BDK-ET-1.3, BDK-ET/FP-1.3 and BDK-ET/OB-1.3
Double Sheet Metal Monitor
for Single Surface Contact Measurement

Technical Manual GB 20.05-96, -97, 20.21-02
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Contents

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1. Application

Double sheet metal monitors find application in situations where pieces of ferrous (Fe) or non-ferrous (NE) metal sheets must be monitored in order to ensure that their thickness lies between upper and lower thresholds. It happens occasionally that two or more pieces adhere to each other when sheet metals are removed from a stack. This must be recognised immediately; otherwise, a double sheet could be feeded into the press, resulting in damage to the tool or the press itself.

The use of double sheet metal monitors ensures the proper feeding of the workpieces and thus prevents the drawing-in of double sheets.

The BDK-ET Double Sheet Metal Monitors, together with various sheet metal sensors and measuring methods, are suitable for the monitoring of ferrous and non-ferrous sheet metals of up to 5.5 mm thickness employing contact measurement only.

2. Configuration

A cover which can be locked protects the evaluation devices against unauthorised access. The sensors and evaluation devices are characterised by sturdy construction and a high protection class. The ready-made connecting leads with plugs and sockets on both sensor and device ends permit quick and easy mounting and commissioning of these devices.

Four operator keys and a four-lined illuminated text display permit the convenient entry of device and measuring parameters. 256 program memory locations permit storage of the measuring programs, facilitating convenient accommodation for changes in materials or tools during operation. The stored programs remain in the memory even when the device is switched off.

3. Method of Operation

Two methods of measurement are available for the monitoring of double sheets and for measuring thicknesses: Magnetic flux and eddy current induction principle.

For both measuring operations either a BDK-ET-1.3 or a BDK-ET/FP-1.3 evaluation unit is necessary. By selection of the individual sensor type the mode of operation is automatically determined: Either single sheet measurement of magnetic flux used for ferrous magnetic metals, or eddy current measurement for non-ferrous magnetic metals. During these modes of measurements the sensor head must be in contact with the metal sheet.

During all measurement operations, the evaluation device calculates the thickness based on the measurement results and compares it with the current thresholds.

In the LC display sensor type, upper and lower threshold, sensor connection, measurement internal/external and the calibration selection are presented depending on the selected program number. After each measurement the measurement value is analysed and indicated in the display.

The indicator and operator display are equipped with signal lamps, which optically present the active status of a measurement, the initiator, 0-, 1- and 2 sheet acknowledgement. In connection with these messages the press controller allows an individual evaluation via three potential-free relay outputs K0, K1, and K2.

The current status of operation can be deducted form the actual signal behaviour. The details of the signal behaviour are described on the back pages.

The operation for the parameter-input and similar information occurs via four keys and their possibilities of combination (see section 5. for detailed description).

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Devices with a PROFIBUS DP field bus interface emit the 0 … 2 sheet metal message, the memory location number of the current program and the current threshold value via the field bus interface instead of via the relay outputs.

The selection of the measuring program and initiation of the measurement can take place either via a parallel interface to the PLC or via the field bus interface.

If the device is operated without without PLC (stand-alone-operation), the measurement program can be selected on the device itself and the measuring operation can be initiated by a proximity switch within the sensor.

4. Versions for Contact Measurement

4.1. Monitoring of Ferrous Sheets

For the single surface contact measurement of ferrous magnetic metals the DSP Sheet Metal Thickness Sensor has to be used for monitoring sheets with a thickness of 0.2 and 5.5 mm.

In the DSP Sheet Metal Thickness Sensors for ferrous workpieces, a field coil in the sensor generates a strong magnetic field. The workpiece is temporarily pulled onto the sensor head and brought to magnetic saturation by the high flux density. A sensor coil measures the saturation flux density, which is approximately proportional to the thickness.

4.2. Monitoring of Non-Ferrous Sheets

This BDWF sensor allows the monitoring of non-ferrous sheets having a measurement range between 0.2 and 5.5 mm.

The BDWF Sheet Metal Thickness Sensor for non-ferrous workpieces has a field coil which induces an eddy current in the non-ferrous workpiece under measurement. The sensor coil measures the field caused by the eddy current, which is almost proportional to the thickness. Since the workpiece is not pulled onto the sensor head during the measurement, no essential air gap between workpiece and sensor head is permissible.

4.3. Sensor for Ferrous- and Non-Ferrous Sheets

The DSPW Sheet Metal Sensor combines the two measuring principles of DSP and BDWF in one sensor.

It allows the monitoring of ferrous sheets with a range between 0.2 and 3.5 mm and non-ferrous sheets with a range between 0.2 and 2.5 mm.

> ☞ ***Note:***
> A selection of the material used has to be determined by the indication of the sensor type (DSPW/FE and DSPW/NE).

4.4. Measurement Accuracy and Influence of Air Gap

With both types of measurement, the accuracy is about 0.1 mm at the calibration point or about 5% of the end-of-scale value throughout the entire measurement range.

A general statement of the permissible air gap for single surface contact measurement is not possible because the influence is mainly dependent on the thickness, the type of sheet metal, the contact area between sensor and sheet metal, and the sensor being used. Principally, there should be no air gap, neither between the sensor and the workpiece nor between the workpieces in the case of a double sheet. See diagrams in the chapter with the title Sheet Metal Thickness Sensors.

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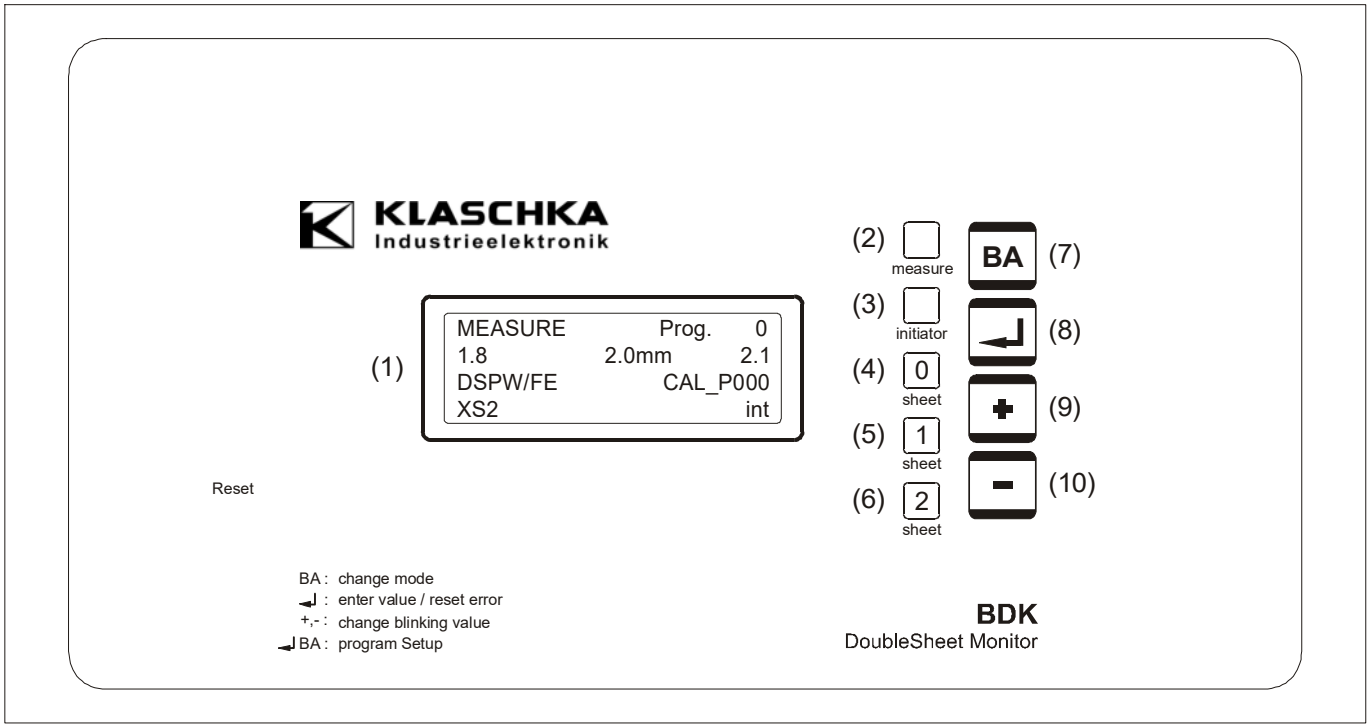

5. Operation

Operation is accomplished using the four operator keys on the front panel of the device:

Mode Change operating mode (7)
↵ Acknowledge entry (8)
\+ Increment value (9)
\- Decrement value (10)

5.1. Indicators

In order to guide the operator, the device is equipped with an illuminated text display (1) with 4 lines of 20 characters each. This permits the monitoring of the current operating status at all times. 5 LED indicators: (2) ... (6) provide additional information about the measurement result.

The illuminated fields mean the following:

Measurement: (2)	Lights during measurem. operation
Initiator: (3)	Lights when the sensor recognises a sheet.
0 Sheet: (4)	Lights when no workpiece is present at sensor or thickness is less than lower threshold.
1-Sheet: (5)	Lights when one sheet metal is detected.
2-Sheet: (6)	Lights to indicate detection of double sheet or general fault

5.2. Basic Settings in “Setup“ Menu

The basic settings must be performed when the device is used for the first time. For this, the "Enter" (7) and the "Mode" (8) keys must be pressed and held down simultaneously. This calls up the "Setup" menu. Subsequently pressing the "Enter" key (8) permits the next setting. The parameters hereto are altered by pressing the "+" and "-" keys (9) and (10) (see flowchart in chapter 5.5).

The following settings can be made:

- Select language to be displayed,
- Initiate measurement internally (using integrated proximity switch in sensor) or externally (using STA input or via field bus interface),
- STA lead breakage recognition switch-on or -off,
- Select program memory location manually (selecting program number in "Threshold" menu) or externally (via PLC or field bus interface),
- Permit remote operation (acknowledge faults, perform calibration, switch on and off via PLC interface),
- Behaviour of relay outputs (switchover between standard and alternative modes),
- Behaviour of relay reset input (high or low active),
- Repetition time (time interval after which subsequent measurement is initiated with continuous start signal). If repetition time is set to 0 seconds, the device will perform only one measurement per start signal, and
- Scaling of DSPW/NE, without sheet, for calibration of the frequency response.

After the last available setting point, the settings are started again at the first point.

Pressing the "Mode" key (7) exits from the "Setup" menu and calls up the main menu. The initial settings can be altered at any time by pressing the "Enter" and "Mode" keys (7 and 8) simultaneously.

☞ ***Note:***

While the parameters are being entered in the "Threshold" and "Calibration" modes, and in the "Setup" menu, the relay output will signal a double sheet message.

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5.3. Operating Modes in Main Menu

Operation can take place in three different modes, which can be selected cyclically using the "Mode" key:

- Program:
  Entering the sensor type with its calibration and the upper and lower thresholds.
- Calibration:
  Calibrating the sensor selected in the “Program” mode
- Mesurement:
  Main mode, measuring the current sheet metal thickness and signalling the results.

5.3.1. “Program” Mode

For monitoring the sheet metal thickness, the device compares the measurement result with an upper threshold to check for a double sheet and a lower threshold to check for nominal thickness and presence of a workpiece. The device has 256 program memory locations for storing the type of sensor with its calibration, and the threshold values. In the "Measure" mode, the appropriate set of parameters can thus be called up from the memory (see flow chart in chapter 5.6).

Programming
Programming is accomplished as follows:

- Select the "Program" mode by repeatingly pressing the "Mode" key (7).
- Using the "**+**" and "**-**" keys (9) and (10), select the memory location (blinking value) and acknowledge using the "Enter" key (8). Subsequently the sensor selection will blink.
- Enter the sensor type to be used by "+" and "-" keys. Change to the next setting parameter by pressing the "Enter" key (8).
- Select the upper threshold, which, when exceeded will result in a double sheet message.

  The upper threshold should be some value between the thickness of a single and a double sheet. The closer this threshold is to the thickness of a single sheet, the greater the certainty that a double sheet will be detected. However, if this threshold is too close to a single sheet thickness, small variations in sheet metal thickness will occasionally result in a double sheet message when only one sheet is present.

  Pressing the "Enter" key (8) leads to the next parameter to be entered.
- Select the lower threshold, which will result in a "too thin" message if the measured thickness is less than this value. Pressing the "Enter" key (8) leads to the selection of the program memory location.
  The required calibration can be selected via keys (8/9) (CAL 0 up to CAL 7 or CAL _ PXXX).
  Pressing the “Enter” key (8) leads again to the selection of the measuring program memory.
- Further measuring programs can be installed int the same way.
- The correct function of the device can now be tested by inserting first one workpiece and then a double workpiece.

> ☞ ***Note:***
> The numbers in ( ) refer to the diagram of the operator panel on page 3.

Selection of the program memory location
Selection of the program to be used can be accomplished by one of the following methods:

Internal Selection
To permit internal selection, the memory location selection must be set to manual in the setup menu. In the "Threshold" mode, using the "**+**" and "**-**" keys (9) and (10), the required memory location can be selected and acknowledged using the "Enter" key.

External Selection
External selection is accomplished either via the PLC interface or the field bus interface (selection via field bus interface, page 12).

To permit this, the memory location selection must be set to external in the setup menu. The required program memory location can be selected by placing the appropriate binary code on inputs A1 … A8. The time required for acknowledgement of the binary code depends on whether or not remote acknowledgement of faults, calibration, and memory location has been switched on in the setup menu.

In the case of an external memory selection without a remote control (standard) the binary A1 ... A8 is interrogated and acknowledged once every program cycle.

In the case of external memory selection with a remote control first bit A8 must be set high; then the binary code must be placed onto A1 ... A7. Achnowledgement occurs with the falling edge of A8.

Chart for Selection of Program Memory Location			
Setup mem. Location selection	Selection bit A8 ... A1	Program memory	Remarks
Manual	- - - - - - - -	0 ... 255	**Manual** entry via keys on operator panel
External remote control **standard**	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1	0 1 . 255	**External** entry via binary code A1 ... A8
External remote control **extended**	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1	0 1 . . . 128	**External** entry via binary code on A1 … A7 and falling edge of A8

5.3.2. “Calibration“ Mode

In order to obtain optimum measurement results, whenever any of the following factors are altered, the sensor should be recalibrated (see flow chart in chapter 5.6):

- Type of sheet metal or its magnetic and electrical characteristics.
- Sensor, type of sensor and its environment.
- Lead length and lead cross section.
- Air gap between sensor and workpiece.

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Calibration can be accomplished by either two methods: Manually on the evaluation device or in remote operation via the PLC interface. Calibration on the device can be performed at any time. Calibration in remote operation via the PLC can be performed only if enabled during setup (setting: extended remote control).

Calibration on Evaluation Device

- Select "Calibrate" mode using the "Mode" key (7). The calibration curve of the sensor most recently selected in the "Threshold" mode will thus be selected for calibration.
- Using the "**+**" and "**-**" keys (9) and (10), set the thickness of the workpieces to be processed. At this point, the thickness most recently selected for this calibration will be displayed. The selected thickness is entered by pressing the "Enter" key (8).
- Subsequently, the device will request that a workpiece be placed in position, and will wait for the operator to start the measurement by pressing the "Enter" key (8).
- After completion of the measurement, the device will signal either a double sheet or a no sheet message. The device requests each step that the operator must perform and waits for the operator to acknowledge by pressing the "Enter" key (8).
- Only after successful calibration the new calibration values can be stored in the non-volatile memory by pressing the "Enter" key (8).

The calibration mode can be terminated at any time by pressing the "Mode" key (7); whereupon, the previously entered parameters will be unaltered and the new ones discarded.

Calibration via the PLC interface

The calibration curve of the sensor and its selected calibration sheet metal piece, which has been stored in the most recently used memory location, will be calibrated.

Calibration will be performed as follows:

- Before beginning calibration, the selection bit A8 must be switched off.
- Place the calibration piece into position. Apply a positive pulse for longer than 20 ms to bit A2 in order to start calibration for "1 sheet".
- Remove the calibration piece. Start calibration for 0 sheets by applying a positive pulse to bit A3.

After completion of the 0 sheet (or 2 sheet) measurement, the measurement results will be stored.

The timing diagram for the signals is illustrated in the graph "External Calibration" on pages 9 or 10.

5.3.3. “Measure” Mode

A measurement is initiated either via the proximity switch in the sensor or via an external "STA" signal on the PLC interface, depending on the start method set during the setup (control via bus interface, see page 10). A continuous "STA" signal causes periodic measurement with a repetition rate between 0.3 and 10 seconds depending on the time interval selected during setup. In addition, a measurement can be initiated at any time by pressing the "Enter" key (8).

Evaluation of the measurement occurs with the calibration curve and the threshold values stored in the currently selected memory location (programming and selection of program memory location, see "Threshold" mode). When the measurement is initiated, the workpiece must completely cover the sensor head. If the workpiece has not reached or has already left this position during measurement, a smaller thickness will be measured, perhaps resulting in a 1 sheet message when, in fact, a double sheet is present.

With “external” start operation, either the PLC or an additional proximity switch can initiate the measurement (STA) at a definite point in time.

Both the leads to the sensor and for the external start signal are monitored for lead breaks so that the measurement operation can be halted in case of a fault, while the drop out of the relays K0, K1, and K2 cause a fault message.

5.4. Acknowledge Fault Message

When the cause of a general fault message has been eliminated, the device must be reset into operating condition. This is accomplished either on the device itself by pressing the "Enter" key (8) or by placing an error code via the interface.

After a fault has been acknowledged, the relay K0 pulls in again. The relay K2 remains dropped out until the next measurement.

☞ ***Important note:***

An incorrectly performed calibration will result in incorrect calculation of the thickness and, thus, in incorrect "1 sheet" and "2 sheet" messages. Therefore, it is imperative that both the calibration and the setting of the thresholds be performed by authorised operating personnel only.

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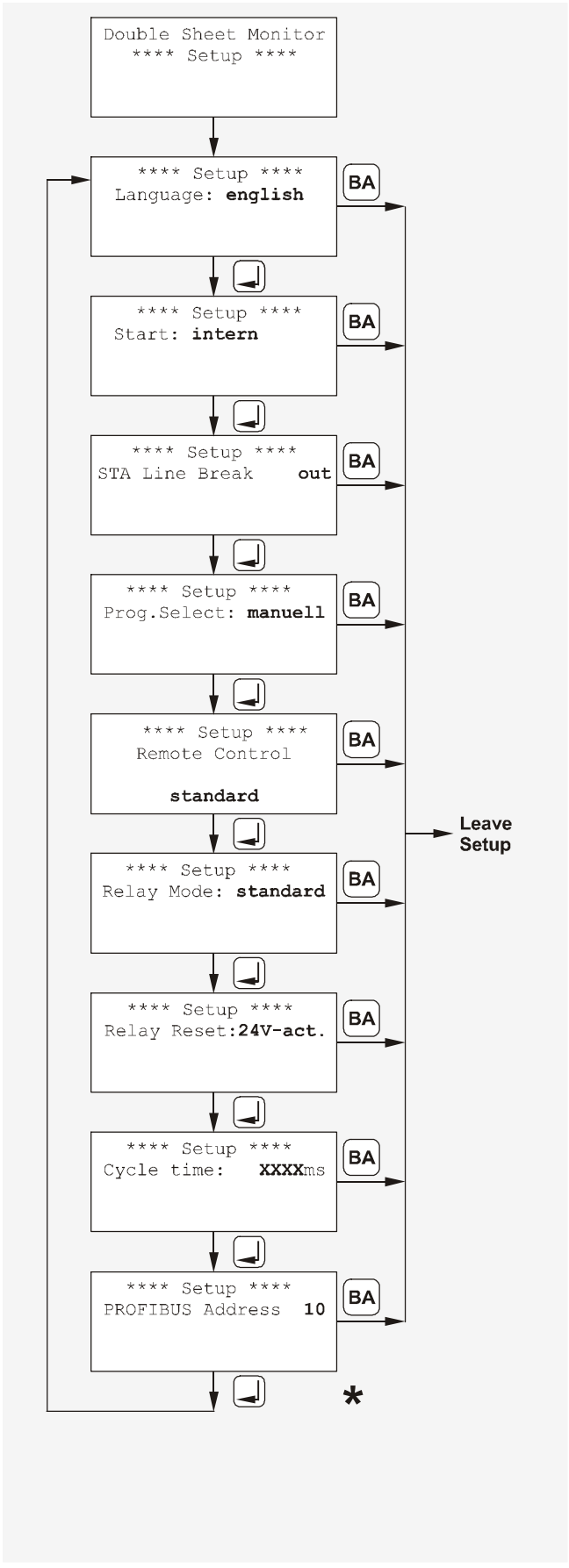
5.5.Setup Menu



Press “BA” and “Enter” at the same time to call the Setup Menu. Press “Enter” to go to the following Setup point and press “BA” to leave the Setup Menu.

The following functions and parameters can be set in the setup menu:

Language of display text:
The following languages can be displayed: German, English, French or Spanish.

Start measurement:
Select “intern” for internal start of measurement via integral proximity switch, or “extern” for external start of measurement via start contact “STA” or via bus interface.

STA lead breakage recognition:
The STA start contact lead can be checked for breakage. Select “on” to activate the detection of lead breakage.

Select memory:
Use the program memory number in the “Program” operating mode to select “manual” memory and the PLC or bus interface to select “extern” (external) memory.

Remote control
Setting of the remote control to the operation mode “standard” or “extended”.

Relay mode:
Switch over between two different relay modes, “standard” and “alternative”.

Relay reset:
Determine whether the relays are to drop out at 24 V level (“24V active”) or at 0 V level (“0V active“).

Repetition time:
Set time between subsequent measurements when start signal is on continously. Setting repetition time to 0 seconds causes device to perform 1 measurement per start signal.

* for Profibus connection at BDK-ET/FP only

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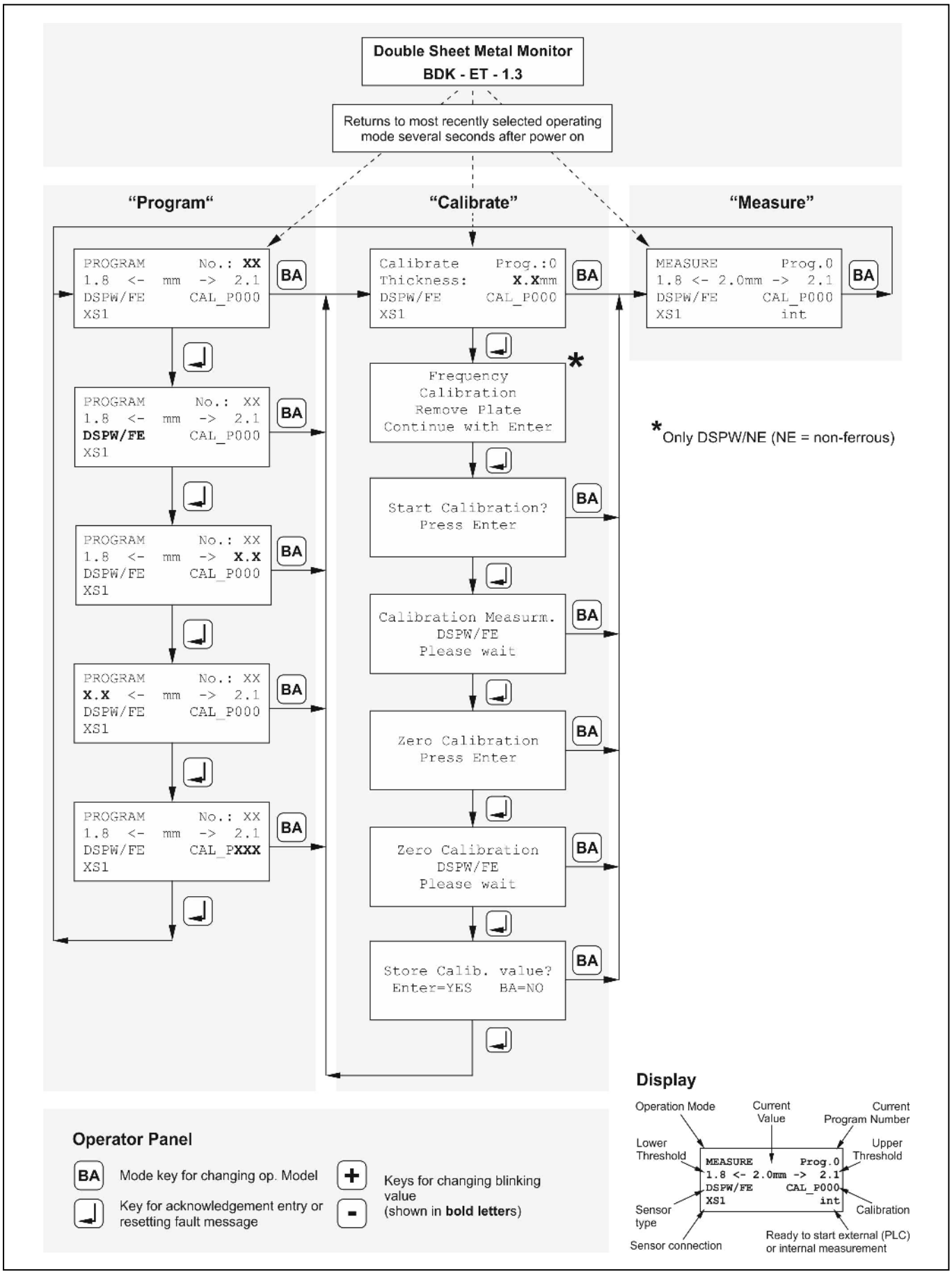
5.6. Main Menu



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6. Interfaces

The Double Sheet Metal Monitoring Devices are available with two different interface versions. The standard devices are equipped with a parallel PLC interface for connection to the I/O level of the controller.

The version with field bus interface is implemented for operation at the PROFIBUS DP.

6.1. Parallel Interfaces

6.1.1. Outputs

The sheet metal thickness monitoring devices without bus interface are equipped with three electrically isolated relay outputs. K1 and K2 are equipped with one reversing switch each. K0 is equipped with one NO and one NC. Depending on the relay mode, the following signals can be generated:

Standard Mode

K0: Result of the most recent thickness measurement (output of result after completion of the measurement).

Pulled in: A thickness greater than the current lower threshold has been measured (1 or 2 sheets).

Dropped out: A thickness less than the current lower threshold has been measured.

K1: 0 sheet message negated
Thickness measurement initiated by the integrated proximity switch (drops out immediately as soon as a workpiece has been detected)

Pulled in: No workpiece has been detected

Dropped out: Workpiece has been detected.

K2: Result of most recent measurement (output of result after completion of measurement).

Pulled in: A thickness less than the current upper threshold has been measured (0 or 1 sheet).

Dropped out: A thickness greater than the current upper threshold has been measured (2 sheets) or general fault message.

In the case of a general fault message, the cause of the fault will be more precisely specified on the operator panel display.

Standard Mode			
Sheets	K0	K1	K2
0	0	1	1
Undersize	0	0	1
1	1	0	1
2	1	0	0
Error	0	0	0

Alternative Mode

At the beginning of the measurement, all the relays pull in. At completion of the measurement, the following message is generated:

K0: 0 sheet message negated

Pulled in: A thickness greater than the current lower threshold has been measured (1 sheet or 2 sheets).

Dropped out: A thickness less than the current lower threshold has been measured (0 sheet or too thin).

K1: 1 sheet message negated

Pulled in: A thickness less than the current lower or greater than the current upper threshold has been measured (0 or 2 sheets).

Dropped out: A thickness less than the current upper and greater than the current lower threshold has been measured (1 sheet).

K2: 2 sheet message negated

Pulled in: A thickness less than the upper threshold has been measured (0 or 1 sheet).

Dropped out: A thickness greater than the current upper threshold has been measured (2 sheets). General fault message.

In the case of a general fault message, the cause of the fault will be more precisely specified on the operator panel display.

Alternative Mode			
Sheet	K0	K1	K2
0	0	1	1
Undersize	0	1	1
1	1	0	1
2	1	1	0
Error	0	0	0

6.1.2. Inputs

STA Input

The measurements can be initiated by an external signal on the "STA" input. This can be an external mechanical switch, a proximity switch, or a PLC.

For the lead break monitoring a resistor must be connected parallel to the switch.

Relay Reset

In order to ensure a reliable operation, the relay outputs must be reset before or after each measurement and dynamically interrogated via the press controller.

While the relays are reset, K0, K1, and K2 are in the dropped out condition. After the relay reset, depending on the selected relay mode, the relays take on the following conditions:

Standard Mode

After the test, K1 pulls in if no workpiece is present. The relays K0 and K2 do not pull in until completion of a measurement. After an error and following fault clearance including acknowledgement, a 2-sheet-message will be signalled (K2 is in dropped out condition).

Alternative Mode

The relays K0, K1, and K2 do not pull in until the beginning of the next measurement. After the measurement, K0, K1, or K2 drop out again, corresponding to the result. These statuses are also achieved after fault acknowledgement.

Control Inputs

The program memory locations and the enabling of the remote control operation are selected via 8 electrically isolated inputs. In the extended remote operation the fault acknowledgement, calibration, and system test can also be performed (see also the time diagram "External Fault acknowledgement" and "External Calibration").

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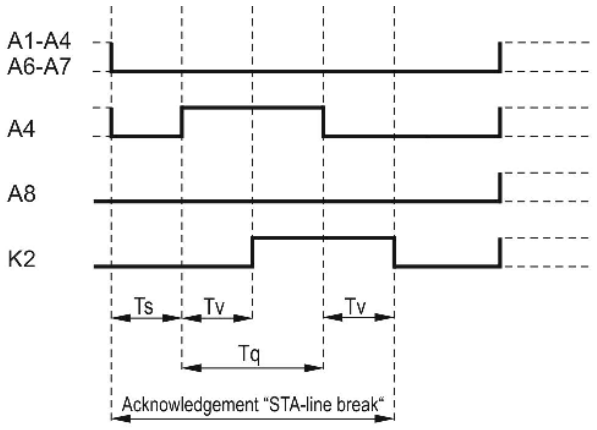
6.1.3. Chart and Time Diagram

Chart for Remote Control Functions

Setup setting Remote control	Selection bit								Remarks
	A8	A7	A6	A5	A4	A3	A2	A1	
Standard	X	X	X	X	X	X	X	X	Program memory selection without remote control function
Extended	⎍	X	X	X	X	X	X	X	Acknowledgement program memory number with remote control function
	0	0	0	0	0	0	⎍	0	1- sheet-cablibration
	0	0	0	0	0	⎍	0	0	0-sheet / 2-sheet-calibration
	0	0	0	0	⎍	0	0	0	Fault acknowledgement STA lead break
	0	0	0	⎍	0	0	0	0	Fault acknowledge, invalid sensor
	0	0	⎍	0	0	0	0	0	Fault acknowledge, sensor fault / OAS lead break
	0	⎍	0	0	0	0	0	0	Fault acknowledge cycle time fault
	0	0	0	0	0	0	0	⎍	Frequency calibration DSPW/NE

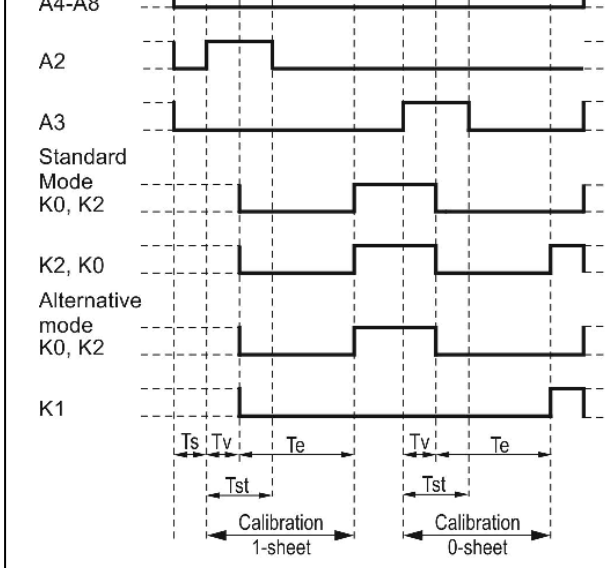
Time Diagram: Acknowledgement Fault Messages Externally



Ts	> 10 ms	Switchover time from storage of program memory number to error message
Tv	< 10 ms	Time until relay K2 switches
Tq	> 20 ms	Duration of error acknowledgement signal

Acknowledgement of "sensor fault", "no valid sensor" and "cycle time fault" as with "STA-line break" but with selection bit A5 ... A7

Time Diagram: External Calibration DSP, BDWF, DSPW/FE



Ts	> 10 ms	Switchover time from acknowledgement of program memory number to calibrate
Tv	< 10 ms	Time until calibration step "Calibrate 1-sheet" or "0-sheet" is recognised
Tst	> 20 ms	Duration of start pulse of calibration
Te	> 50 ms	Calibration time, depending on sensor type max.10 s

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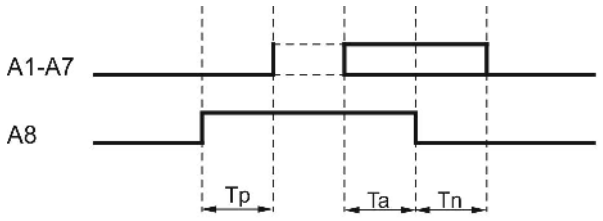
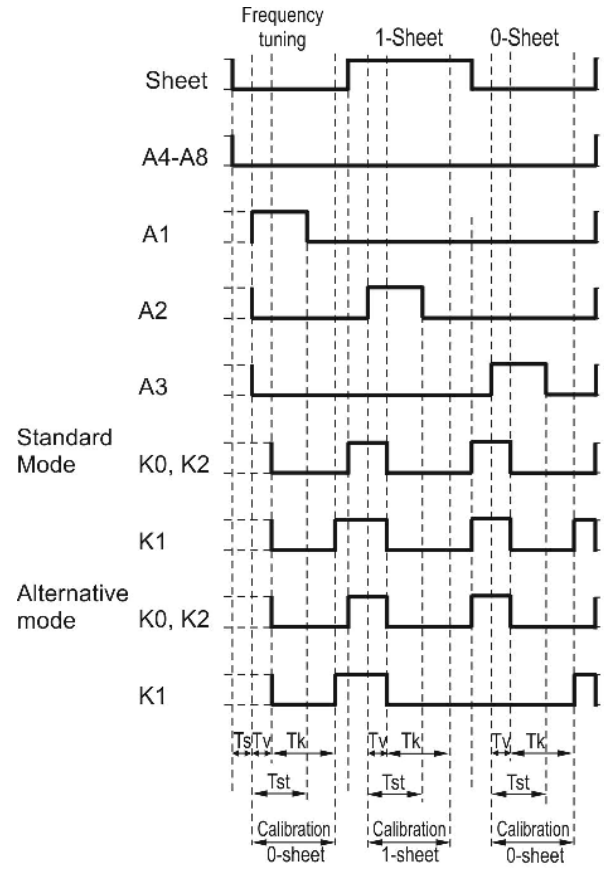
Time Diagram: Change Program Memory Number



Tp	< 10 ms	Time until "Change program memory number" is recognised
Ta	> 10 ms	Time from stable entry of program memory number until acknowledgement
Tn	> 10 ms	Time that program memory number must lie on inputs, after dropping out of A8

Time Diagram: External Calibration DSPW/NE



Ts	> 10 ms	Switchover time from acknowledgement of program memory number to calibrate
Tv	< 10 ms	Time until calibration step "Calibrate 1 sheet" or "0 sheet" is recognised
Tst	> 20 ms	Duration of start pulse of calibration
Tk	> 50 ms	Calibration time, depending on sensor type, max.10 s

6.2.Interface to PROFIBUS DP

Machine control systems often communicate with their decentralised field devices via field busses. The standard versions of the BDK-ET Double Sheet Metal Monitors are available with a PROFIBUS DP field bus interface. All important measurement and control data can be transmitted from and to the controller via these interfaces.

The PROFIBUS DP interface is equipped with standard-round-connectors, making the double sheet metal monitors directly connectable with the PROFIBUS DP field bus. A corresponding GSD file is included.

The individual bits have the following meanings:

6.2.1. The Outputs (Inputs)

Byte 0

bit 0 on: Measurement in progress

bit 1: Workpiece recognition via integrated proximity switch (asynchronous to measuring clock pulse)
- off: Workpiece recognised
- on: No workpiece recognised

bit 2: Result of most recent measurement (synchronous to measuring clock pulse, updated at completion of measurement).
- on: Measured thickness between current upper and lower thresholds (1 sheet)
- off: Status after resetting measurement result, or measured thickness less than current lower or greater than current upper threshold.

bit 3: on: Measured thickness greater than current upper threshold (2 sheets).
- off: Status after resetting measurement result, or measured thickness less than current upper threshold.

bit 4: on: Measurement result available.
- off: Status after resetting measurement result.

bits 5 … 7: Result of fault messages. In the case of a general fault message, the fault is more precisely specified on the display (1).

bit 5 on: Cycle time fault.

bit 6 on: Sensor fault.

bit 7 on: Selected sensor not calibrated or invalid.

Byte 1:

bit 0 … 7: The internally or externally selected memory location is returned (asynchronous to clock pulse).

Byte 2:

bit 0 … 7: Output of the most recent measurement result in mm/10 (synchronous with clock pulse).

Byte 3:

bit 0 … 7: Current upper threshold value in most recently selected memory location in mm/10 (asynchronous to clock pulse).

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6.2.2. The Inputs (Outputs)

Byte 0:

bit 0 on: Start measurement.

bit 1 ….. 3: Unused.

bit 4 on: Reset 0, 1, or 2 sheet message and thickness measurement.

bit 5 … 7 Acknowledge fault message.

100: Cycle time fault

010: Sensor fault

001: Sensor invalid or not calibrated

Byte 1:

bit 0 ….. 7: Selected memory location number 0 ... 255 (binary coded).

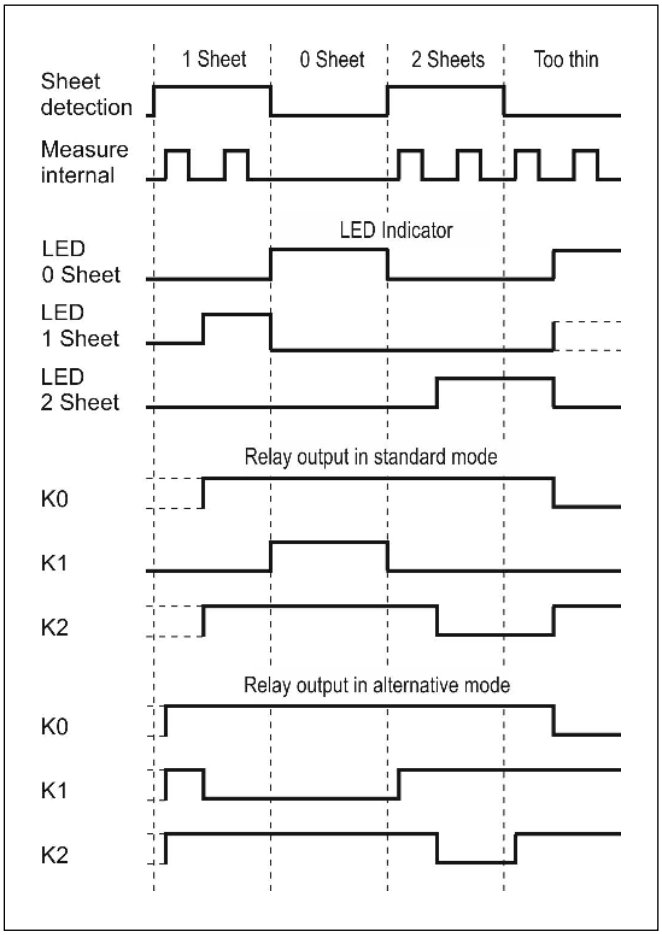
Byte 2 ... 3: Unused.

7. Pulse Diagram for Interrogation of Measured Value

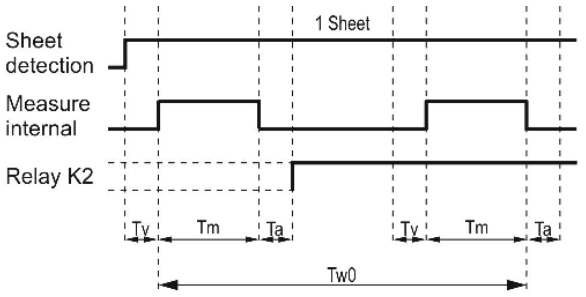
7.1.BDK-ET with PLC Interface

7.1.1. Internal Start of Measurement

Overview of Measurement Sequences



Time Diagram of Measurement

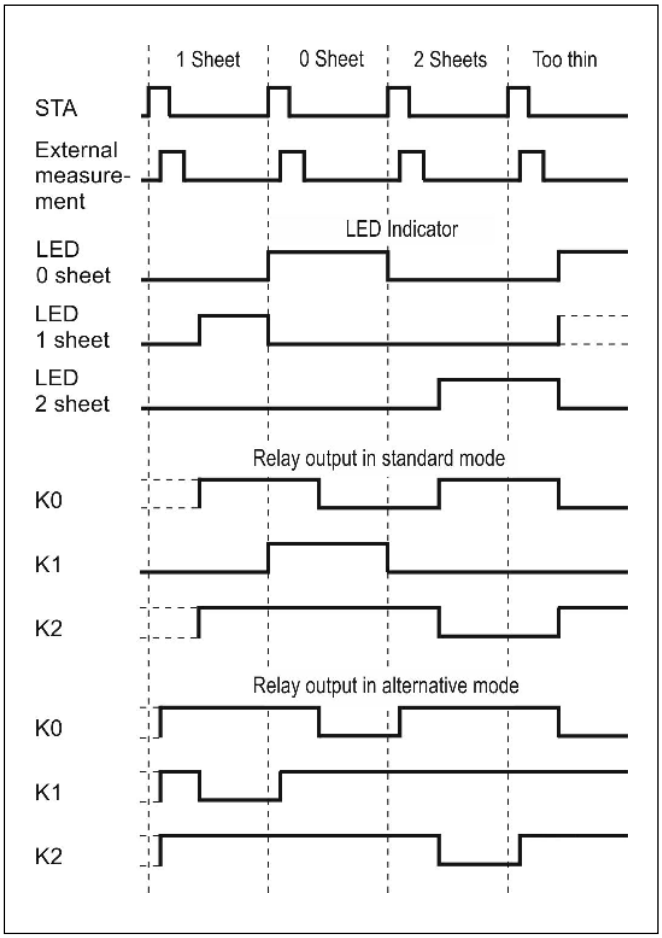


Tw0 = 0.1 ... 10 s adjust in Setup. With continuous measurement, meas. is repeated after this interval.
Minimum repetition time depending on sensor type (see 7.3.)

Tv	< 10 ms	Delay in beginning measurement after sensor (initiator) signal
Ta	< 10 ms	Time until measurement result signalled by relay
Tm	> 20 ms	Measuring time depends on sensor type

7.1.2. External Start of Measurement

Overview of Measurement Sequences



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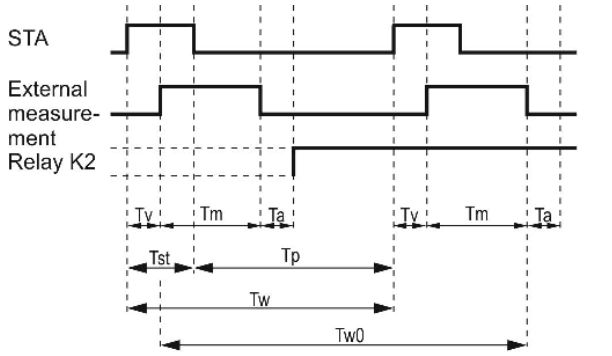
Time Diagram of Measurement

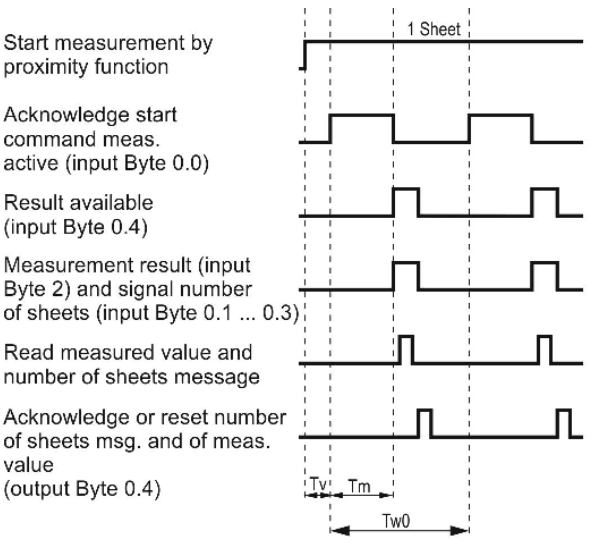


Tst	> 5 ms	Pulse length of "STA" signal
Tp	> 40 ms or 0 (continuous meas.)	Pause time between successive STA pulses
Tw	= Tst + Tp > 100 ms	Repetition time between successive STA pulses
Tw0	= 0.1 ... 10 s adjustable in Setup	With continuous measurement, meas. is repeated after this interval. Minimum repetition time depending on sensor type (see 7.3.)
Tv	< 10 ms	Delay in beginning measurement after STA signal
Ta	< 10 ms	Time until measurement result signalled by relay
Tm	> 20 ms	Measuring time depends on sensor type

7.2 With PROFIBUS DP Interface

7.2.1 Internal Start of Measurement

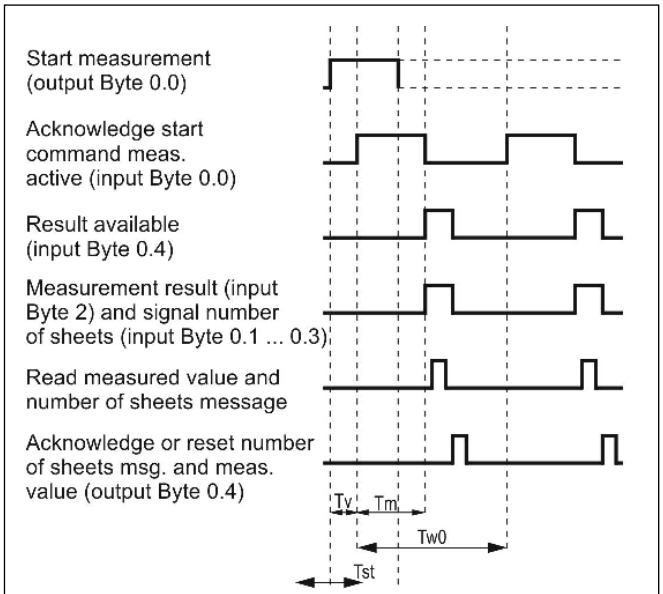
Time Diagram of Measurement (Handshake)



Tw0	= 0.1 ... 10 s adjustable in Setup	With continuous measurement, meas. is repeated after this interval. Minimum repetition time depending on sensor type (see 7.3.)
Tv	approx. 25 ms plus PROFIBUS DP cycle time	Delay in beginning measurement after sensor (initiator) signal
Tm	> 20 ms	Measurement time depends on sensor type

7.2.2 External Start of Measurement

Time Diagram of Measurement (Handshake)



Tst	> 40 ms	Pulse length "external start" signal
Tw0	= 0.1 ... 10 s adjustable in Setup	With continuous measurement, meas. is repeated after this interval. Minimum repetition time depending on sensor type (see 7.3.)
Tv	approx. 25 ms plus PROFIBUS DP cycle time	Delay in beginning measurement after STA signal
Tm	> 20 ms	Measurement time depends on sensor type

7.3. Repeat Time

The setting of the smallest time interval after which the start of the next measurement takes place with a permanent start signal, the setting of the smallest time interval has to be individually adapted to the different sensors and measuring principles. This has to be set in the setup menu. 100 ms can be set as the smallest repetition time, which is limited to 150 ms and/or 300 ms for Fe with DSP- and DSPW sensors.

Type		Ref. no.	Repetition Time
DSP-36sg		13.05-86	150 ms ... 10 s
DSP-42sg		13.05-87	150 ms ... 10 s
DSP-54sg		13.05-89	150 ms ... 10 s
DSP-75sg		13.05-90	300 ms ... 10 s
DSPW-54sg	Ferrous	13.05-67	150 ms ... 10 s
	Non-ferrous		100 ms ... 10 s
BDWF-m54rg-2s		13.05-73	100 ms ... 10 s

☞ ***Important Note:***
To prevent the DSP- and DSPW sensors (measuring mode for ferrous workpieces) from heating up they may be operated at the smallest possible repetition time only with a maximum ED of 50%.

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☞ Thus a larger measuring accuracy on the one hand and in the case of a longer operation the destruction of the sensor on the other hand may occur.

This means that for e.g. at a total measuring time of 1 s a break of min. 1 s has to follow at the smallest possible repetition time.

8. Interconnection with Press Controller

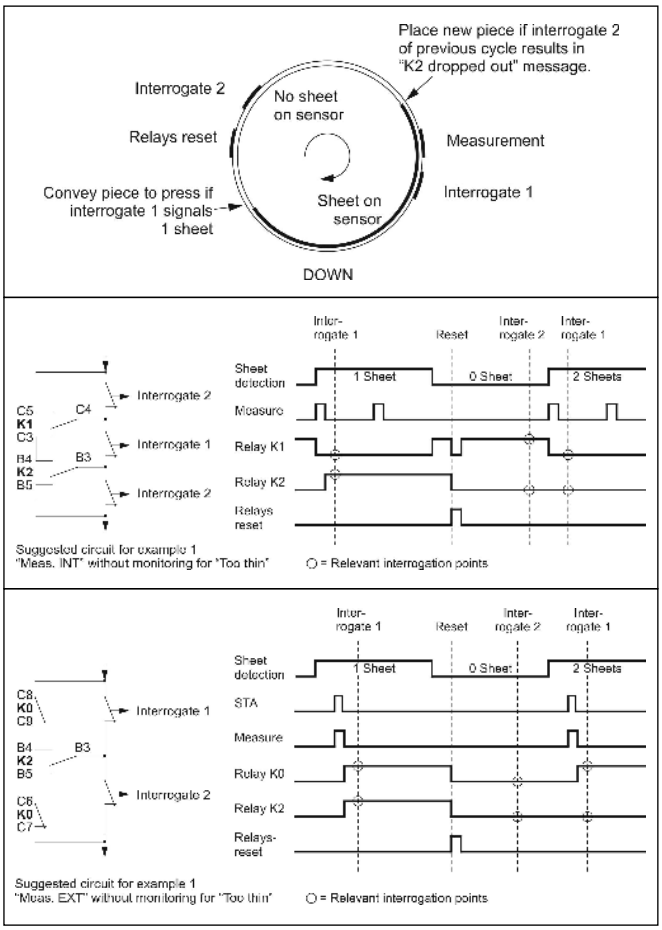
The appropriate interconnection of this device with the press controller considerably improves the safety of the machinery. In order to ensure the best reliability of the machinery, the outputs should be interrogated at various moments in the operating cycle of the press.

All Interrogation should take place such that the relays have to change their status in every cycle.

Example 1:

Operation with relay reset, measuring on an intermediate depositing station or while the workpiece is being transported (standard mode).

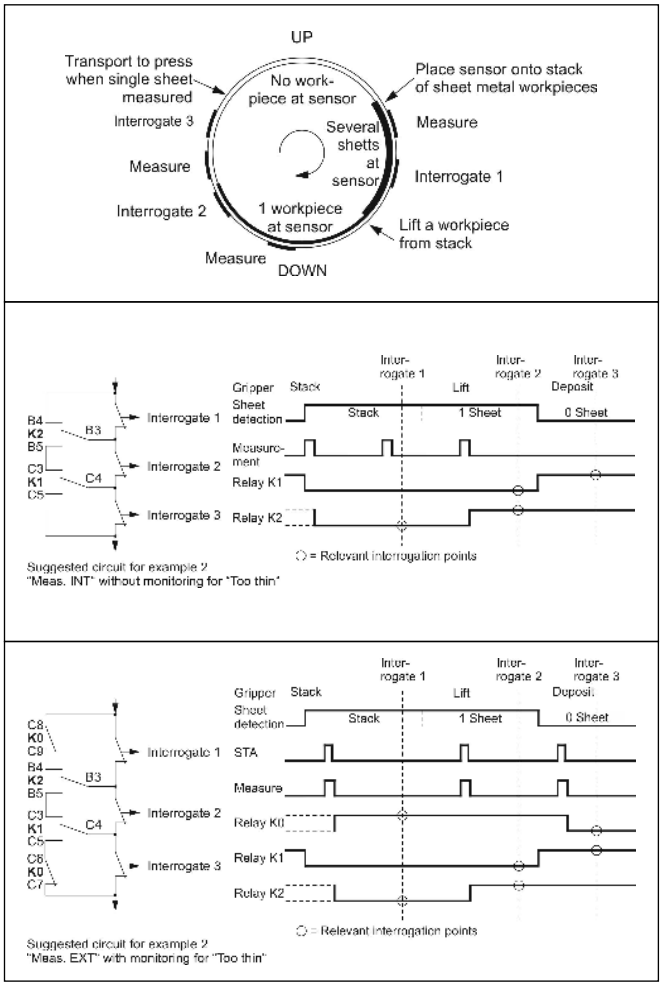
1. Start measurement with proximity switch or external start after sensor has been placed onto workpiece.
2. Interrogation 1, if single sheet has been measured (K1 dropped out, K0 and K2 pulled in).
3. Relays dropped by relay reset.
4. Interrogation 2 if K1 is pulled in or K0 and K2 have dropped out.



Example 2:

Operation without relays reset, workpiece being lifted from stack (standard modus).

1. Start measurement with proximity switch or external start when sensor has been placed on stack.
2. Interrogation 1, if multiple sheet has been measured (K0 pulled in, K1 and K2 dropped out).
3. Further measurements after workpiece has been lifted from stack.
4. Interrogation 2, if single sheet has been measured (K1 dropped out, K0 and K2 pulled in).
5. Workpiece deposite.
6. Measurement after workpiece has been deposited.
7. Interrogation 3, if workpiece has been deposited (K0 dropped out, K1 and K2 pulled in).



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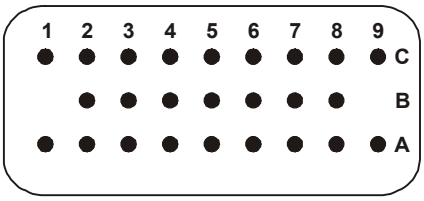
9. Wiring

9.1. Contact Assignment XS3 PLC Interface



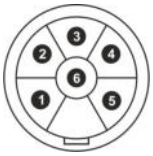
XS3
Harting
Han 25 D

A1 Memory selection BIT 0
A2 Memory selection BIT 1
A3 Memory selection BIT 2
A4 Memory selection BIT 3
A5 Memory selection BIT 4
A6 Memory selection BIT 5
A7 Memory selection BIT 6
A8 Operation „standard“: Memory selection BIT 7
Operation „extended“: Take over selection
A9 STA (External start)

B2 M ext. (0 VDC ground for electr. isolated inputs A1 - A9 B6)
B3 Relay output K2 (center contact)
B4 Relay output K2 (NO)
B5 Relay output K2 (NC)
B6 Relay reset input
B7 0 V DC } aux. voltage e.g. for
B8 + 24 V DC } 24 V inputs, 400 mA load capacity

⏚ PE
C1 + 24 VDC
C2 0 VDC
C3 Relay output K1 (NC)
C4 Relay output K1 (center contact)
C5 Relay output K1 (NO)
C6 Relay output K0 (NC)
C7 Relay output K0 (NC)
C8 Relay output K0 (NO)
C9 Relay output K0 (NO)

9.2. XS6 Power Connection with PROFIBUS DP Interface



1 +24 VDC
2 not assigned
3 0 VDC
4 not assigned
5 PE
6 not assigned

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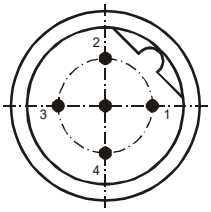
9.3.PROFIBUS DP Connection

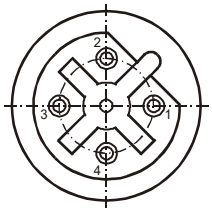
The connectors used correspond to the IEC 947-5-2, but with inverted mechanical coding (Reserve Key Coding). The BDK contains internally a decoupling network, therfore a non-interacting use 3 - 12 MBaud is possible.

M12 Bus connector:

XS4 Input

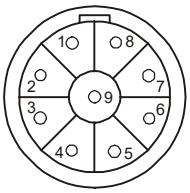


XS5 Output



Pin	Signal	Meaning
1	VP	Power supply - plus, (P5V)
2	RxD/TxD-N	Receive- / transmission data - N, A - lead
3	DGND	Potential of data transmission (reference potential to VP)
4	RxD/TxD-P	Receive- / transmission data - plus, B - lead
5	Shield	Shield or protective ground
Thread	Shield	Shield or protective ground

9.4.BDWF , DSP and DSPW Connection XS1

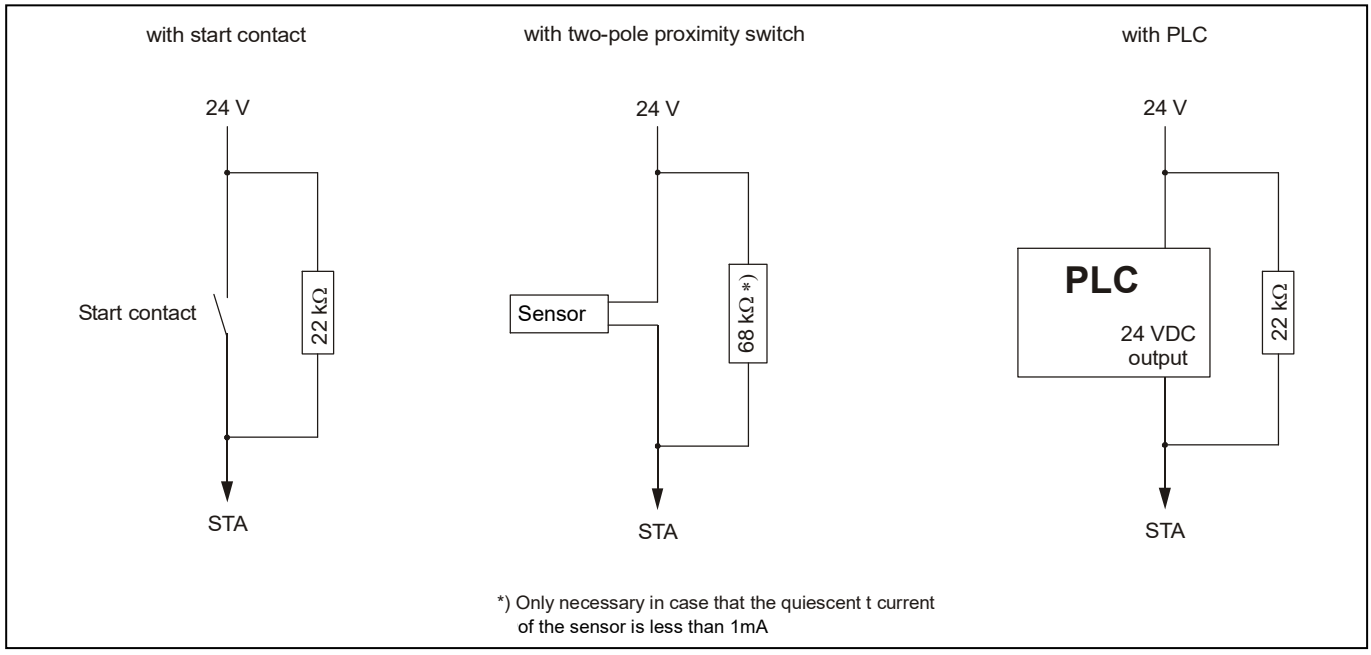


	BDWF	DSP	DSPW	
1	+24 V DC	+24 V DC	+24 V DC	(RD)
2	OUT	not used	OUT	(BU)
3	M	M	M	(VT / BN / GY)
4	IN	not assigned	IN1	(PK)
5	not assigned	Proximity Switch	not assigned	(GN)
6	not assigned	IN	IN2	(BU)
7	not assigned	S-OUT1	S-OUT1	(BN)*
8	not assigned	S-OUT2	S-OUT2	(WH)*
9	not assigned	not assigned	not assigned	-
Housing	Shield	Shield	Shield	Shield

* 1.00 mm²

10. Wiring Diagrams

Connection STA – lead with lead breakage monitor



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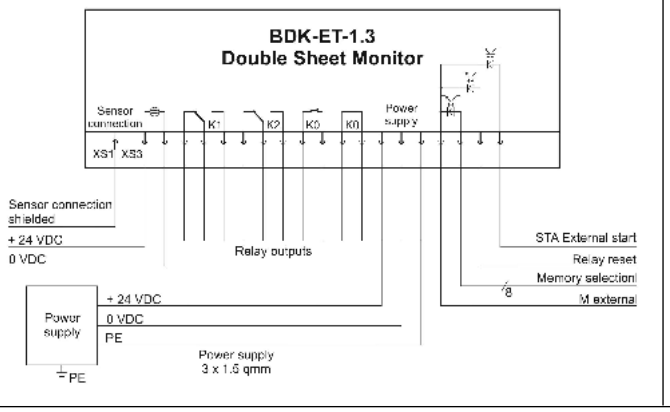
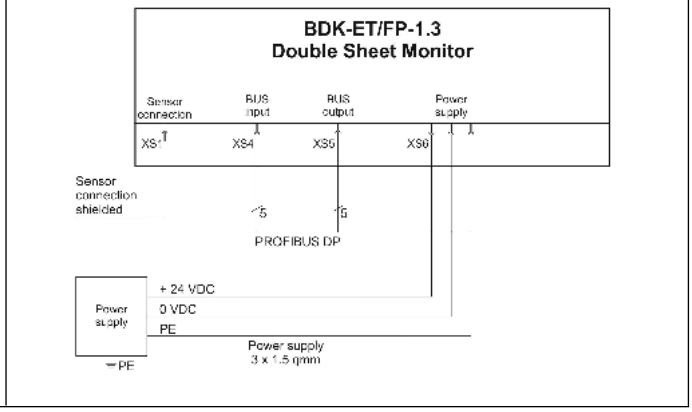
Wiring Diagram BDK-ET-1.3 with PLC Interface

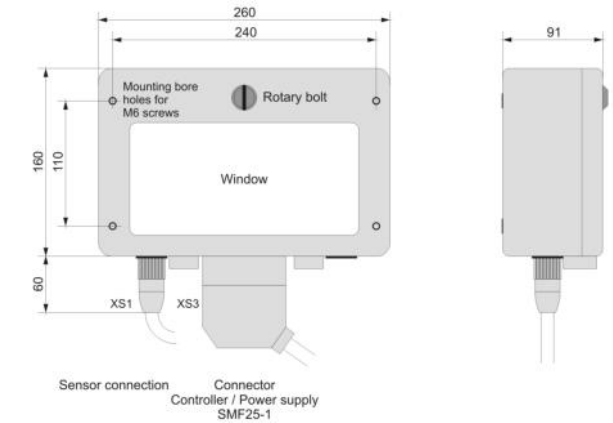


Wiring Diagram BDK-ET/FP-1.3 with Field Bus Interface

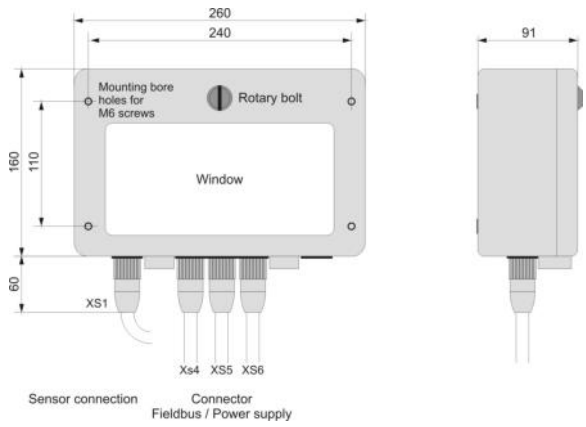


11. Housing Dimensions

Housing with PLC Interface (mm)



Housing with Field Bus Interface (mm)



12. Sheet Metal Thickness Sensors

12.1. DSP, DSPW and BDWF for Single Surface Contact Measurement

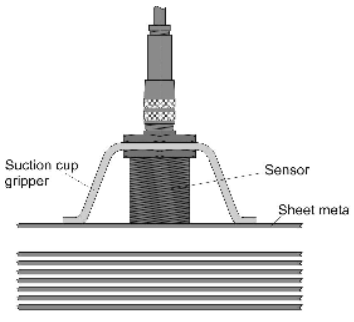
12.1.1. Mounting

The sensor is frequently installed into an appropriately designed suction cup on the grabber.

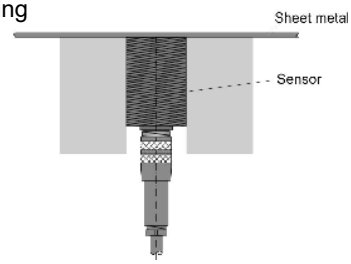
The vacuum gripper lifts the workpiece from the stack, bringing it near the sensor. Just before the workpiece touches the sensor, the proximity switch recognises the sheet metal and initiates the measurement.
In the case of ferrous metals, the workpiece is held onto the sensor during the brief measuring time (≤ 110 ms). Instead of having a sensor in the vacuum gripper, it can be mounted in a measuring station. In such case, however, the workpieces must remain motionless relative to the sensor during measurement. Mounting the sensor directly under and flush with the surface supporting the workpiece avoids accumulation of dirt and filings around the sensor (avoid air gap between sensor and workpiece).

A spring mounted sensor is a suitable expedient if workpieces which are not flat and/or are very stiff (more than 1.5 mm thick) are to be processed. The workpieces must be large enough to completely cover the sensing face of the sensor during measurement.

Mounting in the Suction cup gripper



Flush Mounting



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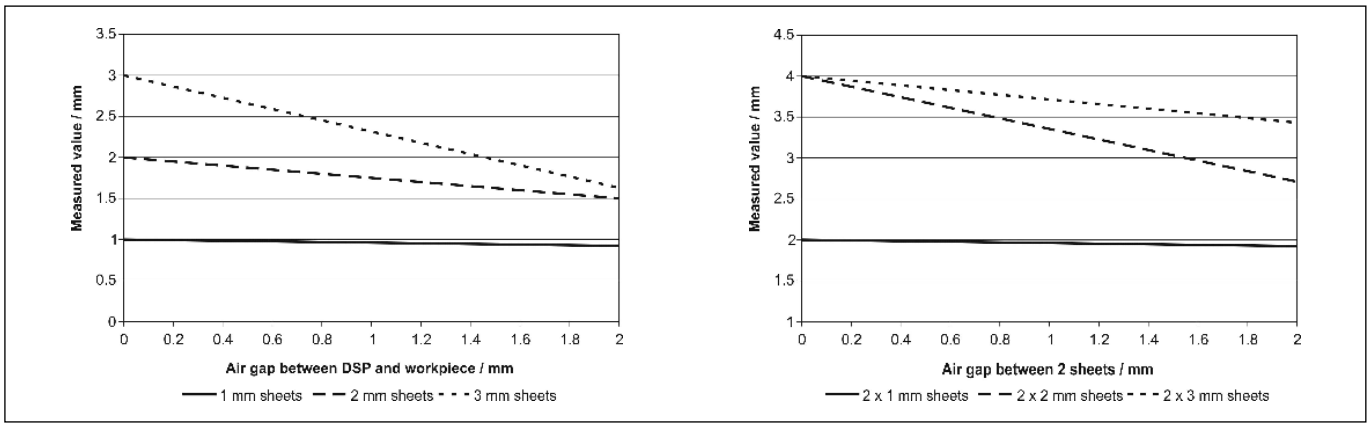
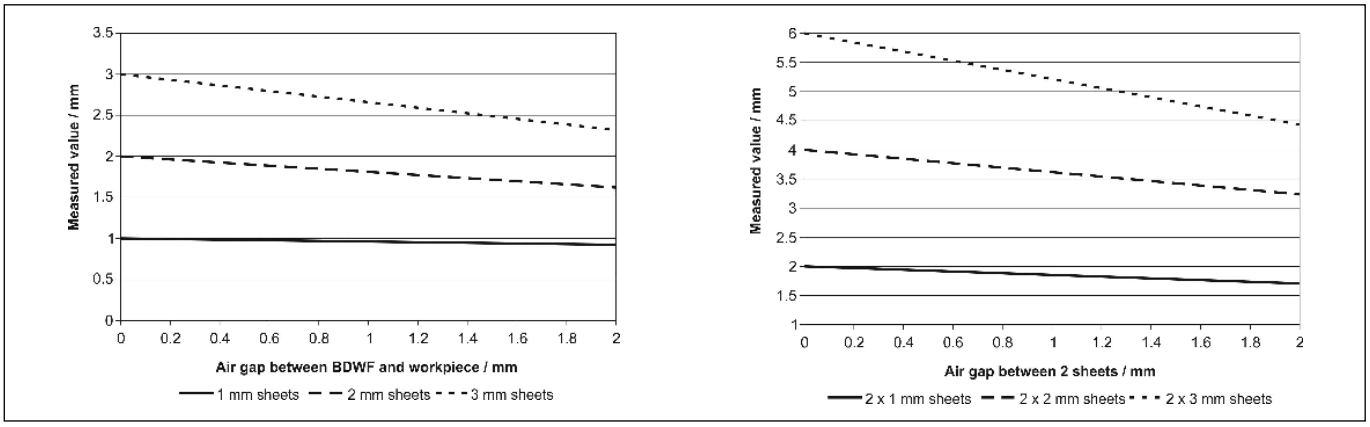
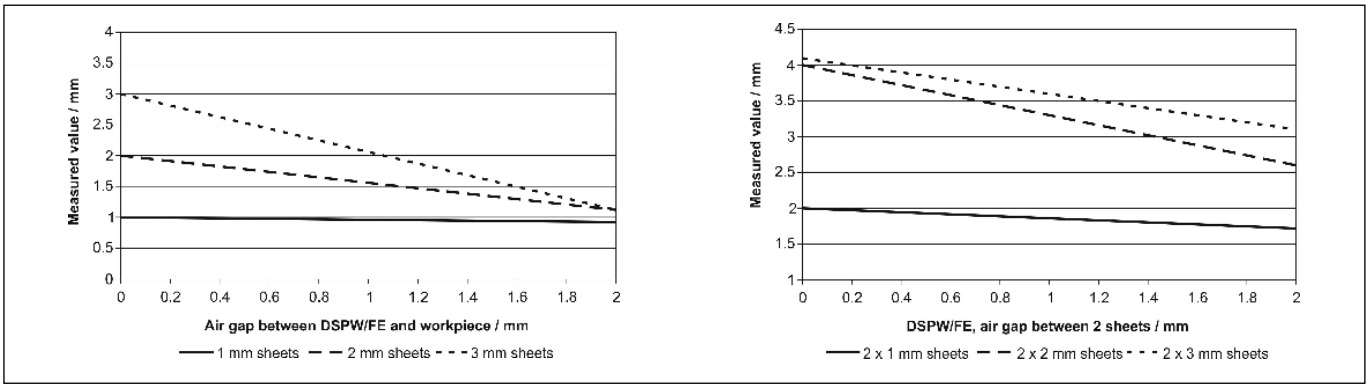
12.1.2. Air Gap Sensitivity with DSP-54sg-1s (Fe sheets)



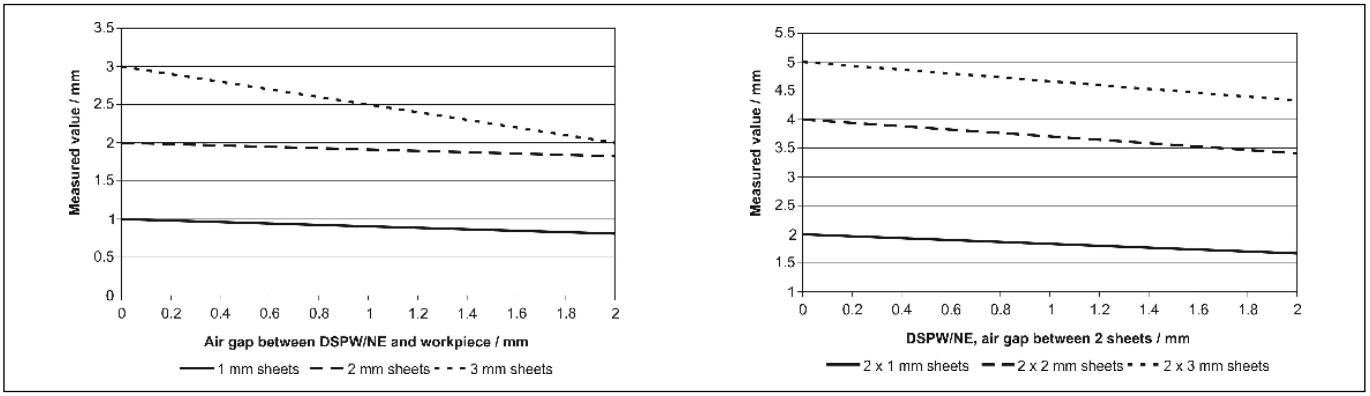
12.1.3. Air Gap Sensitivity with BDWF-m54rg-2s (non-ferrous NE sheets)



12.1.4. Air Gap Sensitivity with DSPW-54sg-1s (Fe sheets)



12.1.5. Air Gap Sensitivity with DSPW-54sg-1s (non-ferrous NE sheets)



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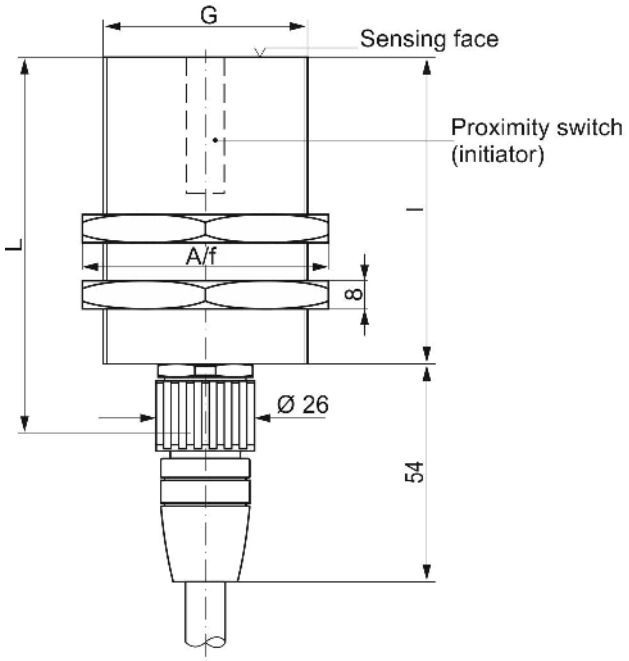
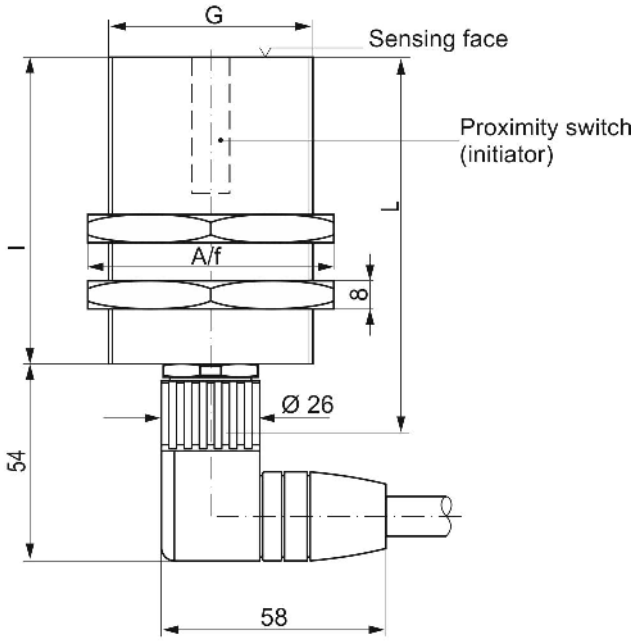
12.1.6. Housing Dimensions DSP (Fe sheets, single-surface contact measurement)

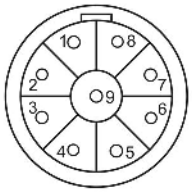
DSP Sheet Metal Thickness Sensor
cylindrical, threaded



DSP Sheet Metal Thickness Sensor
cylindrical, threaded

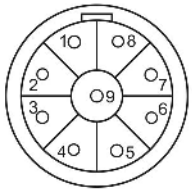


Socket connection



VLG9/2+4PS/X-1
Connecting lead with straight socket
Ref. no. 20.18-35
Lead length X = max. 25 m

Socket connection



VLG9/2+4PS/X-2
Connecting lead with angled socket
Ref. no. 20.18-36
Lead length X = max. 25 m

Type	Ref. no.	Meas. Range mm	Fe sheets up to mm	Meas. time ms	L mm	l mm	G Thread	A/f	Weight g
DSP-36sg-1s	13.05-86	0.2 . . . 2.0	1.5	< 20	90	65	M36 x 1.5	55	380
DSP-42sg-1s	13.05-87	0.2 . . . 3.0	2.5	< 30	100	75	M42 x 1.5	65	910
DSP-54sg-1s	13.05-89	0.2 . . . 4.0	3.5	< 50	107	81	M54 x 0.75	65	1200
DSP-75sg-1s	13.05-90	0.2 . . . 6.0	5.5	< 110	126	100	M75 x 1.5	90	3010

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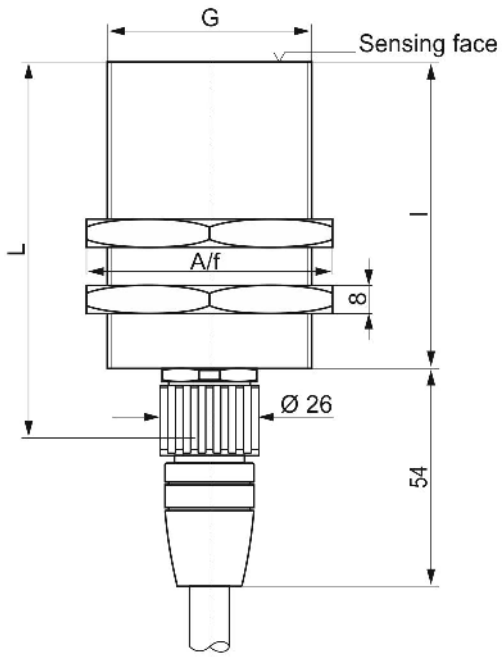
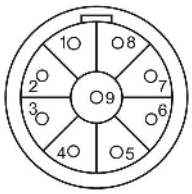
12.1.7. Housing Dimensions DSPW (Fe and NE sheets, single-surface contact measurement) BDWF (NE sheets, single-surface contact measurement)

BDWF, DSPW Sheet Metal Thickness Sensor
cylindrical, threaded

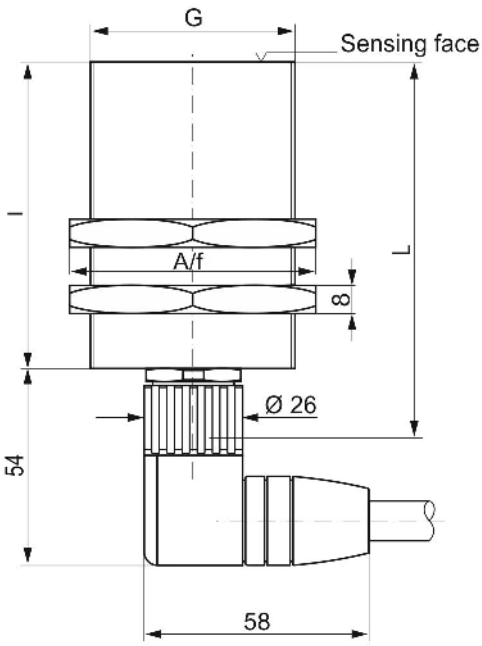


Socket connection

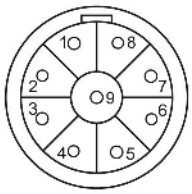


VLG9/2+4PS/X-1
Connecting lead with straight socket
Ref. no. 20.18-35

BDWF, DSPW Sheet Metal Thickness Sensor
cylindrical, threaded



Socket connection



VLG9/2+4PS/X-2
Connecting lead with angled socket
Ref. no. 20.18-36

Type	Ref. no.	Meas. range mm	Max. thickn. mm	Meas. time ms	L mm	l mm	G Thread	A/f	D mm	Weight g	Max.lead length m
DSPW-42sg-1s **)	13.05-66	Fe: 0.2 ... 3.5 NE: 0.2 ... 2.5 NE: 0.2 ... 4.0*)	3.0 2.0 3.0	< 70	117	96	M42 x 1.5	55	42	900	25
DSPW-54sg-1s	13.05-67	Fe: 0,2 ... 4.0 NE: 0.2 ... 3.0 NE: 0.2 ... 5.0*)	3.5 2.5 4.0	< 70	117	96	M54 x 0.75	65	54	1200	25
BDWF-m54rg-2s	13.05-73	NE: 0.2 … 6.0	5.5	< 100	101	81	M54 x 0.75	65	54	650	50

*) The measuring range for non-ferrous (NE) sheets can be extended to 4 mm or rather 5 mm by use of a special adapter for the sensor installation.

When using an unsuitable adapter, the accuracy and linearity of the sensor may deteriorate.

We like to provide you our support to work out the best solution.

**) For using the DSPW-42sg-1s sensor, the evaluation device has to be equipped with software version E118 or higher.

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13. VLG Connecting Leads

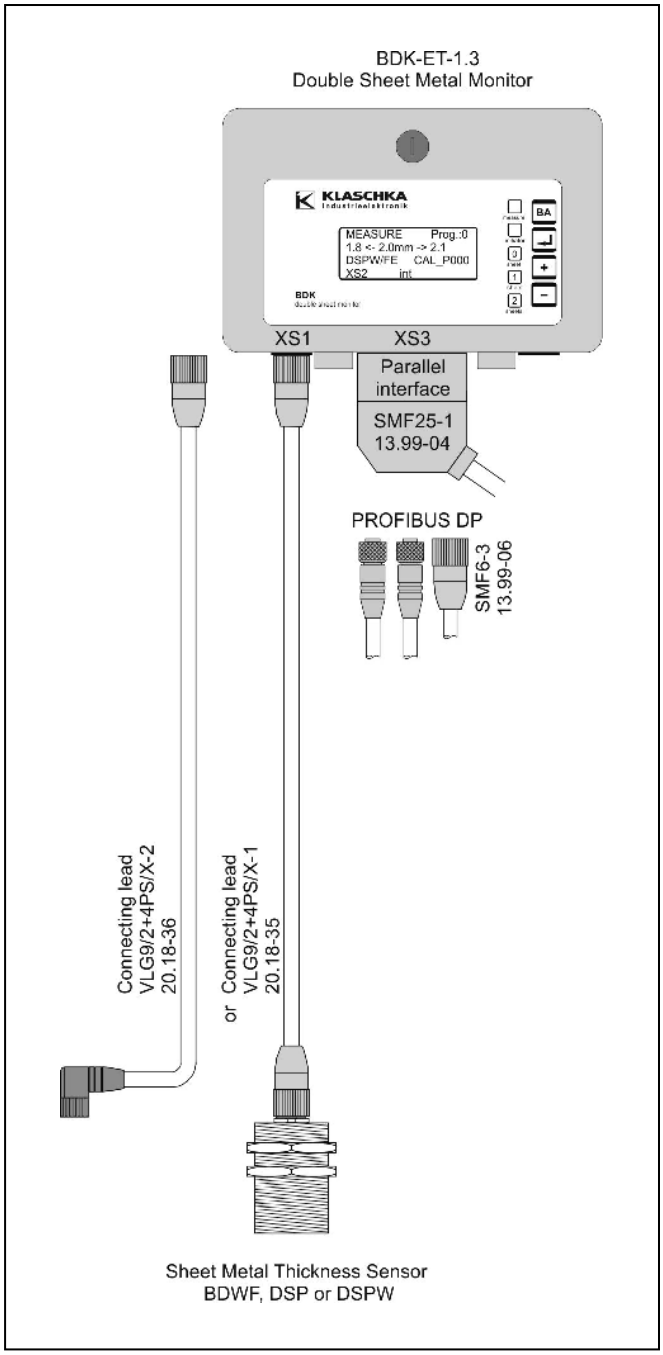
All connecting leads for the connection of the sensor on the evaluation unit are oil-resistant and suitable for drag chains.

The maximum lead length depends on the sensor type.

The connectors are mounted straight on the control devices end and can be straight or right-angled on the sensor end, as required.

Depending on the installation situations the lead with the straight connector VLG9/2+4PS/X-1 (Ref. no. 20.18-35) can be used instead of the lead with the angled connector VLG9/2+4PS/X-2 (Ref. no. 20.18-36).

13.1. Example Configuration for Sheet Metal Thickness Sensors for Single Surface Monitoring



14. ADD1/2-1.3 T-Coupler

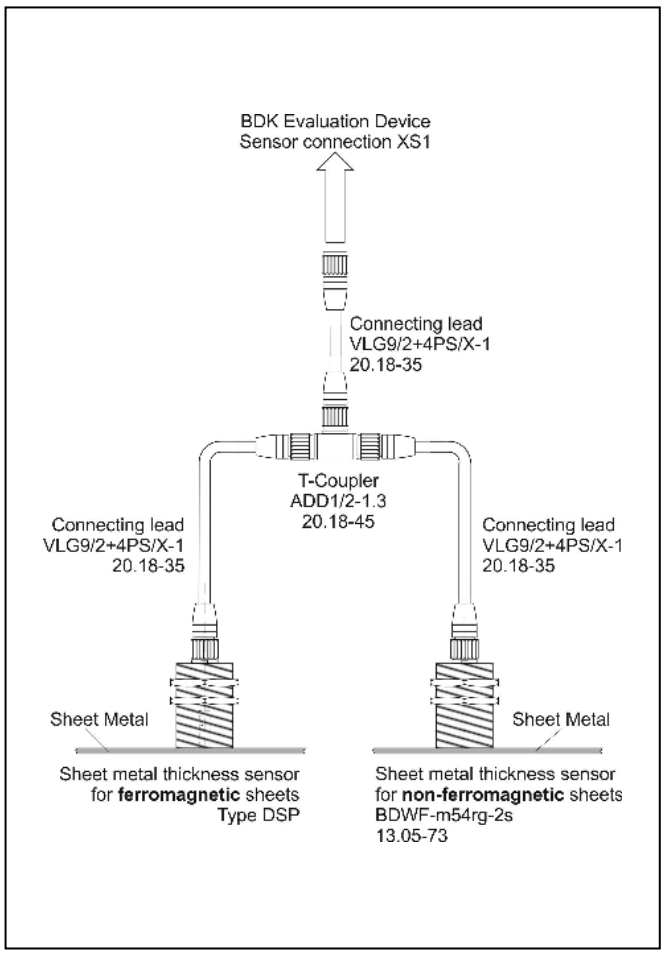
When using the ADD1/2-1.3 T-coupler, two different sensor types can be employed on each (XS1 and XS2) sensor terminal of the BDK-1.3 monitoring device.

The selection of the desired sensor or sensor pair on the corresponding connection takes place via default of the accordingly specified program number.

14.1. Single Surface Contact Monitoring of Ferrous and Non-ferrous Sheets via one Sensor Terminal

The application of the ADD1/2-1.3 T-Coupler enables the operation of one sheet metal thickness sensor of the type series DSP for ferrous magnetic sheets and of one BDWF-m54rg-2s sheet metal thickness sensor for non-ferrous magnetic sheets at the sensor terminal (XS1).

Depending on the installation situations the lead with the straight connector VLG9/2+4PS/X-1 (Ref. no. 20.18-35) can be used instead of the lead with the angled connector VLG9/2+4PS/X-2 (Ref. no. 20.18-36).



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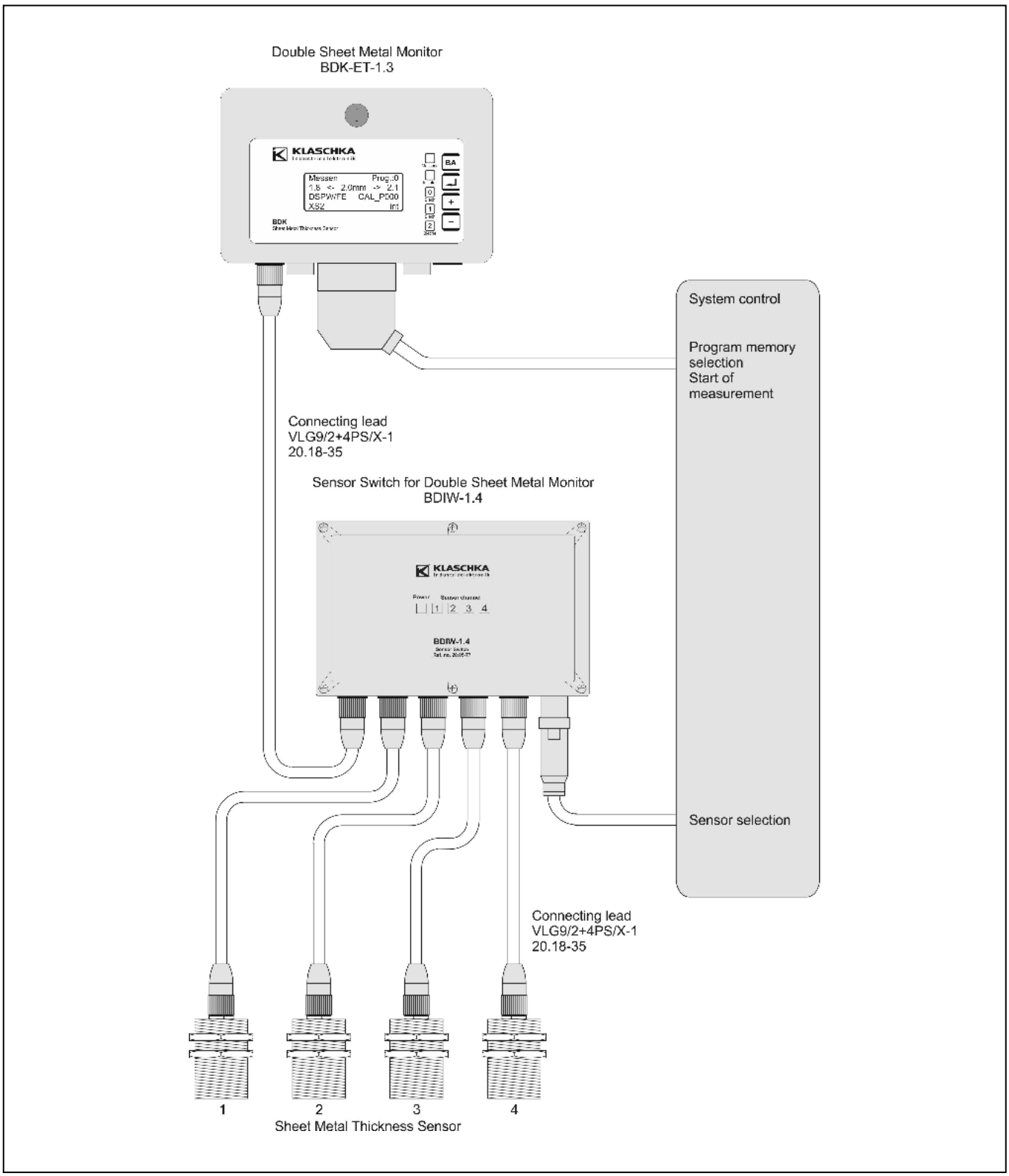
15. BDIW-1.4 Sheet Metal Thickness Switch

During the operation of BDK double sheet metal thickness monitors it often occurs that one monitor has to be connected to different sheet metal thickness sensors. This is e.g. the case when working with very different sheet thickness and -materials at one press or during measurement at different places in material supply.

With two equivalent sensor ternimals XS1 and XS2 as well as the use of the ADD1/2-1.3 T-coupler, the monitoring device disposes of a lot of possibilities to solve this problem. Up to 4 additional different sensors can be operated at the BDK-1.3 sheet metal thickness monitor via each of the XS1 or XS2 sensor terminals by means of the sensor switch.

Please find more details in description KB 20.05-77.



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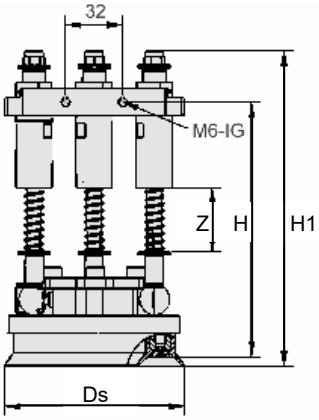
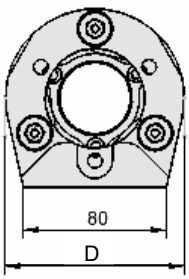
16. Bracket with suction cup for mounting Sheet Thickness Sensor

For single surface contact monitoring (e.g. for destacking equipment), sheet thickness sensors are often built into the suction cup of the gripper. For the DSP, DSPW, and BDWF thickness sensors with (M42, M54) design there are different versions of sensor brackets available.

16.1 For **Sensors** with **M42x1.5, M54x0.75 thread spring-mounted, with suction ring, with a flexible spherical bearing**

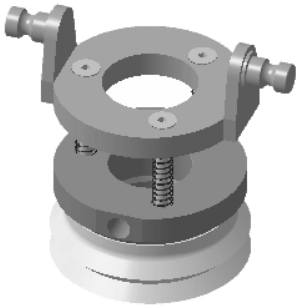


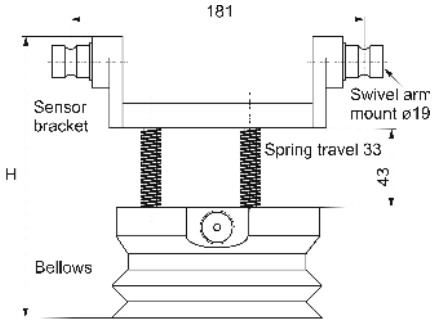


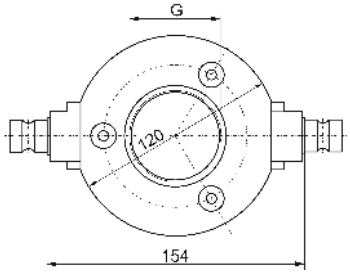
Type Ref. no.	D	Ds	H	H1	Z	Weight (g)
ZBF/FBF42-1 13.99-77	100	100	143	178	36	1070
ZBF/FBF54-2 13.99-87	130	128.8	187	221	80	1300

Spare Parts for Sensor Brackets		
Type	Ref. no.	
ZBF/FB42-1	13.99-78	Suction cup for sensor bracket M42
ZBF/FB54-2	13.99-88	Suction cup for sensor bracket M54

16.2 For **Sensors** with **M42x1.5 and M54x0.75 thread spring-mounted, with bellows**







Type Ref. no.	H	G	Weight (g)
ZBF/FBF42-2 13.99-84	165.2	M42 x 1.5	1300
ZBF/FBF54-1 13.99-69	162.0	M54 x 0.75	1500

Spare Parts for Sensor Brackets		
Type	Ref. no.	
ZBF/FB42-2	13.99-85	Bellows for sensor bracket M42
ZBF/FB54-1	13.99-68	Bellows for sensor bracket M54

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17. Technical Data

17.1 Evaluation Devices

Inputs

External Start (STA)

- lo-level	1 ... 8 V DC
- hi-level	12 ... 30 V DC
- Lead breakage detection	0 ... 1 V DC (external resistor necessary, see page 20)
- Input current	approx. 10 mA
- Electrical isolation	yes (to power supply)

External threshold selection (A1 ... A8 and Relays reset)

- lo-level	0 ... 4 V DC
- hi-level	12 ... 30 V DC
- Input current	approx. 10 mA
- Electrical isolation	yes (to power supply)

Outputs

Relay output K0	1 NC, 1 NO
Relay outputs K1, K2	1 change-over switch each 6 A, 250 V AC

Measurement accuracy

- At calibration point	± 0.1 or. 0.2 mm
- Across measurement range value	± 5% end-of-scale
- Permissible air gap	see page 24

Power supply

DC voltage	24 V DC
- Tolerance	± 15%
- Residual ripple	max. 10%

Power consumption

- During measurement	max. 100 VA (for measur. with DSP and DSPW - sensor, otherw. 20 VA)
- Idle state	approx. 12 VA
Overload protection	via fuses
- At 24 VDC	T3.15 A
Housing	sturdy metal housing, lockable cover with window
- Protection rating	IP 65
- Mounting	screw mounting (4 x M6)
Weight	approx. 3.5 kg
Ambient temperature	0 ... 55 °C

17.2 DSP Sheet Metal Thickness Sensor

Workpiece	ferromagnetic sheets
Exciter coil	
- Nominal voltage	approx. 38 V DC
- Coil current	max. 2.2 A
Proximity switch	
- Type	IAD-m8rg-2k
- Switching distance	approx. 1.2 mm
Housing material	nickel-plated steel
Protection rating	IP 65
Ambient temperature	0 ... 60 °C

17.3 BDWF Sheet Metal Thickness Sensor

Workpieces	non-ferrous sheets
Power supply	24 V DC
Input current	10 Vpp
Sheet detection	
- Switching distance	1 ... 5 mm (dep. on sheet)
Housing material	nickel-plated steel
Protection rating	IP 65
Ambient temperature	0 ... 60 °C

17.4 DSPW Sheet Metal Thickness Sensor

Workpieces	ferromagnetic sheets, non-ferrous sheets
Power supply	24 V DC
Sheet detection	
- Switching distance	1 ... 5 mm
Housing material	nickel-plated steel
Protection rating	IP 65
Ambient temperature	0 ... 60 °C

17.5 Standards Applied

Measuring relays and protection equipment	EN 60255-1
EMC emission	EN 61000-6-4
EMC immunity	EN 61000-6-2

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18. Order Data (designation / ref. no.)

18.1 Evaluation Devices

BDK-ET-1.3 (relay outputs) 20.05-96
BDK-ET/OB-1.3 (semi-conductor relay outputs) 20.21-02
BDK-ET/FP-1.3 (PROFIBUS DP) 20.05-97

18.2 Sheet Metal Thickness Sensors for single-surface contact measurement

DSPW-42sg-1s 13.05-66
for Fe sheets up to 3.0 mm / NE sheets up to 2.0 mm,
thread M42 x 1.5
- For using the DSPW-42sg-1s sensor, the evaluation device has to be equipped with software version E118 or higher.

DSPW-54sg-1s 13.05-67
for Fe sheets up to 3.5 mm / NE sheets up to 2.5 mm,
thread M54 x 0.75

BDWF-m54rg-2s 13.05-73
for NE sheets up to 5.5 mm,
thread M54 x 0.75

DSP-36sg-1s 13.05-86
for Fe sheets up to 1.5 mm,
Thread M36 x 1.5

DSP-42sg-1s 13.05-87
for Fe sheets up to 2.5 mm,
thread M42 x 1.5

DSP-54sg-1s 13.05-89
for Fe sheets up to 3.5 mm,
thread M54 x 0.75

DSP-75sg-1s 13.05-90
for Fe sheets up to 5.5 mm,
thread M75 x 1.5

18.3 Connecting Leads and Accessories

All connecting leads are oil-resistant and suitable for drag chains. Please indicate the lead length X when ordering (standard length X = 5 m). The connectors are device-sided straight and sensor-sided optionally straight or angled.

VLG9/2+4PS/X-1 20.18-35
Connecting lead BDK <---> sensor
Plug sensor-sided straight

VLG9/2+4PS/X-2 20.18-36
Connecting lead BDK <---> sensor
Plug sensor-sided angled

VLG9/2+4PS/X-3 20.18-37
Extension lead: BDK-lead (VLG) <---> sensor
Plug sensor-sided straight

VLG9/2+4PS/X-4 20.18-38
Extension lead: BDK-lead (VLG) <---> sensor
Plug sensor-sided angled

VLG9E/2+4PS/X-1 20.18-39
Connecting lead BDK and multi-coupling
(open ends)

VLG9E/2+4PS/X-2 20.18-40
Connecting lead multi-coupling (open ends)
and sensor, straight socket

VLG9E/2+4PS/X-3 20.18-41
Connecting lead multi-coupling (open ends)
and sensor, angeled socket

ADD1/2-1.3 20.18-45
T-Coupler for BDK,
1 x pin, 2 x socket

SMF25-1 13.99-04
Socket for connection of power supply and
control leads for devices with parallel interface.

SMF6-3 13.99-06
Socket for connection of power supply leads
for PROFIBUS devices.

18.4 Switch for connecting additional Sensors

BDIW-1.4 20.05-77
Sensor switch for selecting one out of four sensors
(BDWF, BDWD, DSP, DSPW, or DSD),
Power supply 24 VDC.

Connecting leads for BDIW-1.4

VLG9/2+4PS/X-1 20.18-35
Connecting lead BDK <---> BDIW and
BDIW <---> Sensor connection BDWF, BDWD,
DSP, DSPW, or DSD-60,
plug sensor-sided straight.

VLG9/2+4PS/X-2 20.18-36
Connecting lead BDIW <---> Sensor connection
BDWF, BDWD, DSP, DSPW, or DSD-60,
plug sensor-sided angled.

18.5 Bracket for mounting Sheet Thickness Sensor

Sensor bracket M42 x 1.5
spring-mounted, with suction ring
ZBF/FBF42-1 **13.99-77**

Sensor bracket M42 x 1.5
spring-mounted, with bellows
ZBF/FBF42-2 **13.99-84**

Sensor bracket M54 x 0.75
spring-mounted, with bellows
ZBF/FBF54-1 **13.99-69**

Sensor bracket M54 x 0.75
spring-mounted, with suction ring
ZBF/FBF54-2 **13.99-87**

Spare parts for sensor brackets:

Suction cup for sensor bracket M42
ZBF/FB42-1 **13.99-78**

Bellows for sensor bracket M42
ZBF/FB42-2 **13.99-85**

Bellows for sensor bracket M54
ZBF/FB54-1 **13.99-68**

Suction cup for sensor bracket M54
ZBF/FB54-2 **13.99-88**

We are certified according to DIN EN ISO 9001

Subject to technical changes!

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