

**SAFEMASTER S
Standstill Monitor
UG 6946**

**Translation
of the original instructions**

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Before installing, operating or maintaining this device, these instructions must be carefully read and understood.



The installation must only be done by a qualified electrician!



Do not dispose of household garbage!
The device must be disposed of in compliance with nationally applicable rules and requirements.



Storage for future reference

To help you understand and find specific text passages and notes in the operating instructions, we have important information and information marked with symbols.

Symbol and Notes Statement



DANGER:
Indicates that death or severe personal injury will result if proper precautions are not taken.



WARNING:
Indicates that death or severe personal injury can result if proper precautions are not taken.



CAUTION:
Indicates that a minor personal injury can result if proper precautions are not taken.



INFO:
Referred information to help you make best use of the product.



ATTENTION:
Warns against actions that can cause damage or malfunction of the device, the device environment or the hardware / software result.

General Notes

The product hereby described was developed to perform safety functions as a part of a whole installation or machine. A complete safety system normally includes sensors, evaluation units, signals and logical modules for safe disconnections. The manufacturer of the installation or machine is responsible for ensuring proper functioning of the whole system. DOLD cannot guarantee all the specifications of an installation or machine that was not designed by DOLD. The total concept of the control system into which the device is integrated must be validated by the user. DOLD also takes over no liability for recommendations which are given or implied in the following description. The following description implies no modification of the general DOLD terms of delivery, warranty or liability claims.

Designated Use

The UG 6946 is used for standstill detection on motors without sensors.

- Standstill detection in safety circuits according to IEC/EN 60204 in machines with dangerous parts or tools to enable protection systems.
- To avoid damage if unexpected start can cause collision.
- Motor control when reversing direction.

When used in accordance with its intended purpose and following these operating instructions, this device presents no known residual risks. Nonobservance may lead to personal injuries and damages to property.

Safety Notes



Risk of electrocution! **Danger to life or risk of serious injuries.**

- Disconnect the system and device from the power supply and ensure they remain disconnected during electrical installation.
- The device may only be used for the applications described in the mutually applicable operating instructions / data sheet. The notes in the respective documentation must be heeded. The permissible ambient conditions must be observed.
- The contact protection of the elements connected and the insulation of the supply cables must be designed in accordance with the requirements in the operating instructions / data sheet.
- Note the VDE and local regulations, particularly those related to protective measures.
- The terminals X1 - X2 - X3 has no galvanic separation to the measuring circuit L1 - L2 - L3. They must be controlled with volt free contacts.



Risk of fire or other thermal hazards! **Danger to life, risk of serious injuries or property damage.**

- The device may only be used for the applications described in the mutually applicable operating instructions / data sheet. The notes in the respective documentation must be heeded. The permissible ambient conditions must be observed. In particular, the current limit curve must be heeded.
- The device may only be installed and put into operation by experts who are familiar with this technical documentation and the applicable health and safety and accident prevention regulations.



Functional error! **Danger to life, risk of serious injuries or property damage.**

- The device may only be used for the applications described in the mutually applicable operating instructions / data sheet. The notes in the respective documentation must be heeded. The permissible ambient conditions must be observed.
- The device may only be installed and put into operation by experts who are familiar with this technical documentation and the applicable health and safety and accident prevention regulations.
- The unit should be panel mounted in an enclosure rated at IP 54 or superior. Dust and dampness may lead to malfunction.



Installation fault! **Danger to life, risk of serious injuries or property damage.**

- Make sure of sufficient protection circuitry at all output contacts for capacitive and inductive loads.



Attention!

- The safety function must be triggered during commissioning.
- It is the liability of the builder of the plant or machine to guarantee the complete safety function by selecting the correct components, wiring and operation.
Also the correct tripping point U_{an} and time delay setting t_s of UG 6946 suitable for the application is in the liability of the user and has to be determined by testing the system under worst case conditions.
If e.g. the motor current is run down slowly using a frequency inverter or a softstop unit, a de-magnetisation of the motor can take place. It is necessary to check if the remaining remanence voltage is sufficient to guarantee a correct and safe standstill monitoring. At high frequencies an increasing damping of the measuring inputs has to be taken into account (see technical data Measuring input „response value dependant on frequency“).
- Opening the device or implementing unauthorized changes voids any warranty



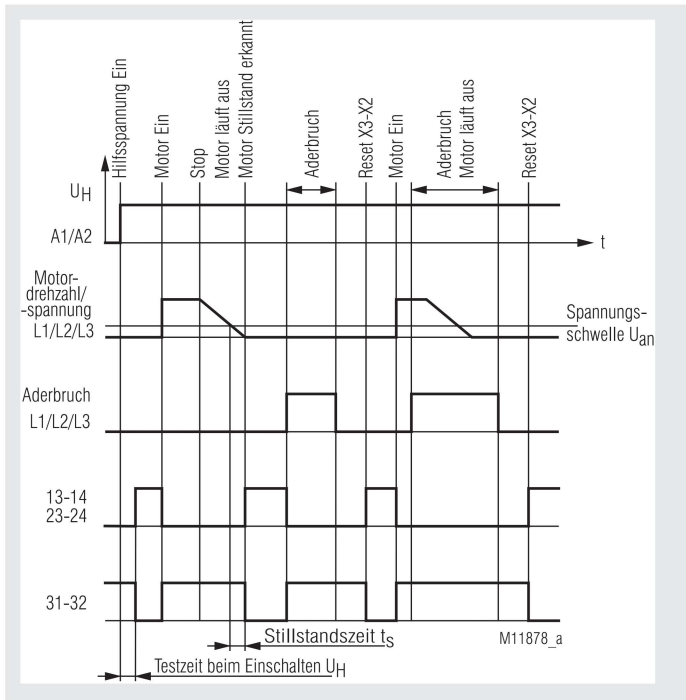
Your Advantages

- Without sensor and safe
- Fast reaction time
- Easy to retrofit
- Combined with Interlock SAFEMASTER STS
- Protection against manipulation by sealable transparent cover over setting switches

Features

- **According to**
 - Perf. Level (PL) e and category 4 to EN ISO 13849-1, EN 61800-5-2
 - SIL-Claimed Level (SIL CL) 3 to IEC/EN 62061
 - Safety Integrity Level (SIL) 3 to IEC/EN 61508, IEC/EN 61511 and EN 61800-5-2
- Safe standstill detection on 3- and single-phase motors
- No external sensors necessary
- Independent of direction
- Broken wire detection
- Forcibly guided safety contacts:
 - 2 NO contacts for AC 250 V
 - 1 NC contact for DC 24 V
- Adjustable voltage setting
- Adjustable standstill time delay
- LED indicators for standstill, event of line breakage and operation voltage
- Suitable for operation with inverters
- Removable terminal strips:
 - UG 6946 PS: plug in screw terminals
 - UG 6946 PC: plug in cage clamp terminals
- Variant / __ _1:
 - Possibility of bridging the speed monitoring (muting)
- Width: 22.5 mm

Function Diagramm



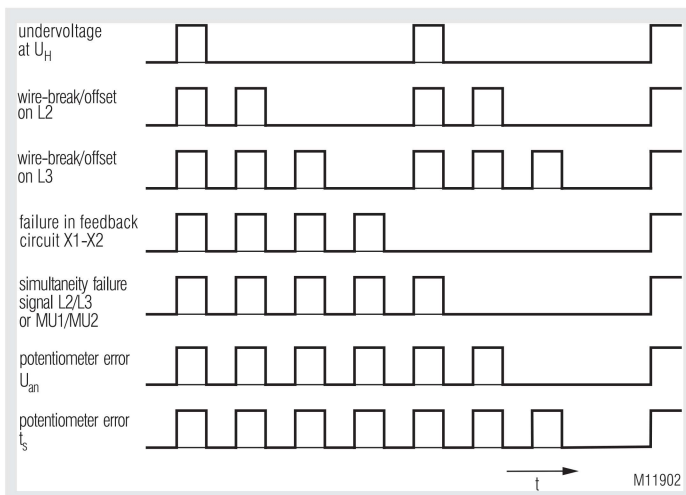
Approvals and Markings



Applications

Safe standstill detection on 3- and single-phase motors, e.g. to enable gate interlocks on machine tools or to activate hold in brakes.

Flashing Codes



Flashing codes of the LED „ERR“ in sequence of priority

Function

The Standstill monitor UG 6946 is suitable to monitor the standstill of all electric motors that generate a remanence voltage while coasting to stop. The UG 6946 is connected to the motor terminals and measures the induced back emf voltage. 2 redundant measuring channels are used (L2-L1 and L3 L1). If the back emf voltage drops to 0 simultaneously in both channels this indicates standstill and the output relay is energized.

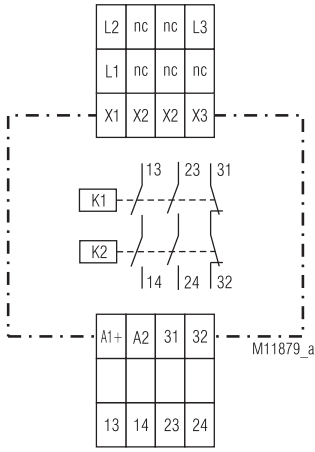
To adopt the unit to all different types of motors and applications the voltage threshold indicating standstill on UG 6946 is adjustable. Also the time delay between detection and energisation of the relay is adjustable (standstill time t_s).

In addition the unit detects broken wire on the measuring inputs L1 / L2 / L3. If broken wire is detected the output relays goes into safe state (as with running motor). This state is stored and can be reset by bridging terminals X3-X2.

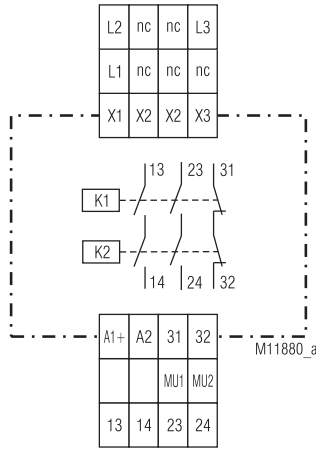
The input signals of both channels are permanently compared. If the signals are different for more than 2.5 sec a simultaneity failure is detected. This failure resets when both input channels receive simultaneous signals with a level, above the voltage threshold and hysteresis.

To the terminals X1-X2 the feedback circuit of external contactors (used for contact reinforcement) is connected (NC contact). If no feedback circuit is required, these terminals must be linked. Open terminals will cause a failure message.

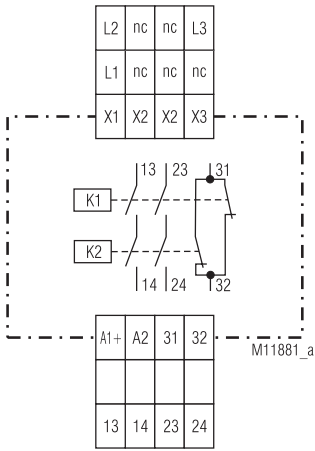
Circuit Diagrams



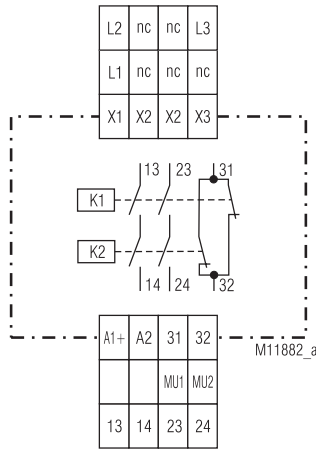
UG 6946.02



UG 6946.02/xx1



UG 6946.22



UG 6946.22/xx1

Function

The UG 6946 can be used for standstill detection on all 3-phase, single phase and DC motors, that generate a voltage caused by remanence when freewheeling. As the voltage level U_{an} for standstill monitoring and the time delay t_s , after detection of standstill until the safety relays are switched on, are adjustable, the function can be adopted to different motors and applications.

Basic function of UG 6946

The auxiliary voltage is connected to the terminals A1-A2; the LED „UH“ lights up green. On undervoltage or missing auxiliary supply the safety outputs are disabled.

A motor connected to the terminals L1-L2-L3 of the UG 6946 generates a voltage when running down (motor is switched off). The voltage is proportional to the speed and caused by residual magnetism (remanence). This voltage is measured redundant on 2 input channels via the terminals L2 and L3 with L1 as common reference.

If the voltage drops on both channels below the adjusted value U_{an} , the unit detects standstill. When the terminals X1-X2 of the feedback circuit are bridged and the time delay t_s is finished, the safety contacts 13-14, and 23-24 close. All contact paths have 2 forcibly guided contacts of 2 safety relays wired in series.

At the same time the LED „OUT“ lights green. During time delay t_s this LED flashes.

If the voltage measured on terminals L1-L2-L3 of UG 6946 rises over the adjusted value plus hysteresis in at least one channel (the motor is switched on or the shaft turns mechanically), the forcibly guided output contacts are switched off immediately (contacts 13-14 and 23-24 open). The LED „OUT“ lights yellow (= U_{an} over adjusted value).

Feedback circuit X1 - X2

If the safety contacts 13-14 and 23-24 control external contactors/components (e.g. to re-enforce or multiply the contacts) the safety function of them must be monitored.

This is done with the feedback circuit (terminals X1-X2) to which the NC contacts of the contactors/components must be connected. (see also wiring diagrams).

The UG 6946 will only enable its safety output if the feedback loop X1-X2 is closed while standstill is detected, i.e. the external contactors/components are in initial state (NC contacts are closed).

The feedback circuit X1-X2 must be closed as long as the safety outputs (because of running motor or external failure) are not enabled. If not the failure „feedback circuit“ is indicated.

If the feedback circuit is not used, the terminals X1-X2 must be bridged.

Connection Terminals

Terminal designation	Signal description
L1-L2-L3	Connection to monitored motor
31-32	Forcibly guided indicator output
13-14, 23-24	Forcibly guided NO contacts for release circuit
X1-X2	Connection of feedback circuit (for external contactors)
X2-X3	Manual reset for external faults
A1-A2	Auxiliary supply (U_H)
MU1, MU2	Muting inputs

Indicators

green-red LED „UH“:	green on, when operation yellow on, when muting operation red on, with internal error
yellow-green LED „OUT“:	yellow on, at $EMK > U_{an}$ flashes green at time progression of t_s permanent on, when output contacts are enable
red LED „ERR“:	flashes at error (see flashing codes)

Function

Failure monitoring

The UG 6946 includes a number of facilities to detect failures that could influence the safety function of the module. The failure check is carried out on power up of the unit and in cycles during normal operation. If a failure occurs the output relays switch off. The failure state is indicated with the LEDs „ERR“ and „UH“.

With safety relevant failures the unit differentiates between external failures (broken wire / offset, simultaneity failure, feedback circuit failure) and internal failures.

Broken wire / offset failures and feedback circuit failures can be stored or automatic reset after removing the fault. (see chapter failure storing).

Broken wire / offset

The connection wires between UG 6946 and motor are continuously monitored for broken wire and on a DC-voltage offset higher than U_{an} . In the case of a broken wire or offset failure the output relays are switched off immediately and the LED „OUT“ lights yellow. In addition a failure signal comes up with delay (on broken wire after 2 s on offset failure after 8 s): the LED „ERR“ flashes with failure code 2 or 3 depending on the failure located either between L1-L2 or L1-L3.

Simultaneity of the measuring signals

As additional safety feature the 2 input signals (L2 and L3) are compared continuously. This allows to detect also internal failures in one measuring channel.

If the signals are different for at least 2.5 s (one channel $>U_{an}$ the other $<U_{an}$) simultaneity failure is detected. LED „ERR“ flashes with failure code 5.

If the measured signals return to the same level $<U_{an}$ the error remains stored and the outputs are disabled.

The simultaneity failure is only reset when both channels return to $>U_{an}$. If after that both channels drop below the setting value, get $<U_{an}$ the out relays will switch on.

Simultaneity of the muting inputs (MU1, MU2)

If the status of MU1, MU2 is different for more than 3 seconds the simultaneity fault is indicated:
The LED "ERR" flashed code 5.

The simultaneity fault is reset only, when both inputs are low and the reset it operated.

Failure in feedback circuit X1-X2

As already mentioned the failure code „feedback circuit“ occurs when the outputs are disabled and there is no connection between terminal X1-X2. The LED „ERR“ flashes with failure code 4.

Also when both input signals drop now to $<U_{an}$ and besides the open feedback loop no other failures are present the feedback circuit failure remains active and the outputs remain disabled.

If the feedback circuit is now closed and the unit is on auto reset for external failures (see failure storing) the output relays are enable and switch on.

Function

Potentiometer error

To achieve the required safety when adjusting the voltage threshold for standstill detection, each setting function is realised with 2 potentiometers having one common setting knob. If on 2 corresponding potentiometers a different setting is detected the potentiometer error U_{an} or t_s is displayed.

To remove the failure please try to readjust the potentiometer. Please make sure that you feel the detent

Internal device failure

Internal failures are always stored, independent of the reset input X3 and cause the output relays immediately to switch off, the LED „UH“ to change it's colour from green to red.

Examples for internal failures:

- Failure on safety relays e.g. welded output contacts
- Internal failures on measuring channels and measuring circuits
- Internal failures on control circuits for the safety relays
- failures on setting potentiometers for U_{an} and t_s
- Undervoltage failure (LED „ERR“ flashes with failure code 1)

Failure indication with flash code of LED „ERR“

The flash codes indicate failures caused externally (see diagram flashing codes for failure indication on page 9).

A series of flash pulses 1-7 followed by a slightly longer space is displayed. The flash code indicates the type of failure. If several failures are present at the same time only the failure with the highest priority (lowest flash code) is shown. When this failure is removed the other existing failures are displayed in the same way according to their priority.

Failure storing / reset (terminals X2-X3)

With the external failures broken wire/offset and feedback circuit the operator can choose between manual and automatic reset after the failure is removed.

X2-X3 open:	manual reset
X2-X3 closed:	automatic reset

Attention

The a.m. storing function of the external failures broken wire /offset, and feedback circuit is not a safety function. I.e. in respect to safety aspects it can not be regarded as guaranteed. The reset for these failures must be therefore regarded as auto reset after removing the faults.

Internal device failures that could occur in seldom cases (e.g. caused by temporary interference) can be reset by switching the supply voltage off and on. If a reset is not possible also if the voltage is applied correctly, the device could be defective and should be sent back to the manufacturer for examination or repair.

Connection of UG 6946

The UG 6946 has to be connected according to connection examples or in a similar way. The connection of DC- motors is made as with single phase AC-motors.

L1 - L2 - L3

The measuring wires L1-L2-L3 have to be connected directly to the windings of the monitored motor (not via transformers) in order to provide a correct broken wire detection for the connection wires and motor windings. The motor windings must not be disconnected from the measuring wires by motor contactors, because broken wire detection is activated and standstill monitoring is disabled.

Interference to the measuring wires should be avoided as no standstill may be detected by the UG 6946. If possible the measuring wires should be run separately from the motor wires or screened wires should be used. In this case the screen can be connected at the motor side.

A1 - A2

Connection of the auxiliary supply, recommended fuse : 2A.

13-14, 23-24

Safety output contacts, connection according to the connection examples or similar.

Recommended fuse: 5 A fast acting, to avoid welding of the contacts in the case of external wiring or component failures. See also technical data.

X1 - X2 (feedback circuit)

Connection of NC contacts of external components or contactors for contact re-enforcement, must be linked if not used.

X2 - X3

Connection for manual or auto reset, connection is made according to the required application. When monitoring DC motors or in the case of DC-braking the broken wire / offset failure will be shown during operation. In this case the terminals must be linked because if storing the failure would not allow activation of the safety contacts at standstill.

MU1, MU2 (at variant /xx1 only)

Using the inputs MU1 and MU2 the standstill detection could be muted. The signal on the inputs must be between DC 10 and 26.4 V against A2. If muting is selected on these inputs the standstill detection is disabled. The output relays are energised and monitoring of broken wire, offset and simultaneity of the measuring signals is not operated.

MU1	MU2	Mode
0	0	Muting deactivated
1	1	Muting activated



Attention

The terminals X1-X2-X3 have electrical connections to the measuring inputs L1-L2-L3. Volt free contacts must be used for bridging. If terminal X3 should be controlled by a PLC via an interface relay this must have the necessary insulation between the motor voltage (measuring input) and PLC potential.

Operation Notes

Motors with switched windings

(e.g. star delta starters, reversing circuits, multi speed motors)

With these applications please make sure, that the measuring inputs must be linked via the motor windings. An open connection will result in broken wire indication and disable the safety contacts.

When connecting the UG 6946 to a 3-phase motor with star delta starter the star contactor must be energized while the motor is switched off, in order to achieve closed circuits between L1-L2-L3 via the motor windings.

If it is not possible to switch in the star contactor after the motor is switched off, the measuring inputs of the UG 6946 have to be connected like a single phase connection. L2-L3 are bridged and connected to one end of a motor winding and L1 to the other end of the same winding.

For reversing circuits and multi speed motors please follow the same procedure.

If in a 3-phase connection of UG 6946 windings are switched over, and the interruptions of the measuring circuits are longer then 2 s, the standstill monitor detects broken wire. In order not to store this failure, the unit should work with auto reset.

Operation with DC motors

The UG 6946 can be used on DC motors if these generate a remanence voltage during run down.

The connection is made similar as with a single phase motor.

As the remanence voltage in this case is normally a DC voltage the unit will detect a broken wire / offset failure and indicate it on LED „ERR“. Taking this in mind and operating the unit with auto reset for these failures the unit can be used for safety standstill monitoring.

Operation with electronic motor controller

(inverters, DC-brakes)

The operation of UG 6946 to detect standstill on motors with electronic motor control is possible, if the output voltage of the motor controller drops under the adjusted response value on standstill. (No position control on inverters, no DC voltage on brakes after standstill).

If the inverter produces a DC offset or a DC brake is active, an offset or broken wire failure is indicated on LED „ERR“. This error resets automatically if on terminals X2-X3 automatic reset is selected.

When there are inverters in the installation it is recommended to use screened measuring wires to the motor. The screen can be connected to the motor.

⚠ Attention

If the motor current is run down by inverters or softstop modules in a slow way the motor may be de-magnetised. It is necessary to check if the remaining remanence voltage is sufficient to guarantee a correct and safe standstill monitoring. At high frequencies an increasing damping of the measuring inputs has to be taken into account (see technical data Measuring input „response value dependant on frequency“).

Setup and Setting

Preparation

- Motor on standstill
- Terminals L1-L2-L3 connected to the motor windings
- Provide link on terminals X1-X2
- Provide also link on X2-X3 on DC motors or DC braking
- Adjust U_{an} to minimum
- Adjust t_s to minimum (0.2 s)

Connect correct auxiliary voltage to terminals A1-A2

⇒ After 1 sec the LEDs „UH“ and „OUT“ light up green and the safety contacts are switched on.

If standstill is not detected (LED „OUT“ lights yellow), possibly interference is coupled on the measuring circuit. Adjust U_{an} higher or screen the measuring wires.

Start of motor

⇒ LED „OUT“ changes colour to yellow. The output relays switch off. On DC motors the LED „ERR“ starts to flash after 2 s with flash code 2.

Stop of motor – run down DC braking off

The speed at which standstill is detected (yellow LED „OUT“ changes to green/green flashing) can be adjusted on Potentiometer „ U_{an} “. When the run down is slow or irregular the time delay must possibly be increased to avoid switching on and off of the output relays. Possibly this effect can also be avoided by slightly increasing U_{an} . During time delay t_s the LED „OUT“ flashes green.

If standstill detection shall only take place at very low speed of the motor, U_{an} is set normally to minimum. By increasing the delay time t_s a possible pulsing of the output relays can be avoided. A longer time delay will also guarantee standstill detection only when the motor has already stopped turning. (especially on motors that generate only a small remanence voltage).

On slow decrease of motor speed it is possible that a simultaneity failure occurs (see failure monitoring) when the measuring channels reach the tripping values slowly and not within 2.5 sec. To avoid this failure a single phase connection could be the solution (to make sure that both inputs get the same signal) or the increase of the setting value U_{an} .

If the run down time of the motor is short t_s can be set to a minimum (0.2 s). This is suitable in production systems to shorten machine cycles.

Attention

It is the responsibility of the user to adjust U_{an} and t_s in a way that standstill detection and enabling of the safety contacts in the application is only possible when danger to men and material by the rotating can be excluded.

Technical Data**Input (L1 - L2 - L3)**

Measuring-/Motor voltage: max. AC 690 V
Input resistance: 500 kΩ
Response value U_{an}: 20 mV ... 400 mV, adjustable or
 0.2 ... 4 V, adjustable

Response value dependent on frequency

Input frequency (Hz):	50	100	200	400	600	1k	1,5 k	2k
Multiplication factor for U _{an} :	1.0	1.1	1.2	1.5	2.0	2.8	5	8

Hysteresis (for detection of running motor): 100 %
Release delay for detection of running motor: < 100 ms
Standstill time delay t_s: 0.2 ... 6 s adjustable

Auxiliary circuit (A1-A2)

Auxiliary voltage U_H: DC 24 V
Recommended fusing: 2 A
Voltage range: 0.9 ... 1.2 U_N
Nominal consumption: 3 W
max. residual ripple (DC): 10 %
Start up delay when connecting U_H at standstill: 0.4 ... 0.8 s + adjustable t_s

Input (MU1-MU2)

Min. operating time / Min. Off-time: > 200 ms

Output

Contacts (saftey contacts): 2 NO contacts, 1 NC contact

The NO contacts are safety contacts
The NC contact 31-32 can only be used for monitoring!

Contact type: relay, positive guide
Nominal output voltage
 NO contact: AC 250 V
 NC contact: DC 24 V
Thermal current I_{th}: 5 A
 (see quadratic total current limit curves)

Switching capacity

to AC 15
 NO contact: 3 A / AC 230 V IEC/EN 60947-5-1
 to DC 13
 NO contact: 1 A / DC 24 V IEC/EN 60947-5-1
 NC contact: 1 A / DC 24 V IEC/EN 60947-5-1
 to DC 13
 NO contact: 4 A / 24 V at 0.1 Hz IEC/EN 60947-5-1
 NC contact: 4 A / 24 V at 0.1 Hz IEC/EN 60947-5-1

Fusing of the

safety contacts: max. fuse rating 4 A gG / gL
 line circuit breaker C6A

Max. operating frequency: 1200 / h

Electrical life

5 A, AC 230 V cos φ = 1: ≥ 2 x 10⁵ switching cycles

Mechanical life: ≥ 20 x 10⁶ switching cycles

Technical Data**General Data**

Nominal operating mode: Continuous operation
Temperature range
 Operation: - 25 ... + 60°C
 (see quadratic total current limit curve)
 At an altitude of > 2000 m the maximum permissible temperature reduces by 0.5°C / 100 m
 Storage: - 40 ... + 75°C

Storage:

Altitude,

Clearance and creepage distance

rated impulse voltage / pollution degree: IEC 60 664-1

≤ 2000 m > 2000 m up to ≤ 4000 m

13, 14, 23, 24 against all others: 6 kV / 2 4 kV / 2

31, 32, A1, A2, MU1, MU2 to

L1, L2, L3: 6 kV / 2 4 kV / 2

L1, L2, L3 each others: 6 kV / 2 4 kV / 2

13, 14 zu 23, 24: 4 kV / 2 2,5 kV / 2

Control terminal X1 / X2 / X3: no galvanic separation to L1 / L2 / L3

EMC IEC/EN 61326-3-1, IEC/EN 62061

Interference suppression: Limit value class B EN 55011

Degree of protection

Housing: IP 40 IEC/EN 60529

Terminals: IP 20 IEC/EN 60529

Enclosure:

thermoplastic with VO behaviour

according to UL subject 94

IEC/EN 60068-2-6

Frequency / Amplitude: 10 ... 57 Hz, 0.075 mm constant

Acceleration: 57 ... 150 Hz, 1 g constant

Climate resistance: 25 / 060 / 04 IEC/EN 60068-1

Terminal designation: EN 50005

Wire connection DIN 46228-1/-2/-3/-4

Wire fixing: captive slotted screw or

cage clamp terminals

Mounting: DIN-rail IEC/EN 60715

Weight: approx. 230 g

Dimensions**Width x height x depth:**

UG 6946 PS: 22.5 x 110 x 120.3 mm

UG 6946 PC: 22.5 x 120 x 120.3 mm

Standard Type

UG 6946.02PS 20 ... 400 mV UH DC 24 V 0,2 ... 6 s
 Article number: 0068412
 • Output: 2 NO contacts, 1 NC contact
 • Response value U_{an}: 20 ... 400 mV
 • Auxiliary voltage U_H: DC 24 V
 • Standstill time t_s: 0.2 ... 6 s
 • Muting: without muting
 • Width: 22.5 mm

Ordering Example

UG 6946 /00 20 ... 400 mV UH DC 24 V 0.2 ... 6 s

Standstill time t_s

Auxiliary voltage U_H

Response value U_{an}

Muting

0 = without muting

1 = with muting

Type of terminals

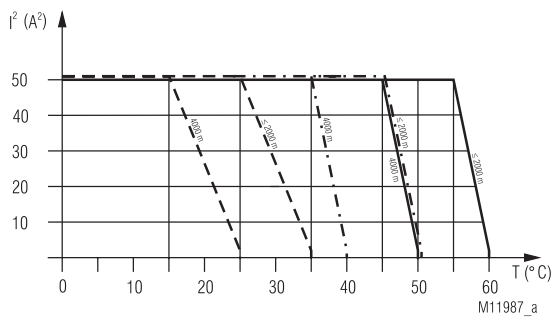
PC (plugin cageclamp):
pluggable terminal blocks
with cage clamp terminals

PS (plugin screw):
pluggable terminal blocks
with screw terminals

Contacts

Type

Characteristic



device free-standing

— max. current at 60°C (≤ 2000 m) or 50°C (4000 m) over
2 contact path = $1A \hat{=} 2 \times 1^2 A^2 = 2A^2$

device mounted with 10mm distance

- · - · max. current at 50°C (≤ 2000 m) or 40°C (4000 m) over
2 contact path = $1A \hat{=} 2 \times 1^2 A^2 = 2A^2$

- - - device mounted without distance heated by
devices with same load.

max. current at 35°C (≤ 2000 m) or 25°C (4000 m) over
2 contact path = $1A \hat{=} 2 \times 1^2 A^2 = 2A^2$

$$\Sigma I^2 = I_1^2 + I_2^2$$

I_1, I_2 - current in contact paths

Quadratic total current limit curve

At an altitude > 2000 m adjustment of the curve by $-0.5^\circ C / 100$ m
(see example 4000 m)