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User Manual:

Mechanical Kiln Monitoring (MKM) System

1. INTRODUCTION:

The MKM-System is an on-line measuring system for rotary kilns with more than 2 Stations to detect abnormalities during operation, which can lead to mechanical failures. The main objective is to detect thermal or permanent cranks in the kiln shell, loss of relative movement on kiln tires and problems in axial movement at an early stage. Analog signal exchange (4 – 20 mA) allows connecting it directly with the factory control system in order to set alarm levels and to take adequate counter-measures. Furthermore the equipment is storing the measured data to a memory card in way to perform off-line analysis at any stage in order to verify origin of upset condition (process or mechanical).

The modular setup allows connecting different measurement units:

The main purpose of the system is to measure cranks in the kiln shell via roller shaft bending measurement. This requires the main unit (1), which includes the control box and a kiln speed sensor and one roller shaft bending unit (2) for each station.

If the kiln is not already equipped with a reliable system to measure the relative movement of the tires, it is recommended to add the unit (3) to each tire.

To measure the axial kiln position, unit (4) can be connected; if not already a similar system is in operation.

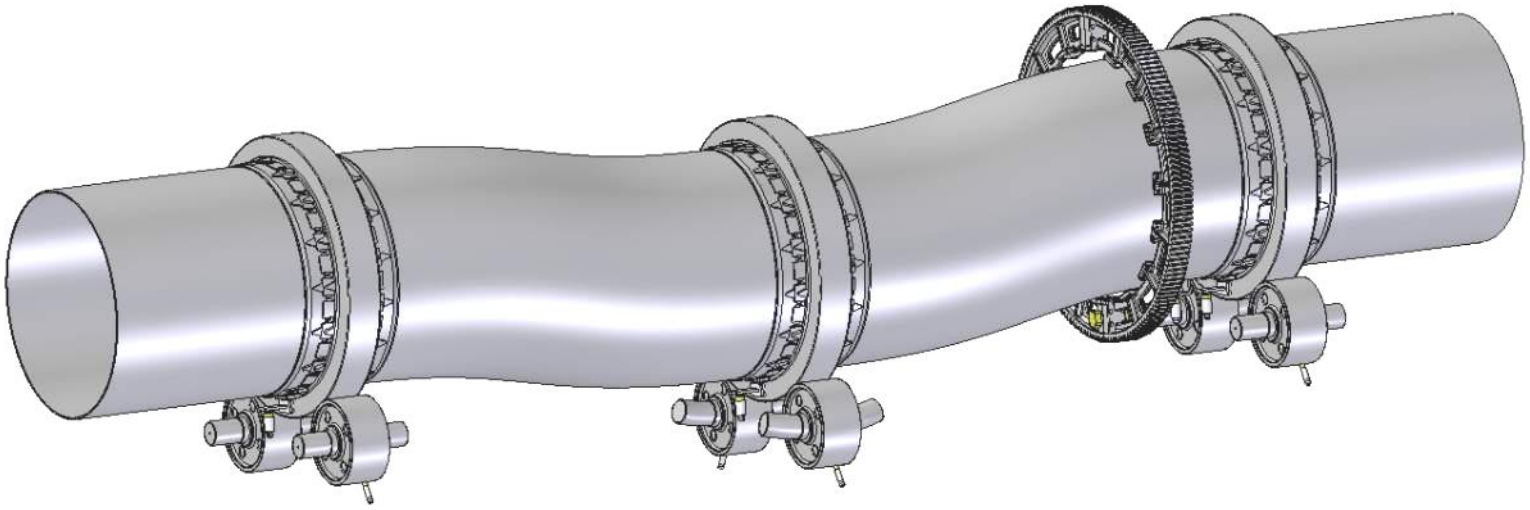


TABLE OF CONTENT

1.1 Safety:

Rotary kilns, dryers and mills, where this tool typically is used, are huge rotating equipments with many pinch points, they can cause serious injuries. Therefore only specialized and trained personnel shall work close to these machines. To use the tool, follow strictly the local safety rules given by the respective plant / factory / local authorities and discuss the application with the safety engineer in charge.

The tools provided by TomTom-Tools GmbH have proven their functionality in various applications; nevertheless TomTom-Tools GmbH does not take any responsibility for the application on site regarding safety. The plant is responsible for the safety, according to the local law, in a way that nobody can be hurt or injured. The application and safety instructions below are guidelines and not exhausted which include the experience from previous measurement campaigns and might need to be adapted to the local safety requirements.

Caution:

Pinching Points:

Do not put your hands nor any items close or into pinching points
(e.g. girth gear / pinion, kiln tires / support rollers, switch flags / sensors,…)

Keeps safe distance to avoid getting caught by moving parts

Magnet Fields:

Be aware of the strong magnet field of the magnetic switch flags.

Keep the tool away from people with pace makers or any other sensitive item as credit cards or magnetic data carrier.

Clamping:

Do not put fingers between the magnets and magnetic surface. There is the risk for clamping or pinching, due to the strong magnetic force.

Gloves:

Wear proper gloves to protect your hands from hot and rough surfaces and sharp edges.

2. MEASURING PRINCIPLE:

The MKM System is equipped with different inductive distance sensors with an analogue output of 0…20mA or with a digital output of 24VDC.

The signals of the sensors are measured and recorded by the data logger in the MKM Control Box. The data logger (DALOG 376) is calculating the different values (roller shaft bending and its peak position, relative tire movement and axial kiln position) and provides an output signal (4…20mA) accordingly.

Furthermore the control box is equipped with a card reader, where periodically (every 2 weeks) all the data from the data logger are stored in the SD card. The data download from the data logger to the SD card can be forced by pushing the button on the card reader.

Note: the download to the SD card takes about 12 minutes (shown by alternating blinking of green and red LED). **Do not remove the card during the download process!!**

The software **DalogUI** (for Windows), which comes together with the measurement tool is made for statistical analysis of the stored data on the SD card.

Kiln Speed Sensor

Axial Kiln Position Sensor

Roller Shaft Bending Sensor

Axial Kiln Position Sensor

Relative Tire Movement Sensor

2.1 Roller Shaft Bending Measurement (Unit 1+2)

On a kiln support roller, the variation of the deflection of the roller shafts show possible cranks in the kiln shell. Cranks are straightness errors in the kiln shell, which are affecting the loads on the roller stations with each kiln revolution.

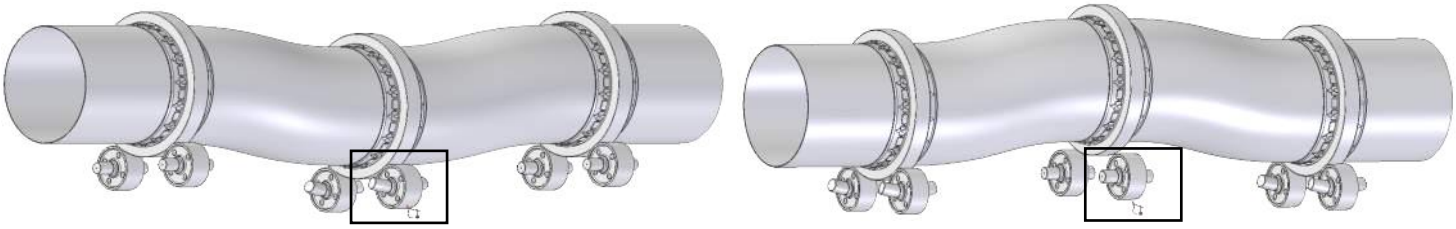
There are two types of cranks:

- **Permanent / Mechanical Crank:**
  Caused by plastic deformations in the kiln shell or errors during the kiln construction.
- **Thermal Crank:**
  Caused by uneven temperature distribution / thermal expansion around the kiln shell circumference. (most severe close to the middle tire)

The load changes caused by cranks can be very strong and overload the tires and rollers, which results in cracks in tires, rollers and roller shafts.

The crank pushes the roller down; hence the distance between the sensor and the roller surface is reduced. Half a kiln revolution later, the crank turns up and the load gets reduced on this station; hence the distance to the sensor is getting bigger.

To measure the effect of a crank, an inductive sensor is placed under the support roller in the line of force. That means on the opposite side of the contact to the kiln tire.
Due to the high stiffness of the roller shafts, these movements are very small (within tenths of millimeter), therefore small sensor Ø12mm are used to have a high accuracy



2.2 Relative Tire Movement (Unit 3)

To measure the relative movement of loose tires (also called “migrating tires”) the speed of the tire has to be measured and compared with the speed of the kiln. This is done with the magnetic switch flag and the tire speed sensors, which provides an impulse (24V) to the control box, when the switch flag is passing by the sensor.

2.3 Axial Kiln Position (Unit 4)

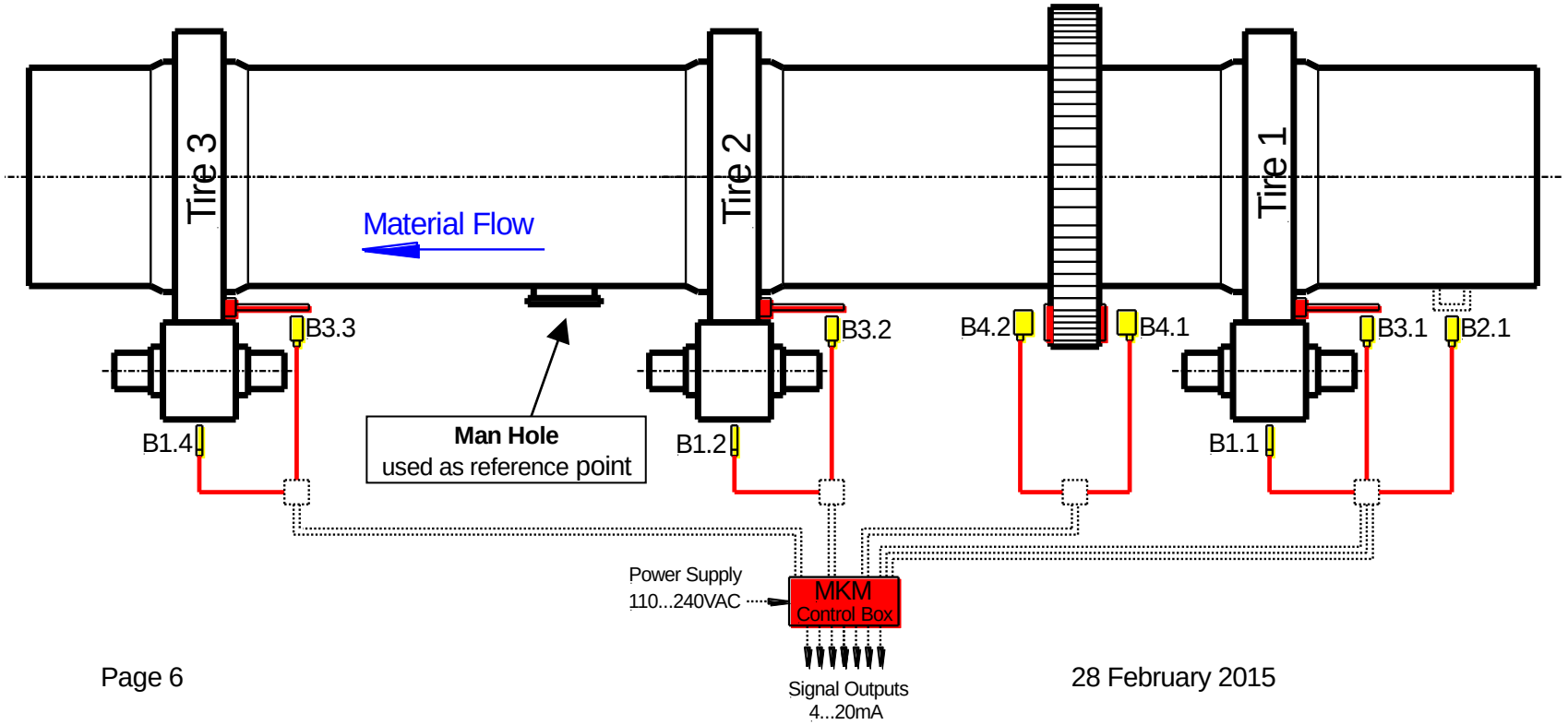
The actual position of the kiln in axial direction is measured with two inductive distance sensors and two switch flags on both sides of the girth gear. Two sensors are required to enlarge the working distance of the sensors. When the kiln is in its middle position, both switch flags are in the range of their sensors. If the kiln moves to one side, the opposite switch flag will go out of the range of its sensor and only the closer one will measure. The calculation for this sensor range increase is done in the control box.

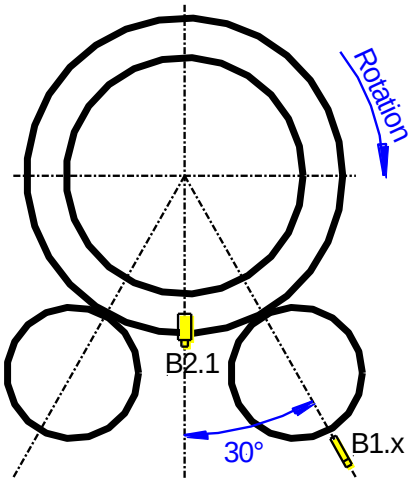
Note: for the first reference and to start the calculation of the axial kiln position, the kiln has to be approximately in the middle position and both sensors have to have a value of max. 45mm

3. SENSOR POSITIONING

3.1 3 Station Kiln

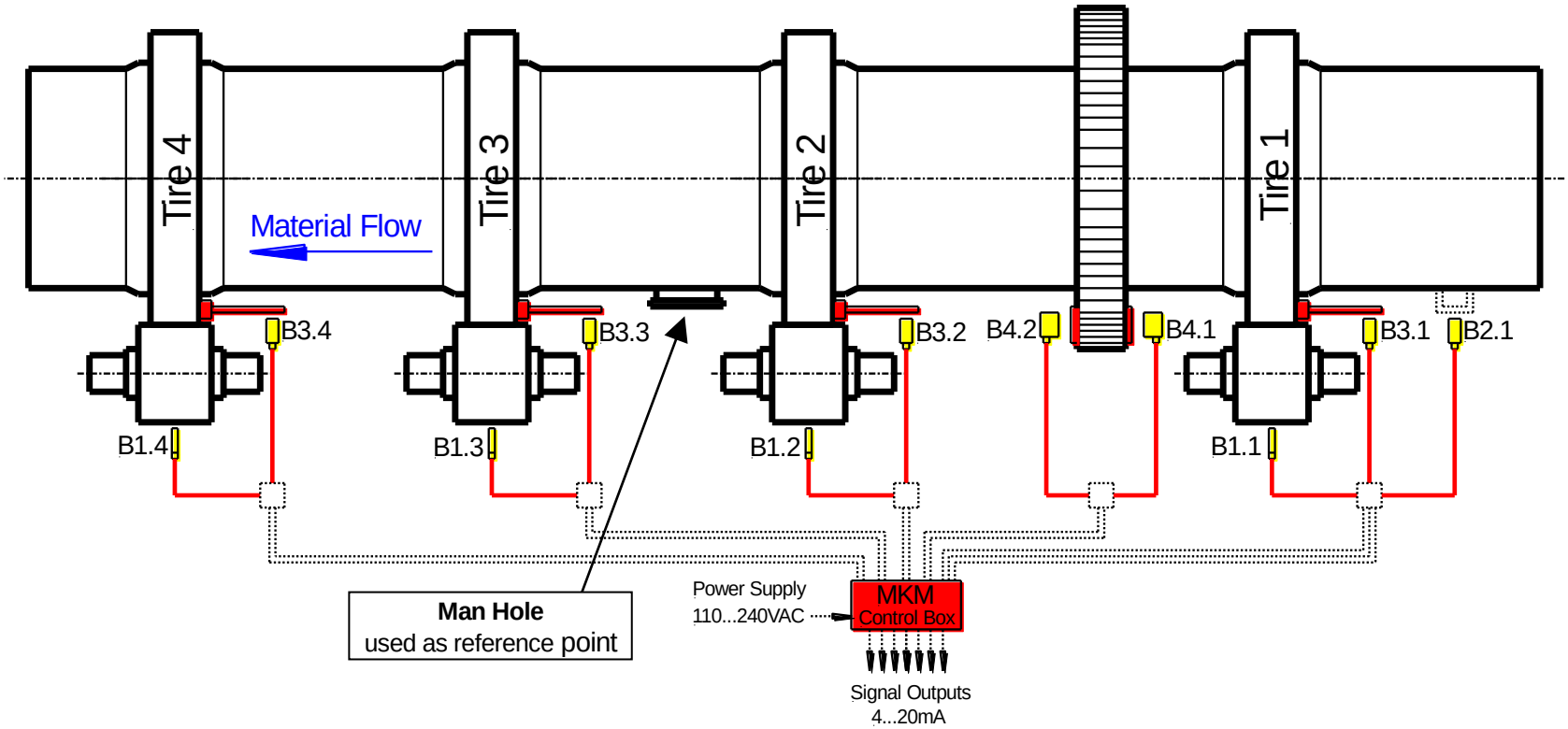
- **1. Main Unit:**
  B2.1 Kiln Speed Sensor to be placed at 6 o'clock position as indicated in the sketch below
  Weld a switch flag (Steel plate) onto the kiln in line with the kiln reference point. Usually the man hole or the position of one of the splits of the girth gear is used as reference point. Place the switch flag with sufficient distance to the kiln shell (250…400mm), to avoid overheating of the sensor.
- **2. Roller Shaft Bending Unit:**
  B1.1 / B1.2 / B1.4 Roller shaft bending tire 1, 2, 3, to be placed at in-running roller in force direction (30°) (see sketch)
  (Note: B.1.3 is not connected)
- **3. Relative Tire Movement Unit:**
  B3.1 / B3.2 / B3.3 Relative movement tire 1, 2, 3, Sensor to be placed between 5 and 7o'clock position. For safety reason, to avoid that somebody get pinched between switch flag and sensor it is recommended to install the sensor to 5 o'clock position (against rotation, see sketch)
- **4. Axial Kiln Position Unit**
  B4.1 / B4.2 Axial kiln position Sensor to be placed on the girth gear (uphill / downhill) in line with the speed sensor (see sketch)

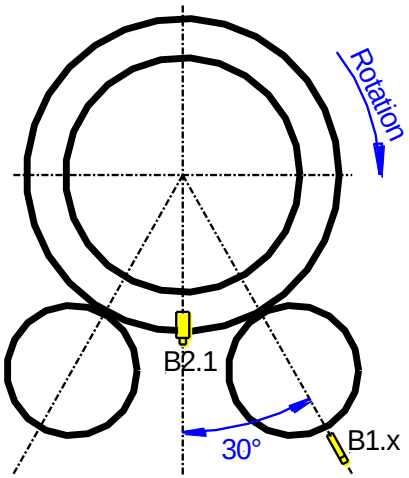




3.2 4 Station Kiln

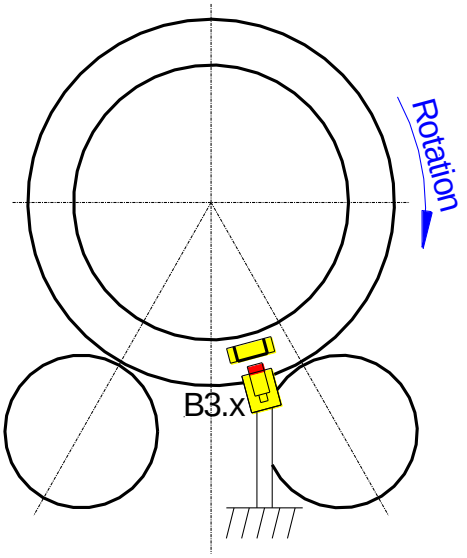
- **1. Main Unit:**
  B2.1 Kiln Speed Sensor to be placed at 6 o'clock position as indicated in the sketch below
  Weld a switch flag (Steel plate) onto the kiln in line with the kiln reference point. Usually the man hole or the position of one of the splits of the girth gear is used as reference point. Place the switch flag with sufficient distance to the kiln shell (250…400mm), to avoid overheating of the sensor.
- **2. Roller Shaft Bending Unit:**
  B1.1 / B1.2 / B1.3 / B1.4 Roller shaft bending tire 1, 2, 3, 4, to be placed at in-running roller in force direction (30°) (see sketch)
- **3. Relative Tire Movement Unit:**
  B3.1 / B3.2 / B3.3 / B3.4 Relative movement tire 1, 2, 3, 4 Sensor to be placed between 5 and 7o'clock position. For safety reason, to avoid that somebody get pinched between switch flag and sensor it is recommended to install the sensor to 5 o'clock position (against rotation, see sketch)
- **4. Axial Kiln Position Unit**
  B4.1 / B4.2 Axial kiln position Sensor to be placed on the girth gear (uphill / downhill) in line with the speed sensor (see sketch)





3.3 Relative Tire Movement Sensors

For the function, the tire movement sensors do not need to be in a line or at a specific position, but for safety reason, it is recommended to install the sensors at 5 o'clock position (see sketch below) in order to get more free space for safe work on the tire during operation (e.g. lubrication).

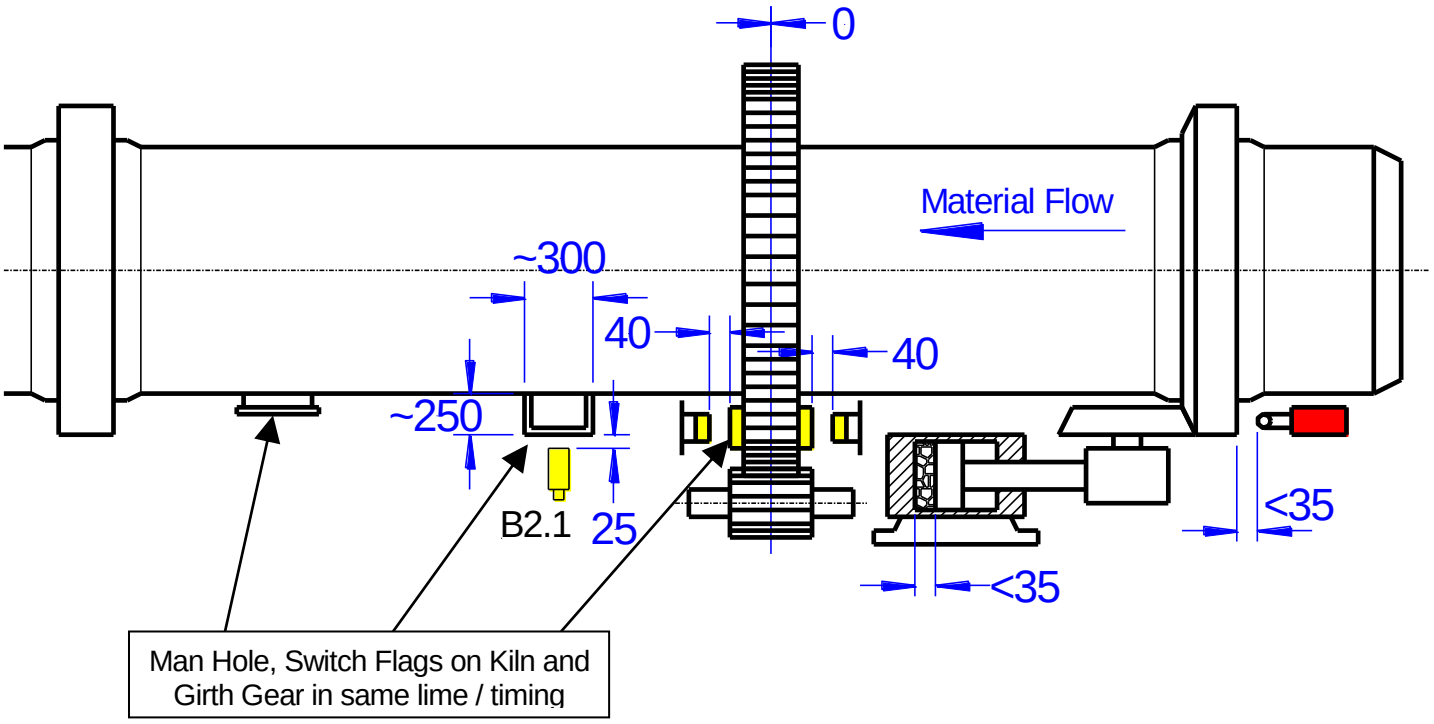


Safety Note:

In case the full length of the switch flag on the tire is not necessary, shorten the switch flag to the required length.

3.4 Axial Kiln Position Sensors:

The Sensors for the axial kiln position have to be installed in the same timing with the kiln speed sensor. The signal from the speed sensor switch flag has to match the center of the switch flag on the girth gear. Hence these sensors are preferable installed at 6 o'clock position
(see sketch below).
Restrict the axial kiln movement to max ±35mm in order not to damage the sensors.
A normal kiln travel is ±20…25mm within 24 hours.

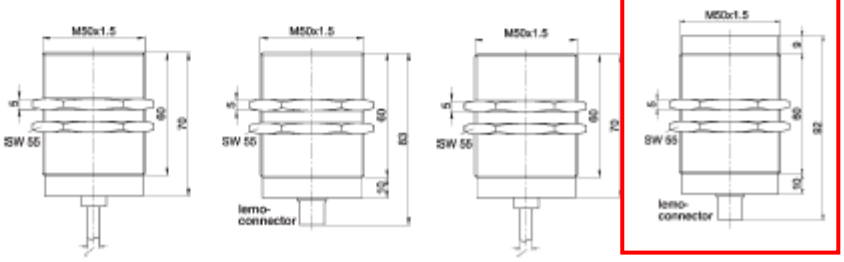


4. SENSOR DATA SHEETS:

4.1 Kiln Speed Sensor

Technical data and wiring diagram of the Sensor **B2.1** (M50x1.5 IN500140):

technical data and article list				
design	M50x1.5	M50x1.5	M50x1.5	M50x1.5
sensing range Sn	20mm	20mm	25mm	25mm
ambient temperature	-25 ... +180°C	-25 ... +180°C	-25 ... +180°C	-25 ... +180°C
mounting	flush	flush	non-flush	non-flush
voltage drop (max. load)	< 2V DC	< 2V DC	< 2V DC	< 2V DC
operating voltage	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC
short-circuit protection	+	+	+	+
reverse polarity protection	+	+	+	+
current consumpt. (w/o load)	≤ 15mA	≤ 15mA	≤ 15mA	≤ 15mA
output current (max. load)	< 150mA	< 150mA	< 150mA	< 150mA
switching output	pnp, no	pnp, no	pnp, no	pnp, no
sampling frequency	100Hz	100Hz	100Hz	100Hz
Sn hysteresis	3 ... 15%	3 ... 15%	3 ... 15%	3 ... 15%
status display	-	-	-	-
system of protect. (EN 60529)	IP65	IP65	IP65	IP65
housing material	stainless steel	stainless steel	stainless steel	stainless steel
front cap material	Vectra®	Vectra®	Vectra®	Vectra®
2m silicone cable	**IB500150**	-	**IN500150**	-
5m silicone cable	**IB500151**	-	**IN500151**	-
10m silicone cable	**IB500152**	-	**IN500152**	-
2m teflon cable	**IB5001T0**	-	**IN5001T0**	-
5m teflon cable	**IB5001T1**	-	**IN5001T1**	-
10m teflon cable	**IB5001T2**	-	**IN5001T2**	-
lemo-connector	-	**IB500140**	-	**IN500140**
wiring diagram see page 27	1	4	1	4
matching cable socket see page 26	-	e.g. **VK500940**	-	e.g. **VK500940**
fixing material see page 27	**AY000102**	**AY000102**	**AY000102**	**AY000102**



silicone cable Ø 5mm
teflon cable Ø 3mm

silicone cable Ø 5mm
teflon cable Ø 3mm

wiring diagram 4 lemo-connector devices 3-wire

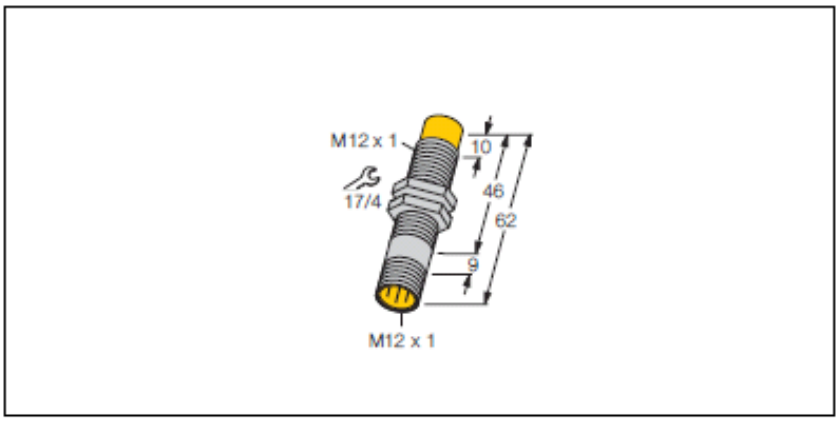
wire colors: bn = brown (1), bk = black (2), bu = blue (3)

4.2 Roller Shaft Bending Sensors

Technical data and wiring diagram of the Sensor **B1.x** (NI5-M12-LiU-H1141)

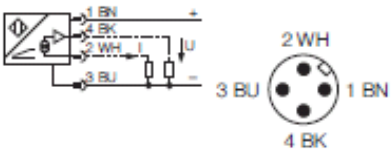
Attention:
For the signal connect **only** the current output (pin 2, white wire)
The voltage output is **not** used (pin 4, black wire)

Inductive sensor
with analogue output
NI5-M12-LiU-H1141



- **threaded barrel, M12 x 1**
- **Chrome-plated brass**
- **4-wire, 15...30 VDC**
- **analogue output**
- **0...10 V and 0...20 mA**
- **connector, M12 x 1**

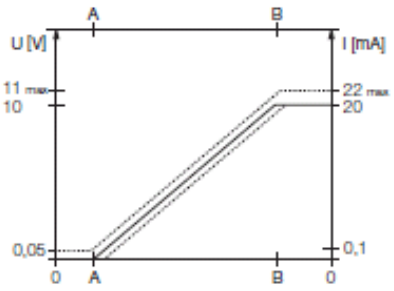
Wiring diagram



Type	NI5-M12-LiU-H1141
Ident-No.	1535535
Measuring range [A...B]	0.5... 4 mm
Mounting condition	non-flush
Correction factors	St37 = 1, V2A – 0.7, Ms – 0.4, Al – 0.3
Repeatability	≤ 1 % of measuring range |A - B|
	≤ 0.5 %, after a warm-up time of 0.5 h
Reproducibility	≤ 35µm
	≤ 17.5µm, after a warm-up time of 0.5 h
Linearity deviation	≤ 3% of full scale
Temperature drift	≤ ± 0.06 %/K
Ambient temperature	-25...+ 70 °C
Operating voltage	15... 30VDC
Residual ripple	≤ 10 % U_{ss}
No-load current I_0	≤ 8 mA
Rated insulation voltage	≤ 0.5 kV
Short-circuit protection	yes
Wire breakage / Reverse polarity protection	yes / complete
Output function	4-wire, analogue output
voltage output	0... 10 V
current output	0... 20 mA
Load resistance voltage output	≥ 4.7 kΩ
Load resistance current output	≤ 0.4 kΩ
Measuring sequence frequency	100 Hz
Output recovery time	≤ 12 ms
Housing	threaded barrel, M12 x 1
Dimensions	62 mm
Housing material	metal, CuZn, chrome-plated
Material active face	plastic, PA12-GF30
Tightening torque of housing nut	10 Nm
Connection	Connectors, M12 x 1
Vibration resistance	55 Hz (1 mm)
Shock resistance	30g (11 ms)
Degree of protection	IP67

Functional principle
Simple control tasks can be accomplished with inductive TURCK sensors featuring an analogue output. They provide a current, voltage or frequency signal that is proportional to the target's distance. With TURCK's analogue sensors, this output signal is linear to the distance of the target over the entire sensing range.

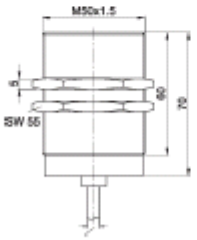
Measuring range

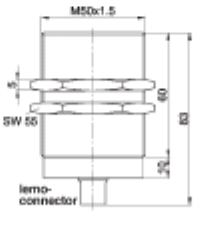


4.3 Relative Tire Movement Sensors

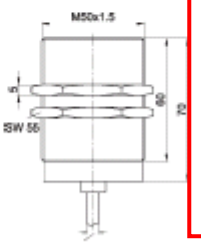
Technical data and wiring diagram of the Sensor **B3.x** (M50x1.5 IN500140):

technical data and article list				
design	**M50x1.5**	**M50x1.5**	**M50x1.5**	**M50x1.5**
sensing range Sn	**20mm**	**20mm**	**25mm**	**25mm**
ambient temperature	**-25 ... +180°C**	**-25 ... +180°C**	**-25 ... +180°C**	**-25 ... +180°C**
mounting	**flush**	**flush**	**non-flush**	**non-flush**
voltage drop (max. load)	< 2V DC	< 2V DC	< 2V DC	< 2V DC
operating voltage	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC
short-circuit protection	+	+	+	+
reverse polarity protection	+	+	+	+
current consumpt. (w/o load)	≤ 15mA	≤ 15mA	≤ 15mA	≤ 15mA
output current (max. load)	< 150mA	< 150mA	< 150mA	< 150mA
switching output	pnp, no	pnp, no	pnp, no	pnp, no
sampling frequency	100Hz	100Hz	100Hz	100Hz
Sn hysteresis	3 ... 15%	3 ... 15%	3 ... 15%	3 ... 15%
status display	-	-	-	-
system of protect. (EN 60529)	IP65	IP65	IP65	IP65
housing material	stainless steel	stainless steel	stainless steel	stainless steel
front cap material	Vectra®	Vectra®	Vectra®	Vectra®
2m silicone cable	**IB500150**	-	**IN500150**	-
5m silicone cable	**IB500151**	-	**IN500151**	-
10m silicone cable	**IB500152**	-	**IN500152**	-
2m teflon cable	**IB5001T0**	-	**IN5001T0**	-
5m teflon cable	**IB5001T1**	-	**IN5001T1**	-
10m teflon cable	**IB5001T2**	-	**IN5001T2**	-
lemo-connector	-	**IB500140**	-	**IN500140**
wiring diagram see page 27	1	4	1	4
matching cable socket see page 26	-	e.g. **VK500940**	-	e.g. **VK500940**
fixing material see page 27	**AY000102**	**AY000102**	**AY000102**	**AY000102**

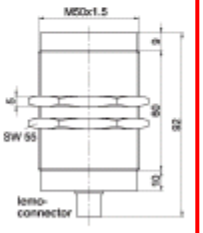




silicone cable Ø 5mm
teflon cable Ø 3mm



silicone cable Ø 5mm
teflon cable Ø 3mm



wiring diagram 4 lemo-connector devices 3-wire

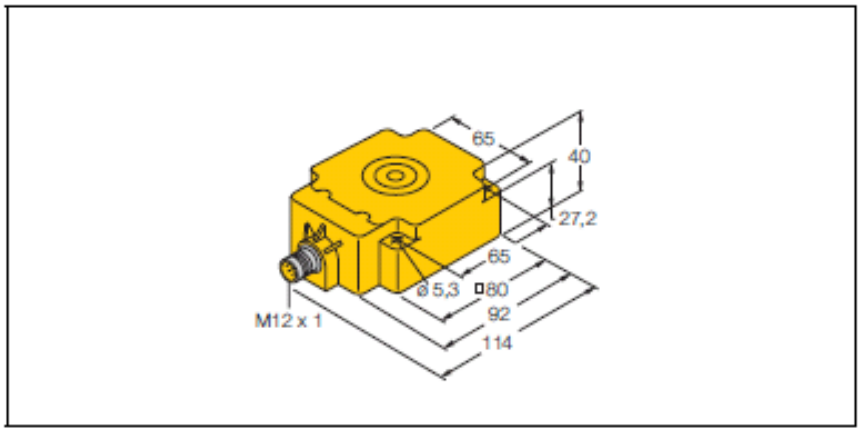
wire colors: bn = brown (1), bk = black (2), bu = blue (3)

4.4 Axial Kiln Position Sensors

Technical data and wiring diagram of the Sensor **B4.x** (NI50-Q80-LiU-H1141):

Attention:
For the signal connect **only** the current output (pin 2, white wire)
The voltage output is **not** used (pin 4, black wire)

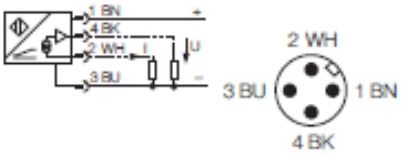
Inductive sensor with analogue output Ni50-Q80-LiU-H1141



- **rectangular, height 40 mm**
- **top active face**
- **Plastic, PBT-GF30-V0**
- **analog+**
- **extended sensing range**
- **4-wire, 15...30 VDC**
- **analogue output**
- **0...10 V and 0...20 mA**
- **connector, M12 x 1**

Type	Ni50-Q80-LiU-H1141
Ident-No.	1535545
Measuring range [A...B]	10... 50 mm
Mounting condition	non-flush
Correction factors	St37 = 1, V2A – 0.7, Ms – 0.4, Al – 0.3
Repeatability	≤ 1 % of measuring range |A - B|
	≤ 0.5 %, after a warm-up time of 0.5 h
Reproducibility	≤ 400µm
	≤ 200µm, after a warm-up time of 0.5 h
Linearity deviation	≤ 5% of full scale
Temperature drift	≤ ± 0.06 %/K
Ambient temperature	-25...+ 70 °C
Operating voltage	15... 30VDC
Residual ripple	≤ 10 % U_{ss}
No-load current I_0	≤ 8 mA
Rated insulation voltage	≤ 0.5 kV
Short-circuit protection	yes
Wire breakage / Reverse polarity protection	yes / complete
Output function	4-wire, analogue output
voltage output	0... 10 V
current output	0... 20 mA
Load resistance voltage output	≥ 4.7 kΩ
Load resistance current output	≤ 0.4 kΩ
Measuring sequence frequency	30 Hz
Output recovery time	≤ 12 ms
Housing	rectangular, Q80
Dimensions	92 x 80 x 40 mm
Housing material	plastic, PBT-GF30-V0, black
Material active face	plastic, PBT-GF30-V0, black
Connection	Connectors, M12 x 1
Vibration resistance	55 Hz (1 mm)
Shock resistance	30g (11 ms)
Degree of protection	IP67

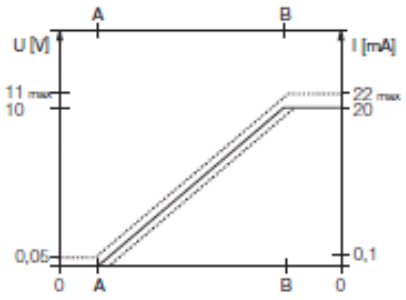
Wiring diagram



Functional principle

Simple control tasks can be accomplished with inductive TURCK sensors featuring an analogue output. They provide a current, voltage or frequency signal that is proportional to the target's distance. With TURCK's analogue sensors, this output signal is linear to the distance of the target over the entire sensing range.

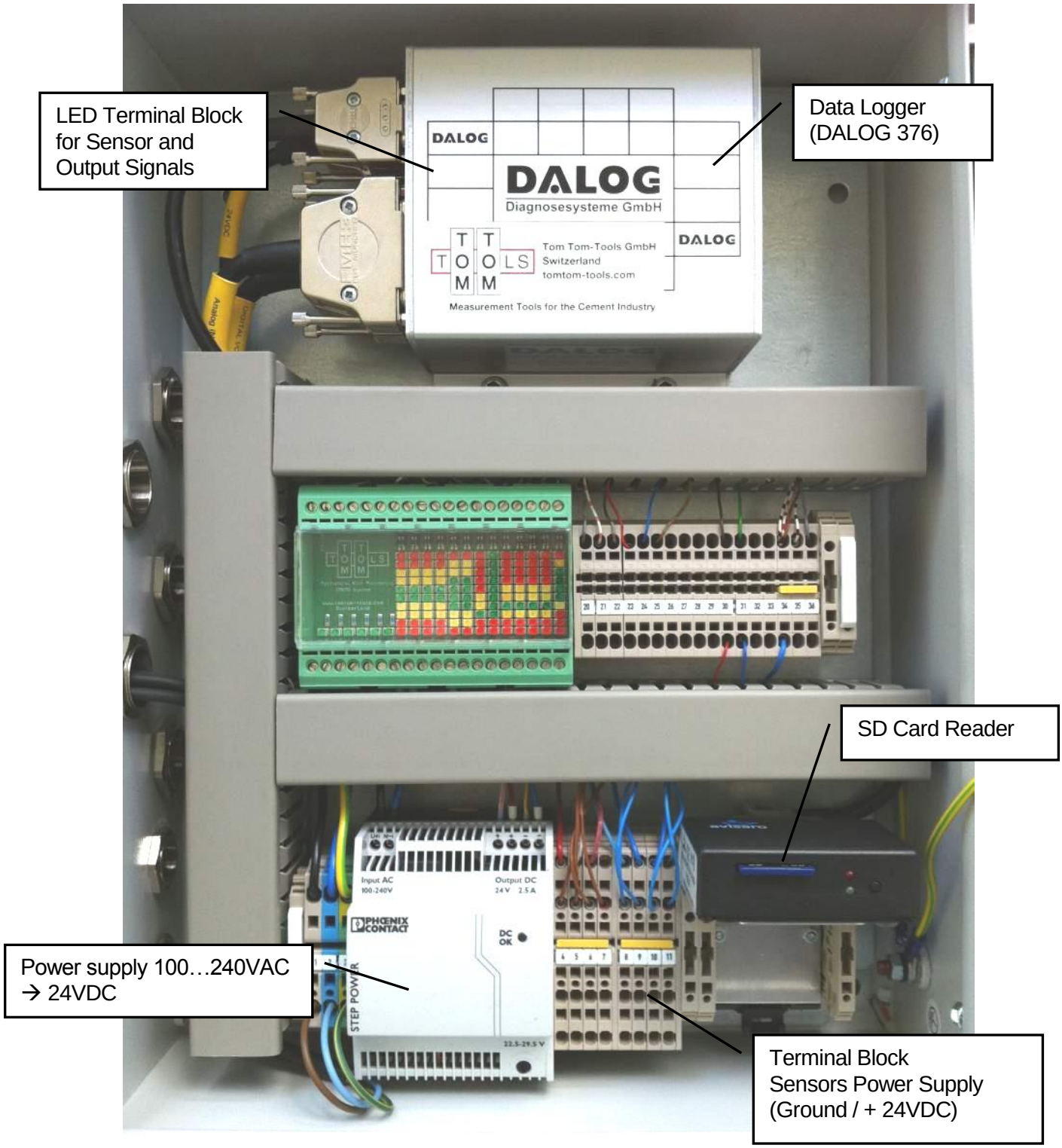
Measuring range



5. CONTROL BOX

5.1 Layout

The cabinet should be placed on a sheltered place away from vibrations and in save distance (min. 5m) of emitting electrical machines like big motors, frequency converters, transformers, etc.



5.2 Analogue Outputs

The following max. 7 analogue signals will be transmitted to the Central Control Room (CCR). The exact number of outputs depends on the installed measurement units and on the number of tires equipped with the relative movement measurement.

The following tables show the possible output signals in mA and how they have to be interpreted

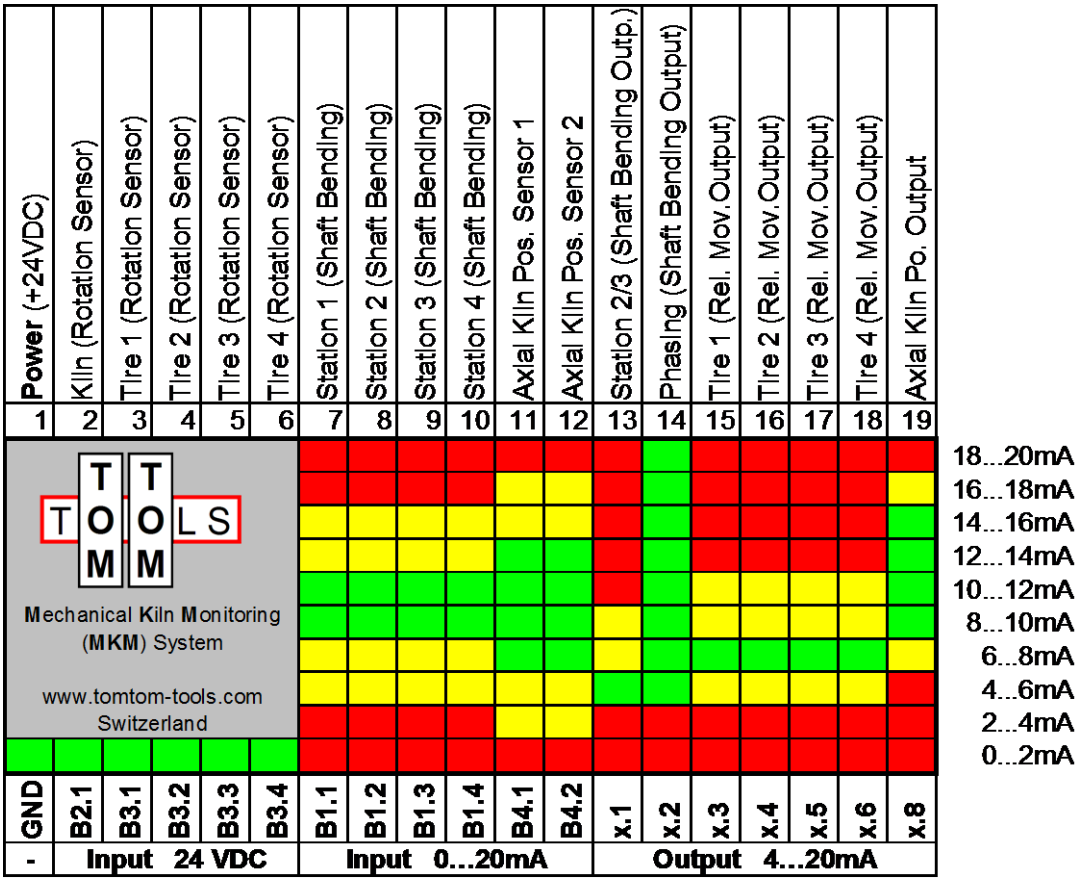
Unit	Signal	Output	Electrical	Mechanical
2	Roller shaft bending (tire 2 / 3)	x.1	(4 … 20) mA	(0 … 0.8) mm
2	Kiln Crank Phasing	x.2	(4 … 20) mA	(0 … 360) °
3	Relative Movement Tire 1	x.3	(4 … 20) mA	(0 … 16) mm/m
3	Relative Movement Tire 2	x.4	(4 … 20) mA	(0 … 16) mm/m
3	Relative Movement Tire 3	x.5	(4 … 20) mA	(0 … 16) mm/m
3	Relative Movement Tire 4	x.6	(4 … 20) mA	(0 … 16) mm/m
4	Axial Kiln Position	x.8	(4 … 20) mA	(-40 … +40)mm

5.3 LED Terminal Block

The terminal block for the sensors and signal output is equipped with LED bars.
The LEDs indicate the signal level (mA) at the respective channel.

The lowest LEDs show 0mA, the highest show 20mA.
The different colors indicate if the signal is in the recommended range or not.

Green: in good recommended range
yellow: slightly out of recommended range
red: out of recommended range



Note: The LED bars can be enabled / disabled by the two switches on top of each bar, below glass

5.4 Values displayed in the CCR

The following tables show the possible output signals and how they have to be displayed in the Central Control Room (CCR).

Signal	Display	Warnings / Alarms*				Unit
		LL	L	H	HH	
Roller shaft bending (tire 2 / 3)	0…0.8	-	-	0.15	0.2	mm
Kiln Crank Phasing	0…360	-	-	-	-	°
Relative Movement Tire 1	0…16*Di_{Tire}	3	5	25	30	mm/rev
Relative Movement Tire 2	0…16*Di_{Tire}	3	5	25	30	mm/rev
Relative Movement Tire 3	0…16*Di_{Tire}	3	5	25	30	mm/rev
Relative Movement Tire 4	0…16*Di_{Tire}	3	5	25	30	mm/rev
Axial Kiln Position	-40…+40	-35	-30	30	35	mm

Roller Shaft Bending Values:

For displaying the crank in the kiln shell of a 3 Station Kiln, the signal of the roller shaft bending on station 2 and its phasing is sufficient. On a 4 Station kiln, the values of station 2 or 3 are transferred to the control room. The signal switches automatically to the station with the higher roller shaft bending value.

Note:
The value of the roller shaft bending is a +/- Value, that means the halve of the peak to peak value

Relative Tire Movement Calculation:

The signal of the Relative Tire Movement has to be multiplied with the inner diameter of the tire Di_{Tire} [m], to get the correct value in [mm/rev].

6. INSTALLATION (PREPARATION WORK)

6.1 3 Station Kiln:

The following cables have to be pulled to connect the Control Box:

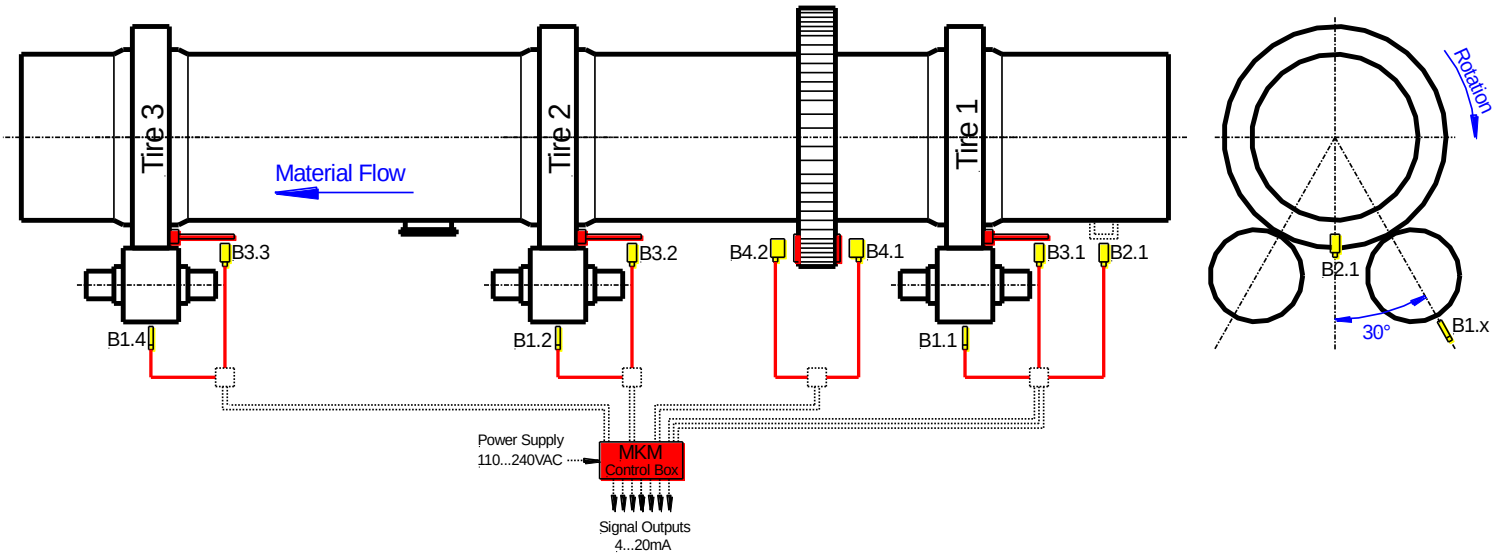
- Electrical Power (100…24VAC) to Terminal Block
- Sensors with LED Terminal Block (see dashed lines in sketch below)

B1.1	Roller Shaft Bending Sensor Tire 1
B1.2	Roller Shaft Bending Sensor Tire 2
B1.3	(not connected)
B1.4	Roller Shaft Bending Sensor Tire 3
B2.1	Speed Sensor Kiln
B3.1	Speed Sensor Tire 1
B3.2	Speed Sensor Tire 2
B3.3	Speed Sensor Tire 3
B4.1	Position Sensor uphill
B4.2	Position Sensor downhill

- Max. 5 analogue outputs 4 … 20 mA for the complete system to connect it with the CCR

x.1	Roller shaft bending	Station 2
x.2	Phasing	Peak position of crank
x.3	Relative Movement	Tire 1
x.4	Relative Movement	Tire 2
x.5	Relative Movement	Tire 3
x.8	Axial Kiln position	

➔ Please see details in Annex



6.2 4 Station Kiln:

The following cables have to be pulled to connect the Control Box:

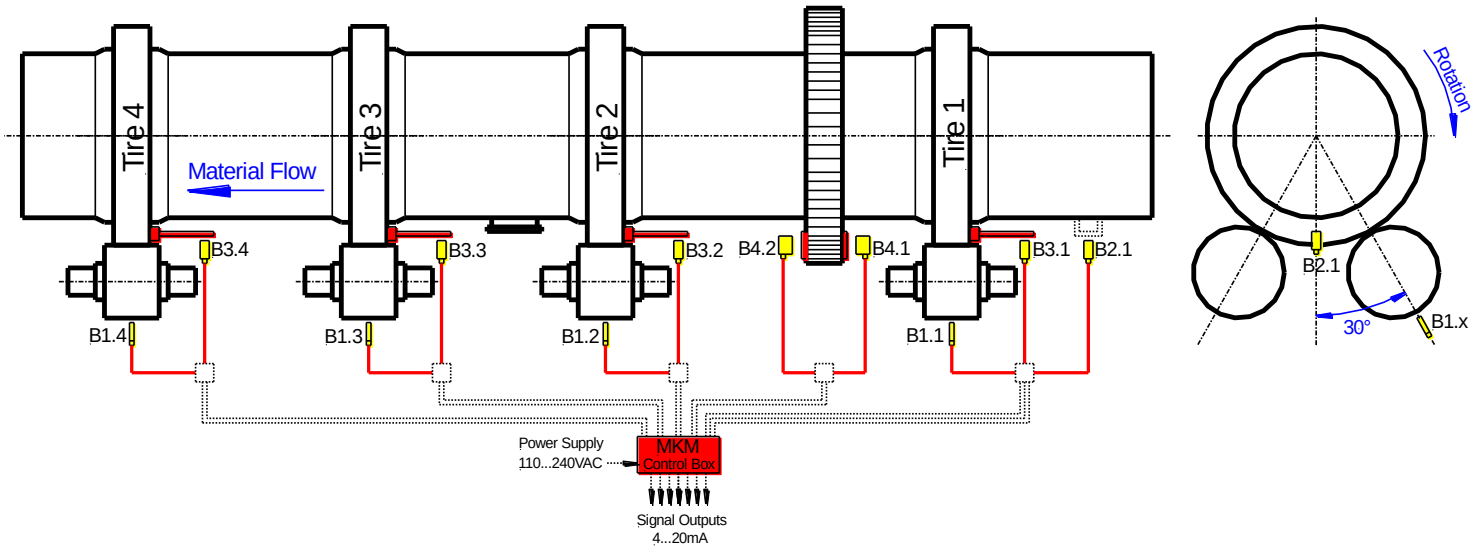
- Electrical Power (100…24VAC) to Terminal Block
- Sensors with LED Terminal Block (see dashed lines in sketch below)

B1.1	Roller Shaft Bending Sensor Tire 1
B1.2	Roller Shaft Bending Sensor Tire 2
B1.3	Roller Shaft Bending Sensor Tire 3
B1.4	Roller Shaft Bending Sensor Tire 4
B2.1	Speed Sensor Kiln
B3.1	Speed Sensor Tire 1
B3.2	Speed Sensor Tire 2
B3.3	Speed Sensor Tire 3
B3.4	Speed Sensor Tire 4
B4.1	Position Sensor uphill
B4.2	Position Sensor downhill

- Max. 5 analogue outputs 4 … 20 mA for the complete system to connect it with the CCR

x.1	Roller shaft bending	Station 2 or 3
x.2	Phasing	Peak position of crank
x.3	Relative Movement	Tire 1
x.4	Relative Movement	Tire 2
x.5	Relative Movement	Tire 3
x.6	Relative Movement	Tire 4
x.8	Axial Kiln position	

➔ Please see details in Annex



7. MISCELLANEOUS

If there are any questions or problems please refer to Thomas Stutz or Thomas Rheinegger,

thomas.stutz@tomtom-tools.com

thomas.rheinegger@tomtom-tools.com

8. ANNEXES

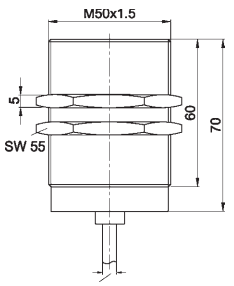
1. Technical Details (Reference and relative tire movement sensor)
2. Technical Details (Roller shaft bending sensors)
3. Technical Details (Axial kiln position sensors)
4. Electrical wiring diagram
5. Technical Details (Sensor mounting)

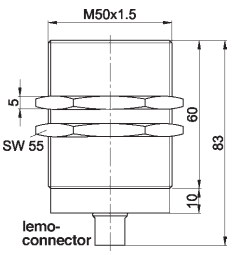
Annex 1
(Reference Sensor)

sensors with integrated amplifier, 10 to 35V DC, 3-wire version

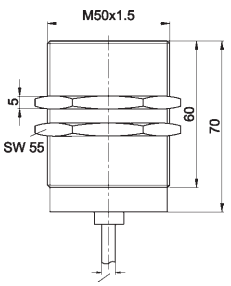
technical data and article list

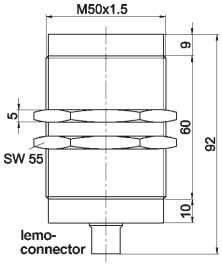
design	M50x1.5	M50x1.5	M50x1.5	M50x1.5
sensing range Sn	**20mm**	**20mm**	**25mm**	**25mm**
ambient temperature	**-25 ... +180°C**	**-25 ... +180°C**	**-25 ... +180°C**	**-25 ... +180°C**
mounting	**flush**	**flush**	**non-flush**	**non-flush**
voltage drop (max. load)	< 2V DC	< 2V DC	< 2V DC	< 2V DC
operating voltage	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC	10 ... 35V DC
short-circuit protection	+	+	+	+
reverse polarity protection	+	+	+	+
current consumpt. (w/o load)	≤ 15mA	≤ 15mA	≤ 15mA	≤ 15mA
output current (max. load)	< 150mA	< 150mA	< 150mA	< 150mA
switching output	pnp, no	pnp, no	pnp, no	pnp, no
sampling frequency	100Hz	100Hz	100Hz	100Hz
Sn hysteresis	3 ... 15%	3 ... 15%	3 ... 15%	3 ... 15%
status display	-	-	-	-
system of protect. (EN 60529)	IP65	IP65	IP65	IP65
housing material	stainless steel	stainless steel	stainless steel	stainless steel
front cap material	Vectra®	Vectra®	Vectra®	Vectra®
2m silicone cable	**IB500150**	-	**IN500150**	-
5m silicone cable	**IB500151**	-	**IN500151**	-
10m silicone cable	**IB500152**	-	**IN500152**	-
2m teflon cable	**IB5001T0**	-	**IN5001T0**	-
5m teflon cable	**IB5001T1**	-	**IN5001T1**	-
10m teflon cable	**IB5001T2**	-	**IN5001T2**	-
lemo-connector	-	**IB500140**	-	**IN500140**
wiring diagram see page 27	1	4	1	4
matching cable socket see page 26	-	e.g. **VK500940**	-	e.g. **VK500940**
fixing material see page 27	**AY000102**	**AY000102**	**AY000102**	**AY000102**





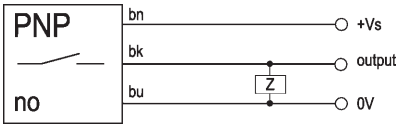
silicone cable Ø 5mm
teflon cable Ø 3mm





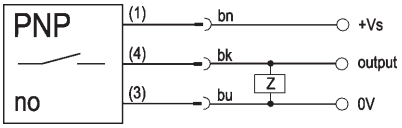
silicone cable Ø 5mm
teflon cable Ø 3mm

wiring diagram 1 cable devices 3-wire



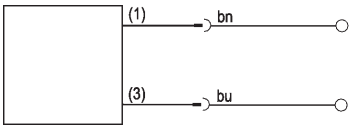
wire colors: bn = brown (1), bu = blue (3), bk = black (4)

wiring diagram 2 connection devices 3-wire



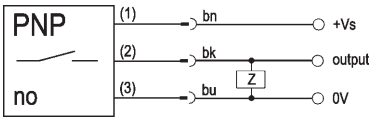
wire colors: bn = brown (1), bu = blue (3), bk = black (4)

wiring diagram 3 connection devices 2-wire



wire colors: bn = brown (1), bu = blue (3)

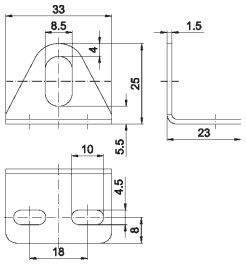
wiring diagram 4 lemo-connector devices 3-wire



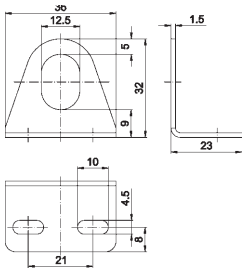
wire colors: bn = brown (1), bk = black (2), bu = blue (3)

fixing material

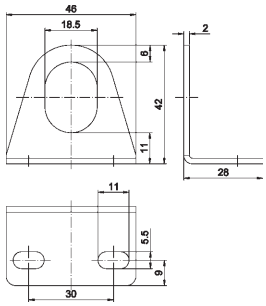
AY000098 for design M8x1, stainless steel



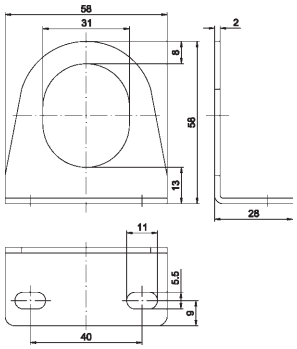
AY000099 for design M12x1, stainless steel



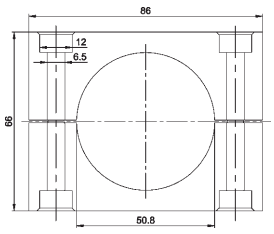
AY000100 for design M18x1, stainless steel



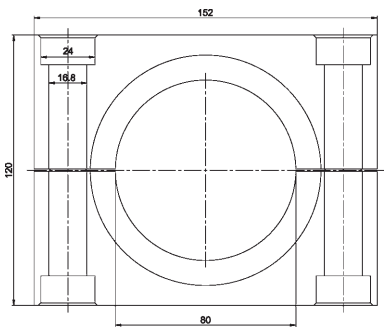
AY000101 for design M30x1.5, stainless steel



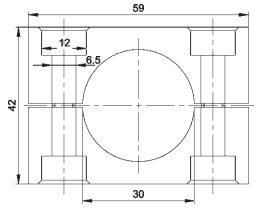
AY000102 for design M50x1.5, aluminium



AY000103 for design M80x1.5, aluminium

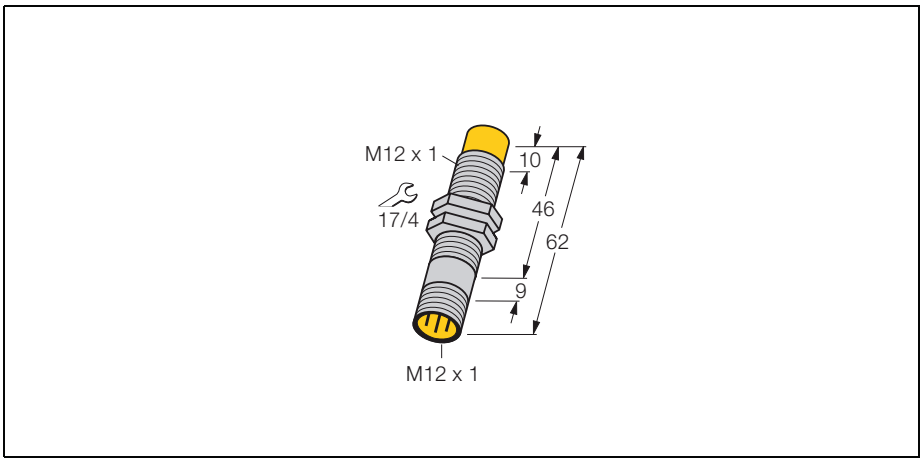


AY000104 for design M30x1.5, aluminium



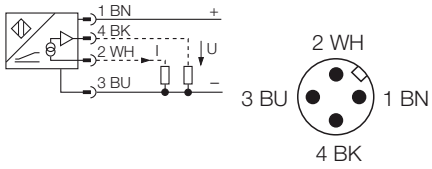
Annex 2
(Roller shaft bending Sensor)

Inductive sensor
with analogue output
NI5-M12-LiU-H1141



- **threaded barrel, M12 x 1**
- **Chrome-plated brass**
- **4-wire, 15…30 VDC**
- **analogue output**
- **0…10 V and 0…20 mA**
- **connector, M12 x 1**

Wiring diagram

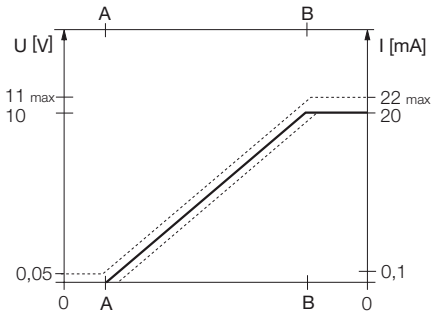


Type	NI5-M12-LiU-H1141
Ident-No.	1535535
Measuring range [A…B]	0.5… 4 mm
Mounting condition	non-flush
Correction factors	St37 = 1, V2A ~ 0.7, Ms ~ 0.4, Al ~ 0.3
Repeatability	≤ 1 % of measuring range |A - B|
	≤ 0.5 %, after a warm-up time of 0.5 h
Reproducibility	≤ 35µm
	≤ 17.5µm, after a warm-up time of 0.5 h
Linearity deviation	≤ 3% of full scale
Temperature drift	≤ ± 0.06 %/K
Ambient temperature	-25…+ 70 °C
Operating voltage	15… 30VDC
Residual ripple	≤ 10 % U_{ss}
No-load current I_0	≤ 8 mA
Rated insulation voltage	≤ 0.5 kV
Short-circuit protection	yes
Wire breakage / Reverse polarity protection	yes / complete
Output function	4-wire, analogue output
voltage output	0… 10 V
current output	0… 20 mA
Load resistance voltage output	≥ 4.7 kΩ
Load resistance current output	≤ 0.4 kΩ
Measuring sequence frequency	100 Hz
Output recovery time	≤ 12 ms
Housing	threaded barrel, M12 x 1
Dimensions	62 mm
Housing material	metal, CuZn, chrome-plated
Material active face	plastic, PA12-GF30
Tightening torque of housing nut	10 Nm
Connection	Connectors, M12 x 1
Vibration resistance	55 Hz (1 mm)
Shock resistance	30g (11 ms)
Degree of protection	IP67

Functional principle

Simple control tasks can be accomplished with inductive TURCK sensors featuring an analogue output. They provide a current, voltage or frequency signal that is proportional to the target's distance. With TURCK's analogue sensors, this output signal is linear to the distance of the target over the entire sensing range.

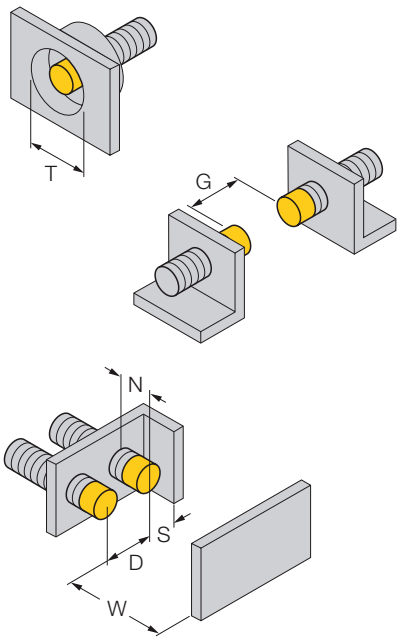
Measuring range



• Edition: • 10.06.2009

Inductive sensor
with analogue output
NI5-M12-LiU-H1141

Mounting instructions	minimum distances
Distance D	36 mm
Distance W	12 mm
Distance T	3 x B
Distance S	18 mm
Distance G	24 mm
Distance N	8 mm
Diameter of the active area B	Ø 12 mm



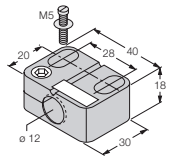
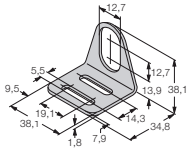
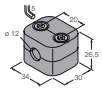
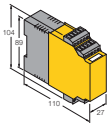
• Edition: • 10.06.2009

Hans Turck GmbH & Co.KG ● D-45472 Mülheim an der Ruhr ● Witzlebenstraße 7 ● Tel. 0208 4952-0 ● Fax 0208 4952-264 ● more@turck.com ● www.turck.com

Inductive sensor
with analogue output
NI5-M12-LiU-H1141

Industrial Automation

Accessories

Type code	Ident-No.	Short text	Dimension drawing
QM-12	6945101	quick-mount fixing clamp with dead-stop; material: chrome-plated brass male thread M16 x 1. Note: The switching distance of proximity switches can be reduced by the use of quick mounting brackets.	
BST-12B	6947212	fixing clamp with dead-stop; material: PA6	
MW-12	6945003	mounting bracket; material: stainless steel A2 1.4301 (AISI 304)	
BSS-12	6901321	fixing clamp; material: polypropylene	
IM43-13-SR	7540041	limit value monitor; single channel; input 0/4…20 mA or 0/2…10 V; supply of 2- or 3-wire transmitters/sensors; limit value adjustment via teach button; three relay outputs with one normally open contact each; removable terminal blocks; 27 mm wide; universal voltage supply 20…250 VUC; further limit value monitors are described in our "Interface Technology" catalogue.	

• Edition: • 10.06.2009

Annex 3
(Electrical wiring diagram)

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Wiesenstrasse 15
5400 Baden/Switzerland

Ph: +41 79 774 06 42
Ph: +41 79 774 06 44
info@tomtom-tools.com

Company / Customer

Project Description Mechanical Kiln Monitoring System (MKM)

Version V1.13

Created 23.07.2009

Executed 09.05.2011

Number of Pages 24

Table of Revision

DALOG_ F17_001

revision name	comment	reason of revison	page name	revision text	editor	date
V1.00	wiring diagramm generated					23.07.2009
V1.10	Sensors defined					14.08.2009
V1.11	Output current (4...20)mA					15.10.2009
V1.12	Name of output channels					30.04.2010
V1.13	Include colour organ					09.05.2011

			Date	09.05.2011				= DOC
			Editor	MB				+
			checked					page 2
Change	Date	Name			MKM	TOOLS	Table of Revision	page 24

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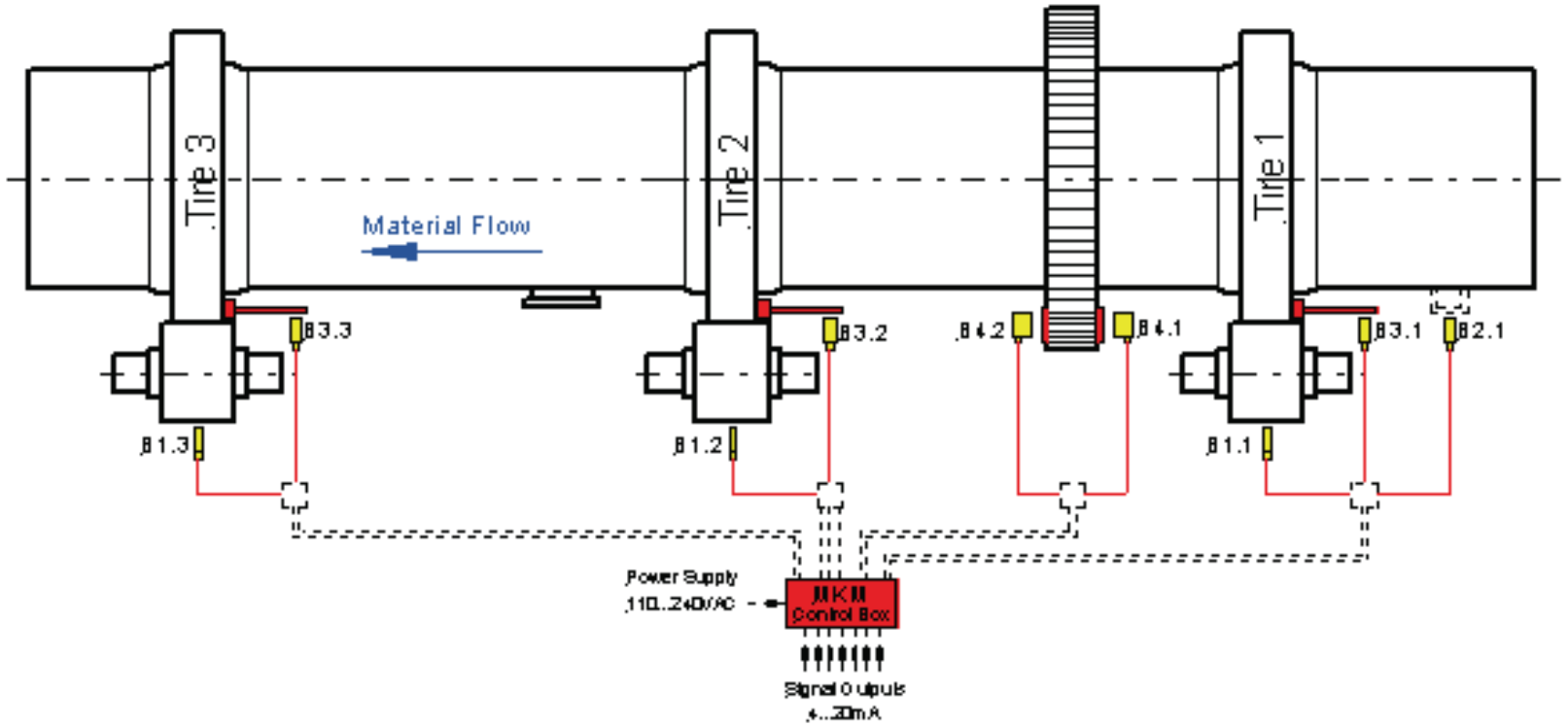
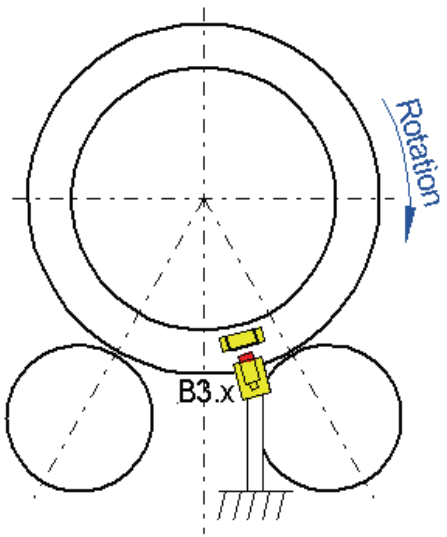
DALOG_F06_001





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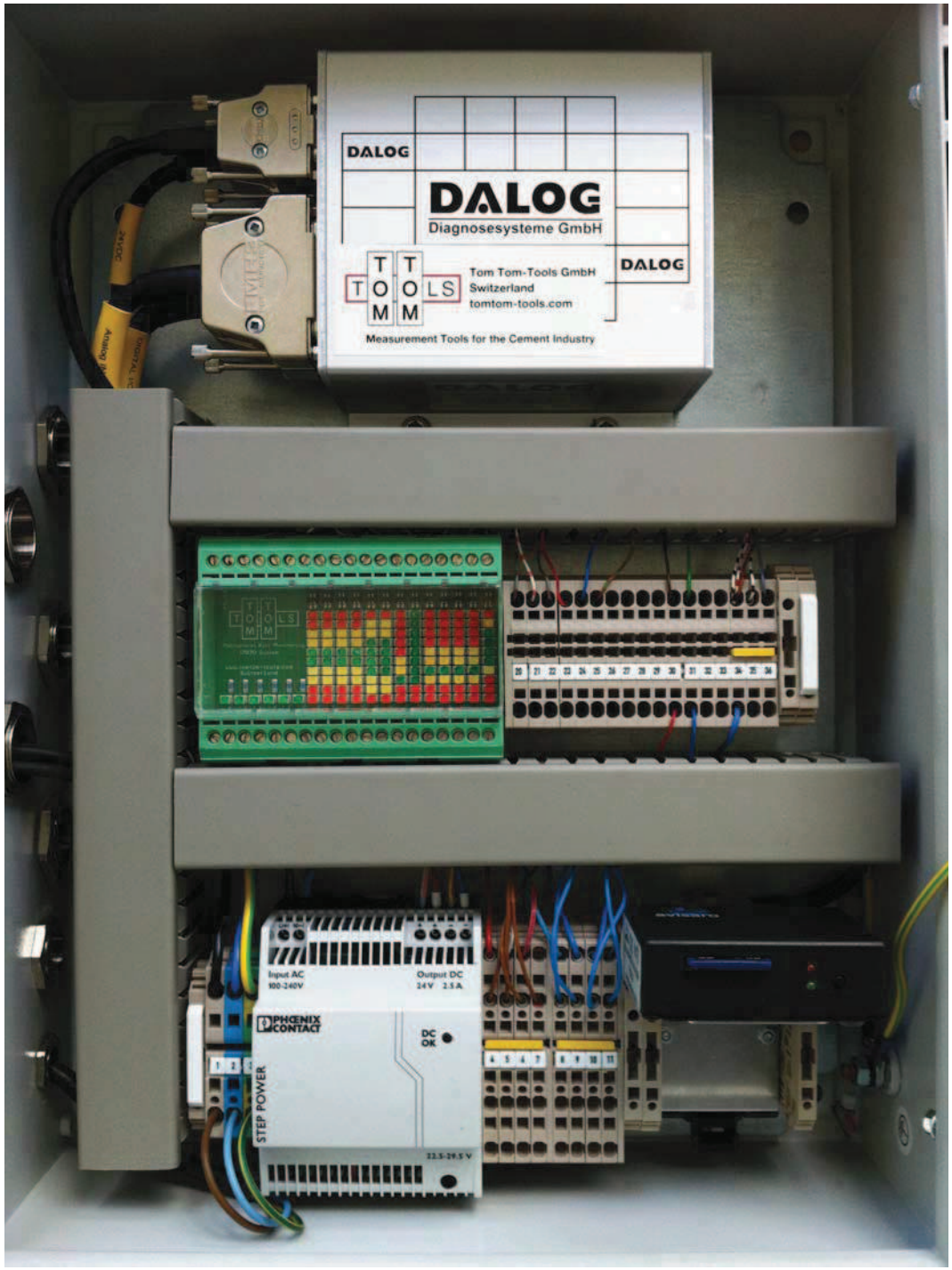
			Editor	MB				+ Control_Box
			checked					page 4
Change	Date	Name						page 24



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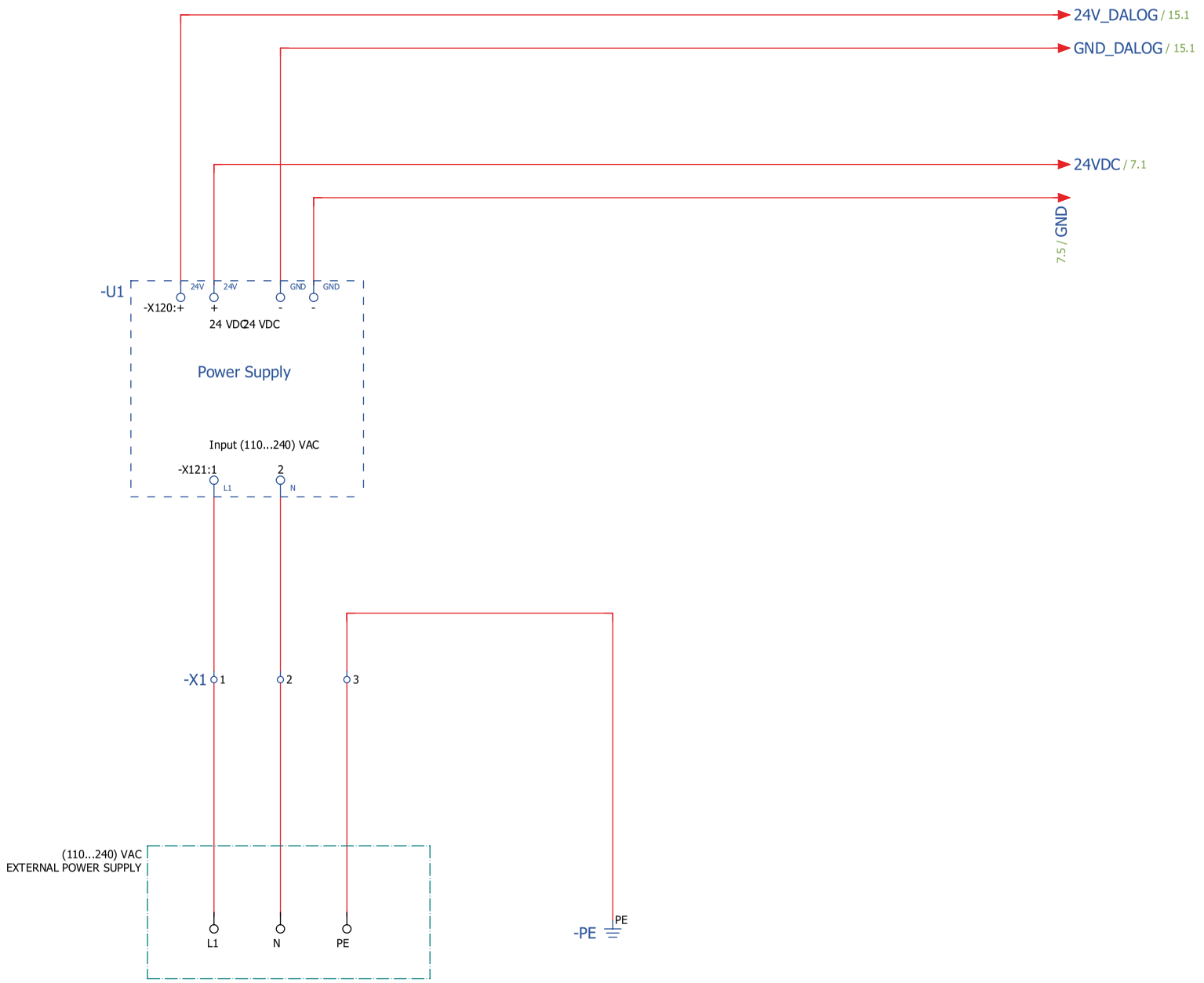
			checked					page 5
Change	Date	Name						page 24



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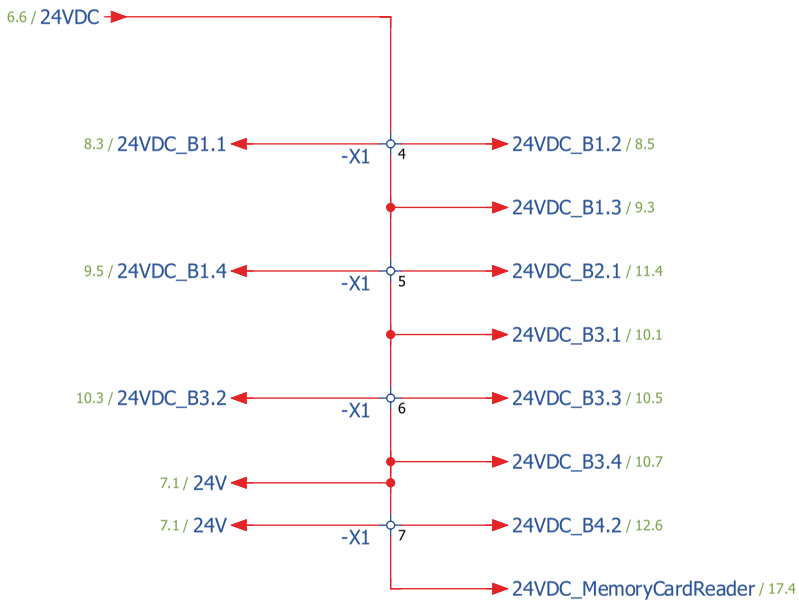
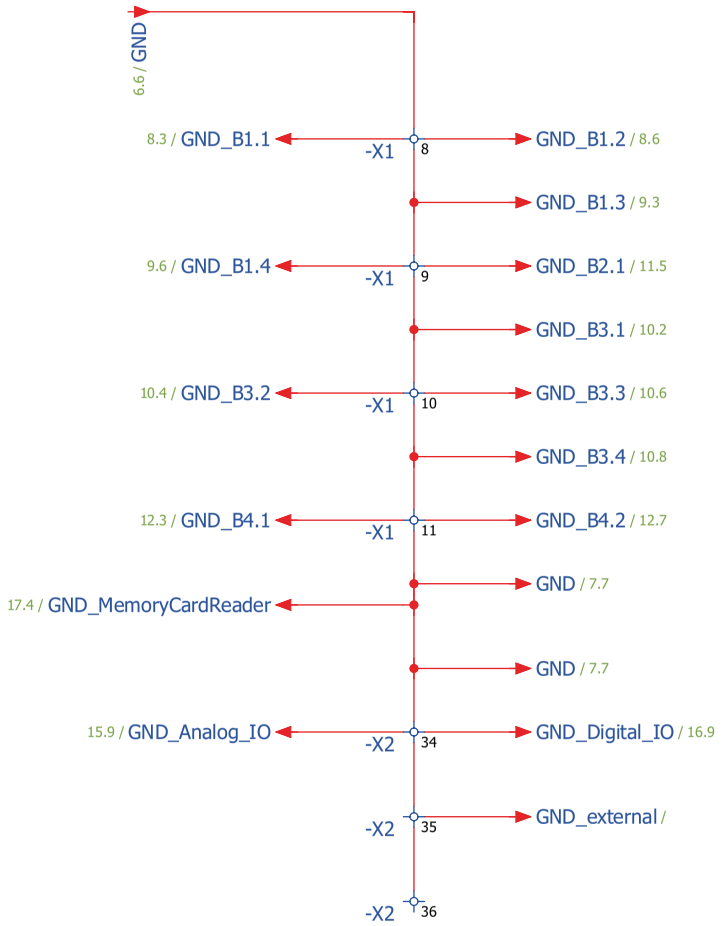
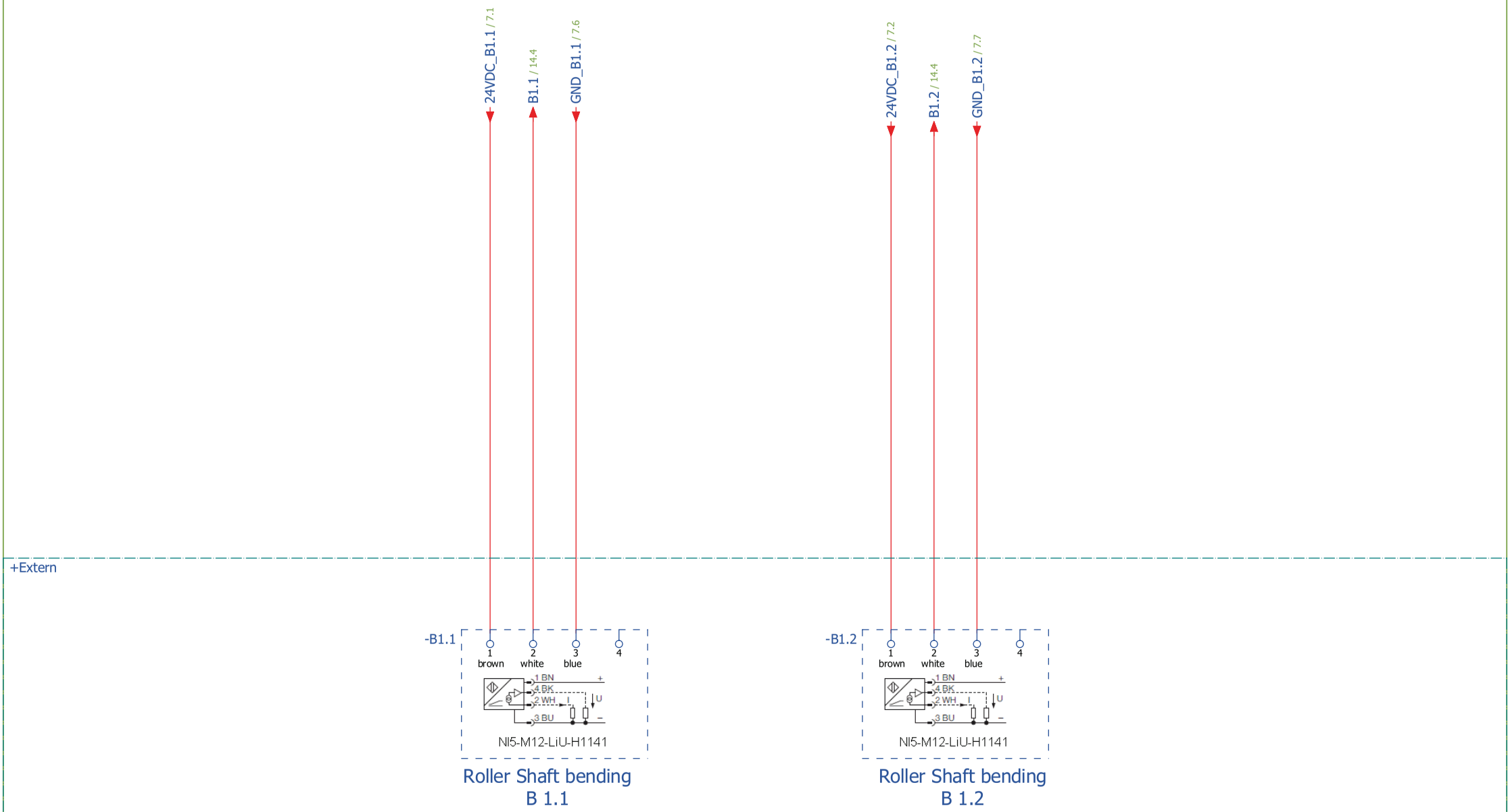
			checked					page 6
Change	Date	Name						page 24





			Date	09.05.2011	MKM			= MKM
			Editor	MB				+ Control_Box
			checked					page 7
Change	Date	Name						page 24

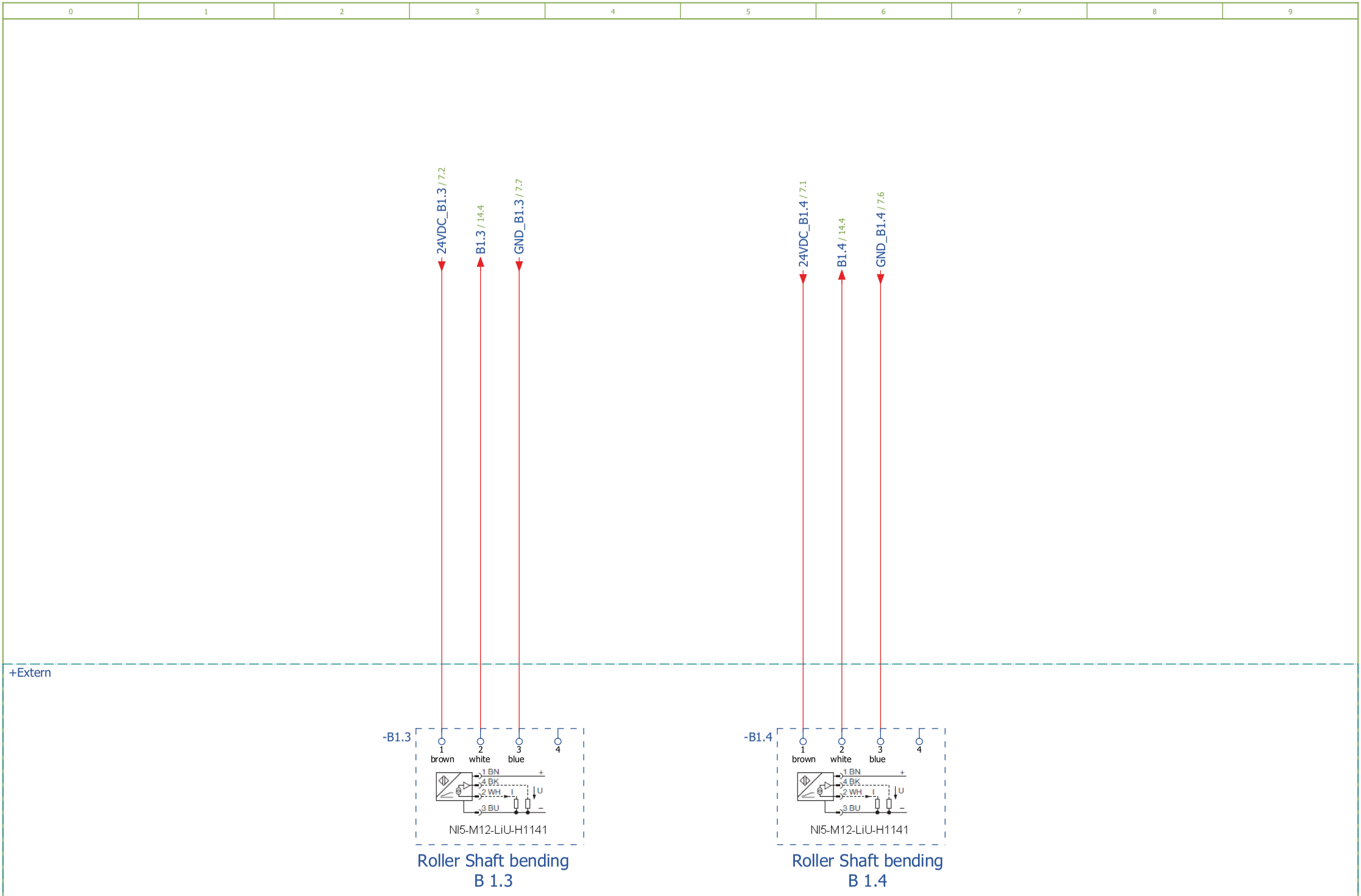


		Date	09.05.2011	
		Editor	MB	
		checked		
Change	Date	Name		

MKM

Roller Shaft bending B1.1 - B1.2

= MKM
+ Control_Box

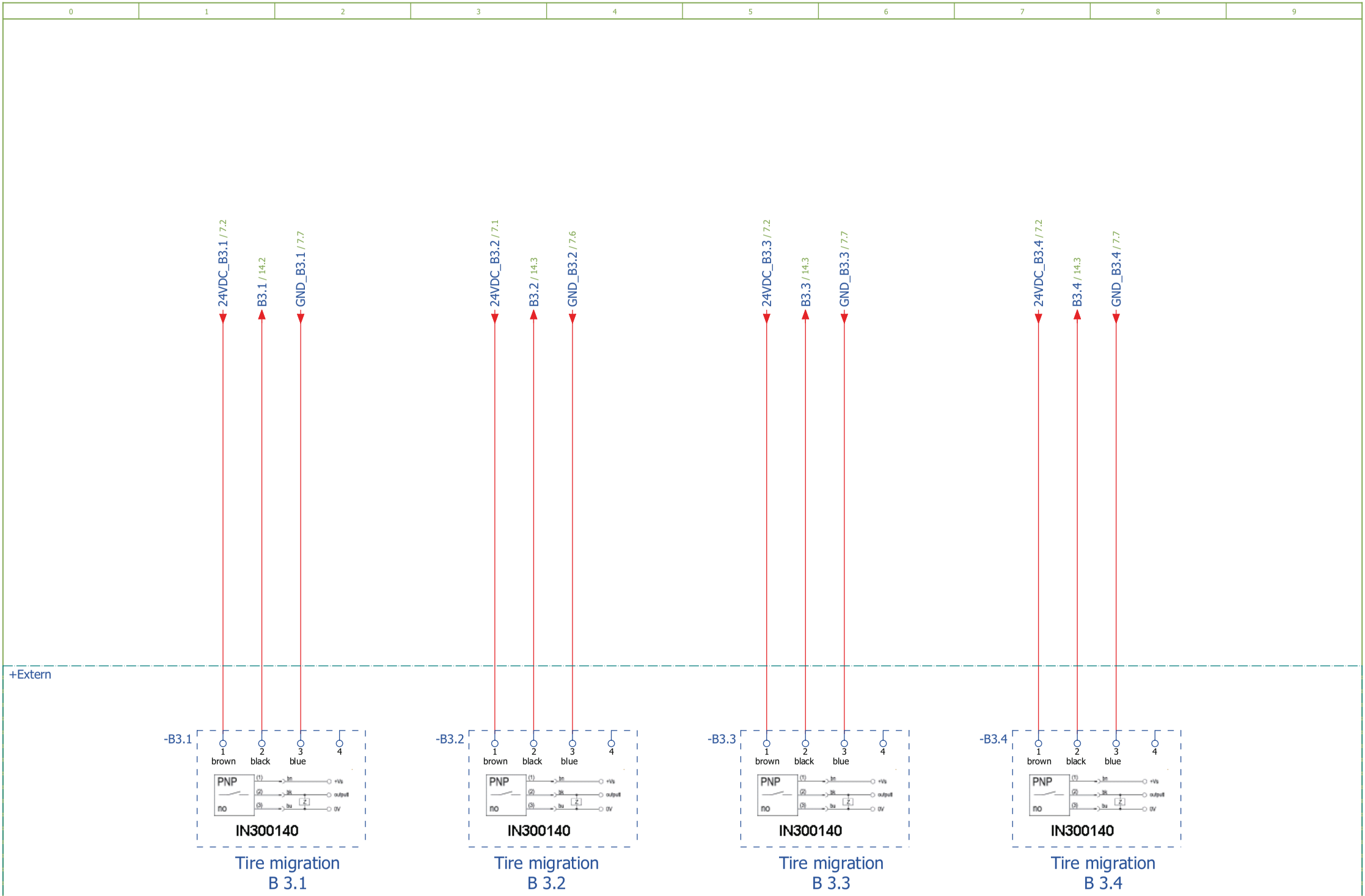


		Date	09.05.2011	
		Editor	MB	
		checked		
Change	Date	Name		

MKM

Roller Shaft bending B1.3 - B1.4

= MKM
+ Control_Box



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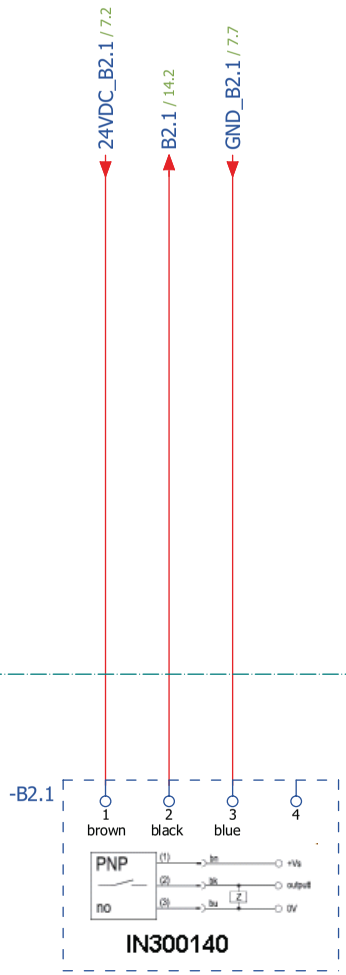
Change	Date	Name						page 24



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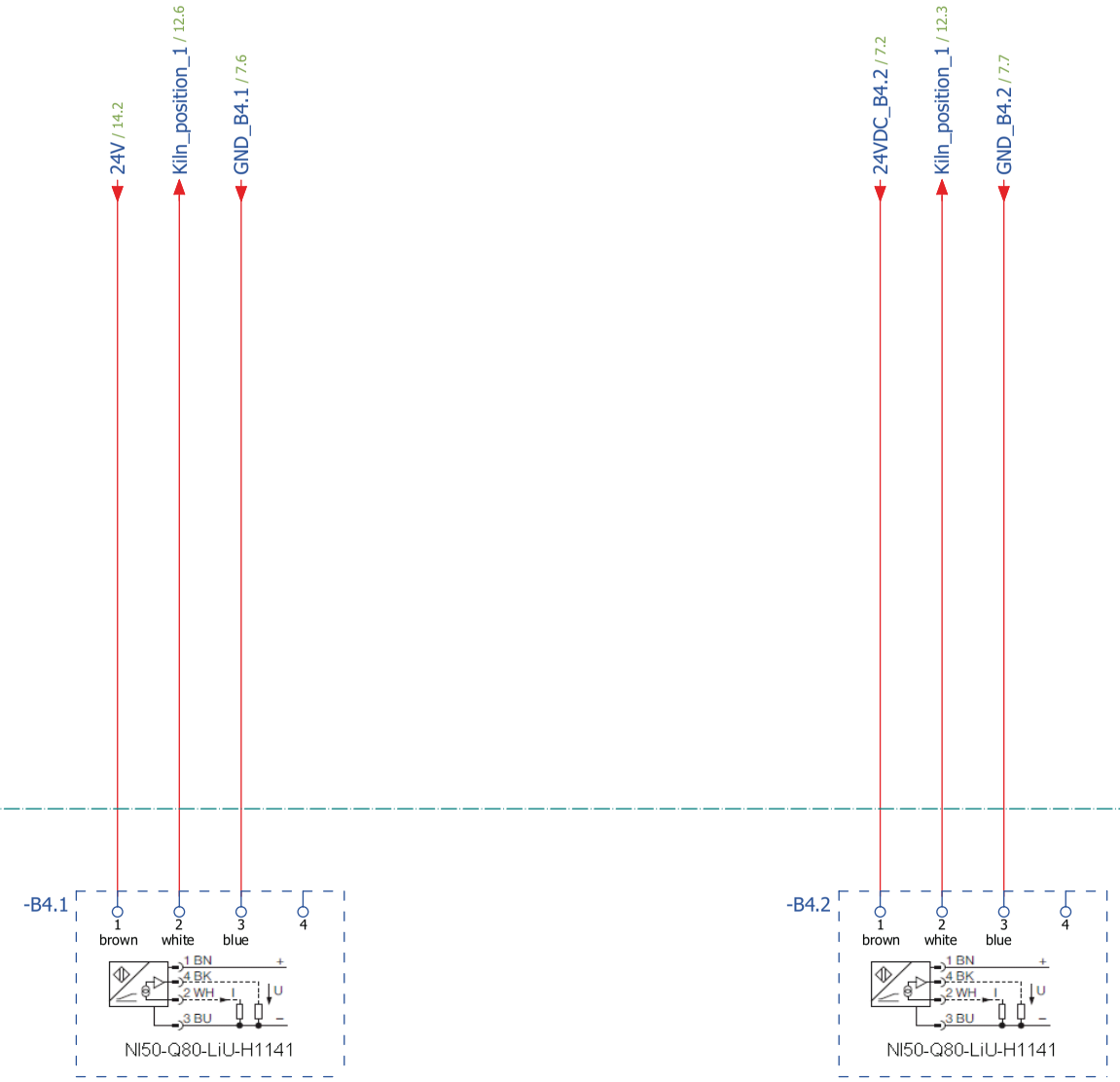
			checked					page 11
Change	Date	Name						page 24

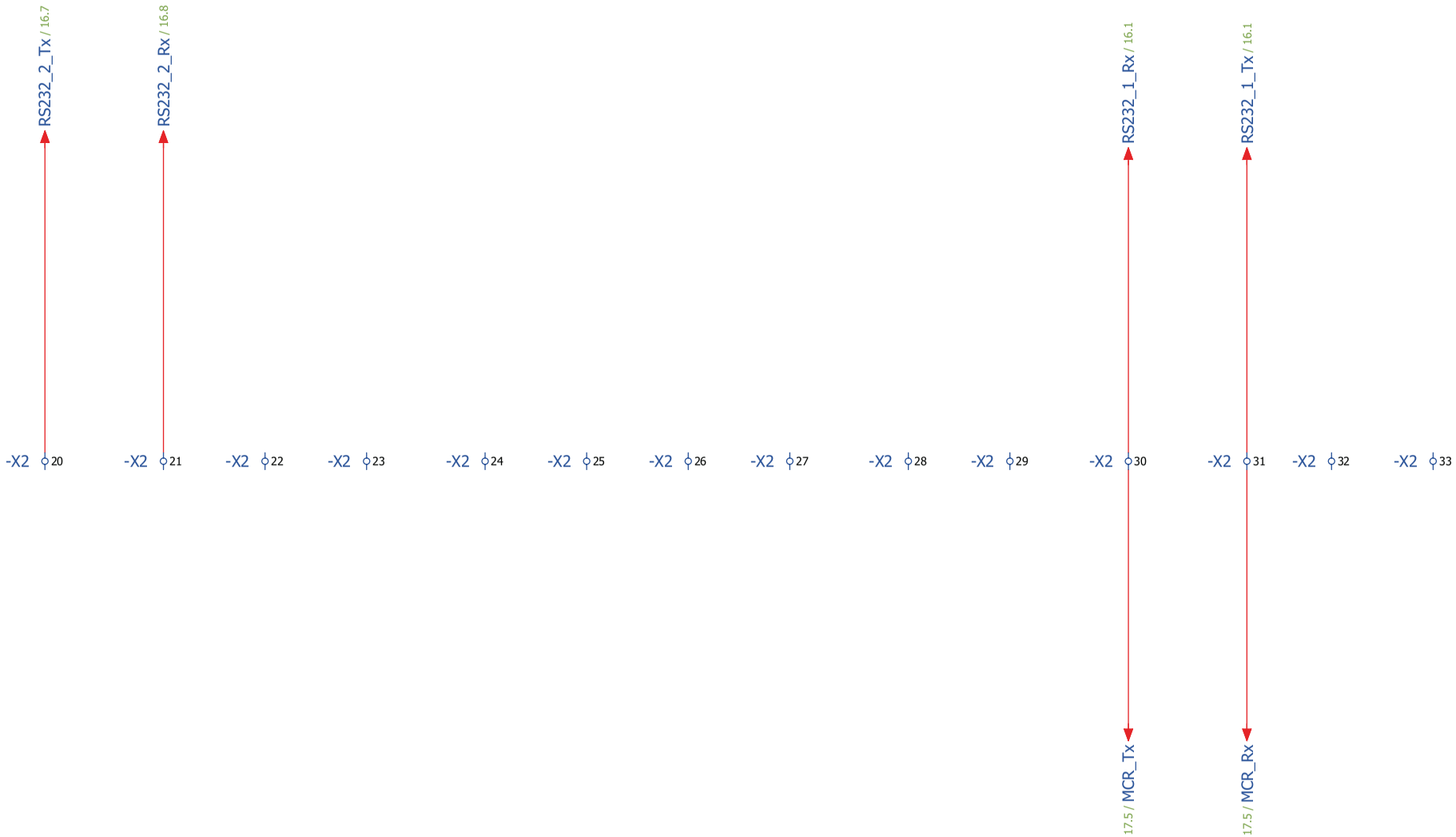
Speed B2 1



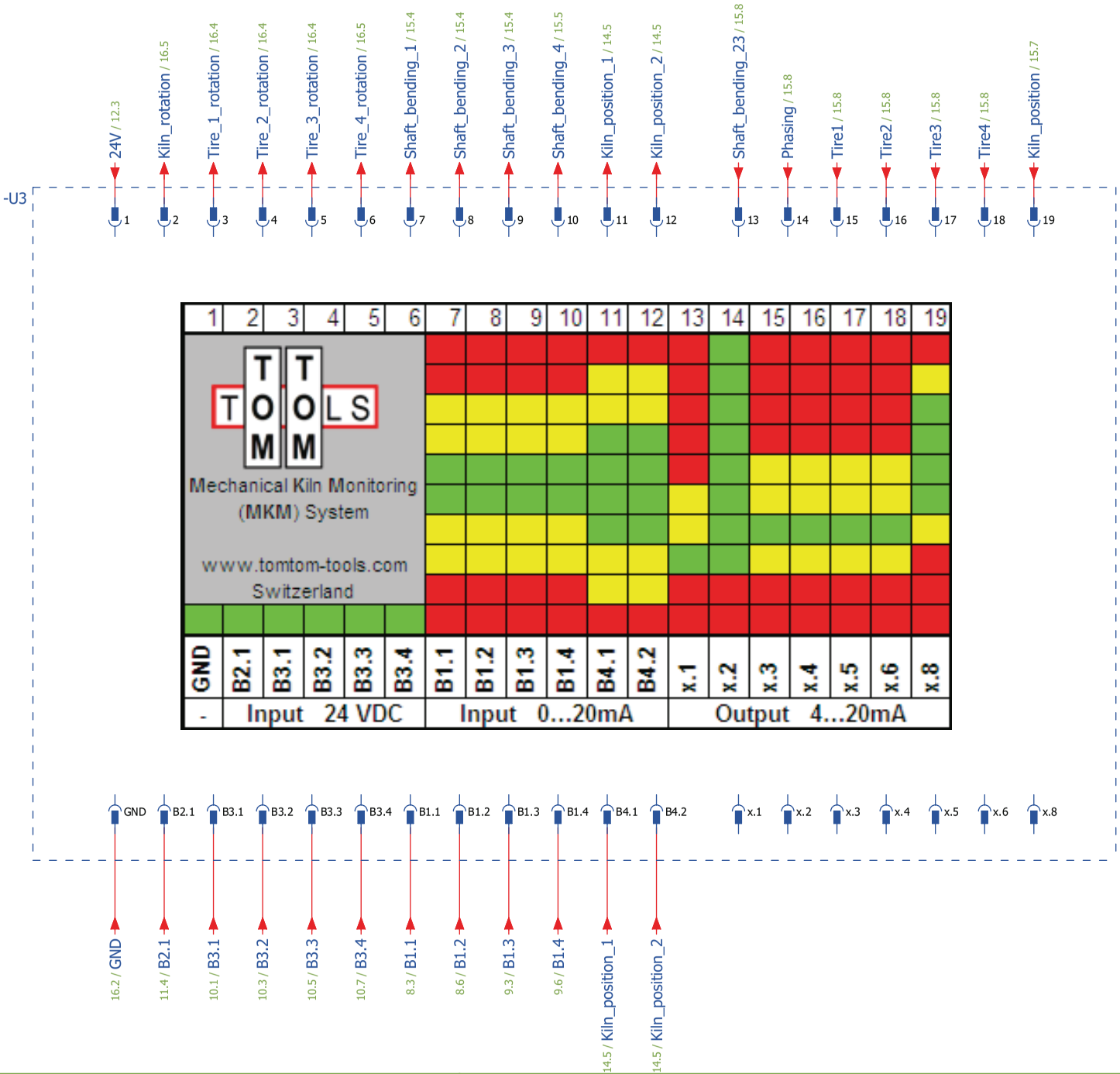
Kiln position
(uphill Sensor)
B 4.1

Kiln position
(downhill Sensor)
B 4.2

			Date	09.05.2011	MKM	Kiln position B4.1 - B4.2	= MKM
			Editor	MB			+ Control_Box
			checked				page 12
Change	Date	Name					page 24



			Date	09.05.2011	MKM	TOOLS	RS232-1/2	= MKM
			Editor	MB				+ Control_Box
			checked					page 13
Change	Date	Name						page 24



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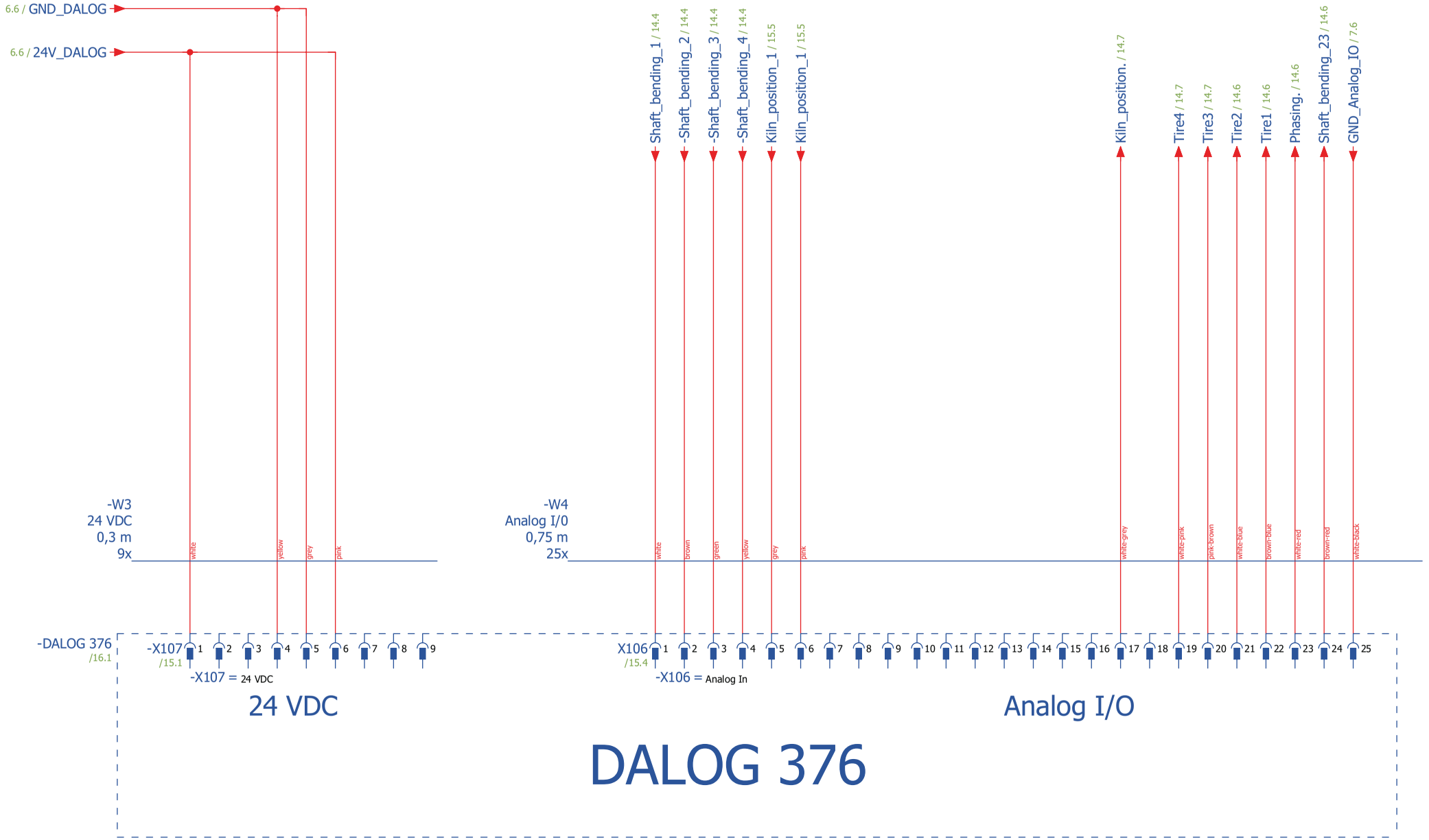
Change	Date	Name					page 24



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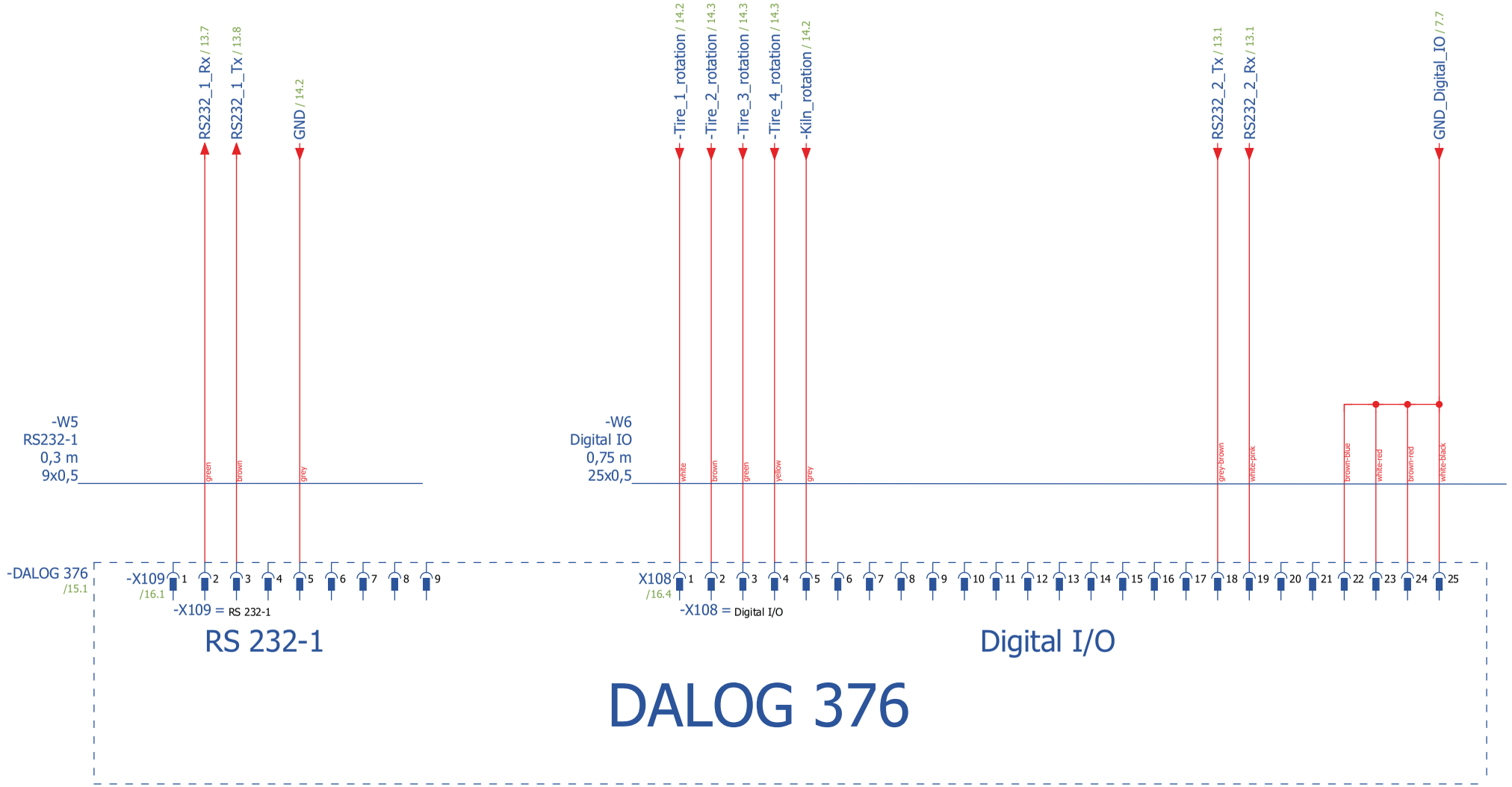
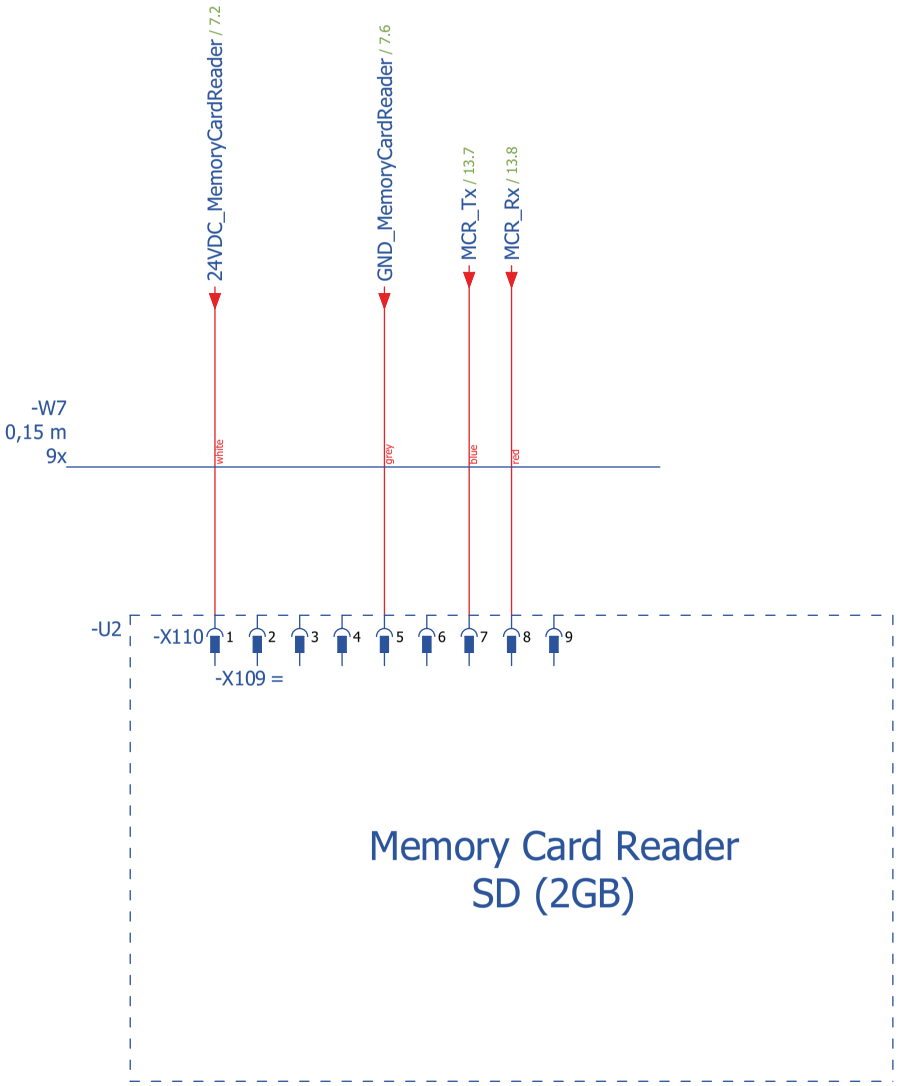
			checked					page 15
Change	Date	Name						page 24



			Date	09.05.2011	MKM	TOOLS	DALOG 376		= MKM
			Editor	MB					+ Control_Box
			checked						page 16
Change	Date	Name							page 24



			Date	09.05.2011	MKM	TOMM TOOLS	Memory Card Reader	= MKM
			Editor	MB				+ Control_Box
			checked					page 17
Change	Date	Name						page 24

Connection Plan

DALOG_F13_006

function text				-W7	cable name	stripe =MKM+Control_Box-X1						cable name				page / column
					cable type	aim description	connection	clamp	bridge	aim description	connection	cable type				
L1						L1		1		-U1-X121	1					/6.1
N						N		2		-U1-X121	2					/6.1
PE						PE		3		-PE	PE					/6.2
24 VDC						+Extern-B1.3	1	4		-U1-X120	+					/7.2
						+Extern-B1.1	1			+Extern-B1.2	1					
24 VDC						+Extern-B3.1	1	5		+Extern-B2.1	1					/7.2
						+Extern-B1.4	1									
24 VDC						+Extern-B3.4	1	6		+Extern-B3.3	1					/7.2
						+Extern-B3.2	1									
24 VDC				white		-U2-X110	1	7		+Extern-B4.2	1					/7.2
GND						+Extern-B1.3	3	8		-U1-X120	-					/7.6
						+Extern-B1.1	3			+Extern-B1.2	3					
GND						+Extern-B3.1	3	9		+Extern-B2.1	3					/7.6
						+Extern-B1.4	3									
GND						+Extern-B3.4	3	10		+Extern-B3.3	3					/7.6
						+Extern-B3.2	3									
GND						-X2	34	11		+Extern-B4.2	3					/7.6
				grey		-U2-X110	5									
						+Extern-B4.1	3									

			Date	09.05.2011	MKM	TOOLS	Klemmenplan =MKM+Control_Box-X1	= AN
			Editor	MB				+ ConnectionPlan
			checked					page 18
Change	Date	Name						page 24

Connection Plan

DALOG_F13_006

function text		-W4	-W5	-W6	cable name	stripe =MKM+Control_Box-X2						cable name	-W7	-W6		page / column
		Analog I/0	RS232-1	Digital IO	cable type	aim description	connection	clamp	bridge	aim description	connection	cable type		Digital IO		
RS 232-2 Tx				grey-brown		-DALOG376-X108	18	20								/13.1
RS 232-2 Rx				white-pink		-DALOG376-X108	19	21								/13.1
								22								/13.2
								23								/13.3
								24								/13.3
								25								/13.4
								26								/13.4
								27								/13.5
								28								/13.6
								29								/13.6
			green			-DALOG376-X109	2	30		-U2-X110	7		blue			/13.7
			brown			-DALOG376-X109	3	31		-U2-X110	8		red			/13.8
GND								32								/13.8
=								33								/13.9
=		white-black				-DALOG376-X106	25	34		-X1	11					/7.6
										-DALOG376-X108	25			white-black		
										-DALOG376-X108	22			brown-blue		
										-DALOG376-X108	23			white-red		
										-DALOG376-X108	24			brown-red		
GND								35								/7.6
=								36								/7.6

			Date	09.05.2011	MKM	TOOLS	Klemmenplan =MKM+Control_Box-X2	= AN
			Editor	MB				+ ConnectionPlan
			checked					page 19
Change	Date	Name						page 24

Cable Plan

DALOG_ F09_001

cable name			cable type		number of skinner	width	cable length		function text
=MKM+Control_Box-W3			24 VDC		9		0,3		
function text	QVW	aim from	connection	skinner	aim to	skinner	QVW	function text	
24 VDC	15	-DALOG376-X107	1	white	-U1-X120	+	6	24 VDC	
GND	15	-DALOG376-X107	4	yellow	-U1-X120	-	6	GND	
=	15	-DALOG376-X107	5	grey	-U1-X120	-	6	=	
24 VDC	15	-DALOG376-X107	6	pink	-U1-X120	+	6	24 VDC	

Cable Plan

DALOG_ F09_001

cable name			cable type		number of skinner		width	cable length		function text
=MKM+Control_Box-W4			Analog I/0		25			0,75		
function text	QVW	aim from	connection	skinner	aim to			skinner	QVW	function text
AI 1 (0...20)mA	15	-DALOG376-X106	1	white	-U3			7	14	Roller shaft bending 1
AI 2 (0...20)mA	15	-DALOG376-X106	2	brown	-U3			8	14	Roller shaft bending 2
AI 3 (0...20)mA	15	-DALOG376-X106	3	green	-U3			9	14	Roller shaft bending 3
AI 4 (0...20)mA	15	-DALOG376-X106	4	yellow	-U3			10	14	Roller shaft bending 4
AI 5 (0...20)mA	15	-DALOG376-X106	5	grey	-DALOG376-X106			6	15	AI 6 (0...20)mA
AO 1 (4...20)mA	15	-DALOG376-X106	17	white-grey	-U3			19	14	axial Kiln position
AO 3 (4...20)mA	15	-DALOG376-X106	19	white-pink	-U3			18	14	relative movement Tire 4
AO 4 (4...20)mA	15	-DALOG376-X106	20	pink-brown	-U3			17	14	relative movement Tire 3
AO 5 (4...20)mA	15	-DALOG376-X106	21	white-blue	-U3			16	14	relative movement Tire 2
AO 6 (4...20)mA	15	-DALOG376-X106	22	brown-blue	-U3			15	14	rel. Tire 1 movement
AO 7 (4...20)mA	15	-DALOG376-X106	23	white-red	-U3			14	14	Shaft Bending Phasing
AO 8 (4...20)mA	15	-DALOG376-X106	24	brown-red	-U3			13	14	Shaft Bending Output
GND	15	-DALOG376-X106	25	white-black	-X2			34	7	GND

Cable Plan

DALOG_ F09_001

cable name			cable type		number of skinner	width	cable length		function text
=MKM+Control_Box-W5			RS232-1		9	0,5	0,3		
function text	QVW	aim from	connection	skinner	aim to	skinner	QVW	function text	
Rx	16	-DALOG376-X109	2	green	-X2	30	13		
Tx	16	-DALOG376-X109	3	brown	-X2	31	13		
GND	16	-DALOG376-X109	5	grey	-U3	GND	14	GND	

Cable Plan

DALOG_ F09_001

cable name			cable type		number of skinner		width	cable length		function text
=MKM+Control_Box-W6			Digital IO		25		0,5	0,75		
function text	QVW	aim from	connection	skinner	aim to			skinner	QVW	function text
DI 1	16	-DALOG376-X108	1	white	-U3			3	14	Tire 1 rotation
DI 2	16	-DALOG376-X108	2	brown	-U3			4	14	Tire 2 rotation
DI 3	16	-DALOG376-X108	3	green	-U3			5	14	Tire 3 rotation
DI 4	16	-DALOG376-X108	4	yellow	-U3			6	14	Tire 4 rotation
DI 5	16	-DALOG376-X108	5	grey	-U3			2	14	Kiln rotation
RS 232-2 Tx	16	-DALOG376-X108	18	grey-brown	-X2			20	13	RS 232-2 Tx
RS 232-2 Rx	16	-DALOG376-X108	19	white-pink	-X2			21	13	RS 232-2 Rx
GND	16	-DALOG376-X108	22	brown-blue	-X2			34	7	GND
=	16	-DALOG376-X108	23	white-red	-X2			34	7	=
=	16	-DALOG376-X108	24	brown-red	-X2			34	7	=
=	16	-DALOG376-X108	25	white-black	-X2			34	7	=

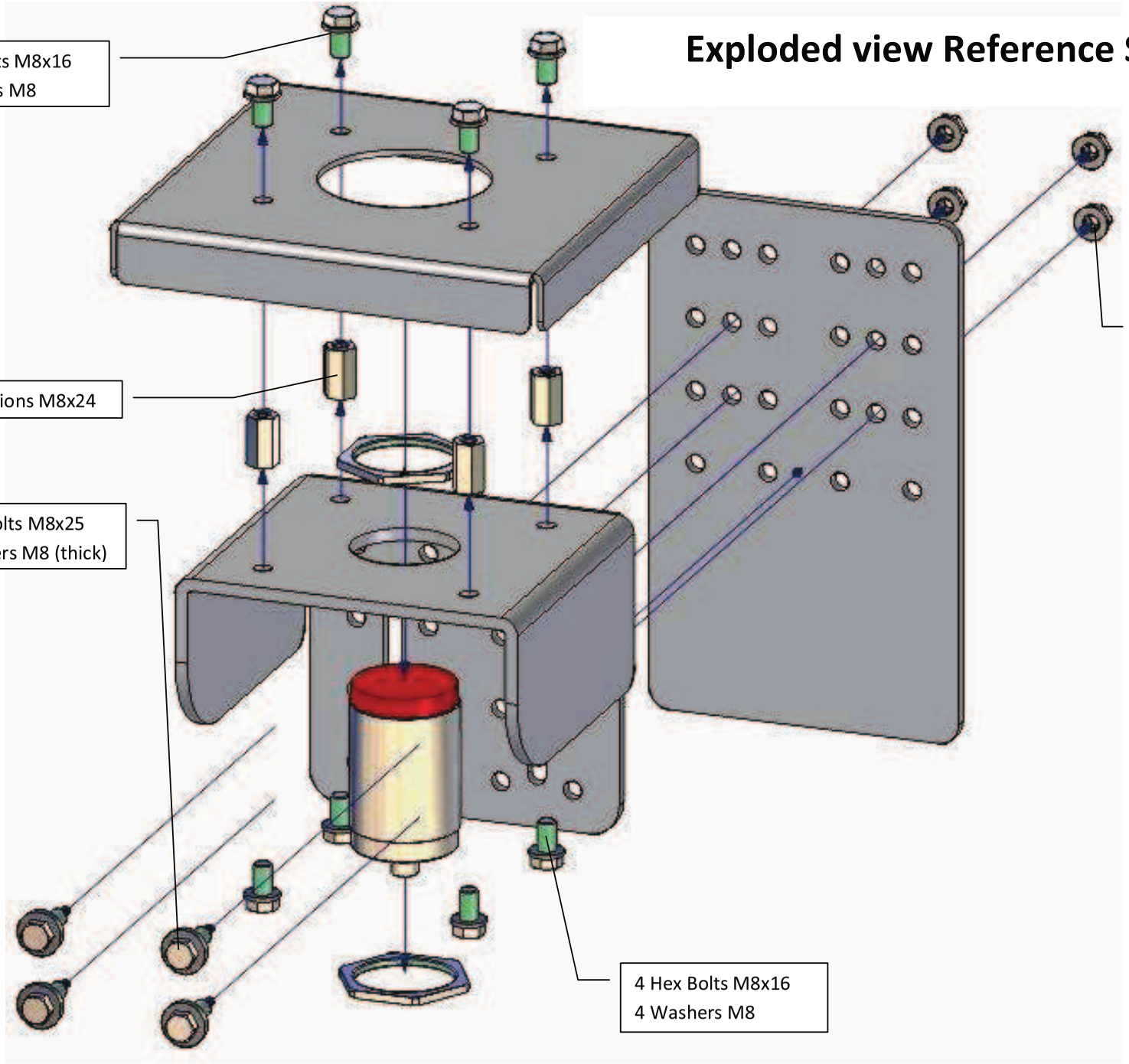
Cable Plan

DALOG_ F09_001

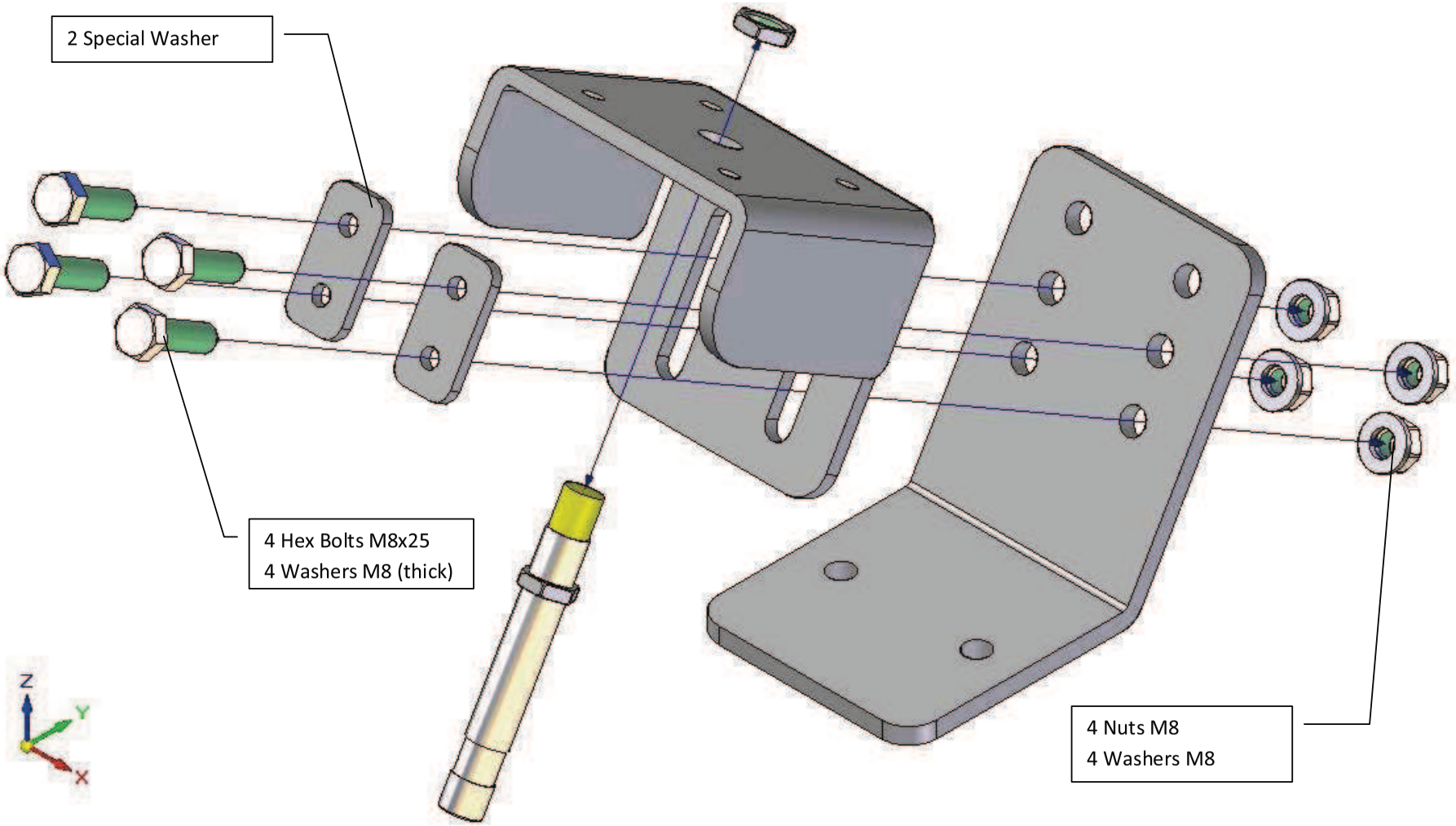
cable name =MKM+Control_Box-W7			number of skinner 9		width	cable length 0,15		function text
function text	QVW	aim from	connection	skinner	aim to	skinner	QVW	function text
24 VDC	17	-U2-X110	1	white	-X1	7	7	24 VDC
GND	17	-U2-X110	5	grey	-X1	11	7	GND
Tx	17	-U2-X110	7	blue	-X2	30	13	
Rx	17	-U2-X110	8	red	-X2	31	13	

Annex 4
(Sensor mounting)

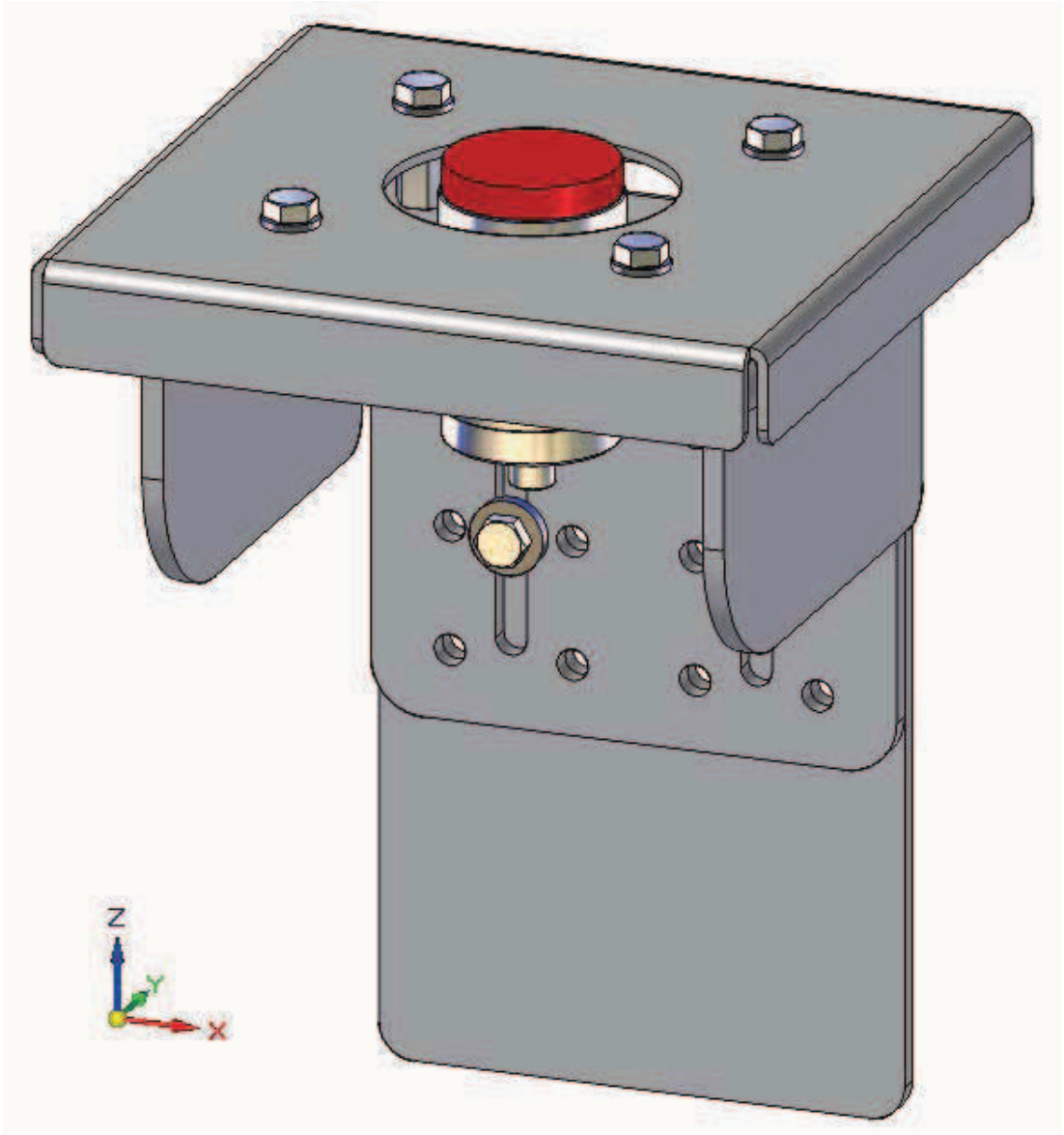
Exploded view Reference Sensor



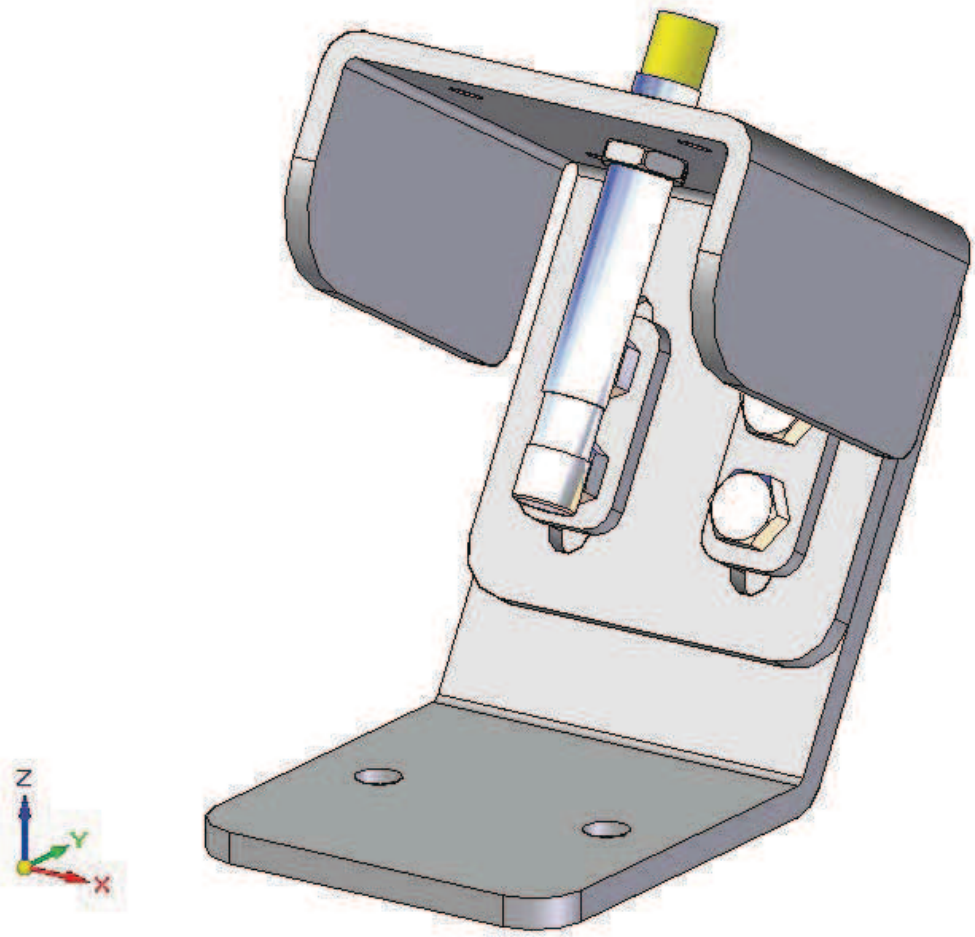
Exploded view Roller shaft bending Sensor



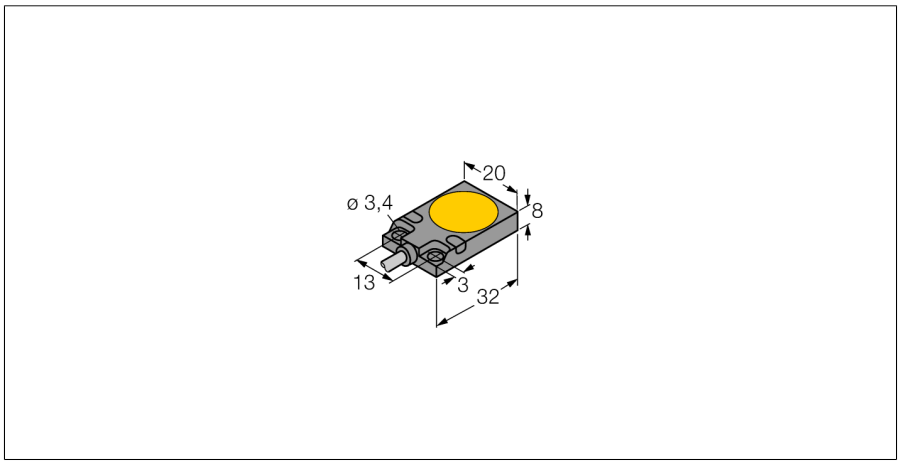
Reference / Tire migration Sensor assembled



Roller shaft Sensor assembled

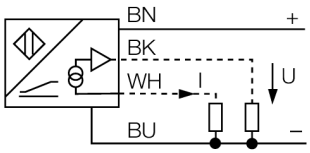


Inductive sensor
With analog output
BI7-Q08-LIU



- **Rectangular, height 8 mm**
- **Active face on top**
- **Metall, zinc die casting**
- **4-wire, 15…30 VDC**
- **Analog output**
- **0…10 V and 0…20 mA**
- **Cable connection**

Wiring diagram



Type code	BI7-Q08-LIU
Ident no.	1534605

Measuring range [A…B]	1…4mm
Mounting condition	flush
Repeatability	≤ 1 % of measuring range |A - B|
	≤ 0.5 %, after warm-up 0.5 h
Reproducibility	≤ 30 µm
	≤ 15 µm, after a warm-up time of 0.5 h
Linearity deviation	≤ 5 %
Temperature drift	≤ ± 0.06 % / K
Ambient temperature	-25…+70 °C

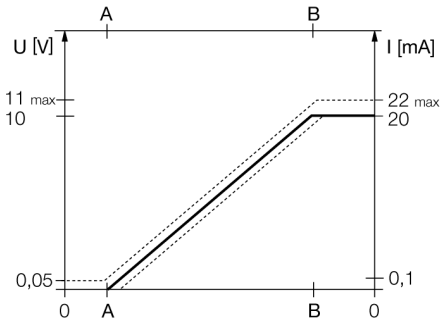
Operating voltage	15…30VDC
Residual ripple	≤ 10 % U_{ss}
No-load current I_0	≤ 8 mA
Rated insulation voltage	≤ 0.5 kV
Short-circuit protection	yes
Wire breakage / Reverse polarity protection	yes/ complete
Output function	4-wire, analog output
Voltage output	0…10VDC
Current output	0…20mA
Load resistance voltage output	≥ 4.7 kΩ
Load resistance, current output	≤ 0.4 kΩ
Measuring sequence frequency	200 Hz

Construction	rectangular, Q08
Dimensions	32 x 20 x 8 mm
Housing material	metal, GD-Zn
Connection	cable
Cable quality	4 mm, LifY-11Y, PUR, 2m
Cable cross section	4 x 0.25 mm^2
Vibration resistance	55 Hz (1 mm)
Shock resistance	30 g (11 ms)
Protection class	IP67
MTTF	751 years acc. to SN 29500 (Ed. 99) 40 °C

Functional principle

Inductive TURCK sensors with analog output accomplish simple control tasks. They provide a current, voltage or frequency signal proportional to the target's distance. The output signal is linear to the distance of the target over the entire sensing range.

Measuring range



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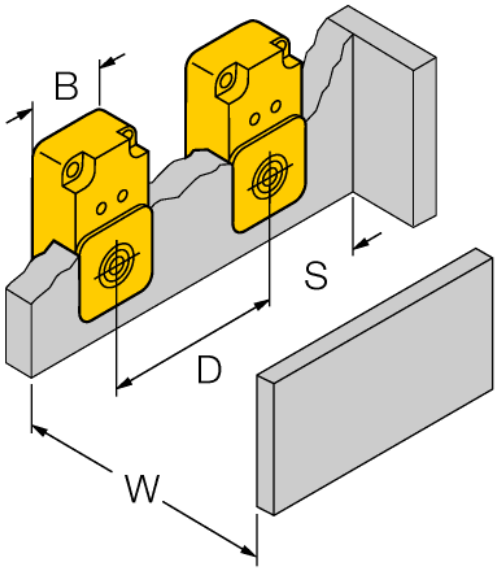
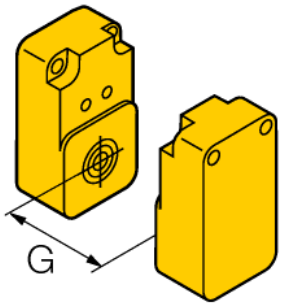
Inductive sensor
With analog output
BI7-Q08-LIU

Distance W	12 mm
Distance S	1.5 x B
Distance G	6 x Sn
Width of the active face B	20 mm





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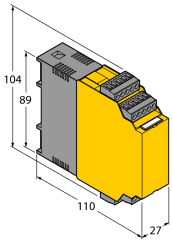
Hans Turck GmbH & Co.KG ● D-45472 Mülheim an der Ruhr ● Witzlebenstraße 7 ● Tel. 0208 4952-0 ● Fax 0208 4952-264 ● more@turck.com ● www.turck.com

Accessories

Type code	Ident no.	Description	Design
IM43-13-SR	7540041	Trip amplifier; 1-channel; input 0/4…20 mA or 0/2…10 V; supply of 2- or 3-wire transmitters/sensors; limit value adjustment via teach button; three relay outputs with one NO contact each; removable terminal blocks; 27 mm wide; universal voltage supply 20…250 VUC; further Limit value indicators are described in our "Interface Technology" catalog.	

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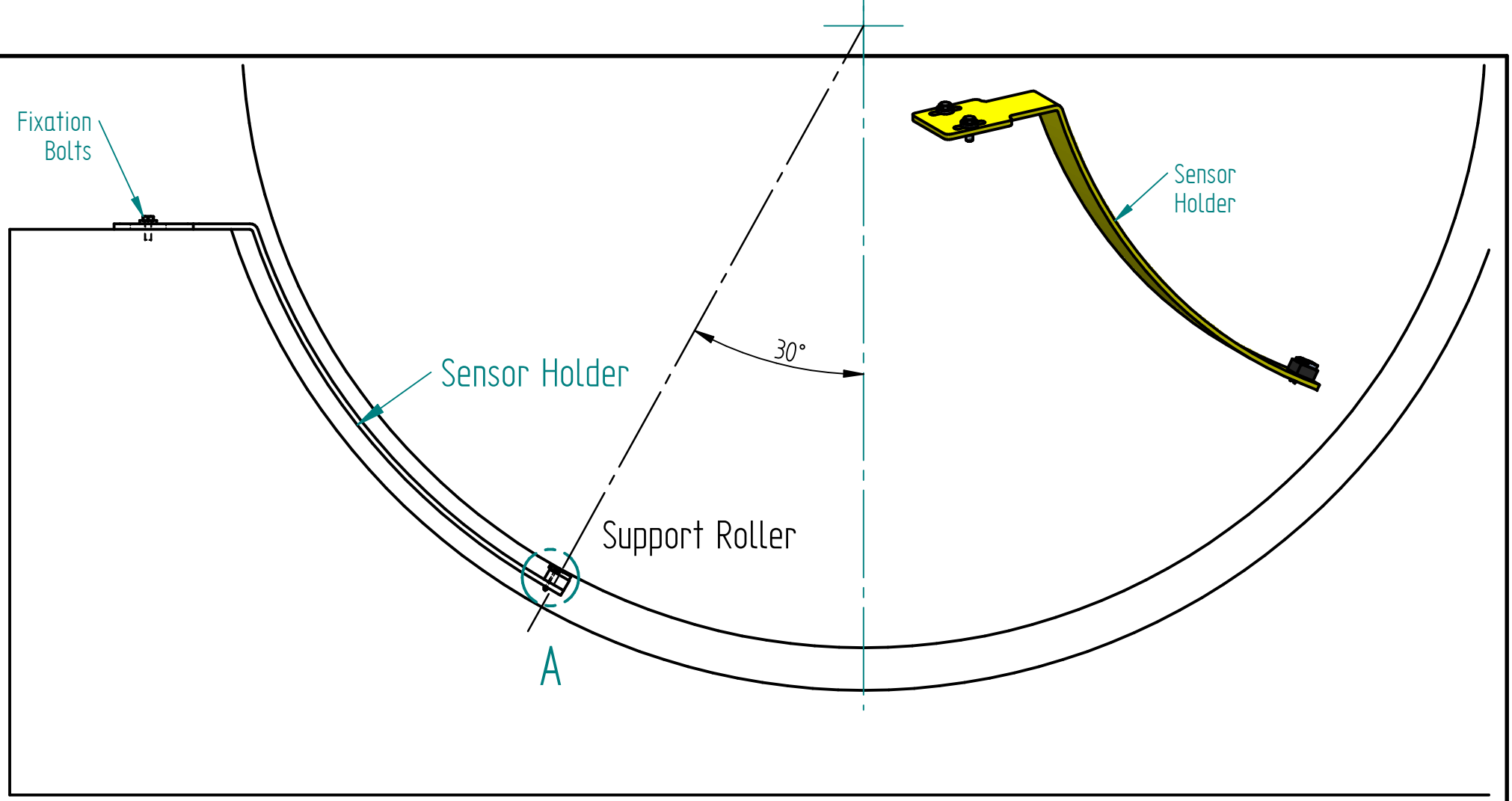
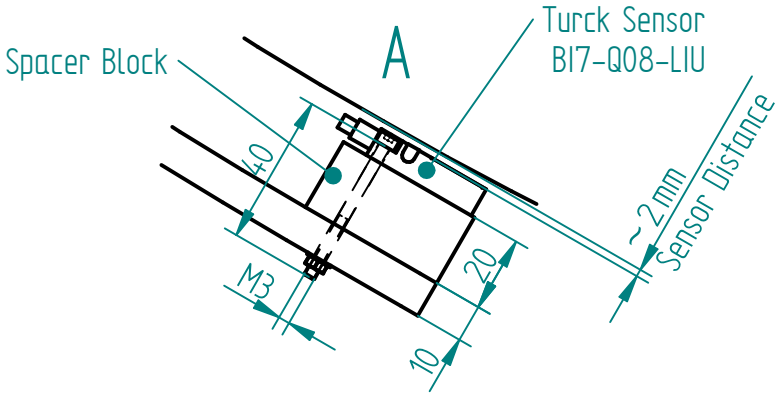
 Hans Turck GmbH & Co.KG ● D-45472 Mülheim an der Ruhr ● Witzlebenstraße 7 ● Tel. 0208 4952-0 ● Fax 0208 4952-264 ● more@turck.com ● www.turck.com





	NAME	DATE
DRAWN	ABC	07/05/15

TomTom-Tools GmbH
Zelgli 20
8905 Arni / Switzerland
www.tomtom-tools.com

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS ± 0.1 mm ANGLES ± 0.1°
TYPICAL EDGE CHAMFER 0.3x45°

Sensor Holder

TITLE
For KHD Support Rollers

SIZE	DWG NO	REV
A4		

FILE NAME: Sensor Holder KHD.dft

SCALE:	WEIGHT:	SHEET 1 OF 1