Original Operating Instructions

MCB140 / 141

Monitoring module to protect individuals in the hazardous area of machinery and equipment

Rev. 06

Revision directory

Revision	Date	Change/comment
01	18 May 2012	Initial version
02	16 July 2012	Text amendments and supplements for MCB141
03	6 September 2012	Information for MCB141 updated based on MCB140-V05 manual
04	10 September 2012	Chapter 1.2. Intended Use revised
04a	14 September 2012	Advance issue for supplied pre-production series
05	23 October 2012	Chapter 5 updated
06	23 October 2012	Type test certification for MCB141 entered

Contents

1. Declaration of Conformity

The manufacturer, DINA Elektronik GmbH Wolfschlugen, hereby declares that the product MCB14x is compliant with the provisions of the following directives:

According to the Machinery Directive 2006/42/EC, Annex II 1A
In accordance with Annex I. 1. 5. 1 of the Machinery Directive, the protective aims of the Low Voltage Directive are fulfilled.
Directive 2004/108/EC: "EMC Directive"
GS-ET-20: Additional requirements for the testing and certification of safety switch devices
DIN EN 60947-5-1: Control units and switching elements; Electromechanical control units
DIN EN 62061: Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN 60204-1:2006 + A1:2009: Electrical equipment of machines
EN 50178:1997: Electronic equipment for use in power installations
The device meets the requirements of the test specifications stated below in Chapter 1.1.

1.1. Test specifications

Test according to EN 13849-1 with validation according to EN 13849-2 for PLe/Cat 4 in dual channel applications for frequency converters with and without STO

Test according to EN 13849-1 with validation according to EN 13849-2 for PLd/Cat 3 in dual channel applications for frequency converters with STO without contact-based energy isolation

Test according to EN 13849-1 with validation according to EN 13849-2 for PLc/Cat 1 in single channel applications for frequency converters with and without STO

EC type test certification:	**MCB140**	**ET 12037**
	MCB141	**ET 12082**

1.2. Intended Use

The intended use of the monitoring module MCB14x is to protect individuals in the hazardous area of machinery and equipment by:

- Monitoring emergency stop devices
- Monitoring the drive speed
- Monitoring existing protective interlocks
- Monitoring the functionality of existing drive energy isolators

Based on the rated input information, various control signals to operate a drive inverter are generated in such a way as to fulfil the following safety operations:

- Status-based drive enable (STO according to EN IEC 61800-5-2)
- Tripping of ramp signal for controlled drive shutdown (SS1 according to EN IEC 61800-5-2)
- Speed-dependent release control of existing protective devices (SLS according to EN IEC 61800-5-2, SMS Safe Maximum Speed and SSM according to EN IEC 61800-5-2)
- Immediate tripping of drive energy isolator in the event of hazards and faults (STO according to EN IEC 61800-5-2)

The user must ensure that a restart interlock function is implemented in the control system.

1.3. Important note

The product described here was developed in order to take over the various safety-related operations as part of an overall system.
The overall system is made up of sensors, evaluation and reporting units and concepts for safe tripping. It is the responsibility of the manufacturer of a system or machine to ensure its correct overall functionality.
The manufacturer of the system/machine is obliged to check and verify the effectiveness of the implemented safety concept within the overall system.
This verification must be performed again after any modification to the safety concept or safety parameters.
The company DINA Elektronik GmbH is unable to guarantee all of the features of an overall system that was not designed by DINA Elektronik GmbH.

In addition, DINA Elektronik GmbH shall not assume any liability for recommendations specified or implied by the following description. No new guarantee, warranty or liability claims that go over and above the General Terms and Conditions of Delivery of Dina Elektronik GmbH can be derived on the basis of the following description.

1.4. Safety regulations

- The device may only be installed and commissioned by a qualified electrician or suitably trained individual, both of whom are familiar with these Operating Instructions and the applicable provisions regarding occupational health and safety and accident prevention.
- Please observe the various VDE and local provisions, in particular regarding protective measures.
- If the safety regulations are not observed, then this may lead to death, severe personal injuries or considerable property damage.
- Make sure you comply with the various conditions according to EN 60068-2-1, 2-2 as regards transportation, storage and operations.
- Any unauthorised refurbishment work shall void any warranty in place. This may cause hazards that lead to serious injury or even death.
- Mount the device in a control cabinet that with at least an IP54 enclosure rating. Dust and moisture can also interfere with the various operations. Mounting in a control cabinet is mandatory.
- Make sure there is a sufficient de-saturation circuit on all output contacts for capacitive and inductive loads.
- The device must be installed whilst taking into account the clearances requested according to DIN EN 50274, VDE 0660-514.
- Any protection covers should not be removed during operation.
- Replace the device after the first fault has occurred.
- Dispose of the device correctly once its lifetime has expired.
- Make sure you keep hold of this product information.
- If the various safety regulations are not observed, or if they are applied incorrectly, then the company DINA Elektronik GmbH shall not assume any liability for any ensuing damage to persons or property.

2. Short description

2.1. Instructions for use

The speed of the drive to be monitored is recorded by a proximity switch (initiators).
(Details can be found in Chapter 3.3., Speed detection, and 4.4., Sensor inputs for speed detection)

3 keys and a 5-digit 7 segment LED readout allow application-specific system configurations and monitoring parameters to be set directly on the module without the need for any additional tools. This data is saved in a fail-safe manner.
This does not need to be controlled during operation.
The monitored drive system can be visually controlled thanks to the quasi-graphical illustration of all input and output states on the 7-segment display and Status LED.
A non safety-related diagnostic output, whose significance can be configured, is provided to communicate with any superordinate control systems.
The occurrence of internal or external faults leads to a loss of operational readiness, the tripping of the safety operation and readout of a corresponding fault code on the 7-segment display.
The system is designed with two redundant channels with self-diagnosis.

2.2. Mounting and housing designs

All inputs and outputs are designed in a manner to protect against wire breaks, crossovers and short circuits, and can be accessed via appropriately labelled screw terminals (MCB140) or spring-cage terminals (MCB141).
The module is manufactured in 2 different enclosure versions:

B-Option MCB140 design
PCB for direct mounting inside the enclosure of the frequency converter to be monitored (all Danfoss frequency converters with B-Option slot, with the exception of FCD302). The safety outputs are connected to their corresponding control inputs.
The power supply of Danfoss frequency converters (terminal 12, 13) is not always sufficient enough to supply the MCB140 (depending on option configuration and output load).

External Option MCB141 design
Connections and operation in line with Option MCB140
The module is mechanically realised as an independent device for the rail mount.

2.3. Function blocks

Figure 1 shows the function-related block structure, and Figure 2 shows the hardware-related block structure. The significance and use of the illustrated inputs and outputs is explained in tables 1-3.

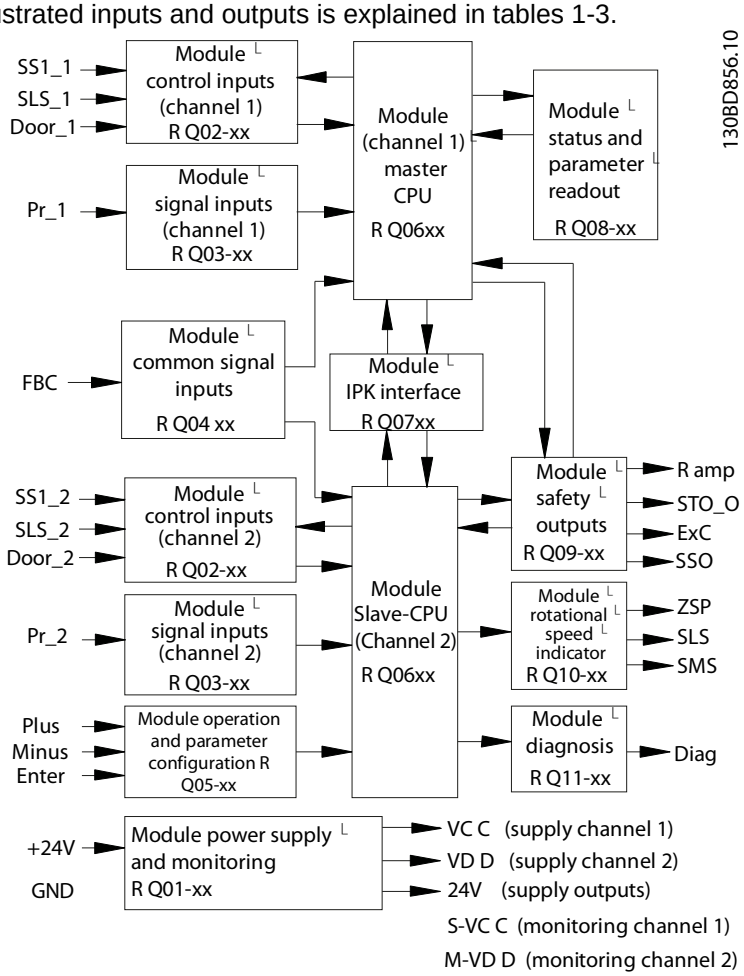


Figure 1: Functional block structure

2.4. Operation statuses

The enabled operation status is visible to the user on the content of the 7-segment readout.

2.4.1. Initialisation

Temporary state after switching on the operating voltage. All test routines must be performed at least once. Normal operation is only resumed once the system is free of any faults.

Normal state

All test routines to determine any internal and external faults are performed in a cyclical manner. If a fault is detected, then the system immediately switches to fault mode.

The safety output states are continuously calculated based on the parameter data and input information and switched to the assigned terminals if the system is free of any faults.

In order to optimise the monitoring configuration, the user can enable parameter input and make the required settings at any time. If the amended parameters are not suitable for the configuration, then the system switches to fault mode.

Parameter input

All safety outputs are destaged during parameter input. The user is free to amend the configuration. The amended configuration is enabled as soon as it is saved, and it then automatically returns to normal mode.

Fault mode

The safety outputs are destaged. This mode can only be exited by resetting after debugging, depending on the fault category.

If it is necessary to amend the parameters for debugging purposes, then the user can also enable parameter input when in fault mode as well.

2.5. Name and use of inputs and outputs

Name		Use
SS1_1/2	Safe Stop 1	Tripping of Safe Stop 1 (in accordance with EN IEC 61800-5-2)
SLS_1/2	Safe Limited Speed	Enabling of monitoring of derated maximum speed (safely derated velocity in accordance with EN IEC 61800-5-2)
Door_1/2		Mode feedback of protective interlock
Pr_1	Proximity switch 1	Speed detection in dual channel or Start/Stop in single channel operation
Pr_2	Proximity switch 21	Speed detection in single channel and dual channel operation
FBC	Feedback contactor	Mode feedback of energy isolator

Table 1: Safety inputs

Name	Use
Ramp	Tripping of ramp signal for controlled drive shutdown
STO_O	Tripping of instantaneous STO (Safe Torque Off in accordance with EN IEC 61800-5-2)
ExC	Control of contactor to drive energy isolator
SSO	Enabling of protective interlock
Pout_1/2	24 V voltage sources with channel-based test cycles

Table 2: Safety outputs

Name	Output type	Use
Configurable multi-function output DIAG	Binary	Faults
		Stop
	Analog	Equivalent speed constant current 4-20mA
		Equivalent speed constant voltage 2-10V

Table 3: Diagnostic output

SS1 must be used.
Pr_1, Pr_2, SLS, Door, FBC and the DIAG diagnostic output can be optionally used.

3. Use when shipped

3.1. Device operation

If the DEFAULT parameters are retained, then all inputs/outputs and all safety operations are enabled. The following features must be taken into account:

- All input signals comply with the fail-safe principle (NC contact type)
- All inputs must be used in dual channel format
- All inputs and outputs must be monitored for crossovers and short circuits
- Drive speed detection is enabled. Appropriate speed sensors must be mounted
- The outputs are force-sampled by way of low-active test pulses (duration approx. 1ms).

3.2. DEFAULT application wiring diagram

Figure 2 shows the layout and wiring diagram. Contact-based signallers with NC operation must be used. The opening of the contact or wire break trips the safety operation assigned to the respective input.
The clocked voltages of the Pout_1/2 outputs must be used to operate the input crossover test. The channel assignment must be observed.
The supply voltage of the proximity switch must be provided externally for speed detection purposes.

3.3. Speed detection

The signals are generated by 2 or 3-wire proximity switches. The mechanical condition of the motor shaft is key to selecting the proximity switch. When mounting, efforts must be made to ensure that at least one switch provides a high signal when stationary.

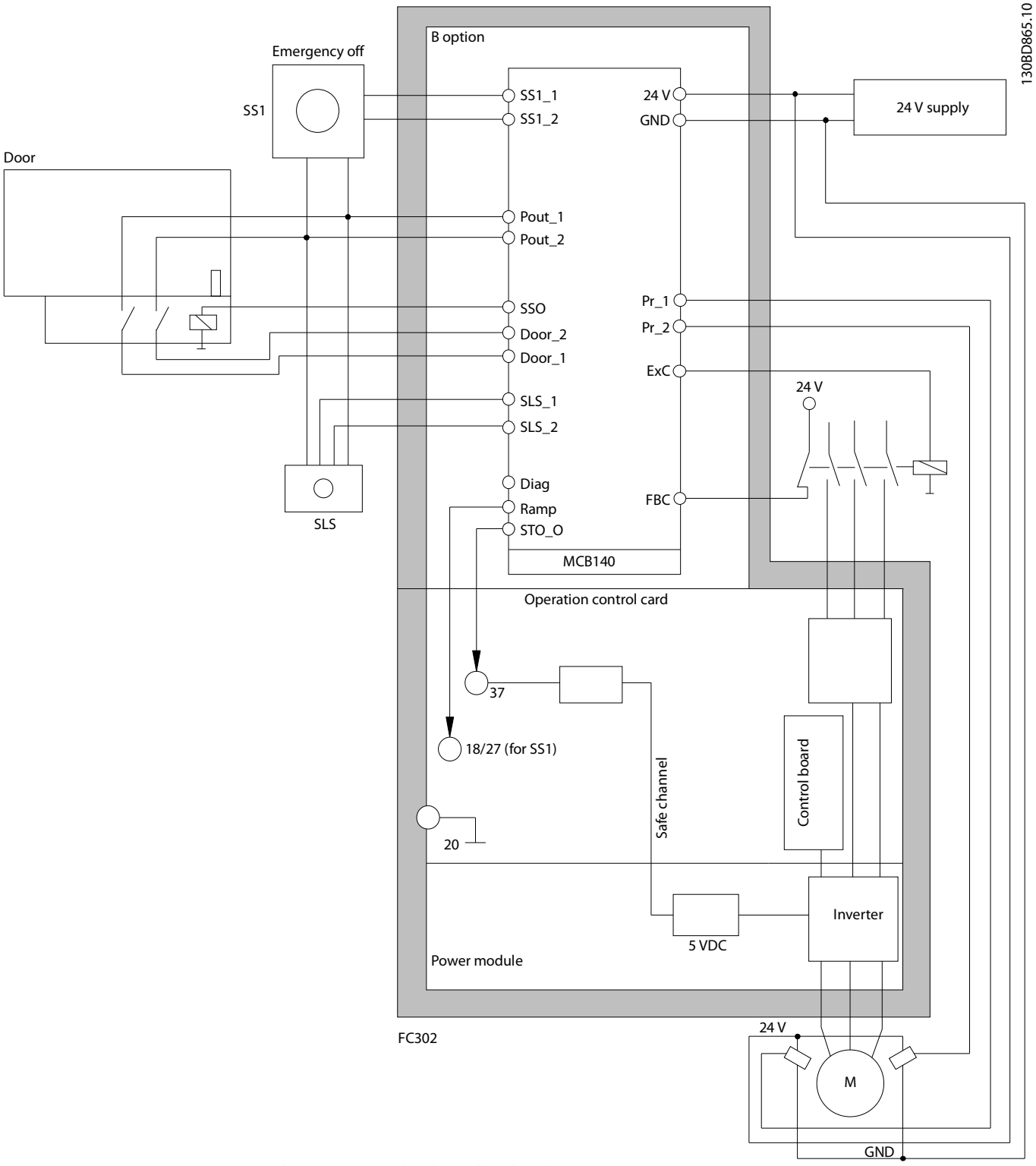


Figure 2: Standard application for DEFAULT parameters

4. Basic operation of device

The description of the various basic operations relates to the DEFAULT configuration when shipped using the speed detection function. The following safety operations are performed:

- Continuous measurement of the speed of the drive to be monitored
- Exceedance of maximum speed SMS (*Parameter P303*) immediately trips STO
- Drive speeds greater than Zero Speed (*Parameter P301*) enable the protective interlock.

The control inputs SS1, SLS and Door extend these safety operations:

Controlled slowdown of drive by enabling frequency converter ramp function
Alternation of maximum speed to be monitored
Detection of open protective devices

The way the outputs react to system and application faults is described in the Chapter entitled "Fault monitoring".

4.1. Operation of inputs

With the exception of FBC, all inputs are read in dual channel format. Contact-based signallers with NC operation and test signal-based power in the DEFAULT configuration are used by the module.

Input SS1 STOP/EMERGENCY stop
Pressing the Emergency Stop switch trips the defined slowdown of the drive to be monitored by the Ramp output. If the drive does not come to a standstill within a specified time frame (*Parameter P301*), then the instantaneous STO is tripped by the STO_O and ExC outputs. If speed detection is disabled, then STO is tripped exclusively in a time-controlled manner. If speed detection is enabled, then STO is tripped once it is detected that the motor is at a standstill, even if the monitoring time has not yet elapsed.

Switch position of SS1 input channels	P 101
Number of input channels used	P 104
Disabling/enabling of speed detection	P 201
Monitoring time SS1	P 301

Table 4: Parameters for setting up the SS1_1/2 inputs

SLS input Derated velocity operating mode
By enabling the input, the derated SLS velocity is monitored instead of the SMS velocity. If the working speed remains below the SLS velocity, then the protective interlock is enabled. If it is exceeded, then STOP is tripped as well.
The SLS operation can only be used if speed detection is enabled (*P201≠ 0*).

Switch position of SLS input channels	P 102
Number of input channels used	P 104
Disabling/enabling of SLS input	P 109
SLS speed	P 303
SMS speed	P 304
Number of speed sensors	P 201

Table 5: Parameters for setting up the SLS_1/2 inputs

Door input Monitoring of protective interlock
If the protective device is open (Door input is enabled) and the SLS input is enabled, then the STO and ExC outputs shall remain switched on from the point of standstill until the SLS velocity is exceeded. If the SLS input is not enabled, then the STO and ExC outputs are generally destaged if the protective device is open.
The Door operation can only be used if speed detection is enabled (*P201≠ 0*).

Switch position of Door input channels	P 103
Disabling/enabling of Door input	P 105
Number of speed sensors	P 201

Table 6: Parameters for setting up the Door_1/2 inputs

FBC input Monitoring of drive energy isolator
The state of the energy isolator contactor controlled by the ExC output is reported back to the FBC input. The auxiliary contact must be NC.
This input is evaluated in a dynamic manner. Any change in state of the ExC output must also bring about a change in state of the FBC input within an expected time frame of 2s.
Either force guided relays (according to EN IEC 60947-5-1) or (auxiliary) contactors with mirror contacts (according to EN IEC 60947-4-1) must be used for this operation.

Disabling/enabling of FBC input	P 106

Table 7: Parameters for setting up the FBC input

4.2. Safety circuits
During dual channel operation, there is a need to detect the failure of a switch contact as a result of welding, for example. As a result, the static input states of both UND channels are not only used internally whilst linked, but also their changes in state and time response are evaluated in relation to one another.

Based on these results, appropriate SKR-SS1, SKR-SLS and SKR-Door safety circuit states are generated internally which constitute the basis for calculating safety operations, instead of direct input signals.

Put simply, each of the 3 safety circuits constitutes a binary state memory that is only high-active in the event both input channels are switched on at the same time.

Even if only one of the input channels is destaged, then this will reset the assigned safety circuit, thus tripping the assigned safety operation.

This safety circuit can only be enabled once again if the other channel is also destaged and both channels are then subsequently switched back on again at the same time.

4.3. Safety outputs

The outputs (*Ramp, STO_O, ExC and SSO*) are safe positive switching semiconductor outputs and are only enabled if all safety circuits (*SKR-SS1, SKR-SLS and SKR-Door*) are enabled.

All safety outputs are immediately destaged in the event of a fault or the forced opening of monitored protective devices.

Ramp

Ramp is the control signal for the controlled slowdown of the drive. Each falling edge of this output causes the frequency converter to trip a braking ramp and starts time monitoring activities at the same time. The drive is expected to come to a standstill within this time frame.

The destaging of Ramp is tripped by enabling SS1 for the drive that is currently in motion.
If the drive is already at a standstill at the time SS1 is tripped, then the ramp start shall not be generated.

If no speed monitoring is implemented, then the drive shall always be deemed continuously in motion, and an exclusively time-controlled braking ramp shall be tripped each time SS1 is pressed.

Ramp down time monitoring time	P 301
Disabling/enabling of speed detection	P 201

Table 8: Parameters for setting up the Ramp output

STO_O

Each time the STO_O output is destaged, this trips STO on the frequency converter (this signal must always be connected to terminal 37 for Danfoss VLT frequency converters).
Once SS1 is enabled, such destaging always occurs if either the monitoring time has elapsed or the drive was detected by the sensors as being at a standstill.

ExC

The ExC output is intended to directly control the energy isolator (contactor). Its switching behaviour is the same as the STO_O output described above.

Use of energy isolator feedback contact	P 201

Table 9: Parameters for setting up the ExC output

SSO

The SSO output controls the enabling of the protective interlock in the event the drive is detected as being at a standstill. This output is only enabled if speed detection is enabled and the drive is at a standstill.

Disabling/enabling of speed detection	P 201
Use of interlock feedback contact	P 105

Table 10: Parameters for setting up the SSO output

4.4. Pr_1/2 Sensor inputs for speed detection

Suitable initiators are required for speed detection purposes. When mounting them, efforts must be made to ensure that an initiator always supplies 24 V for a dual channel measurement. This is necessary in order to ensure faults can be detected.
The proximity switches cannot be supplied from the MCB 140. The 0 V common reference potential must be connected.
Operation without any proximity switches is possible, and derates the MCB 140 to a safety module for time-monitored brake function and subsequent STO operation.

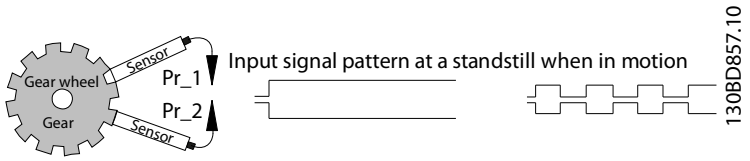


Figure 3: Mounting of proximity switches

2 or 3-wire proximity switches may be used (2-wire may only be used with 24 V supply)

Number of sensors used	P 201
Use of 2/3-wire initiators	P 202
Permitted start-up delay following Start/Stop enabling	P204

Table 11: Parameters for setting up the Pr_1/2 inputs

5. Special aspects of single channel use

Single channel operation can be adjusted separately for control inputs and speed sensor inputs

Number of input channels used	P 104
Number of speed sensors used	P 201

Table 12: Parameters for configuration of the enabled system channels

The inputs of channel 2 (SS1_2, SLS_2, Door_2 and Pr_2) must be used.
The safety circuit states are identical in this case to their internal channel states.
The wiring of SS1_1, SLS_1, or Door_1 inputs trips a fault along with the STO safety operation.

5.1. Special aspects of single channel speed detection

The initiator used must be connected to the Pr_2 terminal.

5.1.1. 2 or 3-wire initiator without wire break detection option

P 201	1
P 202	on (2-wire initiator)
	off (3-wire initiator)

Any wire break or short circuit after 0 V or +24 V on the Pr_2 terminal is incorrectly detected as a standstill.

This operating mode is not suitable for applications with functional safety.

5.1.2. 2 or 3-wire initiator with external wire break detection

Parameters to be set: *same as 5.1.1*
Any wire break or short circuit after 0 V or +24 V on the Pr_2 terminal is detected by external measures. This may be done, for example, by way of checking the plausibility of the standstill signal or the speed signal of the MCB14x with a start signal in a PLC. An expected time must be realised in the PLC in this case. In the event of a fault, the PLC must be able to induce a stop.

This operating mode is therefore only suitable for applications with functional safety if the user provides proof of the overall safety concept realised. The requirements can be found in the application manual.

5.1.3. Use of a 2-wire initiator with wire break control function

Parameters to be set:

P 201	1-2dr
P 202	on (2-wire initiator)

The level at Pr_2 terminal is outside of the tolerance window in the event of a wire break or short circuit after 0 V/+24 V. The plausibility of the encoder signal cannot be checked.
The initiator used must have a minimum MTTFd value of 400 years.
Cat 1/PLc is accessible.

5.1.4. A 2 or 3-wire initiator with additional Start/Stop signal

Parameters to be set:
P 201 = 1-EnA
P 202 = on (2-wire initiator) or P 202 = on (3-wire initiator)
P 204 = time setting according to start-up behaviour
Start/Stop signal (high-active) at Pr_1 terminal
The plausibility of the initiator signal is checked by enabling the Start/Stop signal (operating command of superordinate controller). If no speed pulses are measured at the Pr_2 sensor input once the start-up delay (P 204) has elapsed, then the safety operation is tripped.
Cat 2/PLd is accessible.

6. Logical functionality of the MCB14x

This section explains the logical functionality and priorities of the MCB14x safety operations.

SS1 always has the highest priority. (*terminals 8/9 on MCB140, terminals 11/16 on MCB141*)
If a safe stop 1 is enabled (input signal high -> low), then a braking ramp is tripped on the frequency converter (output signal high -> low) (*terminal 17 on MCB140, terminal 6 on MCB141*)

The safety operation is enabled once the SS1 time (*Parameter P301*) has elapsed or once a standstill is detected (*Parameter P302*):

	STO_O terminal	ExC terminal	
MCB140	5	18	Signal change high -> low
MCB141	7	8	

SMS is always enabled and has the same priority as SS1. Irrespective of the state of the other safety operations, STO is always enabled if the measured velocity exceeds the SMS velocity (*Parameter P304*). In all other cases, a fault is displayed (*Code 002*). This is deleted independently as soon as it falls below the standstill velocity.

By enabling SLS, this ensures the SLS velocity limit (Parameter P303) is always monitored. If the set SLS velocity is exceeded, then STO is enabled and a fault is displayed (*Code 001*), just like for SMS. This is also deleted as soon as it falls below the standstill velocity.

If the Door inputs (*terminals 12/13 on MCB140, terminals 13/18 on MCB141*) are low (i.e. in the event of an open separating protective device, for example), then STO is enabled. This behaviour changes if SLS is also enabled. STO is then disabled and the machine can then be operated up to the SLS velocity. This operation allows the machine to move at a safely reduced velocity in the event of an open separating protective device, for example.

The safe standstill output SSO (*terminal 6 on MCB140, terminal 9 on MCB141*) is high if the measured velocity is always below the set standstill velocity (*Parameter P302*).

6.1. Example application

A FC302 with MCB140 and a self-closing door with two safety outputs for position monitoring and an input for magnet control are used.
During SLS operation, jogging is possible in the event of an open separating protective device.
SS1 is enabled via a separate actuator (e.g. Emergency Stop switch).

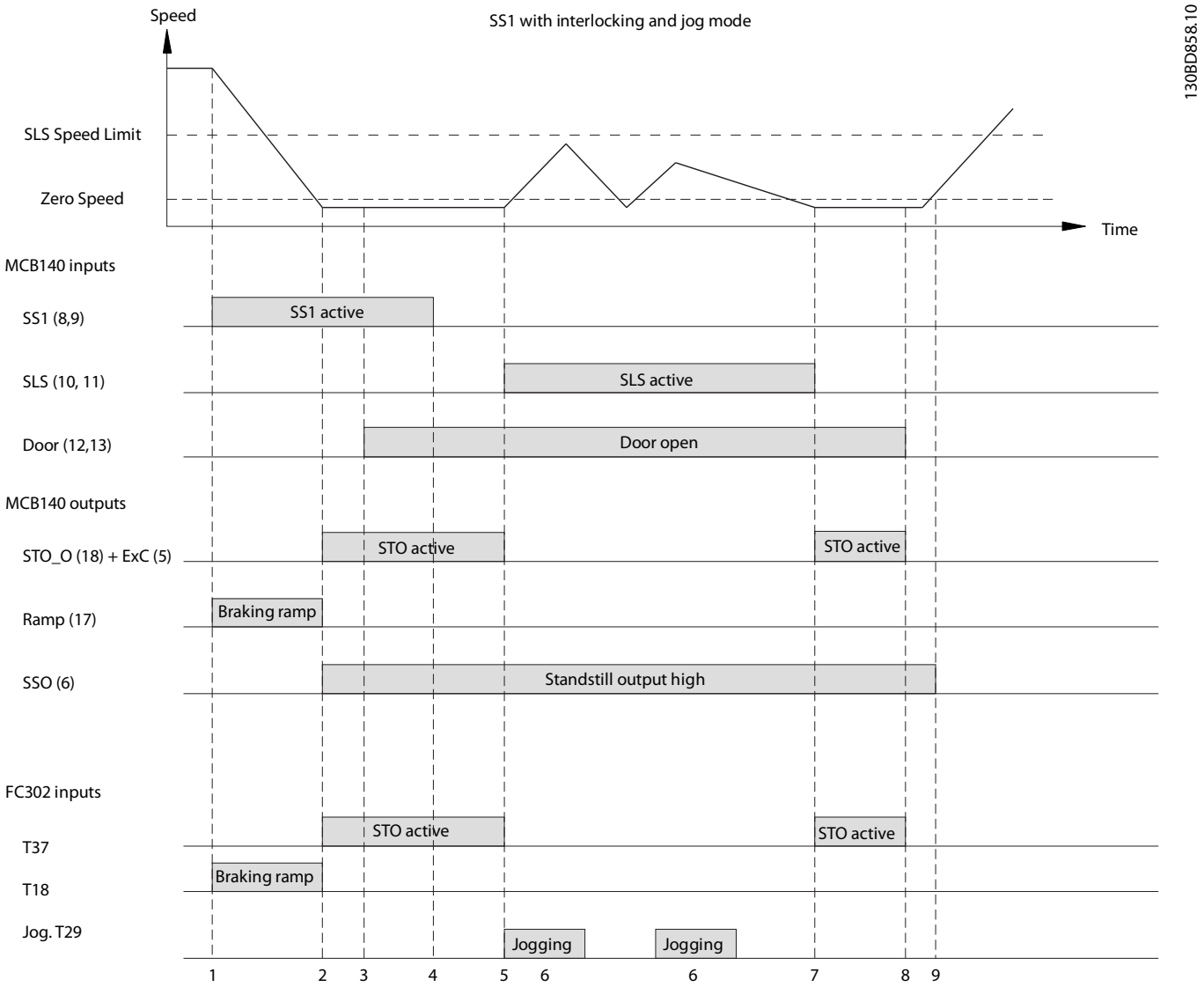


Figure 4: Flow chart of example application

Expiry:

1. SS1 is enabled, meaning that the frequency converter reduces the speed until it comes to a standstill
2. In this example, it falls below zero speed before the SS1 timer has elapsed. If it falls below zero speed, then STO is enabled and the standstill is displayed.
3 Opening the separating protective device leads to STO being enabled. In this example, STO is already enabled following completion of the SS1 operation.
4. In the event the SS1 operation is disabled, STO, which was tripped by the SS1 operation, is then cancelled. In this example, STO remains enabled thanks to the open protective device.
5. When enabling SLS, STO is disabled in the event of an open protective device. Depending on the parameterisation of the frequency converter used, a reset is now required on the frequency converter (in FC302, for example, if STO is set to Alarm).
6. If SLS is enabled, then it can now be moved in the event of an open separating protective device (e.g. by using the Jog operation). If there is movement at velocities faster than the values entered for SLS, then a fault is tripped and STO is enabled.
   The velocity values entered for this jog mode do not come from the MCB14x, but must instead be set in the frequency converter.
7. If SLS is disabled, then STO is enabled again straight away by the open separating protective device.
8. If the separating protective device is closed, then STO is disabled. Just like in Point 6, the safety operation shall need to be reset here.
9. If the movement velocity exceeds zero speed, then the separating protective device is interlocked.

6.2. Overview and name of connection terminals

InputsInputs

Operation	Meaning	MCB140 terminal		MCB141 terminal	
		Channel 1	Channel 2	Channel 1	Channel 2
SS1	Safe Stop 1 (SS1)	Y32/8	Y32/9	11	16
SLS	Derated velocity operating mode	Y32/10	Y32/11	12	17
Door	Monitoring of protective interlock	Y32/12	Y32/13	13	18
Pr_1	Input for speed detection of Start/Stop	Y32/14		15	
Pr_2	Initiator input for speed detection		Y32/15		20
FBC	Contactor (auxiliary contact) of drive energy isolator	Y32/16		5	

Table 13: Assignment of safety inputs

Safety-related outputs

Operation	Meaning	MCB140 terminal	MCB141 terminal
Ramp	Ramp signal for controlled drive shutdown	Y32/17	6
STO_O	Safe Torque Off (STO)	Y32/18	7
ExC	Control of drive energy isolator	Y32/5	8
SSO	Enabling of protective device	Y32/6	9

Table 14: Assignment of safety outputs

Non-safety-related outputs

Operation	Meaning	MCB140 terminal	MCB141 terminal
Diag	Multi-functional diagnostic output	Y32/7	10

Table 15: Assignment of diagnostic output

Diag is not integrated in the safety operation. Depending on the configuration, it can be used as a binary signal output or analog speed output

Connection assignment on MCB140 module

All inputs and outputs are accessible via appropriately labelled screw terminals:

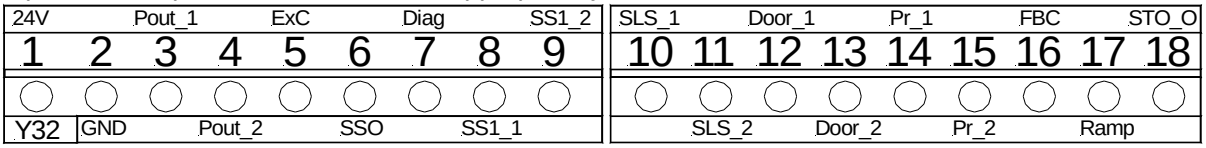


Figure 5: MCB140 connection terminals

Connection assignment on MCB141 enclosure

All inputs and outputs are accessible via appropriately numbered spring-cage terminals:

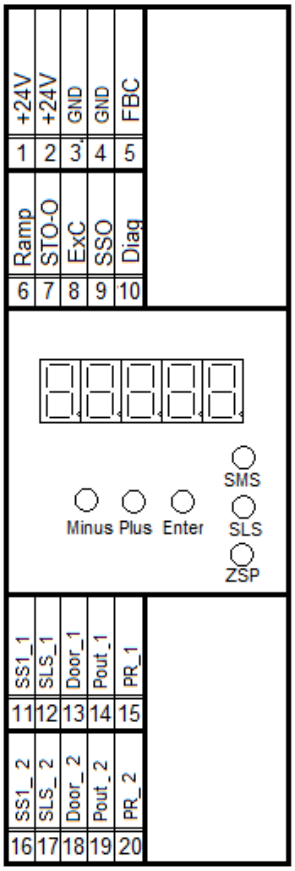


Figure 6: MCB141 connection terminals

6.3. MCB14x operational controls

3 keys (*Minus - Plus - Enter*) are provided to set up the module and to reset any faults:

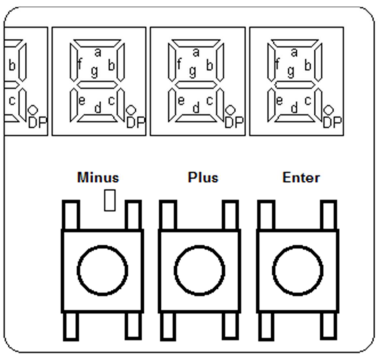


Figure 7: Location of operational controls

6.4. MCB14x status readouts

7-segment multi-function display

The readout content depends on the operation status.
In order to reduce the converted power loss, the readout segments are destaged in normal mode after being shown for 2 minutes, with the exception of initiator inputs. This can be enabled once again by briefly pressing any key.

Readout during initialisation

After switching on the operating voltage, the name of the module followed by the software version are displayed for 1s as follows:

MCB140:

c	b	1	4	0

E	d		0	1

MCB141:

c	b	1	4	1

E	d		0	1

Figure 8: Temporary readouts during initialisation

Readout in normal operation

A light segment is assigned to the input channels, internal safety circuit states and safety outputs in the 5-digit 7-segment display as follows:

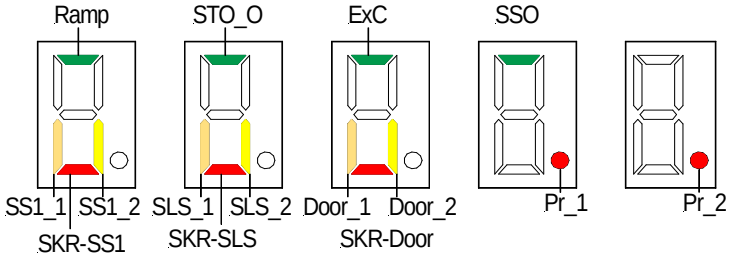


Figure 9: Assignment of status readouts

The way in which input states are shown depends on the respective input configuration. It is not the terminal level that is shown, but rather it is generally the internal logic state instead:

Parameterised contact position	**Terminal state**	**Terminal operation**	**Input and segment state**
NC	24 V DC	Not enabled	On
	Open	Enabled	Off
NO	24 V DC	Enabled	Off
	Open	Not enabled	On

Table 16: Assignment of input terminal states - Input channel states

The respective input channel states form the basis for calculating the safety circuit states:

Input channel_1	**Input channel_2**	**Safety circuit state/readout**
On	On	Enabled
Off	On	Not enabled
On	Off	
Off	Off	

Table 17: Assignment of input channel states – Safety circuit states

The safety circuits only change to an enabled state if both of the associated input channels change to an enabled state at the same time.

If inputs are disabled in a user configuration, then status readouts shall remain permanently switched on on their assigned safety circuit.

Output	Output state/readout	Operation
Ramp	On	Braking ramp operation not enabled
	Off	Braking ramp requested
STO_O	On	Drive enabled
	Off	Drive locked
ExC	On	Drive energy staged
	Off	Drive energy separated
SSO	On	Protective device enabled
	Off	Protective device interlocked

Table 18: Assignment of output states – Safety operation

The safety output states correspond to the respective terminal states.

The Pr_1 and Pr_2 readout segments correspond directly to the respective initiator terminal or switch states. This therefore allows alignment support and movement control.

Readout of fault states

If a fault occurs, then the Ramp, STO_O, ExC and SSO safety outputs are destaged and the corresponding fault code is shown in the 7-segment display:

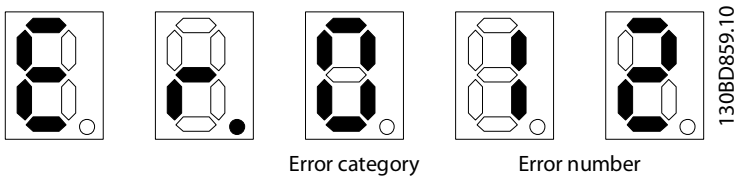


Figure 10: Principal illustration of fault readout

MCB14x LED speed indicators

3 LEDs allow the speed status to be controlled, based on the limit values to be monitored.
If the actual speed exceeds one or more limit values, then the corresponding LEDs go out.
The SLS LED is also controlled in the event the SLS operation is not enabled.

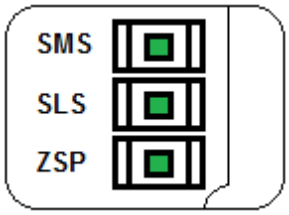


Figure 11: LED speed indicators

The LED switching thresholds are set by way of the following parameters:

LED	Parameter	Meaning
SMS	P 304	Monitored maximum speed
SLS	P 303	Second monitored speed
ZSP	P 302	Maximum permitted speed for defined standstill

Table 19: Parameter assignment of diagnostic LEDs

6.5. Fault management

Any faults detected by the system are divided into 3 categories based on their significance and impact:

Fault category 0

Following debugging, it then automatically returns to normal operation and the outputs are enabled again in accordance with the current system state.
In order to detect any sporadic faults, the fault code readout remains enabled until it is reset by pressing Enter.

Fault category 1

Following debugging and resetting by pressing Enter, it then returns to normal operation.

Fault category 2

In order to delete the saved faults once they have been debugged, the module must be disconnected from the operating voltage for approx. 1 s. If a fault occurs which cannot be debugged by the user, then the module must be sent back to the manufacturer in order for it to be repaired.
Irrespective of the category, faults may only be reset if the drive is at a standstill.

6.6. Overview of faults

Category	Number	Fault cause
0	1	SLS speed exceeded
0	2	SMS speed exceeded
0	3	Protective device open despite interlock in place
1	4…6	Crossover between input channels
1	7	Speed difference between channel 1 and channel 2 greater than 20%
1	8	Standstill at Pr_x and >4x zero speed at Pr_y
1	9	Pr_1 and Pr_2 disabled at standstill
2	10…11	Ramp output shorted or defective
2	12…13	STO_O output shorted or defective
2	14…15	ExC shorted or defective
2	16…17	SSO output shorted or defective
2	18	Outputs cannot be destaged or fed by 24V
2	19	Module temperature > 85°C
1	20	Contactor (auxiliary contact) does not open in the event ExC output is enabled
1	21	DOOR input disabled and 24 V at Door_1 or Door_2 terminals
1	22	SLS input disabled and 24 V at SLS_1 or SLS_2 terminals
1	23	P104 setting "single channel", but 24 V at SS1_1, SLS_1 or DOOR_1
1	24	P201 setting "single channel", but 24 V or pulses at Pr_1
2	25	Enter key permanently pressed
1	26	P106 setting "emergency", but 24 V at FBC terminal
2	27	Operating voltage < +21 V DC or > +28 VDC
1	28	SLS and/or DOOR actively parameterised without Motor Feedback (P201=0
1	29	Wire break in 2-wire initiator (P201=1-2dr)
1	30	No initiator pulses for P201=1-EnA after "start-up delay" (P204) has elapsed
	30…43	Reserve
2	44…55	Internal faults

Table 20: Overview of faults

7. How to Configure

The configuration menu can be enabled in any of the module's operation statuses. All sensors integrated in monitoring activities, actuators, their switch positions and working speeds to be monitored are defined. The settings are made by the user directly on the module and, once saved, are stored in a non-volatile manner in a parameter record within the device.
All of the monitoring module outputs are disabled during configuration.

7.1. Organisation of configuration data

In order to provide a better overview, the configuration menu is in 3 levels, and the various parameters that can be set are assigned to the following 4 groups:

Group	Parameter type	Use
P 1--	Binary inputs	EMERGENCY stop, protecting door, SLS switch
P 2--	Measuring inputs	Speed detection
P 3--	Times and speeds	Standstill, set-up and maximum speed
Store	Memory options	(storage, reset to default

Table 21: Parameter groups

7.2. Enabling of configuration menu

Press the ENTER key for 3s to enable Level 1 (Parameter group selection).
The current parameter checksums are read out for 2s, then parameter group 1 is read out:

c	r	c	*	*

P		1	_	_

Parameterisation Level 1: Parameter group selection/storage
PLUS key to cyclically alternate between enabled groups

P		1	_	_

P		2	_	_

P		3	_	_

S	t	o	r	E

then: ENTER key to confirm group selection and alternate to Level 2 (Parameter selection)

P	r	1	0	1

alternatively: MINUS key to terminate parameterisation

c	r	c	*	*

Parameterisation Level 2: Parameter selection
PLUS key to cyclically alternate between parameter numbers (within the selected group)

P		1	0	1

P		1	0	2

P		1	0	3

then: ENTER key to confirm the parameter to be set and alternate to Level 3

n	c	-	n	c

alternatively: use MINUS key to go back to Level 1 (group selection/storage/termination)

P	r	1	_	_

Parameterisation Level 3: Parameter setting
PLUS or MINUS key to set the desired value

n	c	-	n	c

n	c	-	n	o

	o	s	s	d

then: ENTER key for temporary storage and back to Level 2 (Parameter selection)

n	c	-	n	o

P		1	0	1

or: MINUS key to go back to Level 1 (group selection/storage/termination)

P		1	_	_

Storage of configuration in Parameterisation Level 1

PLUS key to select "Storage" group

P		1	_	_

P		2	_	_

P		3	_	_

S	t	o	r	E

then: ENTER key to confirm storage option selection

		Y	E	S

then: PLUS key to select the desired storage option

		Y	E	S

			n	o

d	E	F	A	U

then: 2. Press ENTER to run the selected storage option
…Placeholder

Once stored, the updated checksum is read out for 2s, then the configuration is automatically terminated and the monitoring operation along with status readout is enabled once again.

c	r	c	*	*

*	*	*		

Notes on operation and configuration menu readout

Restoring the settings as shipped or resetting any unwarranted changes is only possible using the overall configuration feature.
Any changes to the configuration must be explicitly saved before exiting the menu.
If no keys are pressed for 1 min or more when in the enabled configuration menu, then the menu is automatically terminated. Any new settings made are then lost.
The parameters can be set in any order. No parameters will disappear.

Speed settings are also possible, even if speed detection is not parameterised.
In order to ensure the condition zero speed < SLS speed < SMS speed, then any changes to one of these parameters will see the limit values and feedback of the other dependent parameters be automatically checked and,
where necessary, automatically adjusted.

For control purposes, the current 8-bit-checksum (crc**) of all parameters is read out for approx. 2 s when entering and exiting the configuration menu. A comparison of values confirms the effectiveness of the changes made.

Parameter description - Group P1

Parameter No.	Name	Setting value	Default	Notes
P 101	Input type SS1 Tripping of emergency stop	NC/NC	NC/NC	Parameter definitions in Table 26
		NC/NO		
		OSSD		
		PNP-NPN		
		NC-noP		
P 102	Input type SLS Monitoring of derated working speed	NC/NC	NC/NC	Parameter definitions in Table 26
		NC/NO		
		OSSD		
		PNP-NPN		
		NC-noP		
		NO/NO		
		NO-noP		
P 103	Input type Door Monitoring of protective devices	NC/NC	NC/NC	Parameter definitions in Table 26
		NC/NO		
		OSSD		
		PNP-NPN		
		NC-noP		
P 104	Dual channel inputs	YES	YES	Single/dual channel use of inputs
		No		
P 105	Door interlock used	YES	YES	Use of protective interlock feedback contact
		No		
P 106	Use of contactor (auxiliary contact) for FBC input	YES-d	YES-d	dynamically evaluated
		YES-s		statically evaluated
		Not		not used
P 107	Test pulses on outputs	YES	YES	Superimposing of L-active pulses to test the ability to derate the safety outputs
		No		
P 108	Use of DIAG function output	FAout	FAout	Binary fault output
		SSout		Output enabled at standstill
		SIout		Analog speed output 4-20 mA
		SUout		Analog speed output 2-10 V
P 109	SLS used	YES	YES	Use of operating mode selection switch
		No		

Table 22: Parameter group 1

A functional description of the setting values and input wiring are explained in Table 26

Parameter description - Group P2

No.	Name	Setting value	Default	Notes
P 201	Speed feedback Speed detection	0	2	Speed detection disabled
		1		1 initiator at channel 2
		2		2 initiators
		1-2dr		1 2-wire initiator at channel 2
		1-EnA		1 initiator (channel 2), channel 1 enabled
P 202	Proximity switch current	OFF	OFF	Switch on additional load for 2-wire initiators
		On		
P 203	Pulses per revolution	1…50	1	
P 204	Start-up delay	1…128s	4s	Only enabled if P201=1-Ena

Table 23: Parameter group 2

Parameter description - Group P3

No.	Name	Setting value	Default	Notes
P 301	SS1 Delay time	0….7200s	5	Trip delay delay of O23…O33 outputs once SS1 is enabled
P 302	Zero Speed Limit	6 …1350 RPM	60	Upper speed limit for standstill
P 303	SLS Speed Limit	Zero Speed + 10% SMS Speed – 10%	1500	Upper speed limit for operating mode 2
P 304	SMS Speed Limit	SLS Speed + 10% 15000 RPM	12000	Upper speed limit for operating mode 1

Table 24: Parameter group 3

The parameters P302..P304 are only effective if speed detection is enabled (P201 > 0)

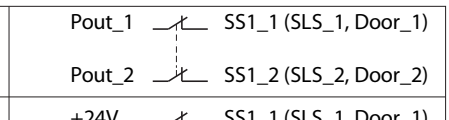
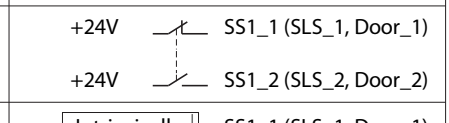
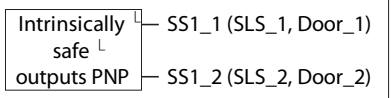
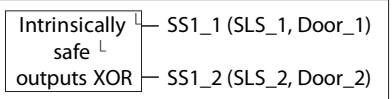
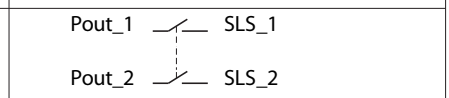
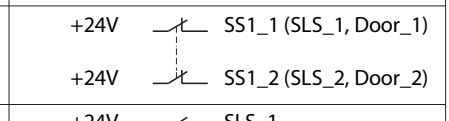
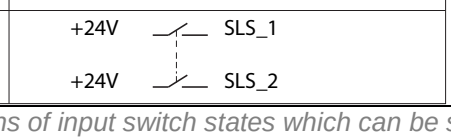
Parameter description - Group STORE (Parameter group 4)

Readout	Memory options	Default	Notes
StorE	YES	Yes	Changes are saved
	No		Changes are discarded
	dEFAULt		All parameters are reset to their default values

Table 25: Parameter group STORE

Overview of input terminal configurations

The following references and signal types are defined:

Mnemonic	Schematic diagram	Notes
NC-NC		Test cycles of Pout_1/2 outputs must be used
NC-NO		Signal antivalence as criterion for short circuit or crossover
OSSD		Short circuit and crossover test carried out by signal reference outputs
PNP-NPN		Short circuit and crossover test carried out by signal reference outputs
NO-NO		Test cycles of Pout_1/2 outputs must be used
NC-noP		Short circuit and crossover test of MCB disabled
NO-noP		Short circuit and crossover test of MCB disabled

130BD860.10

Table 26: Definitions of input switch states which can be set

8. Technical data

Input data

Operating voltage	24 VDC –15 +10%
Medium current draw for U_N	60mA
Rated insulation voltage	< 60 V
Rated impulse withstand voltage (pollution degree 2)	1.5 kV

Initiator data

Operating voltage	24 VDC –15 +10%
Types	2-wire or 3-wire
	NPN NC or NO
Minimum input frequency at Pr_1, Pr_2	0 Hz
Maximum input frequency at Pr_1, Pr_2	12KHz

Output data

Maximum output current of outputs: *Ramp, STO_O, ExC, SSO*	500 mA/output, short circuit-proof semiconductor outputs
DIAG parameterised as: Digital high-side output [0 V / 24 V] Analog voltage output [0 V - 10 V] Analog output current [4 mA, 20 mA]	 Load current max. 10mA Load current max. 1mA R load = 500Ohm

Terminals

Maximum wire cross section - rigid wire	2.5 mm² (MCB140))
Maximum wire cross section - flexible wire	2.5 mm² (MCB140) **Cable end sleeves must be used**

General data

Ambient temperature	-20 to +55°C DIN IEC 60068-2-3
Storage temperature	-40 to +85°C DIN IEC 60068-2-3
Vibration resistance at all 3 levels	Sine-wave 10–55 Hz, 0.35 mm, 10 cycles, 1 octave/min
Service cycle	100%
Enclosure rating	Only for mounting in control cabinet that is at least an IP 54 enclosure Terminal area/IP 20 enclosure
Cable length to signal inputs and outputs	30 m tested, larger lengths possible
EMC limits	EN 55011:2007 +A2:2007: Emission (limit class: B) Interference immunity EN 61326-3-1:2008 (severity level: SIL3)
MTTFd DC SFF PFHd	100 years 99% 95% $2.47*10^{-08}$/h for dual channel application
Category 3 / PL d	dual channel application without I/O test pulses
Category 4 / PL e	dual channel application with enabled I/O test pulses
-See section 5-	Single channel speed detection
Response time of safety operations	20 ms
Fault response time	20 ms
Lifetime	20 years

Appendix 1
List of abbreviations used

Abbreviation	Abbreviation derived from	Meaning
A1		+24 V supply voltage
A2		0 V common
Door		Safe input to control protective interlock
Diag		Diagnostic output
ExC		Safe output to drive energy isolator
GND	Earth	0-V common reference potential for all signal and operating voltages
NC	Normally closed	NC
NO	Normally open	NO
PR_x		Safe input for proximity switch to speed detection
Ramp		Safe output for tripping braking ramp on the inverter
SIL	Safety Integrity Level	Safety Integrity Level
SLS	Safely-Limited Speed	Safely Limited Speed
SMS	Safe Maximum Speed	Maximum velocity to be monitored
SSO		Safe output to enable the protective interlock
SS1	Safe Stop 1 (time-controlled)	Safe Stop 1 (time & ramp monitored)
STO	Safe Torque Off	Safe Torque Off
ZSP	Zero Speed	(Residual) velocity defined as being at a standstill

Appendix 2:
Content of serial number barcodes

Setup

MCB140:	130B5001xxxxzz-wwy
MCB141	130B6447xxxxyy-wwy

xxxx Consecutive serial number
zz Revision information (Rev. A as decimal number in ASCII Code 65)
ww Production week number
y Last digit of years

The serial number for MCB140 and MCB141 depends on the option. The serial number is reset to 0100 each week.

The barcode is an interleaved 2/5 barcode without checksum. This barcode can only show the characters 0-9. All other characters are replaced by the relevant ASCII Code.

Example:
MCB140 produced in week 33 in 2012:

Serial number	130B5001 010065-332
Barcode equivalent	130665001 01006545332