase voltage</td>
</tr>
<tr>
<td>T1, T2, T3</td>
<td>Motor connection</td>
</tr>
<tr>
<td>P1, P2, P3</td>
<td>PTC thermal sensor, bi-metal contact</td>
</tr>
</tbody>
</table>
**Technical Data**

**Phase / motor**
- Voltage L1/L2/L3: 3 AC 200 V -10 % ... 480 V +10 %
- Nominal frequency: 50 / 60 Hz
- Nominal motor power $P_n$: 11 kW
- Switching frequency at 3 x $I_n$, 5 s, $\alpha_0 = 45^\circ$: 20 / h
- Max. permissible braking current: 50 A $\alpha_{et}$
- Start torque: 20 ... 80 %
- Ramp time: 1 ... 20 s
- Braking time: max. 20 s
- Braking delay: 750 ms
- Braking voltage: DC 10 ... 90 V
- Start delay: 250 ms
- Auxiliary voltage $U_H$: model DC 24 V: A1/A2, DC 24 V, + 10 %, - 15 %

**Inputs**
- Control input X1, X2: DC 24 V / 2.5 mA / edge triggered
- Switching current: DC 1 mA
- Switch voltage: DC 5 V
- Switching frequency at 3 x IN, 5 s, $\alpha_0 = 45^\circ$: 20 / h

**Outputs**
- Nominal motor power at 3 AC 400 V: 11 kW
- Control input X1, X2: DC 24 V
- Input P2/P3 for bi-metal contact: Width: 112.5 mm
- Switching current: DC 1 mA
- Switch voltage: DC 5 V
- Input P1/P2 for PTC-sensor: Switching current: DC 1 mA
- Switching voltage: DC 5 V
- Switching frequency at 3 x IN, 5 s, $\alpha_0 = 45^\circ$: 20 / h
- Power consumption: 2 W
- Residual ripple max.: 5 %
- Max. semiconductor fuse: 6600 A $\alpha$ s

**Thermal sensor:** according to DIN 44081
- Number of sensors: 1 ... 6 in series
- Response value: 3 k $\Omega$
- Measuring voltage: max. DC 5 V
- Thermal continous current $I_{th}$: 4 A
- Thermal continous current $I_{th}$: 4 A
- Switching capacity to AC 15
- NO contact: 3 A / 400 V IEC/EN 60947-5-1
- Electrical life: to AC 15 at 3 A, AC 400 V: 2 x 10^6 switch. cycl. IEC/EN 60947-5-1
- Short circuit strength max. fuse rating: 4 A gG / gL IEC/EN 60947-5-1

**General Data**
- Temperature range:
  - Operation: 0 ... + 45 °C
  - Storage: - 25 ... + 75 °C
- Altitude: < 2000 m
- Clearance and creepage distances
  - Rated impulse voltage / pollution degree
  - Control voltage to auxiliary voltage, motor voltage: 4 kV / 2 IEC 60664-1
  - Auxiliary voltage to motor voltage: 4 kV / 2 IEC 60664-1
  - Motor voltage to heat sink: 6 kV / 2 IEC 60664-1
- EMC
  - Electrostatic discharge: 8 kV (air) IEC/EN 61000-4-2
  - HF-irradiation: 80 MHz ... 2.7 GHz: 10 V / m IEC/EN 61000-4-3
  - Fast transients: 2 kV IEC/EN 61000-4-4
  - Surge voltages between wire for power supply: 1 kV IEC/EN 61000-4-5
  - Between wire and ground: 2 kV IEC/EN 61000-4-5
  - HF wire guided: 10 V IEC/EN 61000-4-6
- Interference emission
  - Wire guided: Limit value class B IEC/EN 60849-4-2
  - Radio irradiation: Limit value class B IEC/EN 60849-4-2

**Degree of protection:**
- Housing: IP 40 IEC/EN 60529
- Terminals: IP 20 IEC/EN 60529
- Vibration resistance: Amplitude 0.35 mm frequency 10 ... 55 Hz, IEC/EN 60068-2-6
- Climate resistance: 0 / 075 / 04 IEC/EN 60608-1
- Wire connection
  - Load terminals: 1 x 10 mm² solid
  - 1 x 6 mm² stranded ferruled
  - Control terminals: 1 x 4 mm² solid or
  - 1 x 2.5 mm² stranded ferruled (isolated) or
  - 2 x 1.5 mm² stranded ferruled (isolated)

**Technical Data**

**Standard Type**
- BL 9028.03 3 AC 200 ... 480 V 50/60 Hz $U_h$ DC 24 V 11 kW
- Article number: 0068352
- Nominal motor power at 3 AC 400 V: 11 kW
- Control input X1, X2: DC 24 V
- Width: 112.5 mm

**Variant**
- BL 9028.03/1_: Motor protection with bi-metal contact or PTC thermal sensor

**Ordering Example**
- BL 9028.03/ 3 AC 200...480 V 50/60 Hz $U_h$ DC 24 V 11 kW
- Nom. motor power at 3 AC 400 V
- Aux./Control voltage Nom. frequency
- Phase / motor voltage
- Variant 0 = Standard
- 0 = Standard
- 1 = Input P1/P2/P3 for motor temp. monitoring
- 0 = with standstill detection
- Contacts
- Type
Control input X1, X2

With BL 9028 softstart begins by closing switch S and braking starts when opening switch S. When closing S during braking, softstart begins again. A new start can only be made, after the braking cycle is completed. The control input is triggered with rising edge.

Adjustment Facilities

<table>
<thead>
<tr>
<th>Potentiometer</th>
<th>Description</th>
<th>Initial setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_{on}$</td>
<td>Starting voltage</td>
<td>fully anti-clockwise</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Ramp-up time</td>
<td>fully clockwise</td>
</tr>
<tr>
<td>$I_{br}$</td>
<td>Braking current</td>
<td>fully anti-clockwise</td>
</tr>
</tbody>
</table>

Set-up Procedure

Softstart:
1. Start the motor via control input X1/X2 and turn potentiometer $M_{on}$ up until the motor starts to turn without excessive humming.
2. Adjust potentiometer $t_{on}$ to give desired ramp time.
3. On correct setting the motor should accelerate up to nominal speed. If the start takes too long fuses may blow, especially on motors with high inertia.

- **Attention:** If the ramp-up time is adjusted to short, the internal bridging contact closes before the motor is on full speed. This leads to interruption of the softstart and to fault message 15.

Braking:
Press stop button and adjust with potentiometer $I_{br}$ the braking current to the desired value. Please adjust the braking current high enough so that the brake time is shorter than 20 sec. The brake current should be limited to $1.8 \ldots 2 \times I_e$ of the motor. If the brake function at 1.8 ... 2 times of rated current has not finished within 20 sec the load is too high. The next larger motor should be used. To avoid an overload of the device and the motor, the brake current should be measured with a moving coil instrument in the motor connecting line T1.

Function test of brake circuit:
Before starting the motor the function of the braking circuit is tested by a short braking attempt. If no current flows during the test the device goes into failure mode. By disconnecting and reconnecting of the auxiliary voltage the fault can be reset.

Temperature monitoring:
BL 9028 features overtemperature monitoring of its internal power semiconductors. The unit is therefore protected against overheating during the set up procedure. BL 9028 can be reset after the semiconductors have cooled down by momentarily removing the auxiliary supply voltage.

Monitoring of the power circuit:
To protect the power circuit against overcurrent the current is monitored in L1-T1. To high starting current, braking current or current at stalled motor result in disconnecting the motor current and failure indication by flashing code (see Indicators).

Safety Notes

- Never clear a fault when the device is switched on.
- The user must ensure that the device and the necessary components are mounted and connected according to the locally applicable regulations and technical standards.
- Adjustments may only be carried out by qualified specialist staff and the applicable safety rules must be observed.
During normal operation failure messages may occur. The messages are indicated by a flashing sequence of the „Error” LED.

<table>
<thead>
<tr>
<th>Flashes</th>
<th>Fault</th>
<th>Reason</th>
<th>Failure recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x</td>
<td>Overtemperature on power unit</td>
<td>Permitted duty cycle exceeded</td>
<td>Reduce duty-cycle Wait till heat sink cools down</td>
</tr>
<tr>
<td>2 x</td>
<td>Overtemperature on motor or broken wire in thermistor circuit</td>
<td>High duty-cycle on motor or broken wire</td>
<td>Decrease duty-cycle. Repair wiring of temperature sensor</td>
</tr>
<tr>
<td>3 x</td>
<td>Short circuit in thermistor circuit</td>
<td>Squeeze conduit, defective soldering point</td>
<td>Check connection wire, repair</td>
</tr>
<tr>
<td>4 x</td>
<td>Phase failure</td>
<td>Defective fuse</td>
<td>Change fuse Check voltage range</td>
</tr>
<tr>
<td>5 x</td>
<td>Decrease phase sequence</td>
<td>Connection L1, L2, L3 incorrect</td>
<td>Correct connection sequence see application</td>
</tr>
<tr>
<td>6 x</td>
<td>Mains frequency is out of tolerance</td>
<td>Wrong mains frequency</td>
<td>Device not suitable for the frequency. Contact manufacturer.</td>
</tr>
<tr>
<td>7 x</td>
<td>Broken circuit</td>
<td>Cable break Defective braking relay</td>
<td>Check wiring The unit has to repaired</td>
</tr>
<tr>
<td>10 x</td>
<td>RAM defective</td>
<td>Defective component</td>
<td>The unit has to repaired</td>
</tr>
<tr>
<td>13 x</td>
<td>Overcurrent on power semiconductors</td>
<td>Gravitational start Motor blocked</td>
<td>Prolonging ramp up time. Set starting torque lower. Use unit with higher ranges Remove blockage</td>
</tr>
<tr>
<td>14 x</td>
<td>Brake current to high</td>
<td>Braking current adjusted over permitted value</td>
<td>Back off potentiometer I₀p</td>
</tr>
<tr>
<td>15 x</td>
<td>Overcurrent on ramp</td>
<td>Gravitational start ramp time to short or starting torque to high</td>
<td>Prolonging ramp up time. Set starting torque lower. Use unit with higher ranges</td>
</tr>
<tr>
<td>16 x</td>
<td>Communication error internal</td>
<td>Defective component</td>
<td>The unit has to repaired</td>
</tr>
<tr>
<td>17 x</td>
<td>Overcurrent on bridging relay</td>
<td>Motor blockage</td>
<td>Remove blocking</td>
</tr>
</tbody>
</table>