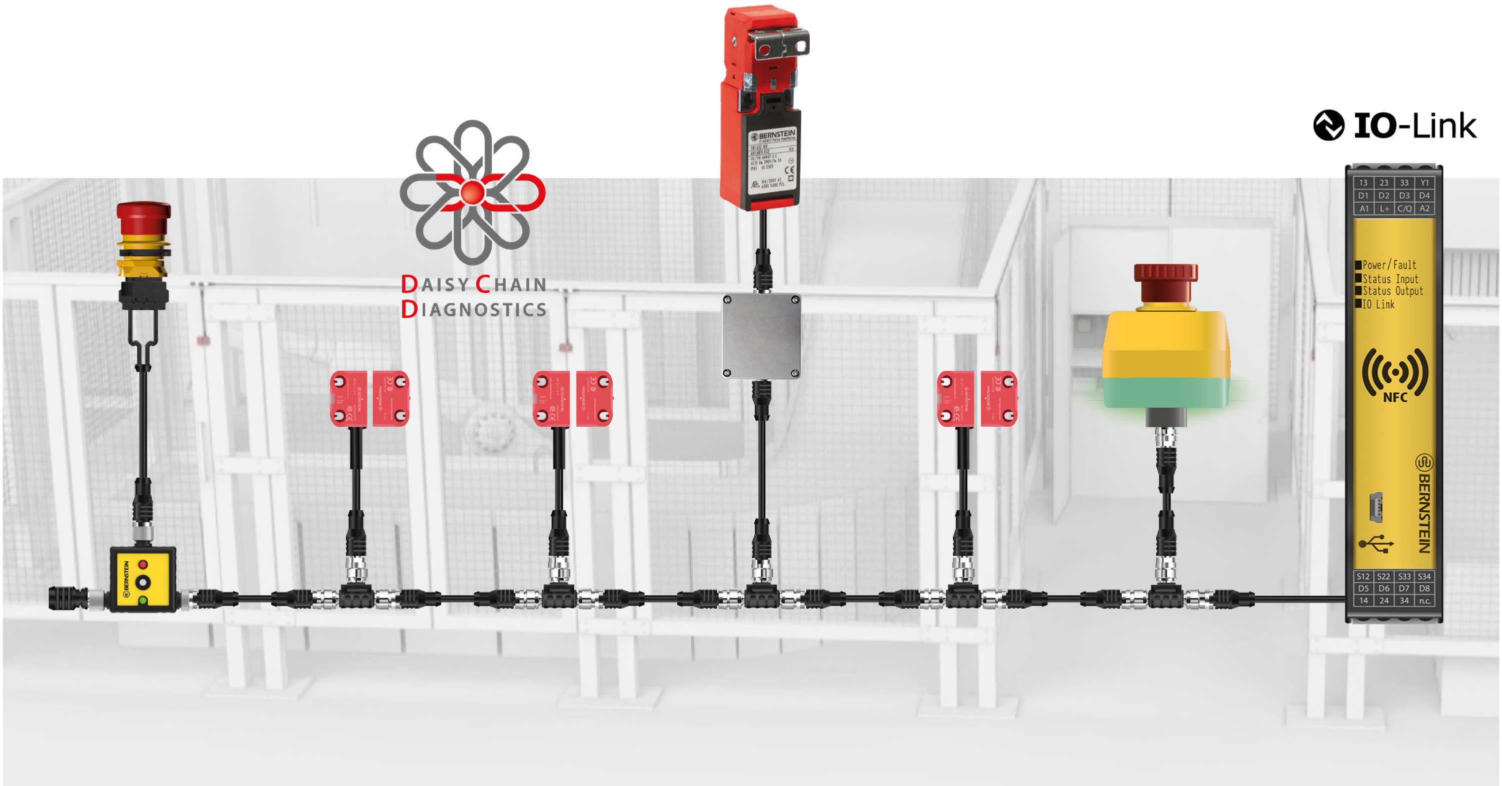


Daisy Chain Diagnostics (DCD)

IO Link Configuration

DETECT

We make safety happen.

Content

1 Definition of terms

Abbreviation	Meaning	Function
SRF	Safety-RFID sensor	Series connection device
SEU 1	Emergency stop	Series connection device
SEU 2	Emergency stop connection box	Series connection device
SRF DI	Diagnostic module	Conversion of BERNSTEIN DCD diagnostic data into standardised formats (e.g. IO-Link)
SCR DI	Safety-monitoring module	Safety relay with integrated diagnostic module

Table 1: Abbreviations

2 Introduction

This document describes the IO-Link Communication Interface of a BERNSTEIN Diagnostic Module. The structure of the interface, the types of IO-Link communication and the meaning of all information is explained.

IO-Link Communication takes place exclusively with the diagnostic modules or Safety-monitoring module of BERNSTEIN. The DCD device information of the connected diagnostic series is collected in the diagnostic modules and provided via the IO-Link Interface.

The connection and communication options of the SCR P, via Ethernet-based fieldbus protocols, are explained in the BMA of the SCR P and are not covered in this document.

2.1 What actually is DCD?

Series connections of safety devices have been used in safety-relevant applications, such as interlocking devices or emergency stop systems, for a very long time.
In addition to the advantages, such as simple wiring and the need for only one redundant safety input of the downstream Safety-monitoring module, the series connection also has disadvantages.
For example, the safety outputs can only detect that a door is open. It does not make clear which one this is. To search for the open door can cost a lot of time and money during troubleshooting but also in the manufacturing process. Particularly when the door is almost closed, but not enough to operate the interlocking device, the only option is to go along the doors and test.
In the SMART Safety System, the device (e.g. the contactless safety sensor SRF) makes it possible to read the states of the individual device into the higher-level controller and in this way, despite series connection of the device, to identify exactly the sensor that triggered the stop signal. In addition to the door status, a variety of other information is transmitted, e.g. Input and output status, defeating (wrong actuator detected), actuator at the edge of the sensing distance, voltage OK as well as the value of the voltage and many more. (See chapter 5.1 "Basic information" and chapter 5.2 "Extended Information").
Technically, this is implemented in such a way that the sensor furthest away from the controller generates a data packet with its status information and modulates it onto the safety signals. The next sensor reads the data packet, adds its own status information to it and passes the packet on to the next sensor. At the control end of the chain there is a diagnostic module that separates the diagnostic information from the safety signal and processes it for the user. BERNSTEIN AG calls this system "Daisy Chain Diagnostics" (DCD).
Essential for the DCD system is the autonomy of the safety signal and DCD data on the line. Likewise, the safety controller and the diagnostic module, which are connected in parallel to the safety outputs, must not influence each other.
BERNSTEIN AG offers a variety diagnostic modules for processing DCD data. And this is exactly where the DCD system technically ends, because the diagnostic module makes the received DCD data available to the user by means of an industry-standard interface.
The SRF DI diagnostic module is an IO-Link device on the output side and thus enables any controller with an IO-Link master to read out the status information of each individual sensor. Profinet, Ethernet/IP or Modbus/TCP are available for the SCR P. Maintenance personnel also have the option of reading out the status of the safety chain via NFC interface with a smartphone app or via USB with a laptop. The basic information about which door is open is also provided as a discrete signal.

2.2 What are the advantages of DCD? And how does it work?

The Daisy Chain Diagnostic (DCD) system provides a wealth of information designed to make machinery and equipment more efficient by eliminating downtime. The DCD system is supported by the sensors (SRF-5), the emergency stop (SEU) and the safety relay (SCR DI). The data of each device is collected in the SCR DI (or stand-alone diagnostic device) and can be output via different interfaces - via ...

• IO-Link to a controller
• USB to a laptop
• NFC to an smartphone

Different data is available depending on the device. A detailed overview of the individual data can be found in chapters 4 "Diagnostic data SCR DI" and 5 "Diagnostic data SRF and SEU".

Thanks to the innovative DCD diagnostic system, time-consuming troubleshooting is a thing of the past. This means that the status of each device can be made available in detail at any time. In the past, when safety switches were connected in a series, it was very difficult to provide the open/closed status of each device. With the DCD system from BERNSTEIN, this information is modulated onto the safety outputs in the form of data packets and each device adds its data packets. This makes it possible to see at any time which door has been opened or which emergency stop has been pressed. With the help of BERNSTEIN diagnostic devices or the SCR DI safety relay, this information can now be made available to the controller – without any loss of safety level.

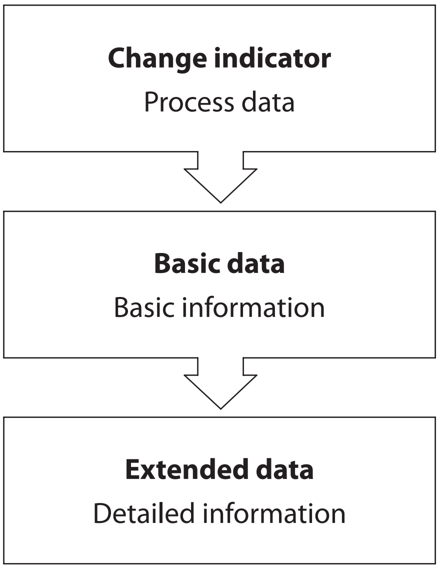
The data packets on the safety outputs are read out by the diagnostic devices and made available to a controller with IO-Link master via the IO-Link interface.

3 IO-Link Communication

This chapter describes the basic message structure and data flow of an IO-Link communication to a BERNSTEIN IO-Link device.

3.1 Structural message structure

Each device in a series connection with DCD technology sends diagnostic information about its own status. As described in Link defekt: Chapter 2.2: "What are the advantages of DCD? And how does it work?", this information is received by a diagnostic module (SRF DI or SCR DI) and provided via IO-Link communication. In addition, the SCR DI safety relay provides its own diagnostic information via IO-Link. Communication always takes place via the connected diagnostic module and not directly with a device of the series connection.
The information that is transmitted via the IO-Link interface can basically be divided into 3 steps: Change indicators, basic data and extended data.



The change indicators are transferred via the process data. The process data contains only the information on whether the basic data of a device (or of the SCR DI) have changed.

The basic data provides basic information about the status of a device (or the SCR DI). The information provides an overview of the most important statuses and messages of the device (e.g.) Actuator detected, emergency stop pressed, safety relay activated).

The extended data is used for more detailed diagnostic of a device (or SCR DI). For example, specific values for temperature, voltage and actuator distance can be transmitted.

Therefore the message structure is designed in such a way that the process data is continuously checked for a change. If a change is pending, the corresponding basic information of the device (or the SCR DI) can be retrieved. If a more detailed diagnostic is required because of the basic information, the extended data can also be retrieved.
This message structure is a recommendation. The basic and extended data can also be retrieved completely independently of each other, completely or only in parts. The structure of the communication is explained in more detail in the following chapters.

3.2 Communication flow

IO-Link offers 3 basic data transmission paths: Process data, which are transmitted cyclically or synchronously, the device data, which are transmitted acyclically or asynchronously and the events, which can be triggered by a message.

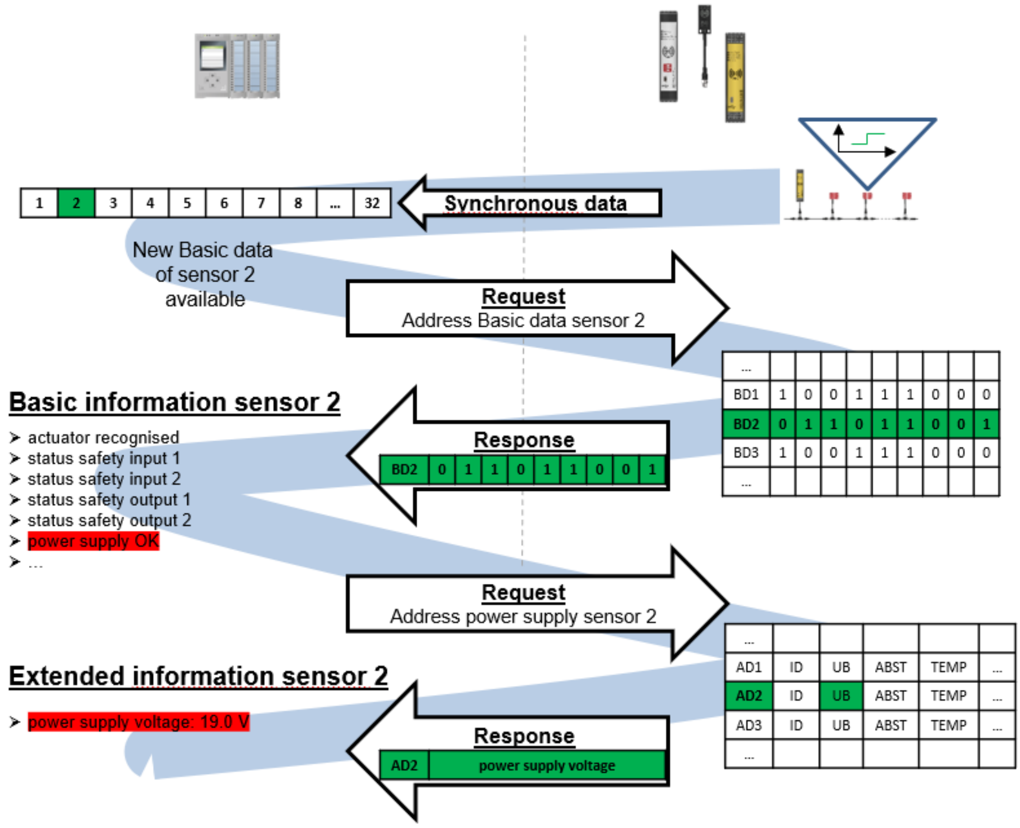


Figure 1: Communication flow exampl

The communication flow is analogous to the message structure. The process data is exchanged cyclically and automatically between an IO-Link device (diagnostic module or safety monitoring module) and a connected IO-Link master (e.g. on a PLC). This data includes a change indicator for each individual device of a connected series (see chapter 3.3 "Cyclical data (process data)"). If a change on a device is detected, the IO-Link master can send a request for the basic data of the corresponding device to the IO-Link device. In the example shown, this is the 2nd Sensor of the series connection. The IO-Link device then transmits the basic data of the corresponding device (response). The transmission of the basic data is thus acyclic, on request (see chapter 3.4 "Acyclic data (Device data)").
As soon as this is done, the change indicator in the process data is automatically reset.
If further, more detailed information is required on the basis of the transmitted basic data, individual, extended data of a sensor can also be transmitted via acyclic communication. For this purpose, the IO-Link master also sends a request to the IO-Link device (Request; with the address of the requested data) and receives the requested information as a response.
If a state occurs at the IO-Link device that does not correspond to normal operation, an (error) message can be triggered by the IO-Link device (e.g. Number of device in diagnostic series 1 not correct). Such messages are transmitted as events, independent of cyclic and acyclic communication (see chapter 3.5: "Events"). The messages are received and signalled by the connected Master.

This communication flow is a recommendation. The basic and extended data can also be retrieved completely independently of each other, completely or only in parts. The structure of the communication is explained in more detail in the following chapters.

3.3 Cyclical data (process data)

The cyclical data or process data is continuously updated by the IO-Link device. The data is used to signal a change in the basic information at one of the connected devices. 32 bits of process data represent the possible 32 devices of a diagnostic series. When the basic information is changed, the corresponding bit is set to '1'. Subsequently, the basic information can be retrieved via acyclic communication. After the basic information has been successfully retrieved, the corresponding bit in the process data is automatically reset.

This mechanism is also used for the basic information of the safety relay SCR DI. The first bit in byte 4 (bit 32) represents a change in the data. As soon as the basic information changes, the bit is set to "1". If the basic information was retrieved via acyclic IO-Link communication, the bit is automatically reset to "0".

Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4** (SCR DI only)
Bit [7..0]	Bit [15..8]	Bit [23..16]	Bit [31..24]	Bit [39..32]

Table 1: Order and position of the information in the synchronous data

The 6-fold diagnostic module "SRF DI6" uses 6 x 4 byte process data to signal a change of the connected devices (Byte 0 to 3: Diagnostic series 1; Byte 4 to 7: Diagnostic series 2; Byte 8 to 11: Diagnostic series 3; ff.).

3.4 Acyclic data (Device data)

In addition to the change indicators in the process data, all actual information are available as acyclic data or device data. Acyclic data means that this information is only retrieved on request and is not transmitted automatically. This is done via configuration software provided by the IO-Link master or via system modules of a programmable controller. The index and subindex can be used to access the corresponding data area. The indexes of all available data are listed in chapter 11 "IO-Link-Configuration".

3.5 Events

Events are used to transmit (error) messages from an IO-Link device. The event codes are listed in chapter 12 "Event codes".

4 Diagnostic data SCR DI

The safety relay (SCR DI) provides its own data that can be retrieved via the IO-Link interface. This data is not provided by an SRF DI diagnostic module. The data of the safety relay is divided into basic and extended information.

4.1 Basic information

The basic information is transmitted as a 16-bit value. The content of the basic information transmitted is listed in Table 2.

Byte 0								Byte 1							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
E1	E2	Q1	SZOW	EFQ	'0'	'0'	'0'	RFK1	RFK2	RFKe	RE	RF	RFKZ	UB	UW

Table 2: Bit positions in basic data

The information stored in the status bits of the basic information is listed in Table 3. For information on the data structure and length, refer to chapter 11.9 "Basic information SCR DI".

Bit	Meaning
E1	Status safety input 1.1
E2	Status safety input 1.2
Q1	Safety output status
SZOW	Stop mode
EFQ	Input error acknowledgement required
RFK1	Status of internal feedback loop 1
RFK2	Status of internal feedback loop 2
RFKe	Status external feedback loop (EDM)
RE	Reset expected (yes: 1, no: 0)
RF	Reset function (auto: 1, manual: 0)
RFKZ	External feedback loop monitoring available
UB	Operating voltage OK
UW	Operating voltage warning

Table 3: Meaning of the bits in the basic information

4.1.1 E1 - Status of safety input 1.1

The bit indicates the status of safety input 1.1. If a high or low signal is present at the safety input, the bit in the diagnostic data is set to '1' or '0' accordingly.

4.1.2 E2 - Status of safety input 1.2

The bit indicates the status of safety input 1.2. If a high or low signal is present at the safety input, the bit in the diagnostic data is set to '1' or '0' accordingly.

4.1.3 Q1 - Status of safety output

The bit reflects the state of the safety output (all enabled paths). When the safety relay is switched on, the bit is set to '1', when the safety relay is switched off, the bit is set to '0'.

4.1.4 SZOW - Stop mode

Indicates whether the safety-monitoring module was interrupted due to an error (see operating manual of the SCR DI: Chapter "LED signals") has been set to stop mode. After the error has been eliminated (if possible), a voltage reset must be performed to restart the device.

4.1.5 EFQ - Input error acknowledgement required

This bit is set when the safety-monitoring module has detected an input error. This error occurs when a channel is switched on again before the second channel was switched off (plausibility check). The error can also be caused by a violation of the SCR times T_a, T_0 or $T_ü$ (See chapter 13 "Discrepancy and switch-off times safety inputs"). To acknowledge the error, both inputs of the safety series must be set to '0' at the same time (open the safety series).

4.1.6 RFK1 - Status of internal feedback loop 1

The internal feedback loop 1 is used to monitor the internal relay 1. The bit indicates the status of feedback loop 1. When the (internal) relay contact is closed, the bit is set to '1', when the contact is open, the bit is set to '0'.

Note: This status may contradict the output status (Q1), indicating an internal error.

4.1.7 RFK2 - Status of internal feedback loop 2

The internal feedback loop 2 is used to monitor the internal relay 2. The bit indicates the status of feedback loop 2. When the (internal) relay contact is closed, the bit is set to '1', when the contact is open, the bit is set to '0'.

Note: This status may contradict the output status (Q1), indicating an internal error.

4.1.8 RFKe - Status of external feedback loop (EDM)

If an external feedback loop is present, the status of the external feedback loop is transmitted. This is required, for example, when monitoring a contactor. The condition monitoring of the external feedback loop is also referred to as "EDM" (External Device Monitoring).

Note: If the unit is equipped with an External Device Monitoring, an external feedback loop must also be connected.

4.1.9 RE - Reset expected

It is displayed whether the safety-monitoring module is waiting for the input of a reset button. This is the case when the safety series is closed and a manual reset is configured. (yes: 1, no: 0)

4.1.10 RF - Set reset function

It is displayed whether the safety-monitoring module is configured for a manual or automatic reset. If a manual reset is configured, the use of a reset button is required. (automatic: 1, manual: 0)

Note: The restart is configured via the corresponding input terminal.

4.1.11 RFKZ - External device monitoring available

This bit indicates whether the safety-monitoring device has External device monitoring. (available: 1, not available: 0)

4.1.12 UB - Operating voltage OK

The operating voltage is monitored cyclically. If the voltage is higher than 30V or lower than 19.2V, an error is detected and the bit is reset. (OK: 1, not OK: 0)

4.1.13 UW - Operating voltage warning

If the operating voltage deviates from 24V by ±15%, a warning is set. (Warning: 1, no warning: 0)

4.2 Extended information

In addition to the basic information, the extended information of the safety relay can be retrieved via the IO-Link interface. Table 4 shows the provided information.
For information on the data structure and length, refer to chapter 11.10 "Extended information SCR DI"

Value
Operating voltage
Temperature
Discrepancy and switch-off times
Switching cycles
Cross-circuit timer
Safety firmware version

Table 4: Extended information of the safety relay

Note: The real values for temperature and operating voltage are transmitted via IO-Link. For devices with Ethernet Communication, a conversion must be made according to the formulas and/or tables in the manual of the specific device.

4.2.1 Operating voltage

The safety-monitoring module records data on the operating voltage. The current operating voltage can be retrieved via the interface.

4.2.2 Temperature

The safety-monitoring module records data on the temperature. The current device temperature can be retrieved via the interface.

4.2.3 Discrepancy and switch-off times

See chapter 13 "Discrepancy and switch-off times safety inputs".

4.2.4 Switching cycles

The safety-monitoring module counts the switching cycles of the safe output and those of the connected actuator, if it is read back via an external device monitoring.
The number of switching cycles for the connected actuator can be reset via the IO-Link interface. For this purpose, a 1 must be sent to the safety-monitoring module (see chapter 11.10 *"Extended information SCR DI"*).

4.2.5 Cross-circuit timer

After detecting an internal output error (e.g. cross-circuit), a timer of 20 minutes is started. The counter indicates the time until the outputs of the relay will be switched off in minutes. If no output error is detected, the timer always has the value of 31.

4.2.6 Safety firmware version

Indicates the version of the safety firmware of the device.

5 Diagnostic data SRF and SEU

The data received from the connected devices of a diagnostic series (sensors, emergency stop, etc.) is separated into basic and extended information. The information can be retrieved via the interface of the diagnostic module.

5.1 Basic information

The basic information is transmitted as a 16-bit value. The structure of the transmitted basic information is listed in Table 5.

Byte 0								Byte 1							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
QS	RB	BB	FB	CE	BE	SV	EF	MF	Q1	Q2	UF	LS	UW	E1	E2

Table 5: Structure of the basic information

The bits in the basic information have different functions depending on the connected device. The functions of the devices are listed in Table 6.

For information on the data structure and length, see chapter 11.2 "Basic information SRF/SEU"

Abbreviation	SRF	SEU
QS	Cross-circuit detected	Cross-circuit detected
RB	Actuator detected	Not relevant
BB	Actuator at the edge of the sensing distance	State of safety contact 1
FB	Wrong actuator	State of safety contact 2
CE	Not relevant	Not relevant
BE	Actuator not taught	Not relevant
SV	Not relevant	Not relevant
EF	Input error acknowledgement required	Input error acknowledgement required
MF	Stop mode	Stop mode
Q1	Status of safety output 1	Status of safety output 1
Q2	Status of safety output 2	Status of safety output 2
UF	Operating voltage error	Operating voltage error
UW	Operating voltage warning	Operating voltage warning
LS	Local reset expected	Local reset expected
E1	Status safety input 1	Status safety input 1
E2	Status safety input 2	Status safety input 2

Table 6: Meaning of the bits in the basic information

5.1.1 QS - Cross-circuit detected

Each connected device tests its safety outputs cyclically. If a cross-circuit between the outputs Q1 and Q2 or a short circuit from one of the outputs to the operating voltage is detected, the corresponding bit is set to '1'. At the same time the timer Q is started, see chapter 5.2.6: *"Cross-circuit timer (Q)"*.

5.1.2 RB

5.1.2.1 SRF - Actuator detected

If an actuator is within the detection range of the SRF, this bit is set to '1'. This information is independent of whether a correct actuator code was received.

5.1.2.2 SEU

This bit is not significant for the SEU.

5.1.3 BB

5.1.3.1 SRF - Actuator at the edge of the sensing distance

If an actuator is at the edge of the sensing distance, the corresponding bit is set to '1'.

5.1.3.2 SEU - State of safety contact 1

For emergency stop devices, this bit indicates the state of the first internal mechanical safety contact. For the junction box and the T-adapter, this bit indicates the state of the first external mechanical safety contact.

5.1.4 FB

5.1.4.1 SRF - Wrong actuator

The safety outputs of a high coded or unicoded SRF can only be switched on with the taught-in (assigned) actuator. If an actuator that has not been taught-in is brought into the detection range of an SRF with an incorrect code, this is detected and the corresponding bit is set to '1'.

5.1.4.2 SEU - State of safety contact 2

For emergency stop devices, this bit indicates the state of the second internal mechanical safety contact.

For the connection box and the T-adapter, this bit indicates the status of the second external mechanical safety contact.

5.1.5 BE

5.1.5.1 SRF - Actuator not taught

With a high coded or unicoded SRF, an actuator must be taught-in during installation. If no actuator has been taught-in yet, the corresponding bit is set to '1'.

5.1.5.2 SEU

This bit is not relevant for the SEU.

5.1.6 EF - Input error acknowledgement required

This bit is set when the device has detected an input error. This error occurs when a channel is switched on again before the second channel was switched off (plausibility check). The error can also be caused by a violation of the SCR times T_a, T_0 or $T_ü$ (See chapter 13 "Discrepancy and switch-off times safety inputs") . To acknowledge the error, both inputs of the safety series must be set to '0' at the same time (open the safety series).

5.1.7 MF - Stop mode

Indicates whether the device has been set to stop mode due to an error (see operating manual of the SRF or SEU: Chapter "LED signals"). After the error has been fixed (if possible), a power reset must be done to restart the device.

5.1.8 Q1 - Status of safety output 1

The bit indicates the status of safety output 1. When safety output 1 is switched on, the bit is set to '1'; when safety output 1 is switched off, the bit is set to '0'.

5.1.9 Q2 - Status of safety output 2

The bit indicates the status of safety output 2. When safety output 2 is switched on, the bit is set to '1'; when safety output 2 is switched off, the bit is set to '0'.

5.1.10 UF - Operating voltage error

If the operating voltage is higher than 30 V or lower than 19.2 V (24 V +25%; 24 V -20%), an error is detected and the corresponding bit is set to '1'.

5.1.11 UW - Operating voltage warning

If the operating voltage higher than 27.6 V or lower than 20.4 V (24 V ±15%), a warning is detected and the corresponding bit is set to '1'.

5.1.12 LS - Local reset expected

If the device has the local reset function and the local reset is expected to switch on the safety outputs, the corresponding bit is set to '1'.

5.1.13 E1- Status of safety input 1

The bit indicates the status of safety input 1. If a 'high' level is detected at safety input 1, the corresponding bit is set to '1'.

5.1.14 E2 - Status of safety input 2

The bit indicates the status of safety input 2. If a 'high' level is detected at safety input 2, the corresponding bit is set to '1'.

5.2 Extended Information

In addition to the basic information, the extended information of the devices can be retrieved via the IO-Link interface of the diagnostic module. However, not every device has the same extended information. Table 7 shows which device type provides which information.

For information on the data structure and length, see chapter 11.3 "Extended information SRF/SEU"

Value	SRF	SEU
Device ID	X	X
Operating voltage	X	X
Actuator distance	X	
Temperature	X	X
Counter operating voltage warning (Vu)	X	X
Cross-circuit timer (Q)	X	X
Counter actuator at the edge of the sensing distance (BB)	X	Not relevant
Received manufacturer code	X	Not relevant
Expected manufacturer code	X	X
Received actuator ID	X	Not relevant
Expected actuator ID	X	Not relevant
Product information	X	X
Number of Teach-Operations remaining	X	Not relevant

Table 7: Extended information per device

Note: The real values for the distance of the actuator, the temperature and the operating voltage are transmitted via IO-Link. For devices with Ethernet Communication, a conversion must be made according to the formulas and/or tables given in the manual.

5.2.1 Device ID

Different devices with DCD technology may be connected in one diagnostic series. For this reason, each device sends a device ID by which the device can be uniquely assigned in its function.

The device IDs used are listed in Table 8.

ID	Device
1	SRF
7	SEU - Emergency Stop
9	SEU - Connection box

Table 8: Device IDs

5.2.2 Operating voltage

Contains the information about the measured value of the operating voltage of the respective device in volts.

5.2.3 Distance

5.2.3.1 SRF

Contains the information about the measured value of the distance from the actuator to the sensor in percent.

5.2.3.2 SEU

This value is not relevent for the SEU.

5.2.4 Temperature

Contains information about the measured value of the internal temperature of the respective device in degrees Celsius.

5.2.5 Counter Operating voltage warning (Vu)

The operating voltage is measured periodically and compared with the limits for the operating voltage warning (see chapter 5.1.11"UW - Operating voltage warning"). If the limits are exceeded, the counter is increased. If the operating voltage is within the warning limits, the counter value will be reduced (min. 0). A counter value >10 indicates a more frequent exceeding of the operating voltage warning limits.

5.2.6 Cross-circuit timer (Q)

After detecting an output error (e.g., Cross-circuit), a timer of 20 minutes is started (see chapter 5.1.1 "QS - Cross-circuit detected"). The counter indicates the time in minutes until the outputs of the device are switched off. If no output error is detected, the timer always has the value of 31.

5.2.7 Counter actuator at the edge of the sensing distance (BB)

5.2.7.1 SRF

The value indicates the duration in hours that an actuator has been in the edge of the sensing distance.

5.2.7.2 SEU

This value is not relevant for the SEU.

5.2.8 Received manufacturer code

5.2.8.1 SRF

The manufacturer information is stored in the actuator in the form of a 4-digit code. This code is received and provided by the sensor.

5.2.8.2 SEU

This value is not relevant for the SEU.

5.2.9 Expected manufacturer code

The expected manufacturer information is stored in the sensor in the form of a 4-digit code.

5.2.10 Received actuator ID

5.2.10.1 SRF

The actuator is coded with an ID. The sensor receives and provides this ID.

5.2.10.2 SEU

This value is not relevant for the SEU.

5.2.11 Expected actuator ID

5.2.11.1 SRF

For high and unique coded sensors, the taught-in (expected) actuator ID is transmitted.

For low coded sensors this value is not relevant.

5.2.11.2 SEU

This value is not relevant for the SEU.

5.2.12 Product information

The device can be equipped with different properties.

The possible properties are listed in Table 9 and Table 10.

Bit	Meaning	SRF	SEU
HC	High coding	X	
RS	Can be connected in series	X	X
MS	With local reset	X	X
MQ	With fault-tolerant output	X	X

Table 9: Product information bits

Byte 0							
7	6	5	4	3	2	1	0
‘0’	‘0’	‘0’	‘0’	HC	RS	MS	MQ

Table 10: Bit position of the product description

5.2.13 Number of remaining Teach-Operations

5.2.13.1 SRF

For high and unique coded sensors, the number of Teach-Operations is limited. The transmitted value indicates the number of remaining Teach-Operations.

For low coded sensors this value is not relevant.

5.2.13.2 SEU

This value is not relevant for the SEU.

6 Machine description

Additional information can be stored as plain text for each diagnostic series. The data is stored in ASCII format.
For information on the data structure and length, refer to chapter 11.5 "Machine description".

6.1 Machine name

A name can be issued for each machine, e.g.: MS-12HB 2000. The length is max. 128 characters.

6.2 Machine position

A description of the machine position can be stored for each machine, e.g.: Building 12, next to conveyor belt 4. The length is max. 128 characters.

6.3 Name of the diagnostic series

A separate name can be assigned to each diagnostic series. The length is max. 128 characters.

6.4 Additional information on the diagnostic area

Additional information or an additional description can be stored for each diagnostic series. The length is max. 128 characters.

7 Device description

A name and position can be assigned to each device in plain text. The information is stored in ASCII format.
Note: If the number of devices within a diagnostic series is changed, the device description must be adjusted manually.
For information on the data structure and length, see chapter 11.6 "Device description".

7.1 Name

Each device can be assigned an individual name. The names are stored in the diagnostics module or the Safety-monitoring module. The length of the name is max. 64 characters.

7.2 Position

For each device, a description of the mounting position at the machine can also be stored. This information is stored in the diagnostic module or the Safety-monitoring module. The length of the data is max. 64 characters.

8 Switching cycles of devices

The diagnostic module and the Safety-monitoring module count the number of switching cycles of each device of a diagnostic series. The data can be retrieved via the IO-Link interface.
The number of switching cycles can be reset via the IO-Link interface (e.g. after replacing a device). For this purpose, the position (1-32) of the device to be reset must be sent to the diagnostic module or the Safety-monitoring module.
For information on the data structure and length, refer to chapter 11.4 "Switching cycles SRF/SEU".

9 Length of the diagnostic series

The expected number of devices in a diagnostic series can be specified via the IO-Link interface of the diagnostic module or the Safety-monitoring module. The actual detected number of devices in the diagnostic series can also be retrieved.
The expected and actual number of devices is compared and checked in the diagnostic module. If the number is not identical, an error is triggered (IO-Link Event; see chapter 12 "Event codes").
For information on the data structure and length refer to chapter 11.8 "Length of the diagnostic series".

10 System time

The system time can be read out and set via the interface of the diagnostic module or the Safety-monitoring module. The structure of the system time is shown in Table 11.
For information on the data structure and length, refer to chapter 11.7 "System time".

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Year	Month	Day	Hour	Minute	Second

Table 11: System time

11 Timer invalid Data

A timer can be read out via the IO-Link interface of the diagnostic module or the safety-monitoring module, which indicates the time since the last valid telegram is received. If invalid data is received from the diagnostic series, the last valid data remains and the timer is started. As soon as valid data is received again, this data will be accepted and the timer is set to "0".
The unit of the value is seconds. Maximum is 200 seconds.
If longer than 30 seconds no valid data is received, an error is triggered (IO-Link Event; see chapter 13: Eventcodes).
For information on the data structure and length refer to chapter 12.9: Timer invalid data.

12 IO-Link-Configuration

12.1 General information

Device characteristics	
SIO mode	No
Min. Cycle time	10 ms
Baud rate	38.4 kbps (COM2)
Process data	32 Bit (SRF DI) 40 Bit (SCR DI) 192 bit (SRF DI6)

Process data	
Width	32/40/192 bit
Alignment	Right
Access	RO
Data type	UINT32

IO-Link device Profile

Index (Hex)	**Meaning**	**Access**
0x0010	Manufacturer name	RO
0x0011	Manufacturer text	RO
0x0012	Product name	RO
0x0013	Item number	RO
0x0014	Product description	RO
0x0015	Serial number	RO
0x0016	Hardware revision	RO
0x0017	Software revision	RO
0x0018	App.-specific string	RO

12.2 Basic information SRF/SEU

Basic information from the diagnostic series

Index (Hex)	**Meaning**	**Access**	**Sub-indices**	**Length**	**Format**
0x40	Basic information series 1	RO	0x00	64 byte	UINT16
		RO	0x01 – 0x20	2 byte	UNIT16
0x41	Basic information series 2	RO	0x00 – 0x20	64/2 bytes	UINT16
0x42	Basic information series 3	RO	0x00 – 0x20	64/2 bytes	UINT16
0x43	Basic information series 4	RO	0x00 – 0x20	64/2 bytes	UINT16
0x44	Basic information series 5	RO	0x00 – 0x20	64/2 bytes	UINT16
0x45	Basic information series 6	RO	0x00 – 0x20	64/2 bytes	UINT16

12.3 Extended information SRF/SEU

Extended information from the diagnostic series					
Index (Hex)	**Meaning**	**Access**	**Sub-indices**	**Length**	**Format**
0x100	Device IDs series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x101	Device IDs series 2	RO	0x00 – 0x20	1 byte	UINT8
0x102	Device IDs series 3	RO	0x00 – 0x20	1 byte	UINT8
0x103	Device IDs series 4	RO	0x00 – 0x20	1 byte	UINT8
0x104	Device IDs series 5	RO	0x00 – 0x20	1 byte	UINT8
0x105	Device IDs series 6	RO	0x00 – 0x20	1 byte	UINT8
0x110	Operating voltage series 1	RO	0x00	128 byte	FLOAT32
		RO	0x01 – 0x20	4 byte	FLOAT32
0x111	Operating voltage series 2	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x112	Operating voltage series 3	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x113	Operating voltage series 4	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x114	Operating voltage series 5	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x115	Operating voltage series 6	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x120	Distances series 1	RO	0x00	128 byte	FLOAT32
		RO	0x01 – 0x20	4 byte	FLOAT32
0x121	Distances series 2	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x122	Distances series 3	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x123	Distances series 4	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x124	Distances series 5	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x125	Distances series 6	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x130	Temperature series 1	RO	0x00	128 byte	FLOAT32
		RO	0x01 – 0x20	4 byte	FLOAT32
0x131	Temperature series 2	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x132	Temperature series 3	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x133	Temperature series 4	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x134	Temperature series 5	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x135	Temperature series 6	RO	0x00 – 0x20	128/4 bytes	FLOAT32
0x140	Counter Vu series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x141	Counter Vu series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x142	Counter Vu series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x143	Counter Vu series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x144	Counter Vu series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x145	Counter Vu series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x150	Counter Q series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x151	Counter Q series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x152	Counter Q series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x153	Counter Q series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x154	Counter Q series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x155	Counter Q series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x160	Counter BB series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8

0x161	Counter BB series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x162	Counter BB series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x163	Counter BB series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x164	Counter BB series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x165	Counter BB series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x170	Received Manufacturer code series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x171	Received Manufacturer code series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x172	Received Manufacturer code series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x173	Received Manufacturer code series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x174	Received Manufacturer code series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x175	Received Manufacturer code series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x180	Extended Manufacturer code series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x181	Extended Manufacturer code series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x182	Extended Manufacturer code series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x183	Extended Manufacturer code series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x184	Extended Manufacturer code series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x185	Extended Manufacturer code series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x190	Extended Actuator-ID series 1	RO	0x00	64 byte	UINT16
		RO	0x01 – 0x20	2 byte	UINT16
0x191	Extended Actuator-ID series 2	RO	0x00 – 0x20	64/2 bytes	UINT16
0x192	Extended Actuator-ID series 3	RO	0x00 – 0x20	64/2 bytes	UINT16
0x193	Extended Actuator-ID series 4	RO	0x00 – 0x20	64/2 bytes	UINT16
0x194	Extended Actuator-ID series 5	RO	0x00 – 0x20	64/2 bytes	UINT16
0x195	Extended Actuator-ID series 6	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1A0	Received Actuator-ID series 1	RO	0x00	64 byte	UINT16
		RO	0x01 – 0x20	2 byte	UINT16
0x1A1	Received Actuator-ID series 2	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1A2	Received Actuator-ID series 3	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1A3	Received Actuator-ID series 4	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1A4	Received Actuator-ID series 5	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1A5	Received Actuator-ID series 6	RO	0x00 – 0x20	64/2 bytes	UINT16
0x1B0	Product description series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x1B1	Product description series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1B2	Product description series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1B3	Product description series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1B4	Product description series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1B5	Product description series 6	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1C0	Remain. Teach-Operations series 1	RO	0x00	32 byte	UINT8
		RO	0x01 – 0x20	1 byte	UINT8
0x1C1	Remain. Teach-Operations series 2	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1C2	Remain. Teach-Operations series 3	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1C3	Remain. Teach-Operations series 4	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1C4	Remain. Teach-Operations series 5	RO	0x00 – 0x20	32/1 bytes	UINT8
0x1C5	Remain. Teach-Operations series 6	RO	0x00 – 0x20	32/1 bytes	UINT8

12.4 Switching cycles SRF/SEU

Read switching cycles

Index (Hex)	Meaning	Access	Sub-indices	Length	Format
0x2000	Switching cycles series 1	RO	0x00	128 byte	UINT32
			0x01 – 0x20	4 byte	UINT32
0x2001	Switching cycles series 2	RO	0x00 – 0x20	128/4 bytes	UINT32
0x2002	Switching cycles series 3	RO	0x00 – 0x20	128/4 bytes	UINT32
0x2003	Switching cycles series 4	RO	0x00 – 0x20	128/4 bytes	UINT32
0x2004	Switching cycles series 5	RO	0x00 – 0x20	128/4 bytes	UINT32
0x2005	Switching cycles series 6	RO	0x00 – 0x20	128/4 bytes	UINT32

Delete switching cycles per device

Index (Hex)	Meaning	Access	Value	Length	Format
0x2010	Switching cycles series 1	WO	1 – 32	1 byte	UINT8
0x2011	Switching cycles series 2	WO	1 – 32	1 byte	UINT8
0x2012	Switching cycles series 3	WO	1 – 32	1 byte	UINT8
0x2013	Switching cycles series 4	WO	1 – 32	1 byte	UINT8
0x2014	Switching cycles series 5	WO	1 – 32	1 byte	UINT8
0x2015	Switching cycles series 6	WO	1 – 32	1 byte	UINT8

12.5 Machine description

Machine and diagnostic series definitions

Index (Hex)	Meaning	Access	Sub-indices	Length	Format
0x3A00	Name of machine/plant series 1	RW	0x00	128 byte	ASCII
0x3A02	Position of machine/plant series 1	RW	0x00	128 byte	ASCII
0x3A04	Name of the diagnostic series 1	RW	0x00	128 byte	ASCII
0x3A05	Additional information series 1	RW	0x00	128 byte	ASCII
0x3B00	Name of machine/plant series 2	RW	0x00	128 byte	ASCII
0x3B02	Position of machine/plant series 2	RW	0x00	128 byte	ASCII
0x3B04	Name of the diagnostic series 2	RW	0x00	128 byte	ASCII
0x3B05	Additional information series 2	RW	0x00	128 byte	ASCII
0x3C00	Name of machine/plant series 3	RW	0x00	128 byte	ASCII
0x3C02	Position of machine/plant series 3	RW	0x00	128 byte	ASCII
0x3C04	Name of the diagnostic series 3	RW	0x00	128 byte	ASCII
0x3C05	Additional information series 3	RW	0x00	128 byte	ASCII
0x3D00	Name of machine/plant series 4	RW	0x00	128 byte	ASCII
0x3D02	Position of machine/plant series 4	RW	0x00	128 byte	ASCII
0x3D04	Name of the diagnostic series 4	RW	0x00	128 byte	ASCII
0x3D05	Additional information series 4	RW	0x00	128 byte	ASCII
0x3E00	Name of machine/plant series 5	RW	0x00	128 byte	ASCII
0x3E02	Position of machine/plant series 5	RW	0x00	128 byte	ASCII
0x3E04	Name of the diagnostic series 5	RW	0x00	128 byte	ASCII
0x3E05	Additional information series 5	RW	0x00	128 byte	ASCII
0x3F00	Name of machine/plant series 6	RW	0x00	128 byte	ASCII
0x3F02	Position of machine/plant series 6	RW	0x00	128 byte	ASCII
0x3F04	Name of the diagnostic series 6	RW	0x00	128 byte	ASCII
0x3F05	Additional information series 6	RW	0x00	128 byte	ASCII

12.6 Device description

Names and positions					
Index (Hex)	**Meaning**	**Access**	**Sub-indices**	**Length**	**Format**
0x1000	Name and position of sensor 1.01	RW	0x00	128 byte	ASCII
	Name of sensor 1.01	RW	0x01	64 byte	ASCII
	Position of sensor 1.01	RW	0x02	64 byte	ASCII
0x1001	Name and position of sensor 1.02	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1002	Name and position of sensor 1.03	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x101E	Name and position of sensor 1.31	RW	0x00 – 0x02	128/64 bytes	ASCII
0x101F	Name and position of sensor 1.32	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1100	Name/Position sensor 2.01	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x111F	Name/Position sensor 2.32	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1200	Name/Position sensor 3.01	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x121F	Name/Position sensor 3.32	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1300	Name/Position sensor 4.01	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x131F	Name/Position sensor 4.32	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1400	Name/Position sensor 5.01	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x141F	Name/Position sensor 5.32	RW	0x00 – 0x02	128/64 bytes	ASCII
0x1500	Name/Position sensor 6.01	RW	0x00 – 0x02	128/64 bytes	ASCII
…	…	…	…	…	…
0x151F	Name/Position sensor 6.32	RW	0x00 – 0x02	128/64 bytes	ASCII

12.7 System time

System time					
Index (Hex)	**Meaning**	**Access**	**Sub-indices**	**Length**	**Format**
0x2100	System time of machine/system	RW	0x00	6 byte	BCD

12.8 Length of the diagnostic series

Devices					
Index (Hex)	**Meaning**	**Access**	**Sub-indices**	**Length**	**Format**
0x2020	Number of expected device series 1	RW	0x00	1 byte	UINT8
0x2021	Number of expected device series 2	RW	0x00	1 byte	UINT8
0x2022	Number of expected device series 3	RW	0x00	1 byte	UINT8
0x2023	Number of expected device series 4	RW	0x00	1 byte	UINT8
0x2024	Number of expected device series 5	RW	0x00	1 byte	UINT8
0x2025	Number of expected device series 6	RW	0x00	1 byte	UINT8
0x2026	Number of received device series 1	RO	0x00	1 byte	UINT8
0x2027	Number of received device series 2	RO	0x00	1 byte	UINT8
0x2028	Number of received device series 3	RO	0x00	1 byte	UINT8
0x2029	Number of received device series 4	RO	0x00	1 byte	UINT8
0x202A	Number of received device series 5	RO	0x00	1 byte	UINT8
0x202B	Number of received device series 6	RO	0x00	1 byte	UINT8

12.9 Timer invalid Data

Index (HEX)	Meaning	Access	Sub-indices	Length	Format
0x2040	Time since last valid data series 1	RO	0x00	1 Byte	UINT8
0x2041	Time since last valid data series 2	RO	0x00	1 Byte	UINT8
0x2042	Time since last valid data series 3	RO	0x00	1 Byte	UINT8
0x2043	Time since last valid data series 4	RO	0x00	1 Byte	UINT8
0x2044	Time since last valid data series 5	RO	0x00	1 Byte	UINT8
0x2045	Time since last valid data series 6	RO	0x00	1 Byte	UINT8

12.10 Basic information SCR DI

Index (HEX)	Meaning	Access	Sub-indices	Length	Format
0x2110	Status bits	RO	0x00	2 byte	UINT16

12.11 Extended information SCR DI

Index (HEX)	Meaning	Access	Sub-indices	Length	Format
0x2111	Voltage/temperature	RO	0x00	8 byte	FLOAT32
	Supply voltage value	RO	0x01	4 byte	FLOAT32
	Temperature value	RO	0x02	4 byte	FLOAT32
0x2112	SCR times	RO	0x00	6 byte	UINT16
	Time T_a	RO	0x01	2 byte	UINT16
	Time T_0	RO	0x02	2 byte	UINT16
	Time $T_ü$	RO	0x03	2 byte	UINT16
0x2113	Switching cycles	RO	0x00	8 byte	UINT32
	Safety relay outputs	RO	0x01	4 byte	UINT32
	External device monitoring	RO	0x02	4 byte	UINT32
0x2114	Cross-circuit timer	RO	0x00	1 byte	UINT8
0x2115	Safety firmware version	RO	0x00	14 byte	ASCII

Reset counter reading external device monitoring

Index (HEX)	Meaning	Access	Value	Length	Format
0x2120	Reset external device monitoring	WO	1	1 byte	UINT8

13 Event codes

All standard event codes are defined in the IO-Link specification. The specification is available to download under IO-Link.com ready for download.

13.1 Manufacturer-specific

In addition to the event codes defined in the IO-Link specification, there are the following manufacturer-specific event codes.

Event code	Meaning
0x8CA0	Number of incorrect devices in diagnostic series 1
0x8CA1	Number of incorrect devices in diagnostic series 2
0x8CA2	Number of incorrect devices in diagnostic series 3
0x8CA3	Number of incorrect devices in diagnostic series 4
0x8CA4	Number of incorrect devices in diagnostic series 5
0x8CA5	Number of incorrect devices in diagnostic series 6
0x8D04	No valid data received from series 1
0x8D05	No valid data received from series 2
0x8D06	No valid data received from series 3
0x8D07	No valid data received from series 4
0x8D08	No valid data received from series 5
0x8D09	No valid data received from series 6

14 Discrepancy and switch-off times safety inputs

The time response of the safety outputs of the previous device are monitored at the safety inputs. For the switching behaviour of these safety outputs, specifications have been made for the discrepancy and switch-off times. Therefore, the outputs must be switched on and off simultaneously in a time frame. If the outputs are switched off, there is a waiting time until the outputs are switched on again. These times are configured in the evaluation and defined as follows:

- T_a: Maximum offset when switching off the safety outputs.
- $T_ü$: Maximum offset when switching on the safety outputs.
- T_0: Minimum time that the safety outputs must be switched off.

The times are given in 10ms steps.

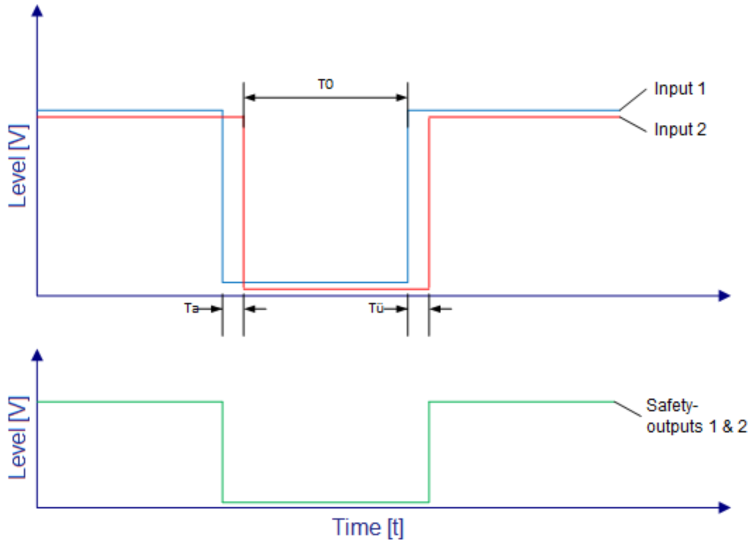


Figure 2: Discrepancy and switch-off times

Times	SCR DI	SRF	SEU	SEU mech. Contacts
T_a	3 s	3 s	3 s	0 s
$T_ü$	0 s	0 s	0 s	0 s
T_0	0 s	0 s	0 s	0 s

Table 15: Preset discrepancy and switch-off times

0 s corresponds to the infinite setting.

BERNSTEIN

DETECT
We make safety happen.

PROTECT
We keep safe your visions.

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