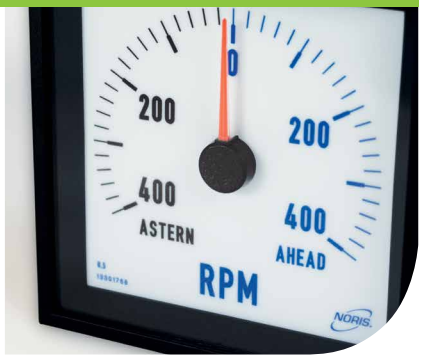
NORIS AUTOMATION



Speed measurement systems –
Solutions for reversing and non-reversing drives

Contents

Overview of frequency measurement methods

Speed measurement systems based on the frequency measurement method

Speed measurement systems evaluate signals in which the frequency is proportional to the speed. These signals can either be generated by mechanically driven speed pickups or by contactless speed sensors. They are evaluated by limit value switches, measuring transducers or multifunctional devices that can be connected to other systems. The visualisation systems take the form of analogue indicators.

Possible applications of the various frequency measurement methods

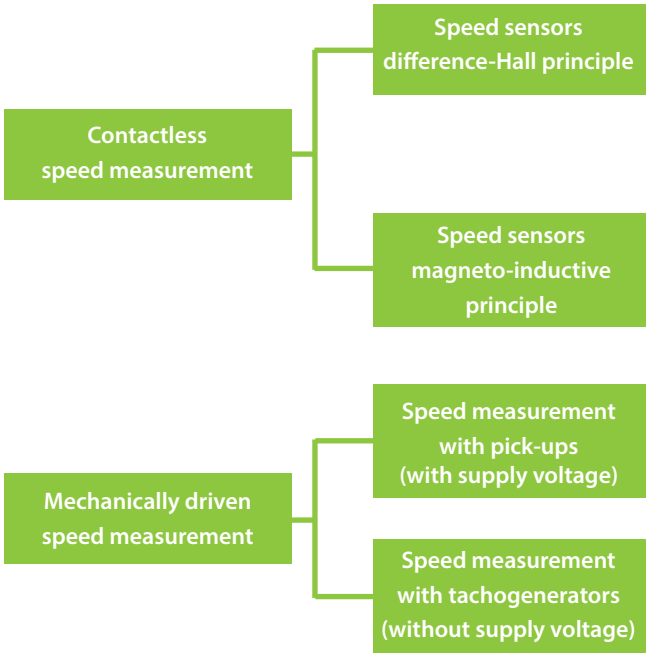
Mechanically driven speed pickups can be directly flange-mounted on the end face of a rotating shaft using an adapter. Alternatively, they can be connected mechanically to a shaft or a flywheel by means of a friction wheel. Contactless speed sensors are capable of sensing moving ferromagnetic bodies that have a suitable surface structure. These could take the form of gearwheels with various tooth shapes, screw heads, drill holes, apertures, grooves or even pulse bands mounted on smooth shafts (see page 29).

Speed measurement and rotational direction detection

If you just want to measure the speed, it is sufficient to use speed pickups with one channel. However, if you want to implement an additional function for detecting the rotational direction, you have to have two output signals with a phase offset of 90°. This can be achieved either by using two single-channel speed pickups/speed sensors (which must be positioned precisely in relation to one another) or by using one two-channel speed pickup/speed sensor instead.

If mechanically driven two-channel speed pickups are used, there is already a phase offset of exactly 90° between the two output signals. Depending on their type, contactless two-channel speed sensors are either permanently pre-set at the factory for the relevant ferromagnetic material measure or they can be adjusted during installation by rotating the sensor until a 90° phase offset is achieved. The direction of rotation can be evaluated with an analogue indicator featuring integrated rotational direction detection, a multifunctional device or an enclosed speed measurement system (see page 21).

An overview of the various frequency measurement methods



Characteristics of the difference-Hall principle

- Sensors available with a multi-channel design
- Also suitable for very low speeds (< 5 Hz)
- Immune to radial vibrations
- Direction-specific installation

Characteristics of the magneto-inductive principle

- Straightforward and user-friendly mounting (installation is not direction-specific)
- Only 1-channel sensors available
- Restrictions apply at very low speeds

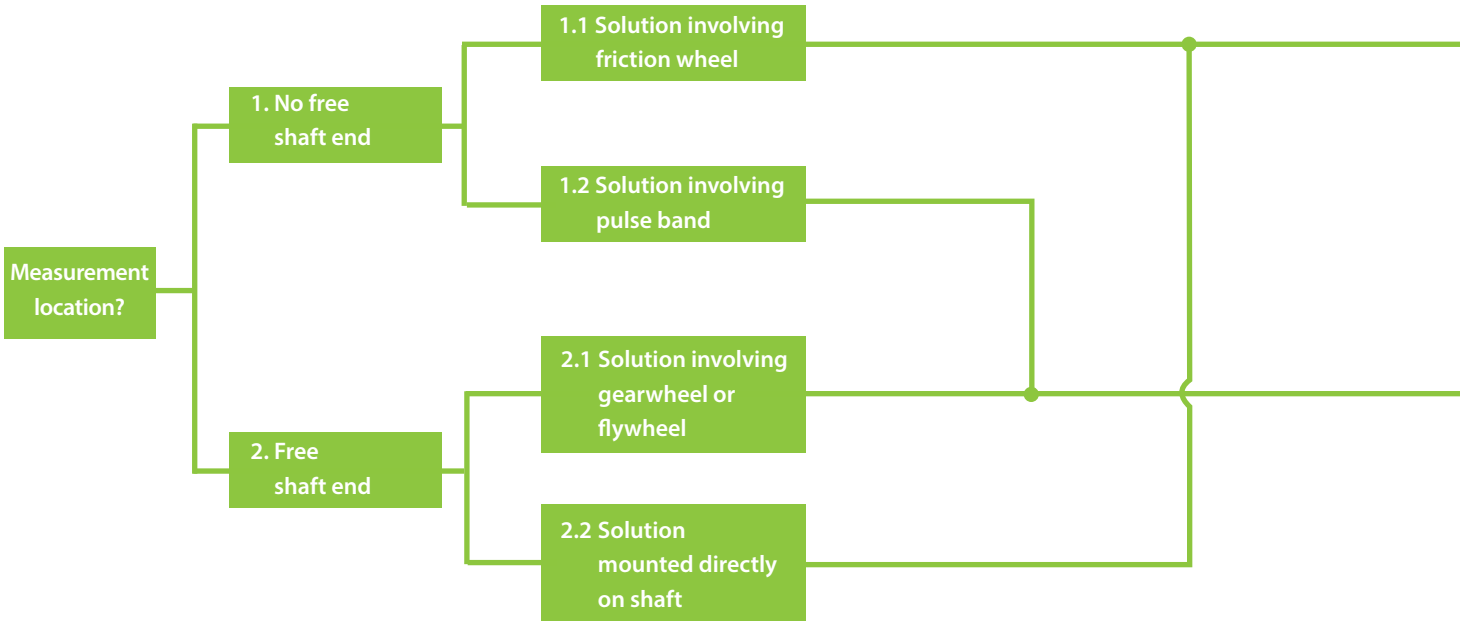
Characteristics of mechanically driven speed pickups

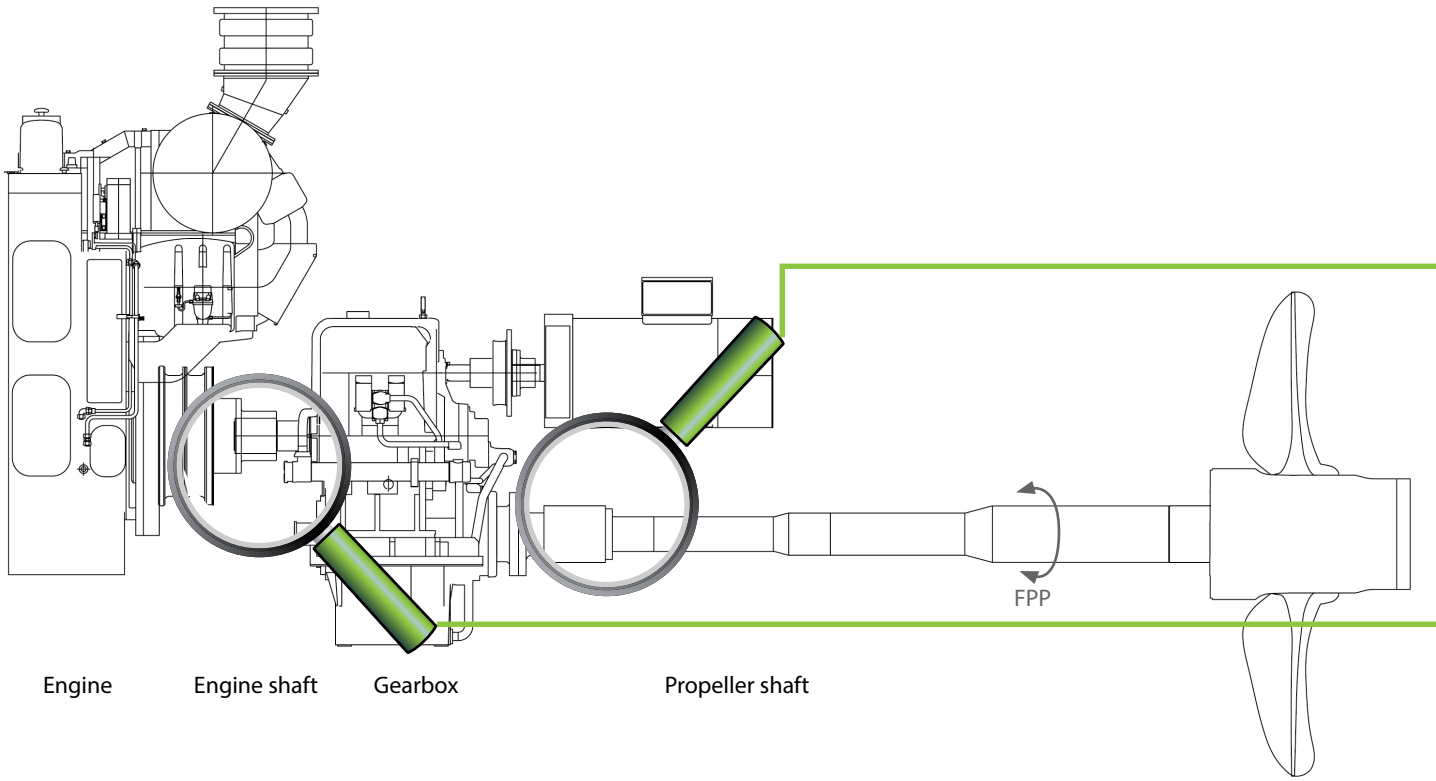
- Suitable for very low speeds
- Can be mounted directly instead of using a flexible shaft
- No supply voltage required if tachogenerators are used

Overview – Solutions for reversing drives

Overview

We can devise complete speed measurement systems for your drive (e.g. for reversing gearbox systems or reversing 2-stroke engines) – from signal acquisition and processing right through to display and evaluation. Various acquisition approaches are possible, depending on how the sensors are mounted. Another crucial factor for the acquisition approach is whether there is a free shaft end available or whether a flywheel or gearwheel can be used for the purpose of measuring the speed. The various approaches are illustrated by the examples in the following overview. The examples are then described on subsequent pages. In the case of reversing drives (anticlockwise/clockwise rotation), a function is required to detect the rotational direction of the shaft.





Solution A — Option I: Option II:

NADS3 NIx3-...-FD1 VF5 RF5

- Speed measurement with mechanically driven speed pickup, type NADS3
- NORIMETER 3 analogue indicator featuring integrated rotational direction detection, type NIx3-...-FD1
- **Option I:** One or more measuring transducers, type VF5, for additional analogue measuring signals
- **Option II:** One or more limit value switches, type RF5, for additional switching points
- **For further details, see page 8, solution A**

Solution B

NADS3 FMN6 NIx3-...-Ux/Ix

- Speed measurement with mechanically driven speed pickup, type NADS3
- NORISPEED multifunctional device, type FMN6, for rotational direction detection and speed monitoring, with extra outputs plus slip and offset measurement
- NORIMETER 3 analogue indicator, type NIx3-...-Ux/Ix
- **For further details, see page 9, solution B**

Solution C — Option I: Option II:

FAHZ11 NIx3-...-FD1 VF5 RF5

- Contactless sensing with 2-channel speed sensor, type FAHZ11
- NORIMETER 3 analogue indicator featuring integrated rotational direction detection, type NIx3-...-FD1
- **Option I:** One or more measuring transducers, type VF5, for additional analogue measuring signals
- **Option II:** One or more limit value switches, type RF5, for additional switching points
- **For further details, see page 10, solution C**

Solution D

FAHZ11 FMN6 NIx3-...-Ux/Ix

- Contactless sensing with 2-channel speed sensor, type FAHZ11
- NORISPEED multifunctional device, type FMN6, for rotational direction detection and speed monitoring, with extra outputs plus slip and offset measurement
- NORIMETER 3 analogue indicator, type NIx3-...-Ux/Ix
- **For further details, see page 13, solution D**

Solution E — Option I: Option II:

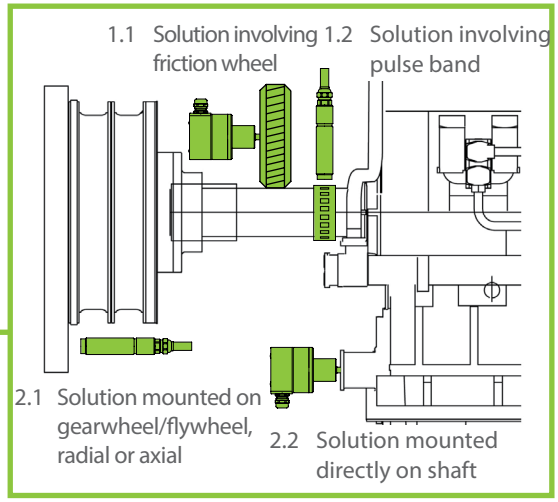
2 x FAJ11 2 x FAH11 NIx3-...-FD1 VF5 RF5

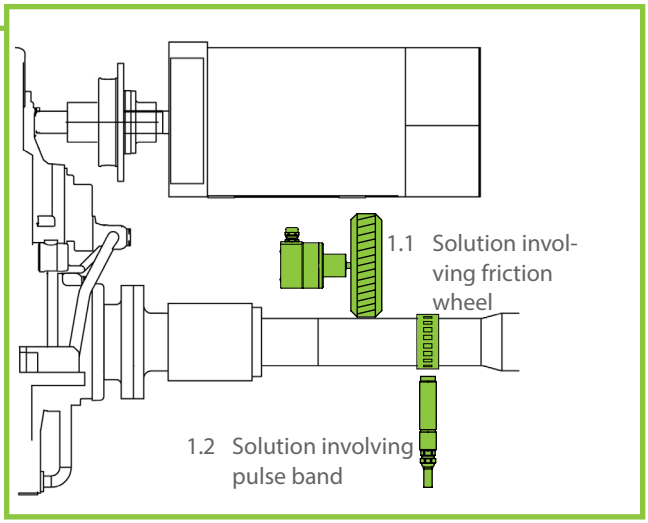
- Contactless sensing with two 1-channel speed sensors, type FAJ11 or FAH11
- NORIMETER 3 analogue indicator featuring integrated rotational direction detection, type NIx3-...-FD1
- **Option I:** One or more measuring transducers, type VF5, for additional analogue measuring signals
- **Option II:** One or more limit value switches, type RF5, for additional switching points
- **For further details, see page 10, solution E**

Solution F

2 x FAJ11 2 x FAH11 FMN6 NIx3-...-Ux/Ix

- Contactless sensing with two 1-channel speed sensors, type FAJ11 or FAH11
- NORISPEED multifunctional device, type FMN6, for rotational direction detection and speed monitoring, with extra outputs plus slip and offset measurement
- NORIMETER 3 analogue indicator, type NIx3-...-Ux/Ix
- **For further details, see page 13, solution F**

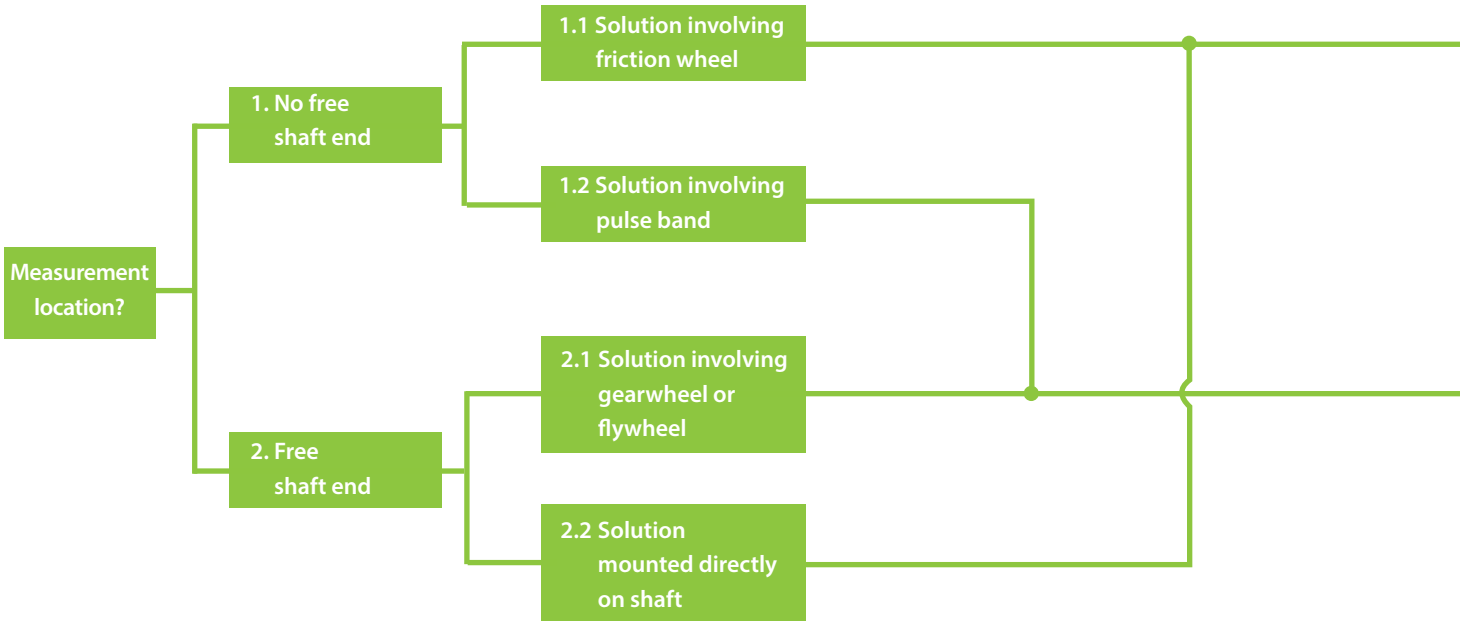


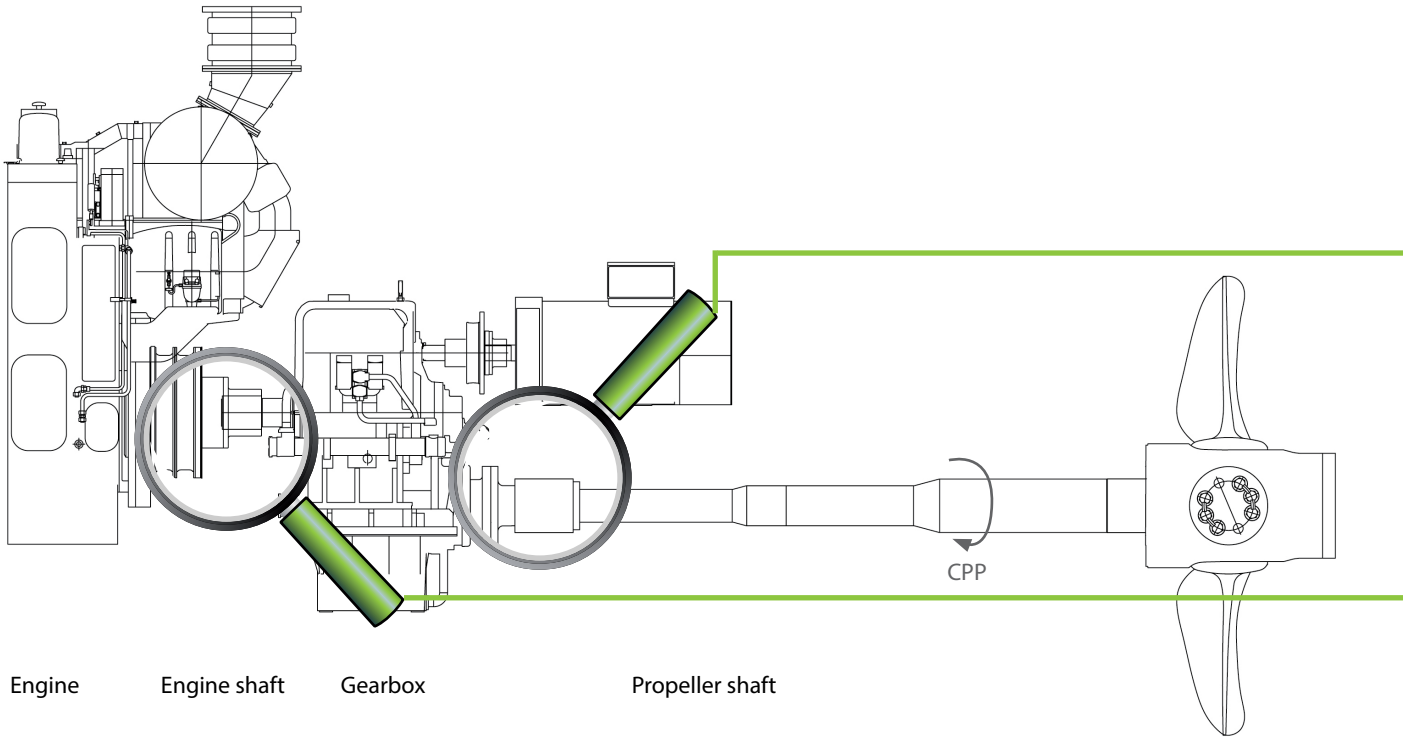


Overview – Solutions for non-reversing drives

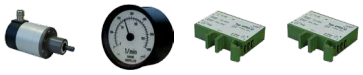
Overview

We can devise complete speed measurement systems for your drive – from signal acquisition and processing right through to display and evaluation. Various acquisition approaches are possible, depending on how the sensors are mounted. Another crucial factor for the acquisition approach is whether there is a free shaft end available or whether a flywheel or gearwheel can be used for the purpose of measuring the speed. The various approaches are illustrated by the examples in the following overview. The examples are then described on subsequent pages. In the case of non-reversing drives, no function is required to detect the rotational direction of the shaft.





Solution G Option I: Option II:



NADS3 NIx3-...-F1 VF5 RF5

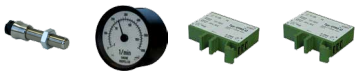
- Speed measurement with mechanically driven speed pickup, type NADS3
- NORIMETER 3 analogue indicator, type NIx3-...-F1
- **Option I:** One or more measuring transducers, type VF5, for additional analogue measuring signals
- **Option II:** One or more limit value switches, type RF5, for additional switching points
- **For further details, see page 16, solution G**

Solution H

NADS3 FMN6 NIx3-...-Ux/Ix

- Speed measurement with mechanically driven speed pickup, type NADS3
- NORISPEED multifunctional device, type FMN6, for extra outputs, limit monitoring plus slip and offset measurement
- NORIMETER 3 analogue indicator, type NIx3-...-Ux/Ix
- **For further details, see page 17, solution H**

Solution I Option I: Option II:



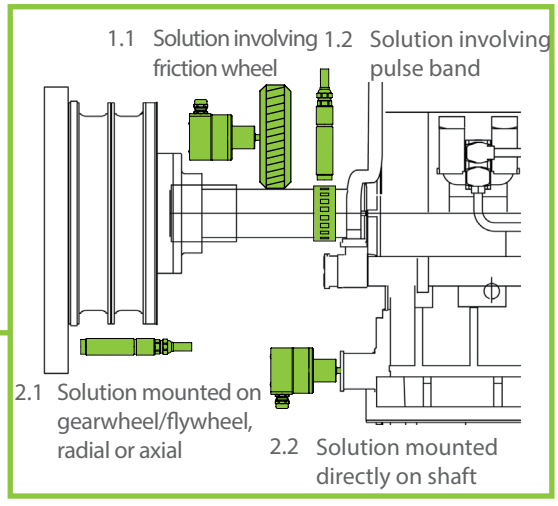
FAH11/ FAJ11 NIx3-...-F1 VF5 RF5

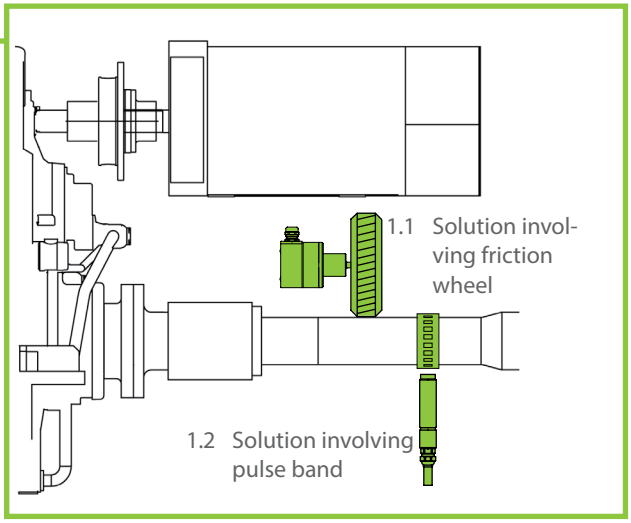
- Contactless sensing with 1-channel speed sensor, type FAH11 or FAJ11
- NORIMETER 3 analogue indicator, type NIx3-...-F1
- **Option I:** One or more measuring transducers, type VF5, for additional analogue measuring signals
- **Option II:** One or more limit value switches, type RF5, for additional switching points
- **For further details, see page 18, solution I**

Solution J

FAH11 FAJ11 FMN6 NIx3-...-Ux/Ix

- Contactless sensing with 1-channel speed sensor, type FAH11 or FAJ11
- NORISPEED multifunctional device, type FMN6, for extra outputs, limit monitoring plus slip and offset measurement
- NORIMETER 3 analogue indicator, type NIx3-...-Ux/Ix
- **For further details, see page 19, solution J**





Our solutions for reversing drives

Solution A

Speed measurement with mechanically driven speed pickup, type NADS3, optionally available with additional analogue speed signals and/or switching points for a speed monitoring function

Standard:	Speed pickup	+ analogue indicator (round or square)	
Option I:	Speed pickup	+ analogue indicator (round or square)	+ measuring transducer
Option II:	Speed pickup	+ analogue indicator (round or square)	+ limit value switch

Description of system

The mechanically driven NADS3 is a two-channel speed pickup that emits two square wave signals at its two outputs with a phase offset of 90° between them. The output frequency is proportional to the speed.

With this solution, the NADS3 is either directly flange-mounted on the end face of a rotating shaft using an adapter *(see page 5, Fig. 2.2 and page 35)* or is mechanically connected to a shaft or a flywheel by means of a friction wheel *(see page 5, Fig. 1.1 and page 34)*.

The NADS3 is connected to a NORIMETER 3 analogue indicator featuring a frequency input and integrated rotational direction detection. Various versions are possible; ***see table entitled „Technical reference"***.

In addition to the speed, the indicator also shows the rotational direction by pointing to the left or to the right. The indicator detects the rotational direction on the basis of the phase offset between the two NADS3 output signals. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. If the rotational direction shown by the indicator is not correct, this problem can be resolved by swapping over the two signal lines on the indicator or by accessing the setting menu on the indicator (see indicator installation and operating instructions).

Option I: If one or more analogue speed signals are required in addition to the speed indication function (e.g. for a controller), extra VF5 measuring transducers with a frequency measurement input can be connected to the NADS3. These measuring transducers provide standardised frequency-dependent analogue output signals (0...10 V, 2...10 V, 0...20 mA, 4...20 mA).

Solution A | **Option I:** | **Option II:**


NADS3


NIx3-...-FD1


VF5


RF5

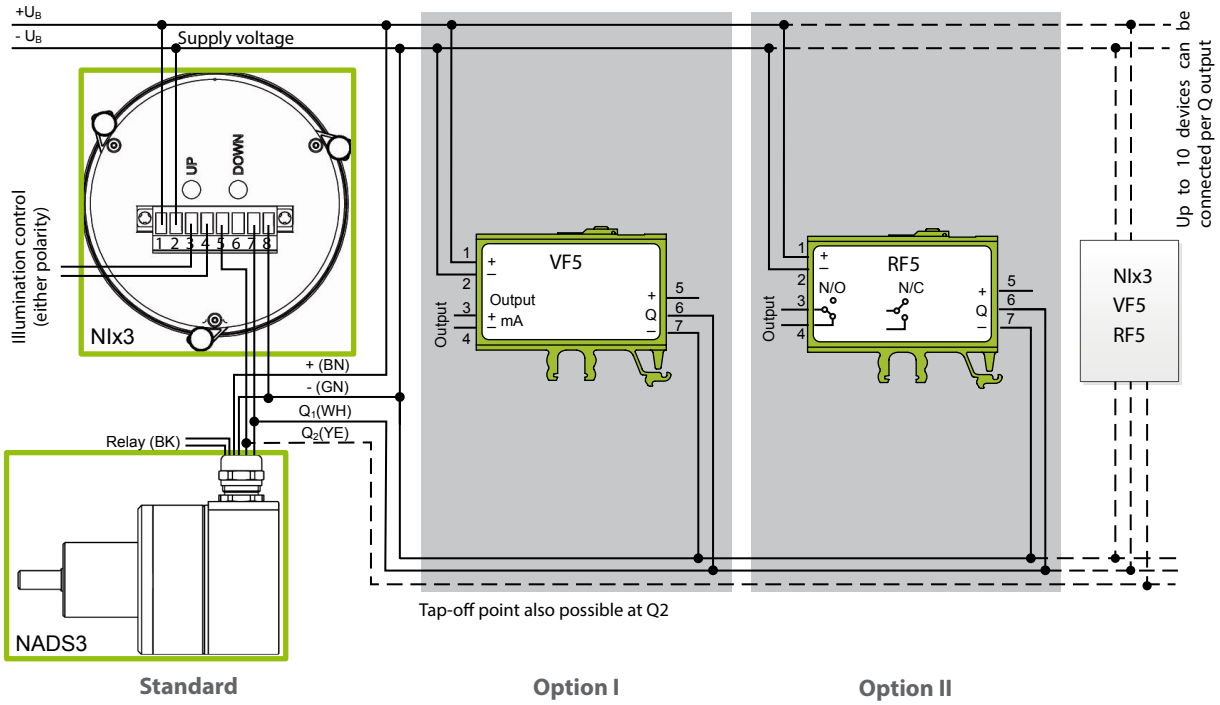
Technical reference

Product	*Reference data sheet*
Speed pickup NADS3	DB-NADS3
Analogue indicator NIR3-...-FD1	DB-NIR3 (round)
Analogue indicator NIQ3-...-FD1	DB-NIQ3 (square)
Measuring transducer VF5	DB-VF5
Limit value switch RF5	DB-RF5

Option II: If additional switching points are required, e.g. for automatic speed monitoring (engine slowdown, shutdown etc.), additional RF5 limit value switches with a frequency measurement input can be connected to the NADS3. Each of these limit value switches can be used to set a freely selectable switching point within the specified speed range.

Naturally, any of the devices listed under options I and II can be combined with one another. It is also possible to use multiple indicators. A total of ten devices (i.e. any combination of indicators, measuring transducers and switching devices) may be connected to each channel of one NADS3. However, the number of connected devices may be subject to restrictions in individual cases if the line is too long and there are high levels of interference.

Connection diagram for solution A, example scenario involving the NADS3, VF5, RF5 and NIR3



Solution B

Speed measurement with mechanically driven speed pickup, type NADS3, with multiple outputs, speed monitoring plus slip and offset measurement

Standard: Speed pickup + multifunctional device + analogue indicator (round or square)

Description of system

The mechanically driven NADS3 is a two-channel speed pickup that emits two square wave signals at its two outputs with a phase offset of 90° between them. The output frequency is proportional to the speed.

With this solution, the NADS3 is either directly flange-mounted on the end face of a rotating shaft using an adapter *(see page 5, Fig. 2.2 and page 35)* or is mechanically connected to a shaft or a flywheel by means of a friction wheel *(see page 5, Fig. 1.1 and page 34)*.

Both output signals from the speed pickup are fed into the NORISPEED FMN6 multifunctional device, where they are evaluated. The device is freely parametrisable. As well as detecting the speed, it also determines the rotational direction of the shaft on the basis of the phase shift between the signals. The multifunctional device also offers some other handy functions:

- For each frequency measurement channel, there is an integrated measuring transducer with standardised frequency-dependent analogue output signals (0...5 V, 0..10 V, 2...10 V, +/-5 V, +/-10 V, 0...20 mA or 4...20 mA) to allow connection to external systems.
- There are several programmable limit values for speed monitoring (e.g. engine slowdown, shutdown).

Solution B


NADS3


FMN6


NIx3-...-Ux/Ix

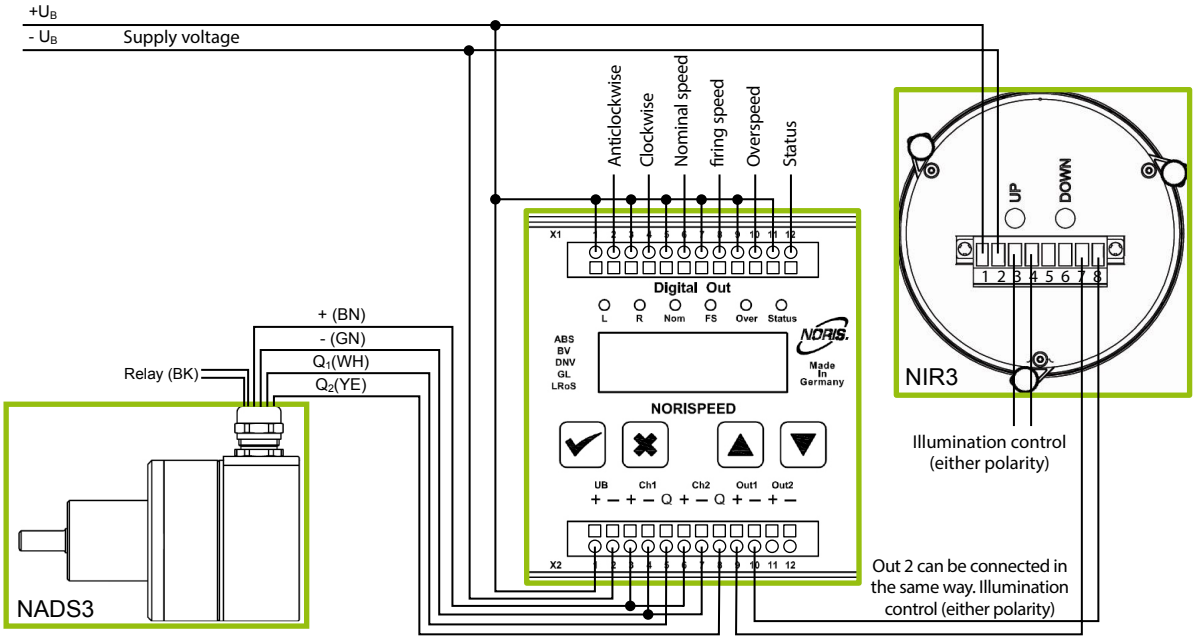
Technical reference

Product	*Reference data sheet*
Speed pickup NADS3	DB-NADS3
Multifunctional device FMN6	DB-FMN6
Analogue indicator NIx3-...-U1 Analogue indicator NIx3-...-U2 Analogue indicator NIx3-...-U4 Analogue indicator NIx3-...-I1 Analogue indicator NIx3-...-I2	DB-NIR3 (round) DB-NIQ3 (square)

The device can be easily adjusted via the buttons and integrated display.

A NORIMETER 3 analogue indicator (round or square) with a voltage or current input is connected to the NORISPEED. Various versions are possible; ***see table entitled „Technical reference“***. The indicator shows the speed and rotational direction (by pointing to the left or right). If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer.

Connection diagram for solution B, example scenario involving the NADS3, FMN6 and NIR3



Solution C and Solution E

Contactless speed measurement with one 2-channel speed sensor, type FAHZ11 (solution C), or with two 1-channel speed sensors, type FAJ11 or FAH11 (solution E), optionally available with additional analogue speed signals and/or switching points for a speed monitoring function

Standard:	One FAHZ11 or two FAJ11/FAH11	+ analogue indicator (round or square)	
Option I:	One FAHZ11 or two FAJ11/FAH11	+ analogue indicator (round or square)	+ measuring transducer
Option II:	One FAHZ11 or two FAJ11/FAH11	+ analogue indicator (round or square)	+ limit value switch

Description of system

The FAHZ11 and FAJ11/FAH11 contactless speed sensors either detect the speed via a pulse band *(see page 5, Fig. 1.2)* or via a gearwheel/flywheel *(see page 5, Fig. 2.1)*. The speed sensors emit a square wave signal at each of their outputs, the frequency of which is proportional to the speed.

In order to implement a function for detecting the rotational direction, it is necessary to have two output signals with a phase offset that is as close to 90° as possible. In the case of the FAHZ11 two-channel sensor, this can be achieved by rotating the sensor in its holder. If two FAJ11/FAH11 sensors are used, they must both be positioned precisely in relation to one another so that the desired phase offset is established between the two signals.

The two output signals from the sensors with the phase offset of 90° between them are connected to a NORIMETER 3 analogue indicator featuring a frequency input and integrated rotational direction detection. Various versions are possible; ***see table entitled „Technical reference“***.

Solution C

		Option I:	Option II:
			
FAHZ11	NIx3-...-FD1	VF5	RF5

Solution E

		Option I:	Option II:
			
2 x FAJ11/ 2 x FAH11	NIx3-...-FD1	VF5	RF5

Technical reference

Product	*Reference data sheet*
Speed sensor FAHZ11	DB-FAHZ11
Speed sensor FAJ11/FAH11	DB-FAJ11, DB-FAH11
Analogue indicator NIR3-...-FD1	DB-NIR3 (round)
Analogue indicator NIQ3-...-FD1	DB-NIQ3 (square)
Measuring transducer VF5	DB-VF5
Limit value switch RF5	DB-RF5

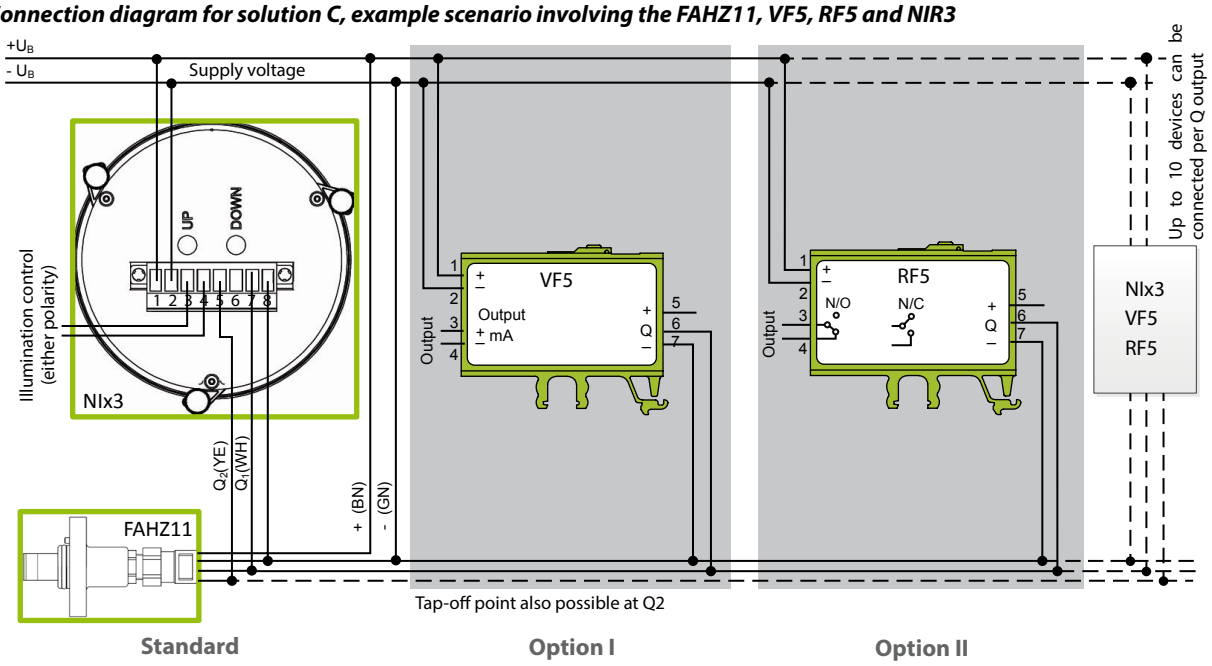
In addition to the speed, the indicator also shows the rotational direction by pointing to the left or to the right. The indicator detects the rotational direction on the basis of the phase offset between the two output signals. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. If the rotational direction shown by the indicator is not correct, this problem can be resolved by swapping over the two signal lines on the indicator or by accessing the setting menu on the indicator (see indicator installation and operating instructions).

Option I: If one or more analogue speed signals are required in addition to the speed indication function (e.g. for a controller), extra VF5 measuring transducers with a frequency measurement input can be connected to the sensor. These measuring transducers provide standardised frequency-dependent analogue output signals (0...10 V, 2...10 V, 0...20 mA, 4...20 mA).

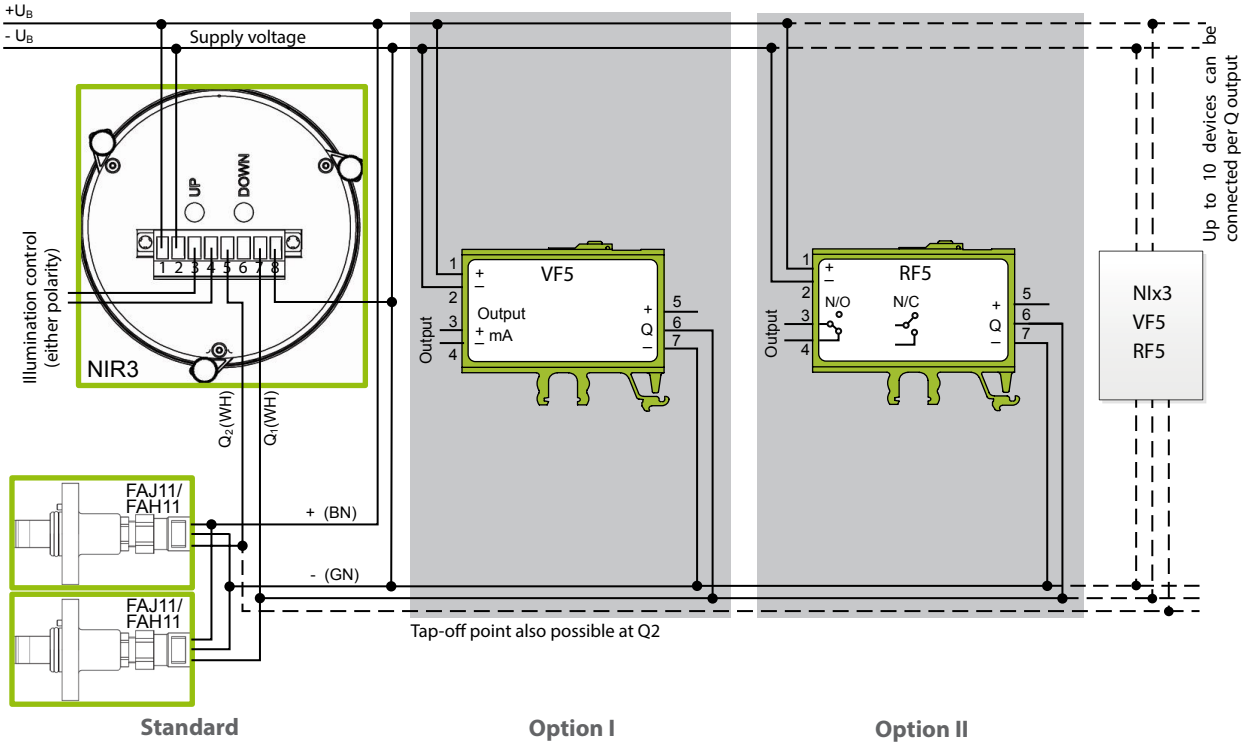
Option II: If additional switching points are also required, e.g. for automatic speed monitoring (engine slowdown, shutdown etc.), additional RF5 limit value switches with a frequency measurement input can be connected to the sensor. Each of these limit value switches can be used to set a freely selectable switching point within the specified speed range.

Naturally, any of the devices listed under options I and II can be combined with one another. It is also possible to use multiple indicators. A total of ten devices (i.e. any combination of indicators, measuring transducers and switching devices) may be connected to each sensor channel. However, the number of connected devices may be subject to restrictions in individual cases if the line is too long and there are high levels of interference.

Connection diagram for solution C, example scenario involving the FAHZ11, VF5, RF5 and NIR3



Connection diagram for solution E, example scenario involving 2 x FAJ11/FAH11, VF5, RF5 and NIR3



For both solutions, we also offer compatible accessories to facilitate mounting on the shaft or on the gearwheel/flywheel. A mounting example for ***solution C can be found on page 31***. A mounting example for ***solution E can be found on page 32***.

An overview of the key advantages of the two solutions and differences between them

	Solution C	*Solution E with 2 x FAJ11*
Application	**Speed pick-up:** The FAHZ11 speed pickup functions according to the difference-Hall principle. Installation is direction-specific. For the purpose of installing and aligning the sensor, the scan object should ideally be visible. Once the sensor has been precisely aligned, it outputs two square wave signals with a phase offset of 90° between them.	**Speed pick-up:** Easy to use: FAJ11 speed pickups rely on the magneto-inductive principle. Installation of the individual sensors is not direction-specific. Therefore, this solution is used when the scan object is not freely accessible and it is difficult to align a sensor precisely. Nevertheless, both sensors must be aligned for sensing in such a way that there is a phase offset of 90° between the two signals.
Speed	Also suitable for very low speeds: 0.2...20,000 Hz	Restrictions apply at very high and very low speeds: 5...10,000 Hz
Module sizes	m1 to m3	≥ m2
Tooth face width	> 7 mm	> 5 mm
Temperature range	-40...+120 °C	-40...+105 °C
Degree of protection	IP66, optionally IP 68	IP66 or IP67
Backup	No backup possible	If either of the sensors fails, speed measurement can still be performed. However, it may be necessary to swap the signal connections. In this case, rotational direction detection is no longer possible.

Solution D and solution F

Contactless speed measurement with one 2-channel sensor, type FAHZ11 (solution D), or with two 1-channel sensors, type FAJ11 or FAH11 (solution F), with multiple outputs, speed monitoring plus slip and offset measurement

Standard: One FAHZ11 or two FAJ11/FAH11 + multifunctional device + analogue indicator (round or square)

Description of system

The FAHZ11 and FAJ11/FAH11 contactless speed sensors either detect the speed via a pulse band *(see page 5, Fig. 1.2)* or via a gearwheel/flywheel *(see page 5, Fig. 2.1)*. The speed sensors emit a square wave signal at each of their outputs, the frequency of which is proportional to the speed.

In order to implement a function for detecting the rotational direction, it is necessary to have two output signals with a phase offset that is as close to 90° as possible. In the case of the FAHZ11 two-channel sensor, this can be achieved by rotating the sensor in its holder. If two FAJ11/FAH11 sensors are used, they must both be positioned precisely in relation to one another so that the desired phase offset is established between the two signals.

Both output signals from the sensors with the phase offset of 90° between them are fed into the NORISPEED FMN6 multifunctional device, where they are evaluated. The device is freely parametrisable. As well as detecting the speed, it also determines the rotational direction of the shaft on the basis of the phase shift between the signals. The multifunctional device also offers some other handy functions:

- For each frequency measurement channel, there is an integrated measuring transducer with standardised frequency-dependent analogue output signals (0...5 V, 0…10 V, 2...10 V, +/-5 V, +/-10 V, 0...20 mA or 4...20 mA) to allow connection to external systems.
- There are several programmable limit values for speed monitoring (e.g. engine slowdown, shutdown).

The device can be easily adjusted via the buttons and integrated display.

Solution D


FAHZ11


FMN6


NIx3-...-Ux/Ix

Solution F


2 x FAJ11/
2 x FAH11


FMN6

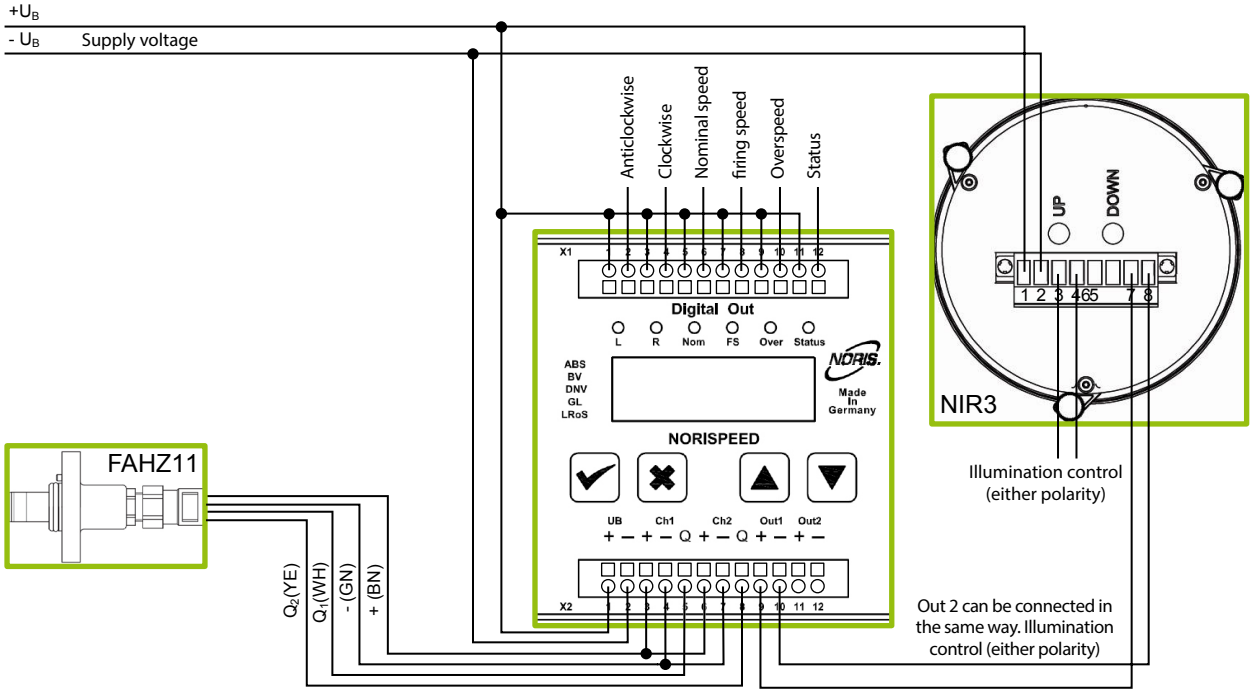

NIx3-...-Ux/Ix

Technical reference

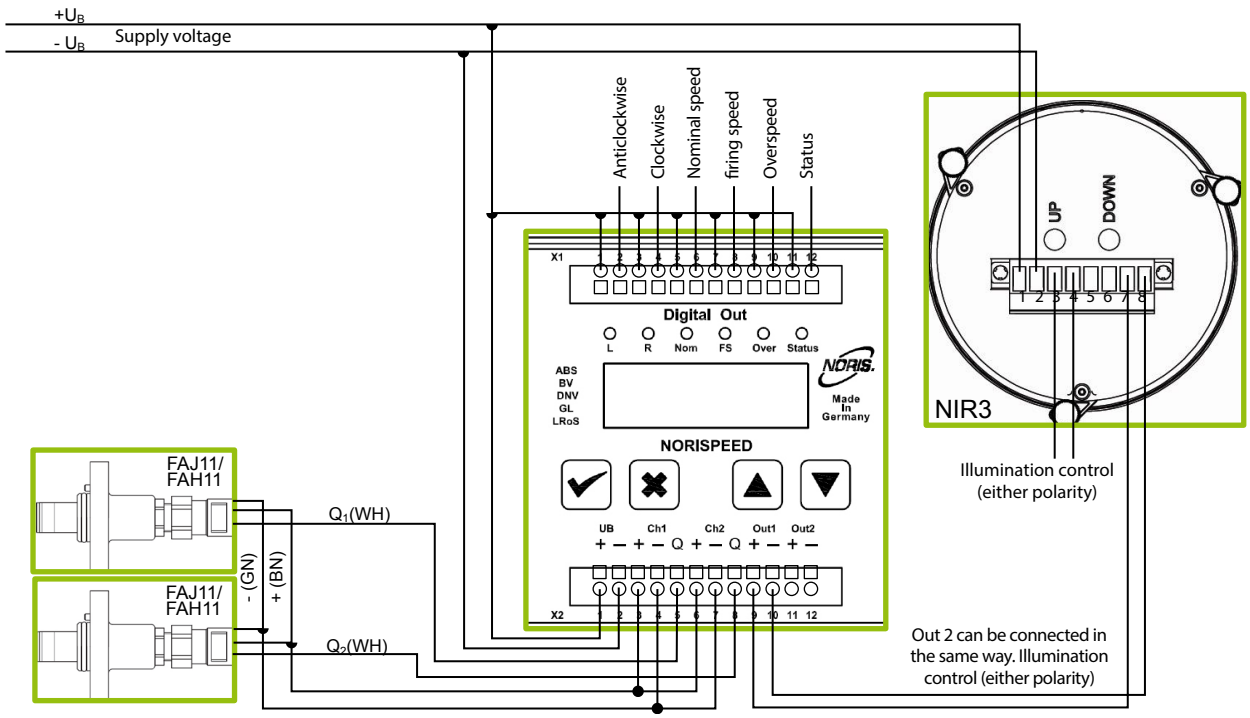
Product	Reference data sheet
Speed sensor FAHZ11	DB-FAHZ11
Speed sensor FAJ11/FAH11	DB-FAJ11/DB-FAH11
Multifunctional device FMN6	DB-FMN6
Analogue indicator NIx3-...-U1 Analogue indicator NIx3-...-U2 Analogue indicator NIx3-...-U4 Analogue indicator NIx3-...-I1 Analogue indicator NIx3-...-I2	DB-NIR3 (round) DB-NIQ3 (square)

A NORIMETER 3 analogue indicator (round or square) with a voltage or current input is connected to the NORISPEED. Various versions are possible; **see table entitled „Technical reference“**. The indicator shows the speed and rotational direction (by pointing to the left or right). If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer.

Connection diagram for solution D, example scenario involving the FAHZ11, FMN6 and NIR3



Connection diagram for solution F, example scenario involving 2 x FAJ11, FMN6 und NIR3



For both solutions, we also offer compatible accessories to facilitate mounting on the shaft or on the gearwheel/flywheel. A mounting example for ***solution D can be found on page 31***. A mounting example for ***solution F can be found on page 32***.

An overview of the key advantages of the two solutions and differences between them

	Solution D	*Solution F with 2 x FAJ11*
Application	**Speed pick-up:** The FAHZ11 speed pickup functions according to the difference-Hall principle. Installation is direction-specific. For the purpose of installing and aligning the sensor, the scan object should ideally be visible. Once the sensor has been precisely aligned, it outputs two square wave signals with a phase offset of 90° between them.	**Speed pick-up:** Easy to use: FAJ11 speed pickups rely on the magne-to-inductive principle. Installation of the individual sensors is not direction-specific. Therefore, this solution is used when the scan object is not freely accessible and it is difficult to align a sensor precise-ly. Nevertheless, both sensors must be aligned for sensing in such a way that there is a phase offset of 90° between the two signals.
Speed	Also suitable for very low speeds: 0.2...20,000 Hz	Restrictions apply at very high and very low speeds: 5...10,000 Hz
Module sizes	m1 to m3	≥ m2
Tooth face width	> 7 mm	> 5 mm
Temperature range	-40...+120 °C	-40...+105 °C
Degree of protection	IP66, optionally IP 68	IP66 or IP67
Backup	No backup possible	If either of the sensors fails, speed measurement can still be performed. However, it may be necessary to swap the signal connections. In this case, rotational direction detection is no longer possible.

Our solutions
for non-reversing drives

Solution G

Speed measurement with mechanically driven speed pickup, type NADS3, optionally available with additional analogue speed signals and/or switching points for a speed monitoring function

Standard:	Speed pickup	+ analogue indicator (round or square)	
Option I:	Speed pickup	+ analogue indicator (round or square)	+ measuring transducer
Option II:	Speed pickup	+ analogue indicator (round or square)	+ limit value switch

Description of system

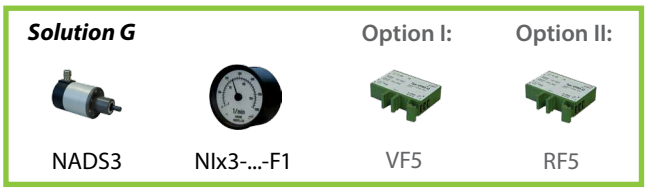
The mechanically driven NADS3 is a two-channel speed pickup that emits two square wave signals at its two outputs with a phase offset of 90° between them. The output frequency is proportional to the speed.

With this solution, the NADS3 is either directly flange-mounted on the end face of a rotating shaft using an adapter *(see page 7, Fig. 2.2 and page 35)* or is mechanically connected to a shaft or a flywheel by means of a friction wheel *(see page 7, Fig. 1.1 and page 34)*.

The NADS3 is connected to a NORIMETER 3 analogue indicator featuring a frequency input. Various versions are possible; ***see table entitled „Technical reference"***. For the purpose of indicating the speed, either output Q1 or Q2 can be used.

The indicator shows the speed of the shaft. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. The scale can be designed for the pointer to move either to the right or to the left.

Option I: If one or more analogue speed signals are required in addition to the speed indication function (e.g. for a controller), extra VF5 measuring transducers with a frequency measurement input can be connected to the NADS3. These measuring transducers provide standardised frequency-dependent analogue output signals (0...10 V, 2...10 V, 0...20 mA, 4...20 mA).



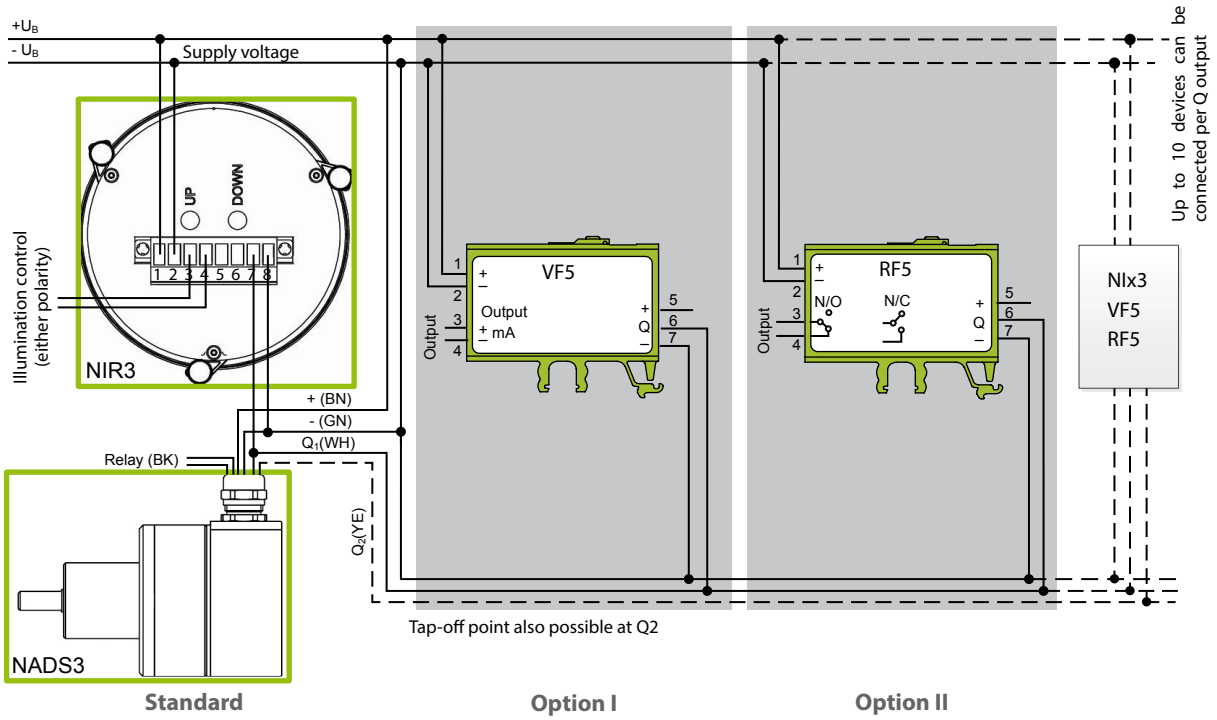
Technical reference

Product	*Reference data sheet*
Speed pickup NADS3	DB-NADS3
Analogue indicator NIR3-...-F1	DB-NIR3 (round)
Analogue indicator NIQ3-...-F1	DB-NIQ3 (square)
Measuring transducer VF5	DB-VF5
Limit value switch RF5	DB-RF5

Option II: If additional switching points are also required, e.g. for automatic speed monitoring (engine slowdown, shutdown etc.), additional RF5 limit value switches with a frequency measurement input can be connected to the NADS3. Each of these limit value switches can be used to set a freely selectable switching point within the specified speed range.

Naturally, any of the devices listed under options I and II can be combined with one another. It is also possible to use multiple indicators. A total of ten devices (i.e. any combination of indicators, measuring transducers and switching devices) may be connected to each channel of one NADS3. However, the number of connected devices may be subject to restrictions in individual cases if the line is too long and there are high levels of interference.

Connection diagram for solution G, example scenario involving the NADS3, VF5/RF5 and NIR3



Solution H

Speed measurement with mechanically driven speed pickup, type NADS3, with multiple outputs,speed monitoring plus slip and offset measurement

Standard: Speed pickup + multifunctional device + analogue indicator (round or square)

Description of system

The mechanically driven NADS3 is a two-channel speed pickup that emits two square wave signals at its two outputs with a phase offset of 90° between them. The output frequency is proportional to the speed.

With this solution, the NADS3 is either directly flange-mounted on the end face of a rotating shaft using an adapter *(see page 7, Fig. 2.2 and page 35)* or is mechanically connected to a shaft or a flywheel by means of a friction wheel *(see page 7, Fig. 1.1 and page 34)*.

One or both of the output signals from the speed pickup are fed into the NORISPEED FMN6 multifunctional device, where they are evaluated. The device is freely parametrisable. As well as detecting the speed, it also determines the rotational direction of the shaft on the basis of the phase shift between the signals. The multifunctional device also offers some other handy functions:

- For each frequency measurement channel, there is an integrated measuring transducer with standardised frequency-dependent analogue output signals (0...5 V, 0…10 V, 2...10 V, +/-5 V, +/-10 V, 0...20 mA or 4...20 mA) to allow connection to external systems.
- There are several programmable limit values for speed monitoring (e.g. engine slowdown, shutdown).

Solution H


NADS3


FMN6


NIx3-...-U1/I1/I2

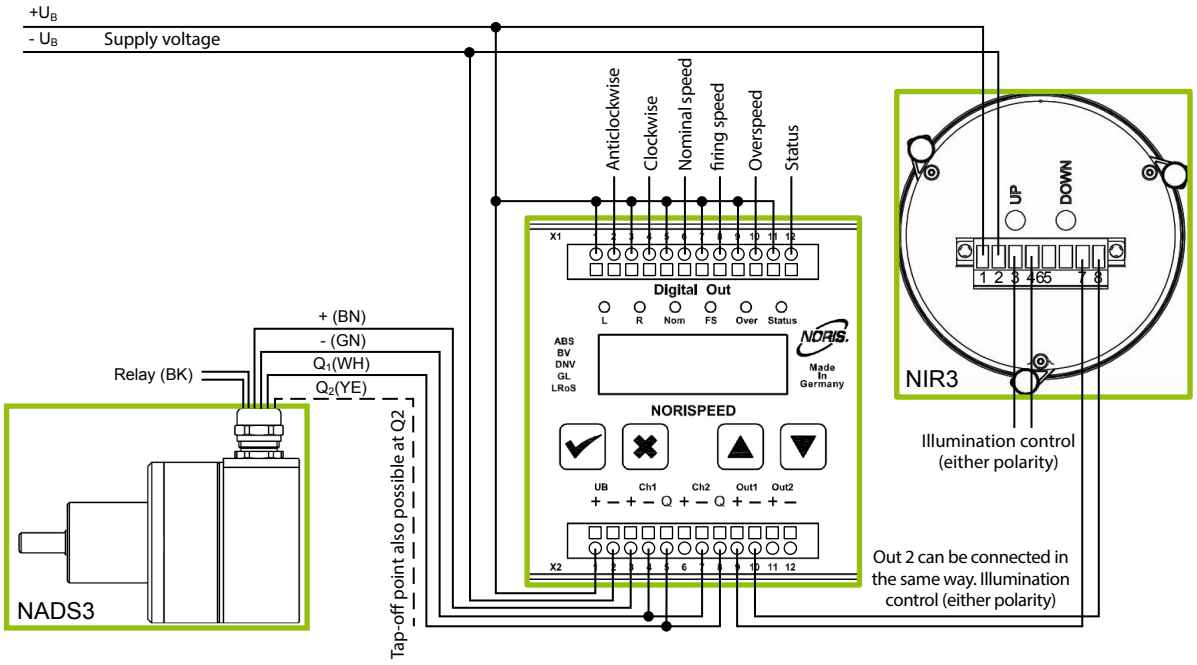
Technical reference

Product	*Reference data sheet*
Speed pickup NADS3	DB-NADS3
Multifunctional device FMN6	DB-FMN6
Analogue indicator NIx3-...-U1 Analogue indicator NIx3-...-U2 Analogue indicator NIx3-...-I1 Analogue indicator NIx3-...-I2	DB-NIR3 (round) DB-NIQ3 (square)

The device can be easily adjusted via the buttons and integrated display.

A NORIMETER 3 analogue indicator (round or square) with a voltage or current input is connected to the NORISPEED (various versions are possible; see table entitled „Technical reference“). The indicator shows the speed of the shaft. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. The scale can be designed for the pointer to move either to the right or to the left.

Connection diagram for solution H, example scenario involving the NADS3, FMN6 and NIR3



Solution I

Contactless speed measurement with one 1-channel sensor, type FAH11 or FAJ1, optionally available with additional analogue speed signals and/or switching points for a speed monitoring function

Standard:	FAJ11 or FAH11 speed sensor	+ analogue indicator (round or square)	
Option I:	FAJ11 or FAH11 speed sensor	+ analogue indicator (round or square)	+ measuring transducer
Option II:	FAJ11 or FAH11 speed sensor	+ analogue indicator (round or square)	+ limit value switch

Description of system

The FAH11 and FAJ11 contactless speed sensors either detect the speed via a pulse band *(see page 7, Fig. 1.2)* or via a gear-wheel/flywheel *(see page 7, Fig. 2.1)*. The speed sensors emit a square wave signal at their outputs, the frequency of which is proportional to the speed.

The output signal from the sensors is connected to a NORIMETER 3 analogue indicator featuring a frequency input. Various versions are possible; ***see table entitled „Technical reference"***.

The indicator shows the speed of the shaft. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. The scale can be designed for the pointer to move either to the right or to the left.

Option I: If one or more analogue speed signals are required in addition to the speed indication function (e.g. for a controller), extra VF5 measuring transducers with a frequency measurement input can be connected to the sensor. These measuring transducers provide standardised frequency-dependent analogue output signals (0...10 V, 2...10 V, 0...20 mA, 4...20 mA).

Solution I | Option I: | Option II:


FAH11/FAJ11


NIx3-...-F1


VF5 + RI5


RF5

Technical reference

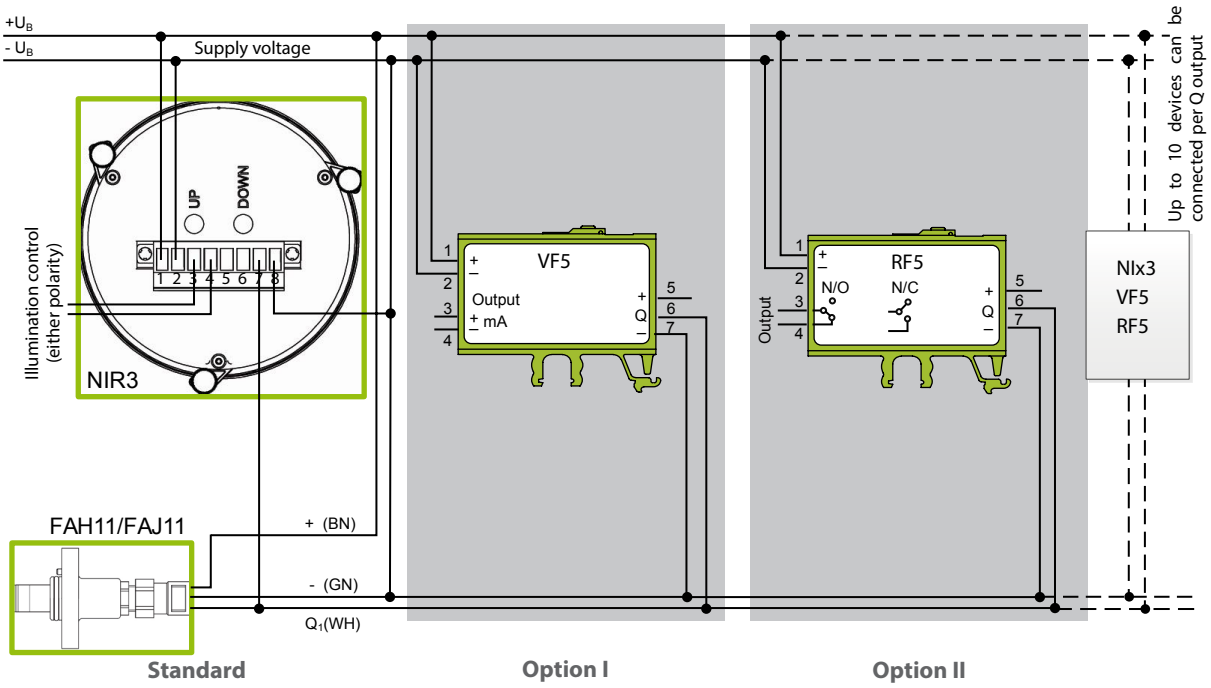
Product	*Reference data sheet*
Speed sensor FAH11	DB-FAH11
Speed sensor FAJ11	DB-FAJ11
Analogue indicator NIR3-...-F1	DB-NIR3 (round)
Analogue indicator NIQ3-...-F1	DB-NIQ3 (square)
Measuring transducer VF5	DB-VF5
Limit value switch RF5	DB-RF5

Option II: If additional switching points are also required, e.g. for automatic speed monitoring (engine slowdown, shutdown etc.), additional RF5 limit value switches with a frequency measurement input can be connected to the sensor. Each of these limit value switches can be used to set a freely selectable switching point within the specified speed range.

Naturally, any of the devices listed under options I and II can be combined with one another. It is also possible to use multiple indicators. A total of ten devices (i.e. any combination of indicators,

measuring transducers and switching devices) may be connected to each channel of one NADS3. However, the number of connected devices may be subject to restrictions in individual cases if the line is too long and there are high levels of interference.

Connection diagram for solution I, example scenario involving the FAH11/FAJ11, VF500 or RF5 and NIR3



Solution J

Contactless speed measurement with one 1-channel sensor, type FAH11 or FAJ11, with multiple outputs, speed monitoring plus slip and offset measurement

Standard: FAJ11 or FAH11 speed sensor + multifunctional device + analogue indicator (round or square)

Description of system

The FAH11 and FAJ11 contactless speed sensors either detect the speed via a pulse band *(see page 7, Fig. 1.2)* or via a gearwheel/flywheel *(see page 7, Fig. 2.1)*. The speed sensors emit a square wave signal at their outputs, the frequency of which is proportional to the speed.

The output signal from the sensor is fed into the NORISPEED FMN6 multifunctional device, where it is evaluated. The device is freely parametrisable and detects the speed on the basis of the signal frequency. The multifunctional device also offers some other handy functions:

- For each frequency measurement channel, there is an integrated measuring transducer with standardised frequency-dependent analogue output signals (0...5 V, 0…10 V, 2...10 V, +/-5 V, +/-10 V, 0...20 mA or 4...20 mA) to allow connection to external systems.
- There are several programmable limit values for speed monitoring (e.g. engine slowdown, shutdown).

Solution J


FAH11/FAJ11


FMN6


NIx3-...-U1/I1/I2

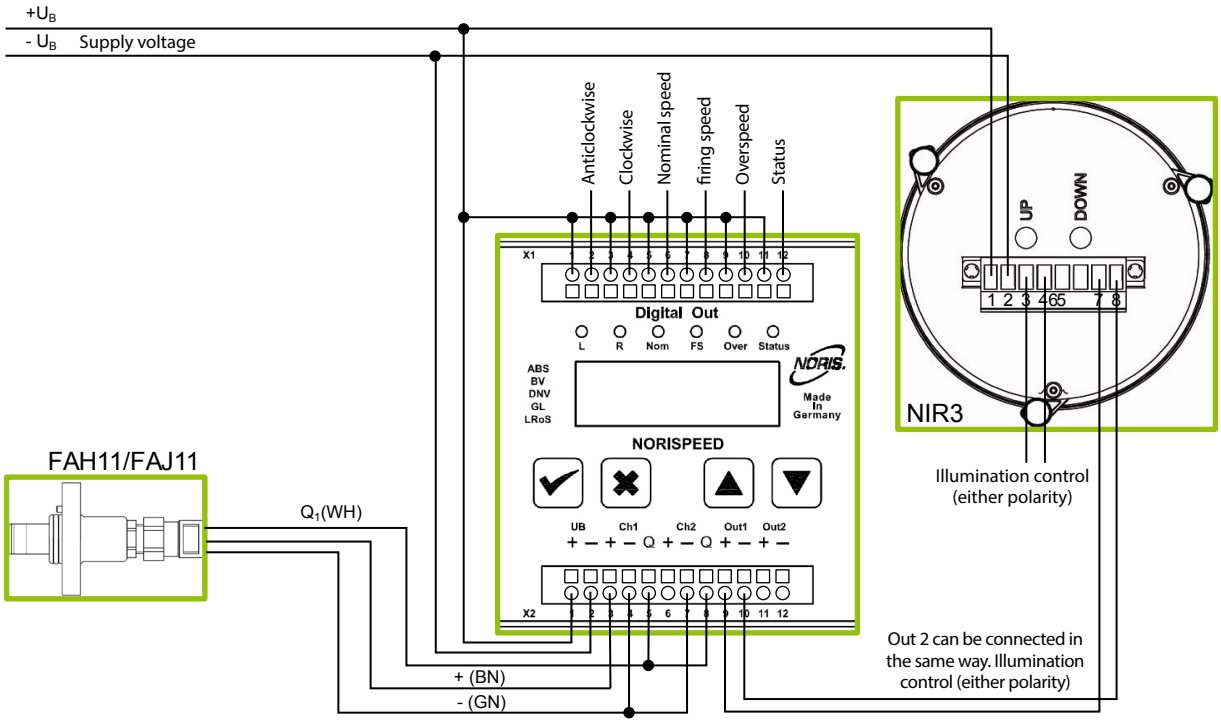
Technical reference

Product	*Reference data sheet*
Speed sensor FAH11	DB-FAH11
Speed sensor FAJ11	DB-FAJ11
Multifunctional device FMN6	DB-FMN6
Analogue indicator NIx3-...-U1 Analogue indicator NIx3-...-U2 Analogue indicator NIx3-...-I1 Analogue indicator NIx3-...-I2	DB-NIR3 (round) DB-NIQ3 (square)

The device can be easily adjusted via the buttons and integrated display.

A NORIMETER 3 analogue indicator (round or square) with a voltage or current input is connected to the NORISPEED (various versions are possible; see table entitled „Technical reference“). The indicator shows the speed of the shaft. If a speed limit value is required, it can be indicated by an additional status LED on the indicator or by means of a flashing pointer. The scale can be designed for the pointer to move either to the right or to the left.

Connection diagram for solution J, example scenario involving the FAH11/FAJ11, FMN6 and NIR3

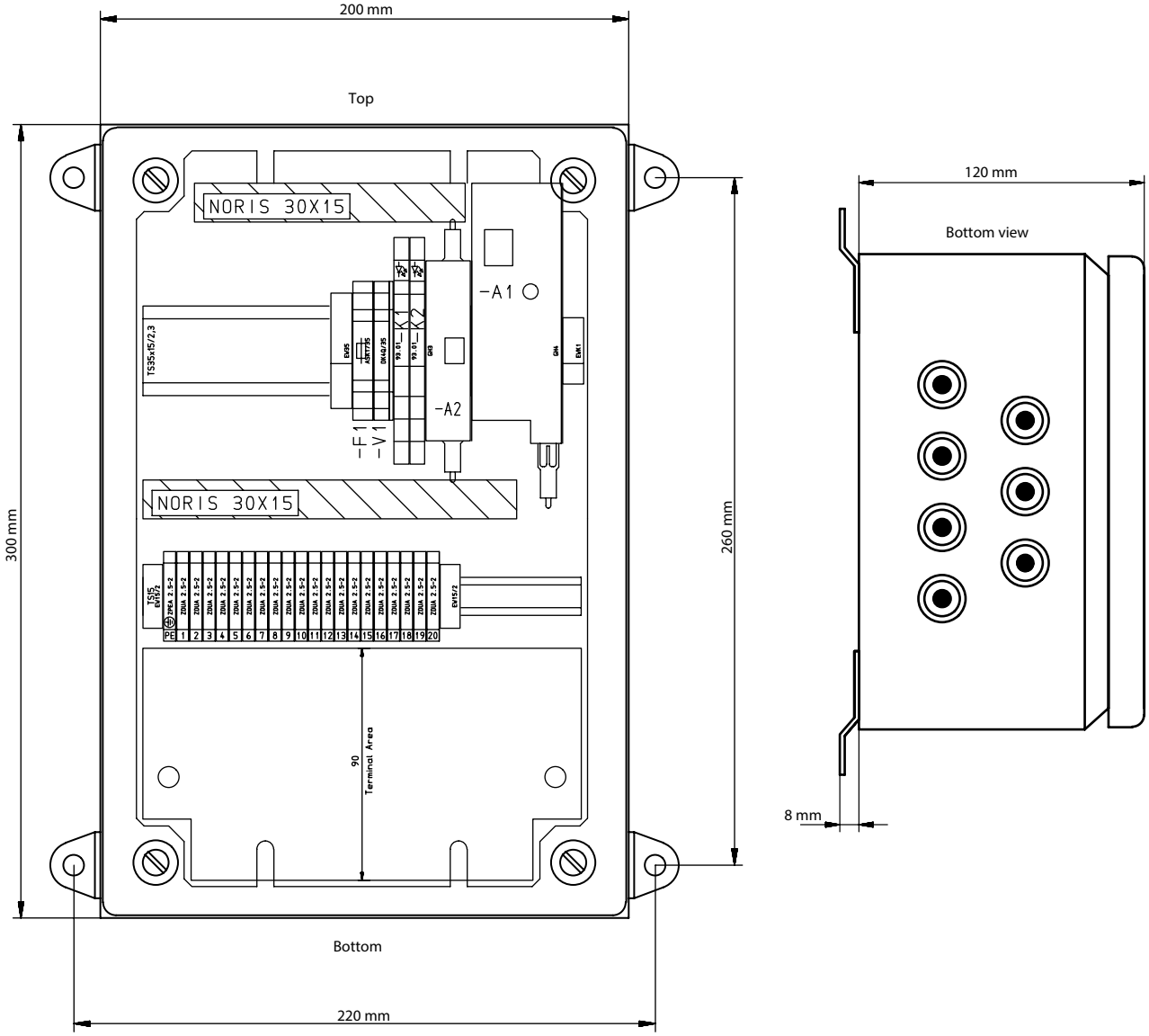


Speed measurement systems inside enclosures

GDMA enclosed speed measurement systems comprise two speed pickups, one or more indicators plus a fully prewired evaluation electronics unit, which is installed inside a control cabinet. We can also supply the components individually on request. In this case, the customer is responsible for carrying out the installation and wiring work. The systems are available in three different versions and can be used with reversing as well as non-reversing drives. The same enclosure is used for all versions (GDMA1-1, GDMA2-1 and GDMA 3-1). The versions differ in terms of the evaluation electronics unit that is installed. The individual components are mounted on top-hat rails inside the enclosure. The cable outlet is located in the base of the enclosure.

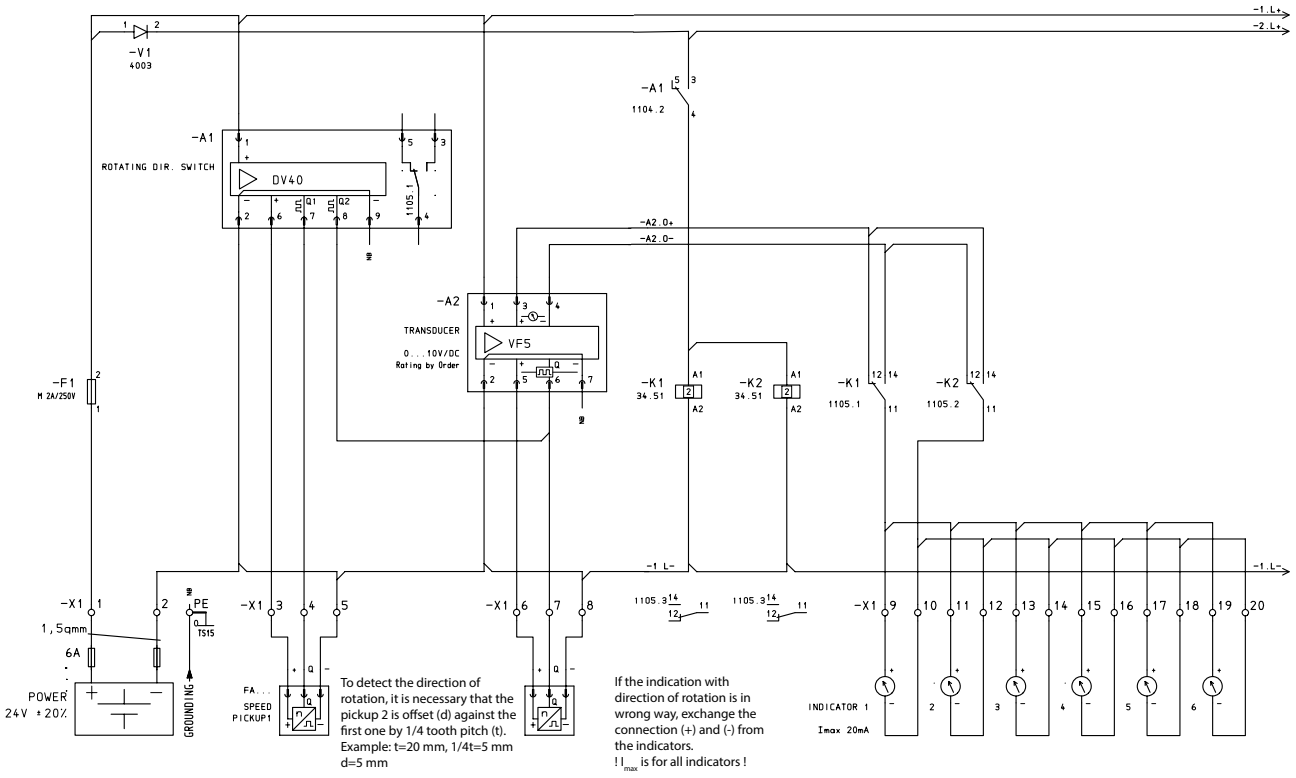
Please note that certain installed system components do not currently have approvals from shipbuilding classification societies.

GDMA1-1 enclosed speed measurement system with one measuring transducer and a direction of rotation switch

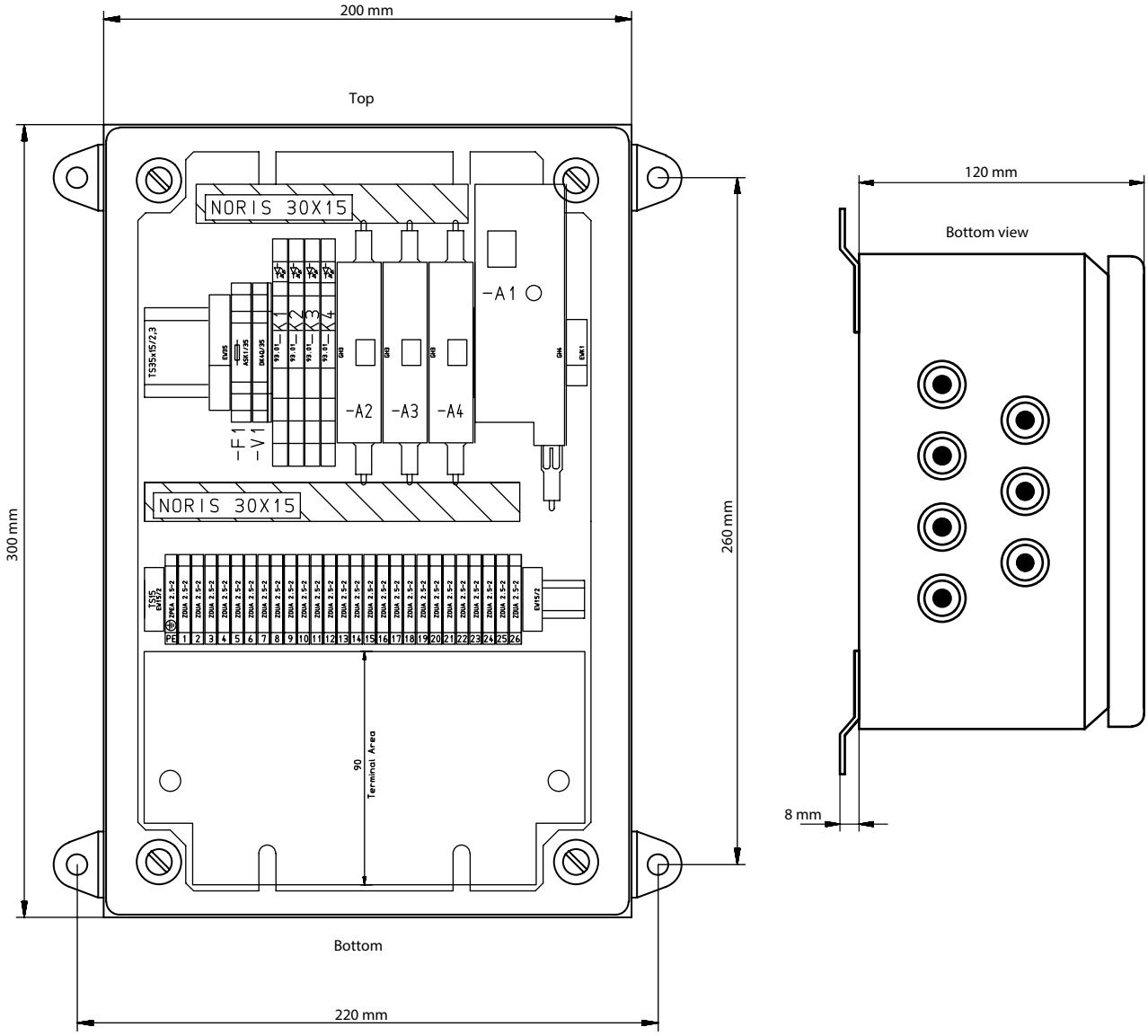


Designation	Component
-A1	Direction of rotation switch DV40 (no shipbuilding approval)
-A2	Measuring transducer VF5
-K1, -K2	Relay N010-206

GDMA1-1 circuit diagram

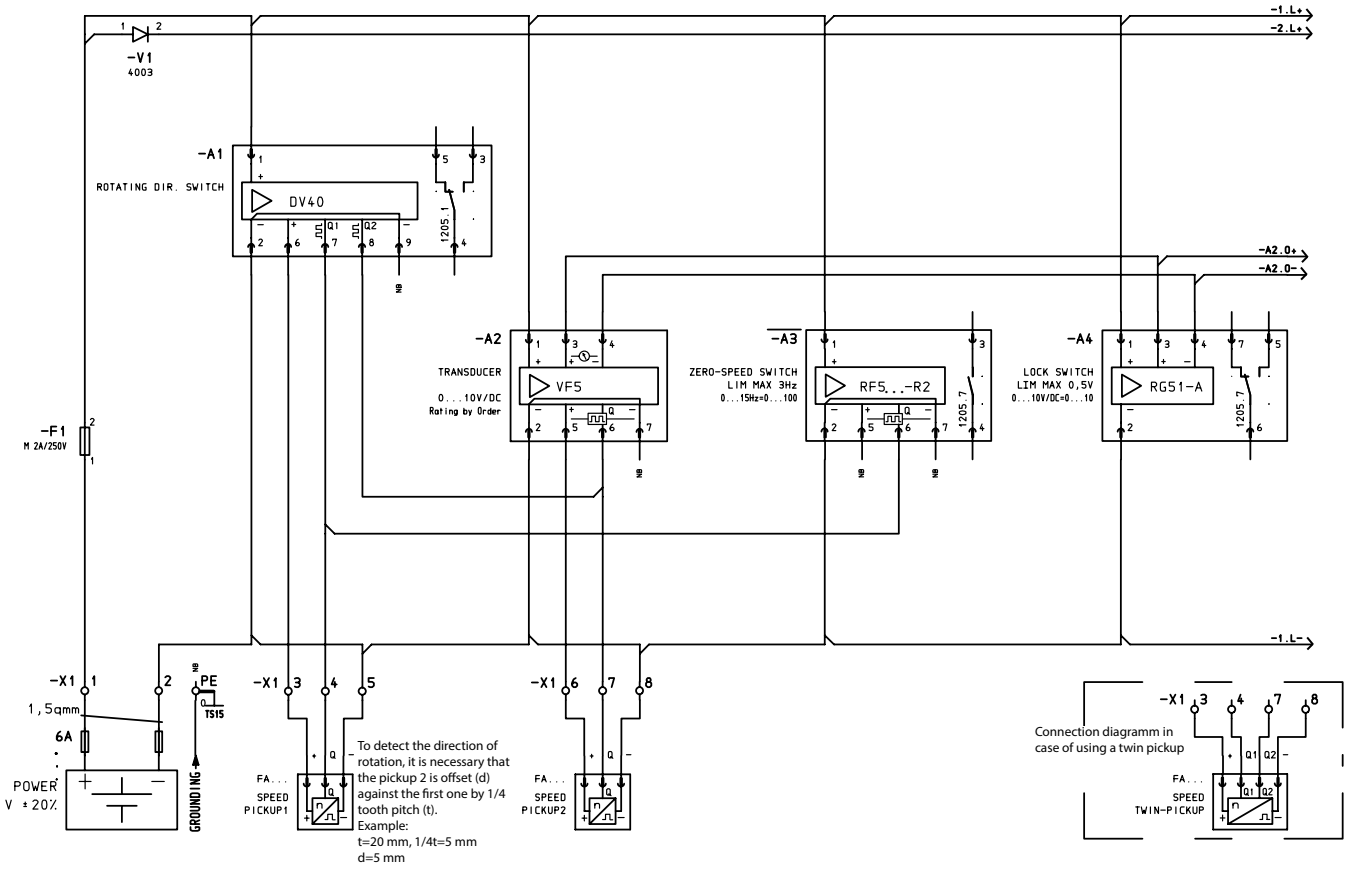


GDMA2-1 enclosed speed measurement system with one measuring transducer, a direction of rotation switch and two limit value switches (zero-speed switch, lock switch)

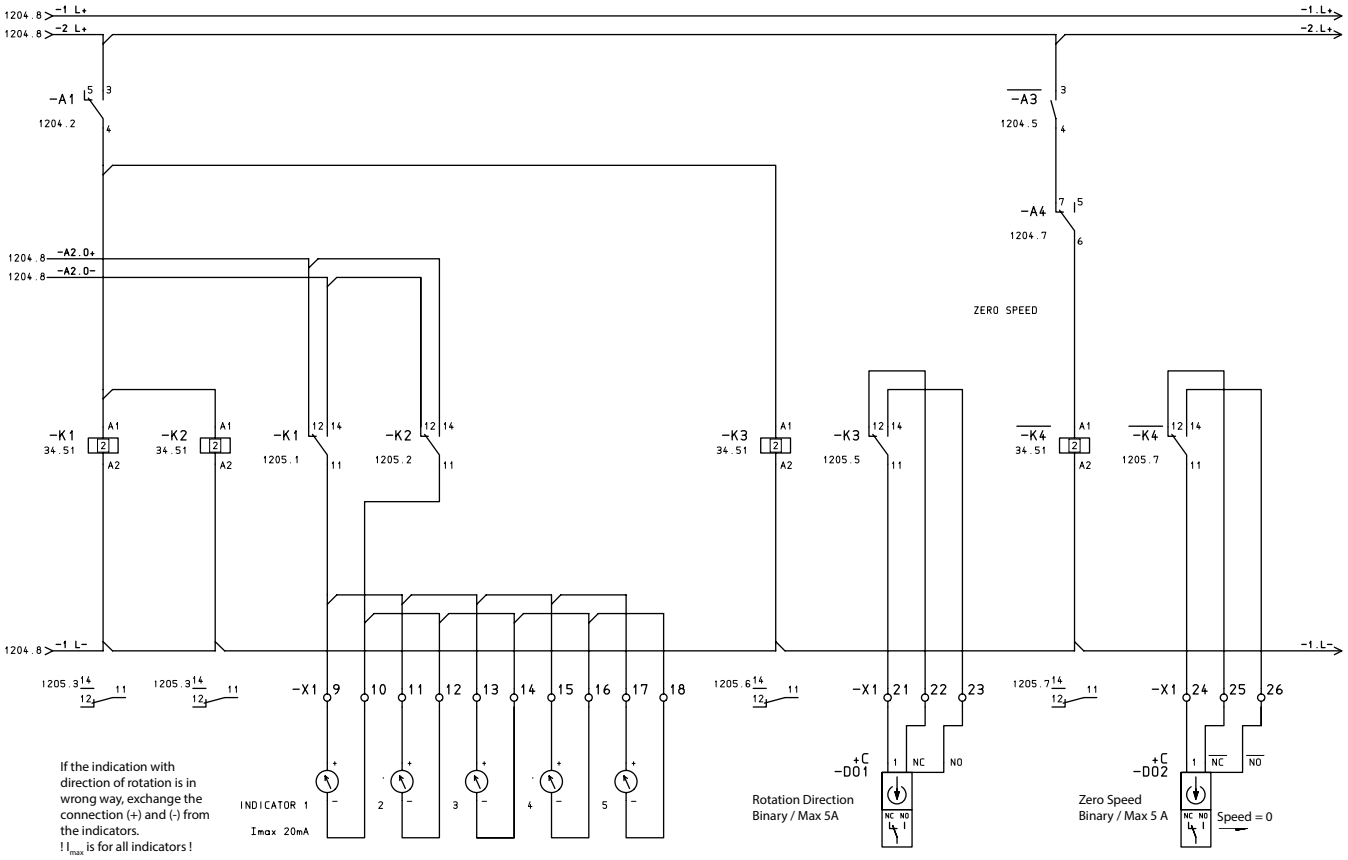


Designation	Component
-A1	Direction of rotation switch DV40 (no shipbuilding approval)
-A2	Measuring transducer VF5
-A3	Limit value switch RF5...-R2...
-A4	Limit value switch RG51-A
-K1, -K2, -K3	Relay N010-206

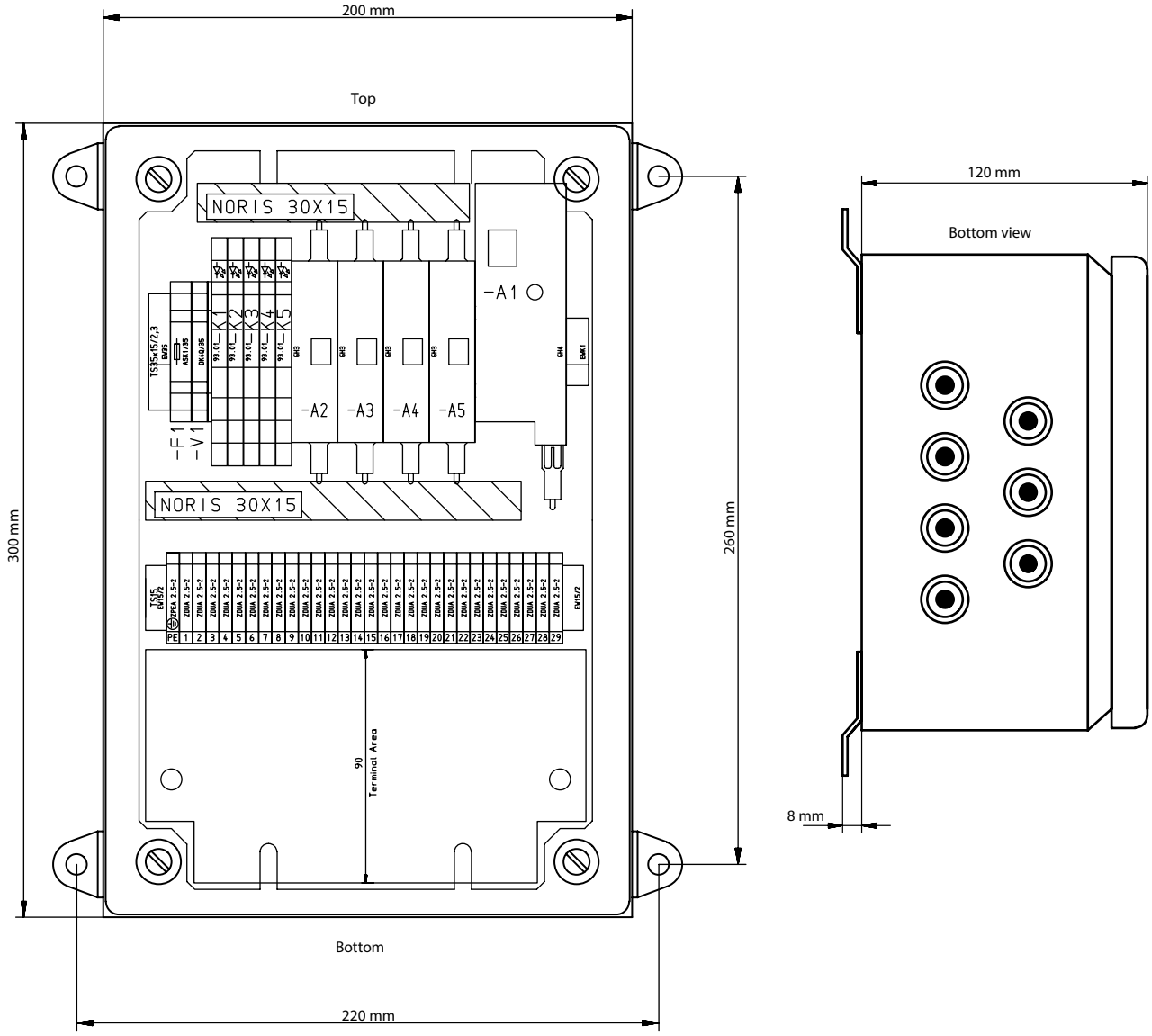
GDMA2-1 circuit diagram (part 1/2)



GDMA2-1 circuit diagram (part 2/2)

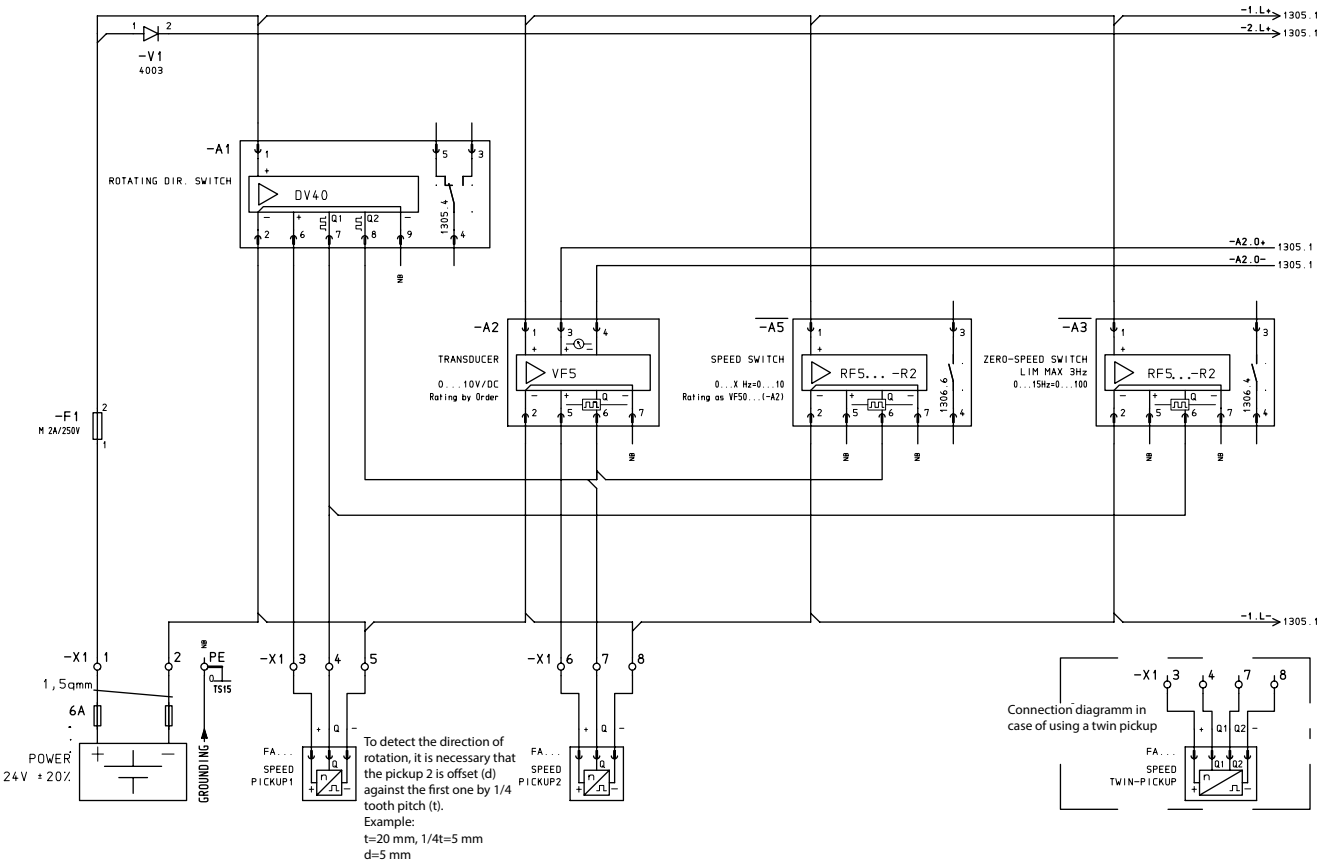


GDMA3-1 enclosed speed measurement system with one measuring transducer, a direction of rotation switch and three limit value switches (zero-speed switch, lock switch, speed switch)

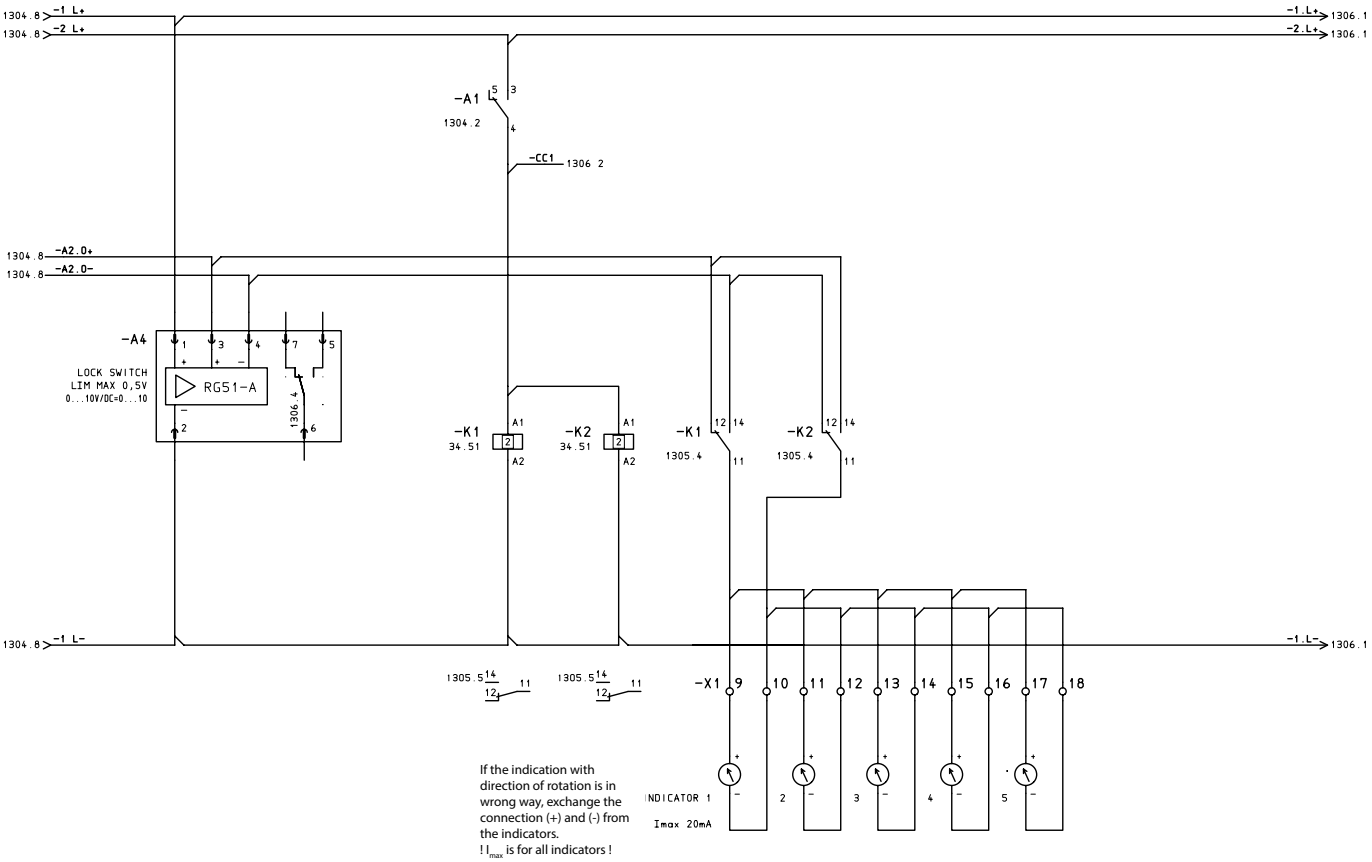


Designation	Component
-A1	Direction of rotation switch DV40 (no shipbuilding approval)
-A2	Measuring transducer VF5
-A3	Limit value switch RF5...-R2-...
-A4	Limit value switch RG51-A
-A5	Limit value switch RF5...-R2
-K1, -K2, -K3, -K4, -K5	Relay N010-206

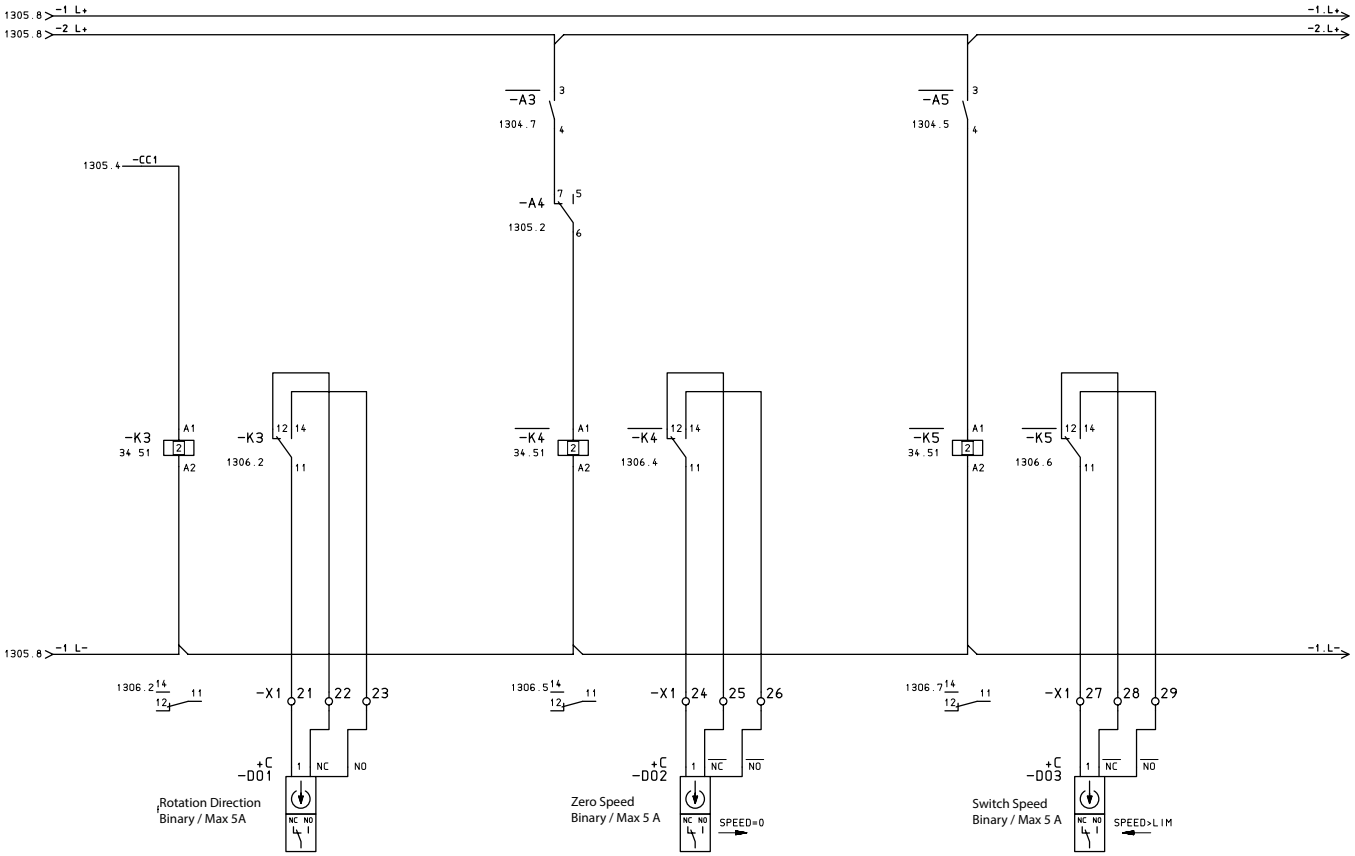
GDMA3-1 circuit diagram (part 1/3)



GDMA3-1 circuit diagram (part 2/3)



GDMA3-1 circuit diagram (part 3/3)



Speed measurement systems with tachogenerators

Speed pickups with tachogenerators and no supply voltage

On some systems, there is no power supply available for speed pickups at the measuring point. In such cases, tachogenerators are used because they do not require a supply voltage. Once again, this application allows you to create two kinds of speed measurement system: those with and those without a rotational direction detection function. Where necessary, limit monitoring (e.g. ignition speed, overspeed) can be implemented for both kinds of system by using limit value switches (e.g. type RW5).

Combinations of devices for speed measurement systems without rotational direction detection

The following types of tachogenerator output an AC voltage signal: GE121, GE122, GE120, GE14-09, GE14-10 and GE14-91. They can be used in conjunction with moving-coil indicators with no supply voltage, e.g. types PRQ96, RQ96 or R60.

Combinations of devices for speed measurement systems with rotational direction detection

Our GE1214 tachogenerators feature an integrated rotational direction detection function. They can be used in conjunction with moving-coil indicators with no supply voltage, e.g. type PRQ96.

Solution K

GE14/GE12x

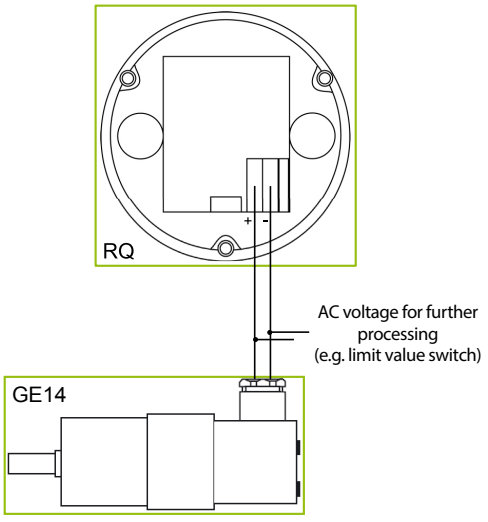
RQ 096

Solution L

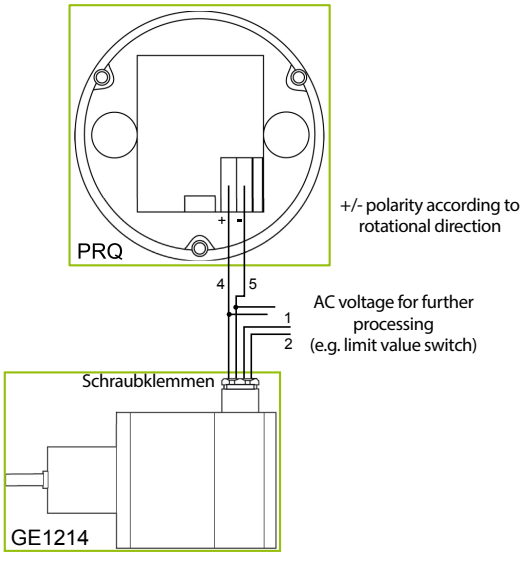
GE1214

PRQ 096

Connection diagram, example scenario involving GE14... und RQ96



Connection diagram, example scenario involving GE1214... und PRQ96



Modernisation of existing systems

We also modernise existing speed measurement systems by adding our components. Tachogenerators that are already in use can be connected to our modern electronic components. If line drivers are installed, even coil sensors with an AC voltage signal can be used together with our evaluation electronics. These sensors can also be connected directly to a compatible indicator featuring a frequency input (types NIx3-...-F2 or NIx3-...-FD2).

Similarly, analogue indicators from the NORIMETER 3 product family can be used in existing systems. Tachogenerators are often still present, for instance. Type GE1214 can, for example, be used with indicators of type NIx3-...-G0.

Accessories

Pulse bands for shafts

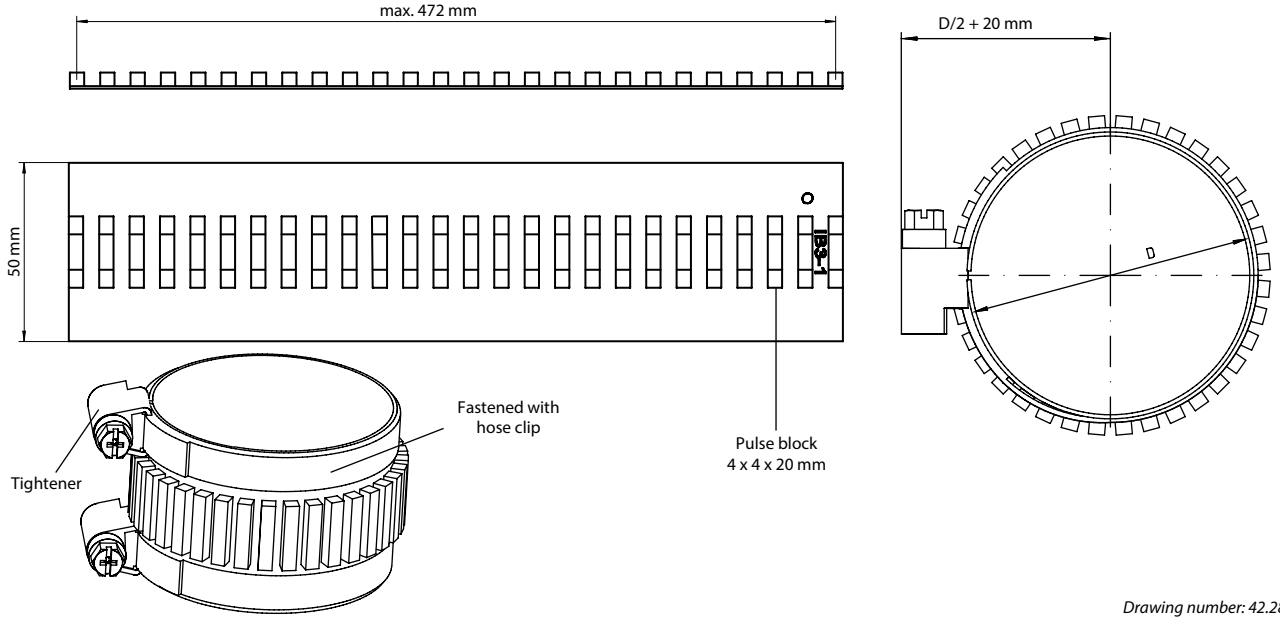
Pulse bands as a substitute for gearwheels

Pulse bands are a straightforward solution for contactless sensing in cases where no gearwheel can be accessed for this purpose. The pulse band is placed around the shaft and fastened with a tightener. A contactless speed sensor is aligned with the pulse band by means of a mounting device ***(see pages 31 and 32)*** and senses the welded-on pulse blocks.

Properties of pulse bands

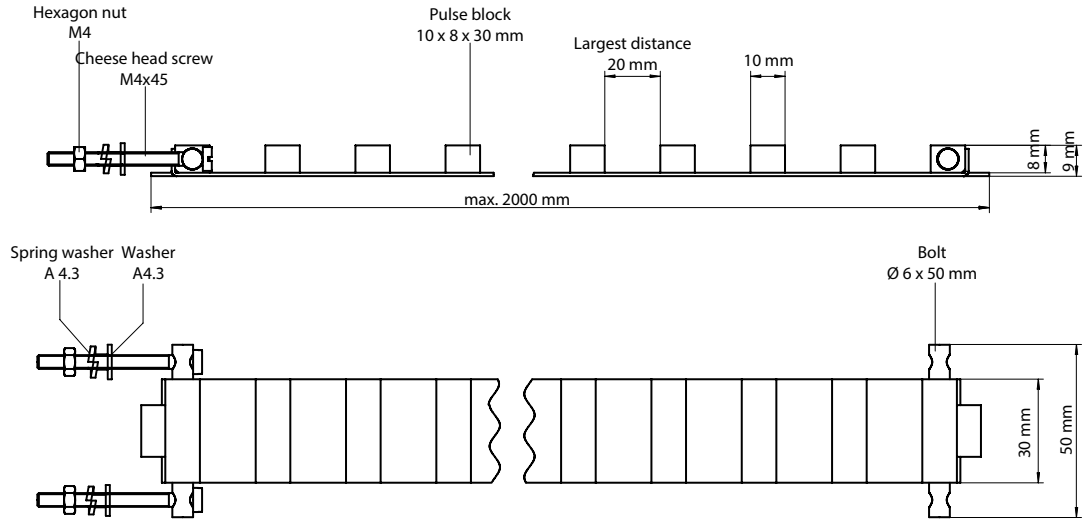
Pulse bands can be supplied for shaft diameters of 50 mm to 635 mm. In the case of larger diameters, split pulse bands can be used. The shaft diameter determines how many welded-on pulse blocks there are. To ensure that the pitch is even (particularly in the vicinity of the tightener), you must specify the shaft diameter precisely (+/- 0.3 mm) when placing your order. The maximum permissible circumferential velocity is 15 m/s. At velocities of 10 m/s or above, a cover must be installed for safety reasons.

Pulse band IB3-1 for shaft diameters of 50...150 mm



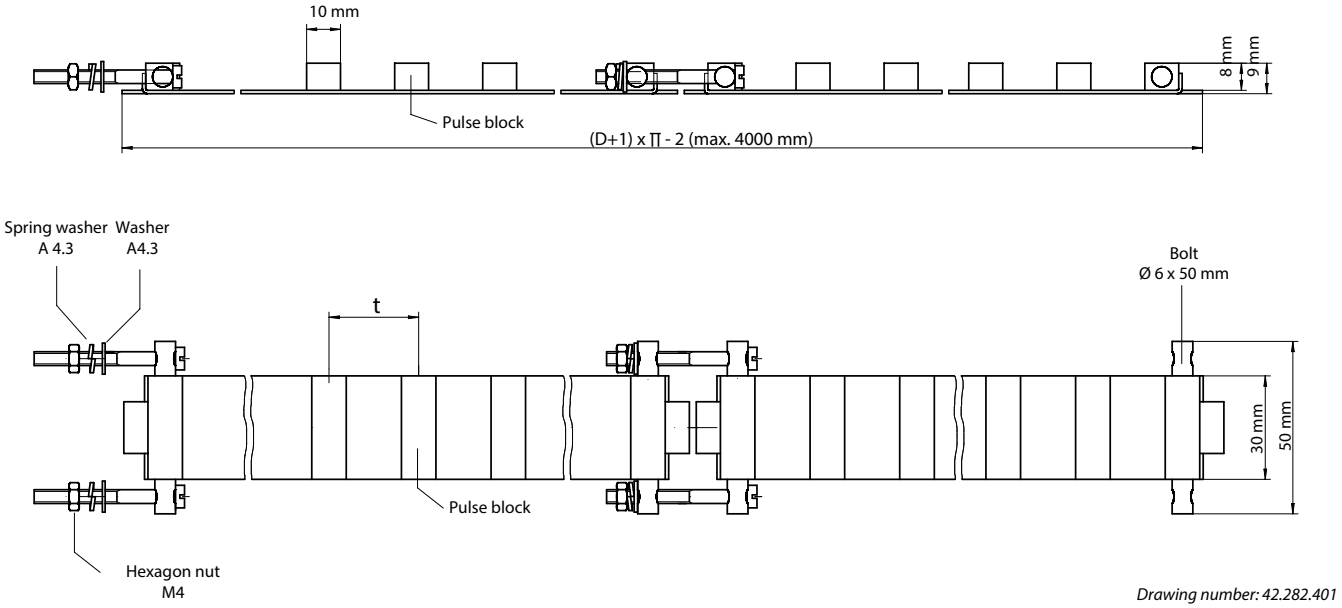
Drawing number: 42.282.6

Pulse band IB1-1 for shaft diameters of 150...635 mm



Drawing number: 42.282.5

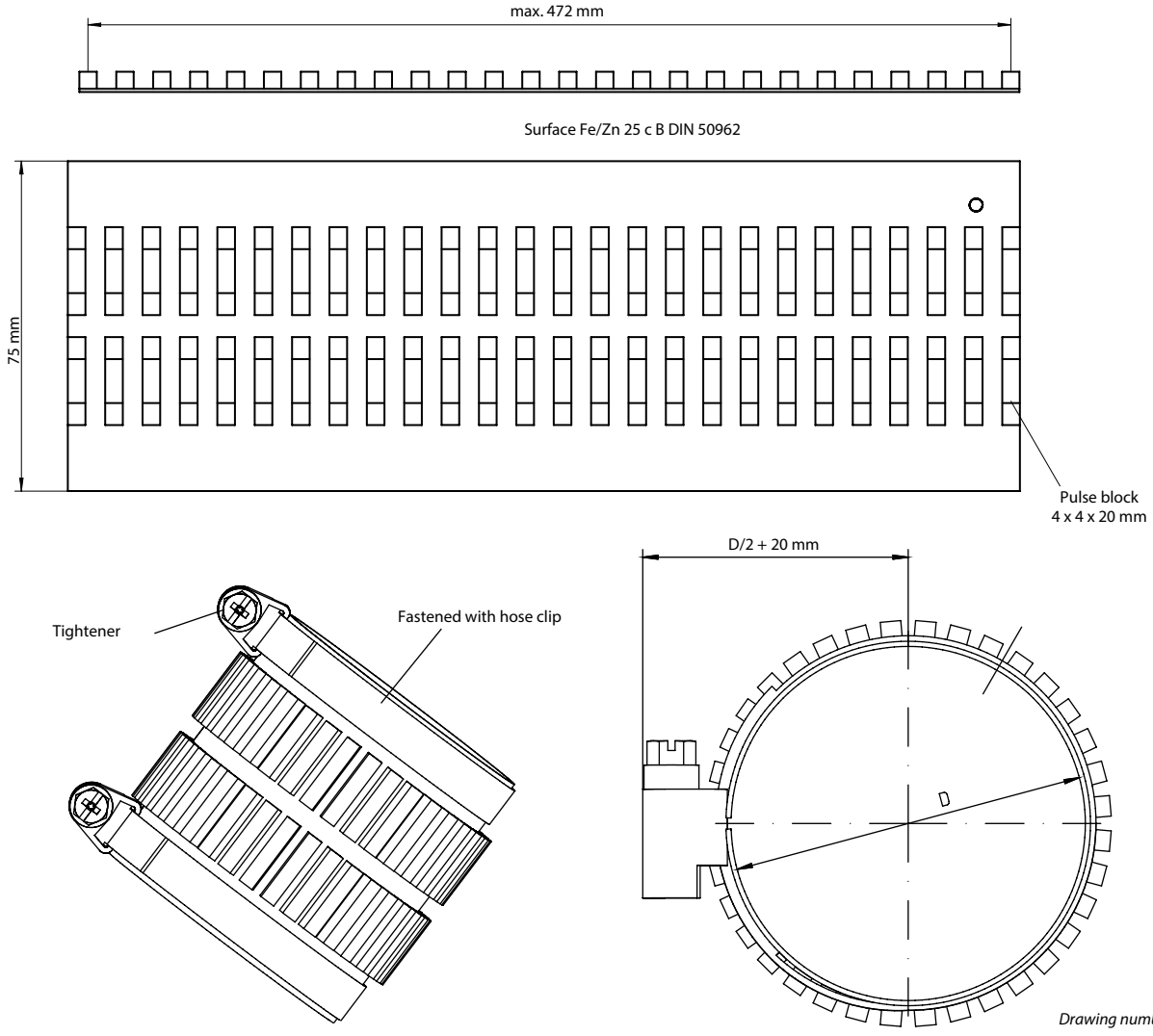
IB1-11 split pulse band for shaft diameters of 636...1272 mm



Drawing number: 42.282.401

IIB3-3 pulse band for shaft diameters of 50...150 mm

The IB3-3 pulse band is a double pulse band, which can be used for dual speed measurements (backup) or for speed measurement plus rotational direction detection. To enable speed measurement plus rotational direction detection, two 1-channel speed sensors are aligned with the double pulse band by means of a mounting device ***(see page 32)*** so that two output signals are generated with a phase offset of 90° between them.



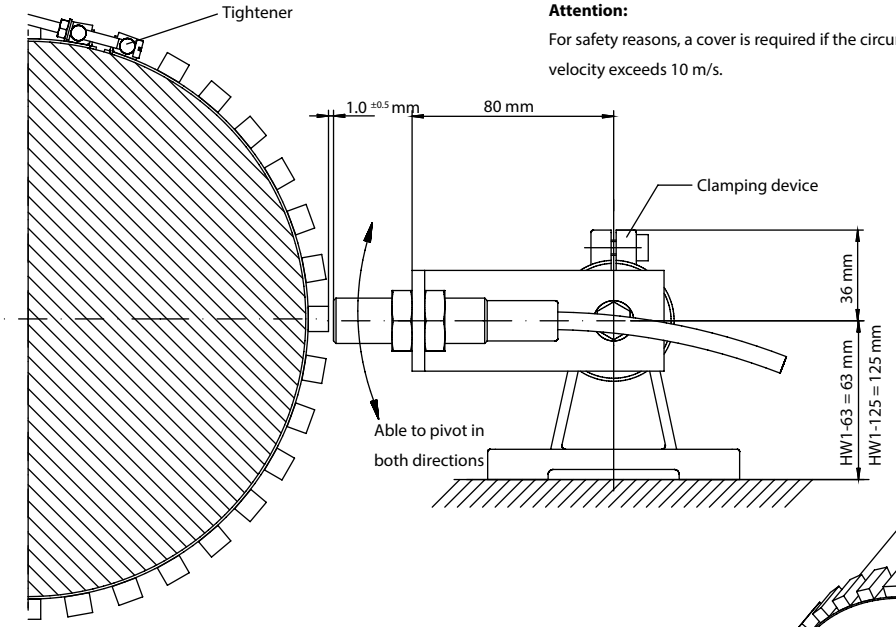
Drawing number: 42.282.62

Accessories

Brackets for speed pickups

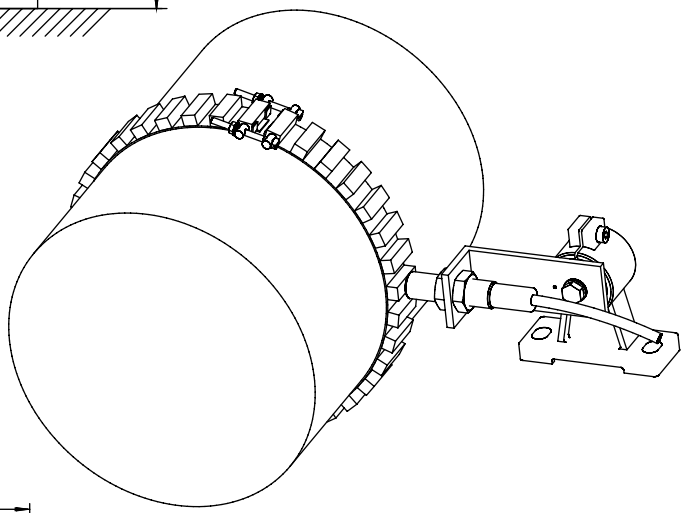
Mounting example involving mounting device HW1-63 or HW1-125, consisting of angle bracket WI31-1 and holder HA8-1 or HA8-2 plus one speed sensor

The HW1-… mounting device has been developed for use with speed sensors in conjunction with pulse bands or gearwheels. It is attached to an even surface directly on the shaft. The speed sensor (e.g. FAHZ11) is secured in the angle bracket by means of two nuts. To protect the speed pickup from damage, the bracket is pivot-mounted in the clamping spigot using a latching mechanism. This means that the pickup and angle bracket can pivot to the side if a foreign object enters the air gap between the shaft and pickup. In addition, the clamping device enables the speed sensor to be optimally aligned with the pulse band.

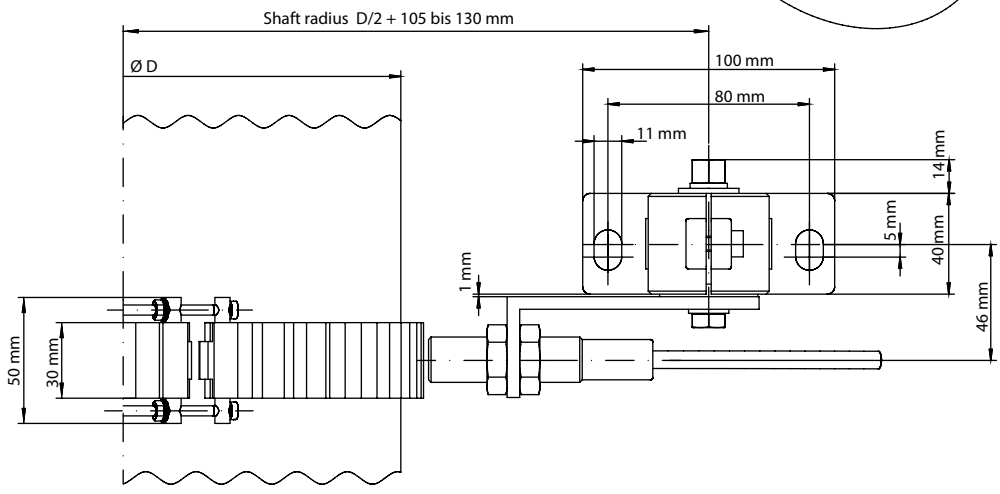


Attention:
For safety reasons, a cover is required if the circumferential velocity exceeds 10 m/s.

Mounting device type
HW1-63
HW1-125



During installation, it is important to ensure that the speed sensor points to the centre of the propeller shaft. The clamping spigot of the angle bracket can be rotated to facilitate this. Once the installation position of the speed sensor has been set via the clamping device, it must fixed.

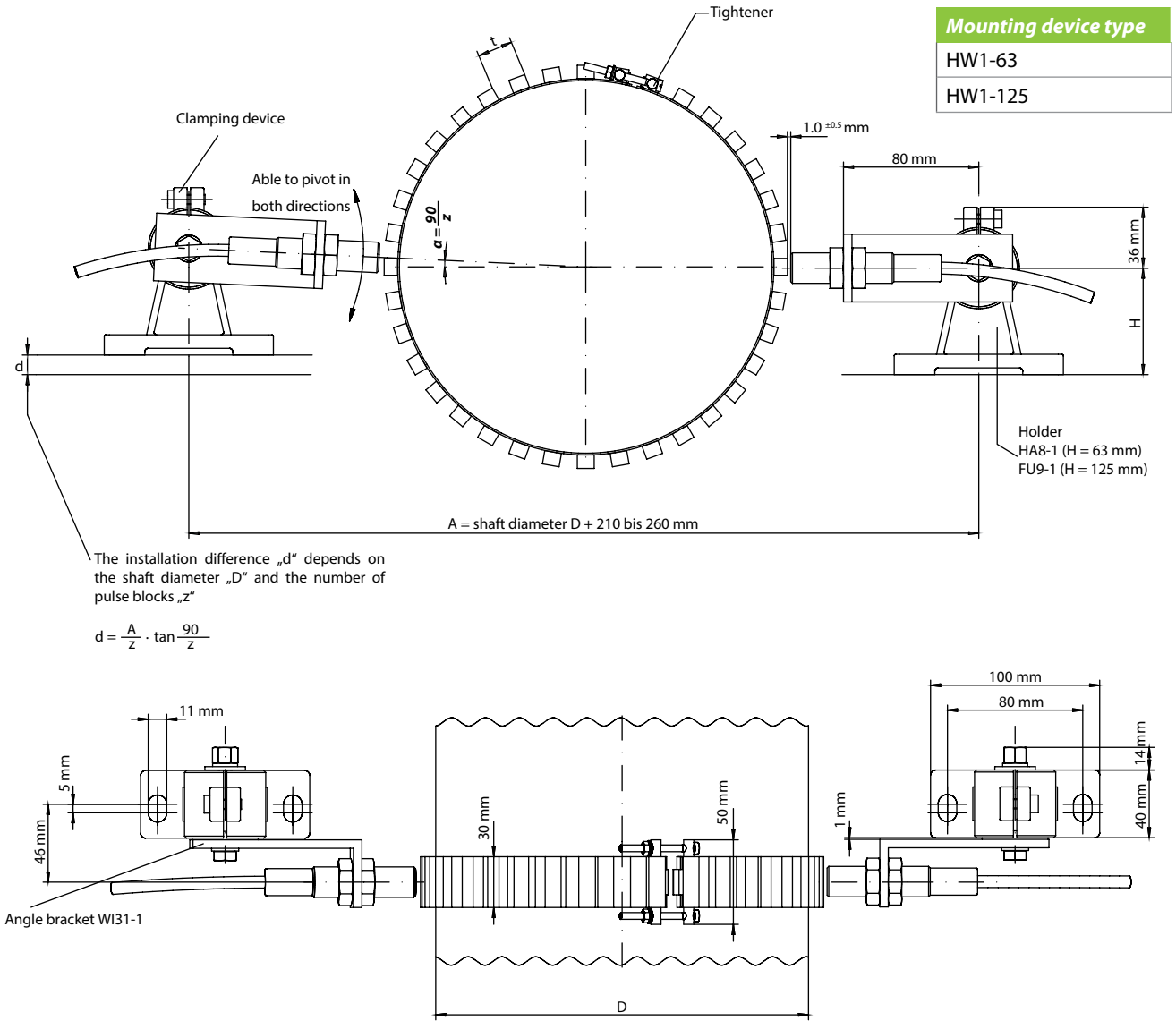


Drawing number: 42.282.21

Mounting example involving mounting device HW1-... (in duplicate), consisting of angle bracket WI31-1 and holder HA8-1 or FU9-1plus two speed sensors for direction of rotation detection

The HW1-… mounting device has been developed for use with speed sensors in conjunction with pulse bands or gearwheels. It is attached to an even surface directly on the shaft so that the pulse band or gearwheel can be scanned by sensors. Both speed sensors (e.g. 2 x FAJ11) are attached to the bracket by means of nuts. In order for the rotational direction to be detected, attention must be paid to the installation difference „d": The second sensor is installed so that there is an offset of 1/4 tooth pitch t between it and the first sensor. This results in a 90° phase shift between the two output signals (see example in figure below).

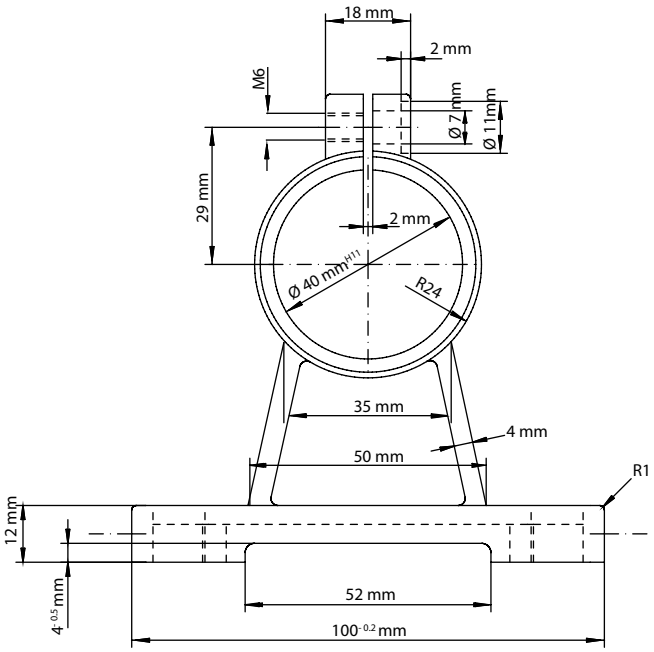
The bracket is pivot-mounted in the clamping spigot using a latching mechanism. This means that the pickup and angle bracket can pivot to the side if a foreign object enters the air gap between the shaft and pickup.

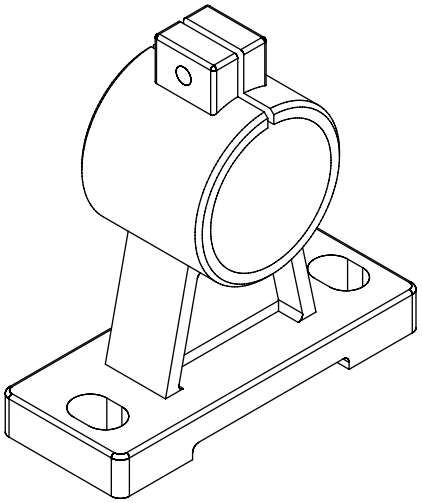


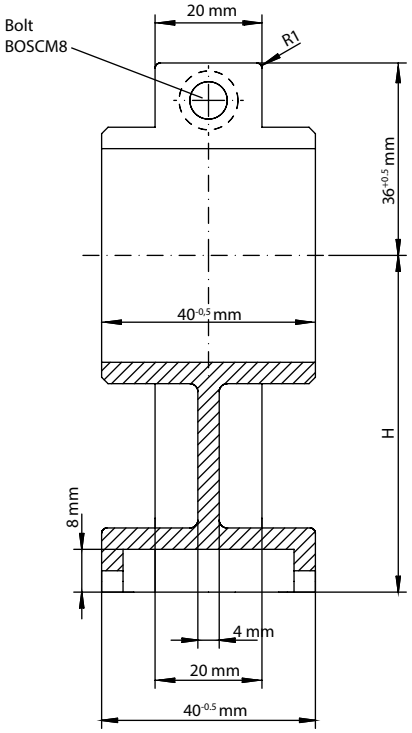
Mounting device type
HW1-63
HW1-125

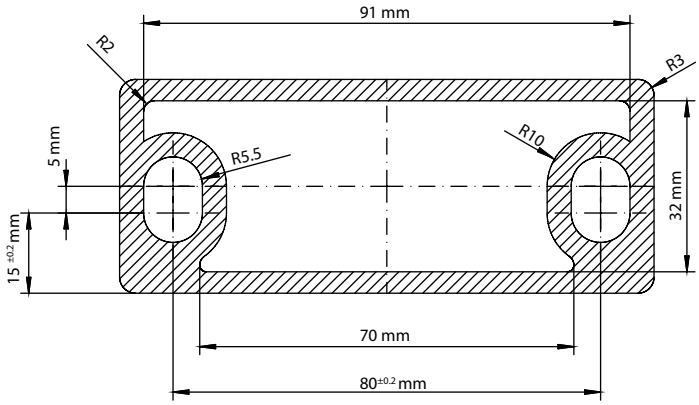
Drawing number: 42.282.22

Holder HA8-1 for tachogenerators (drawing FU9-1 on request)









Holder type	*Height H*
HA8-1	63 mm
FU9-1	100 - 125 mm

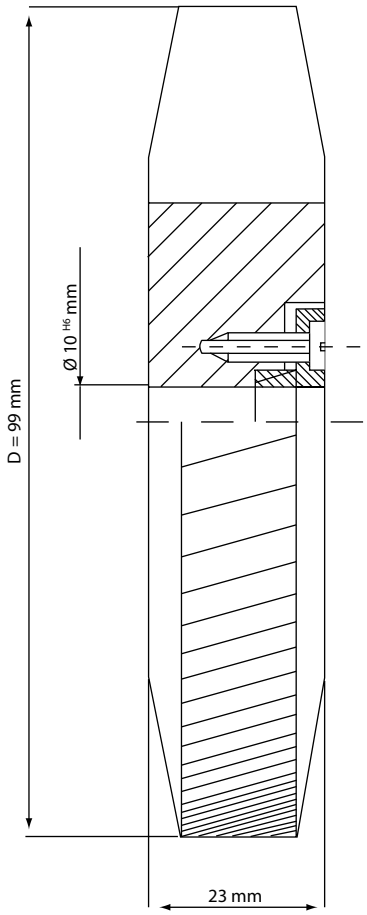
Drawing number: HA8-1
Drawing FU9-1 on request

Accessories

Friction wheel for shafts

Friction wheels are attached to the shaft and the speed is passed on to them mechanically. The speed is then recorded using a speed pickup (e.g. type NADS3), the pin of which is secured in the friction wheel by means of a clamping screw connection. A friction wheel can only be used if the shaft is freely accessible.

Friction wheel type
RR99

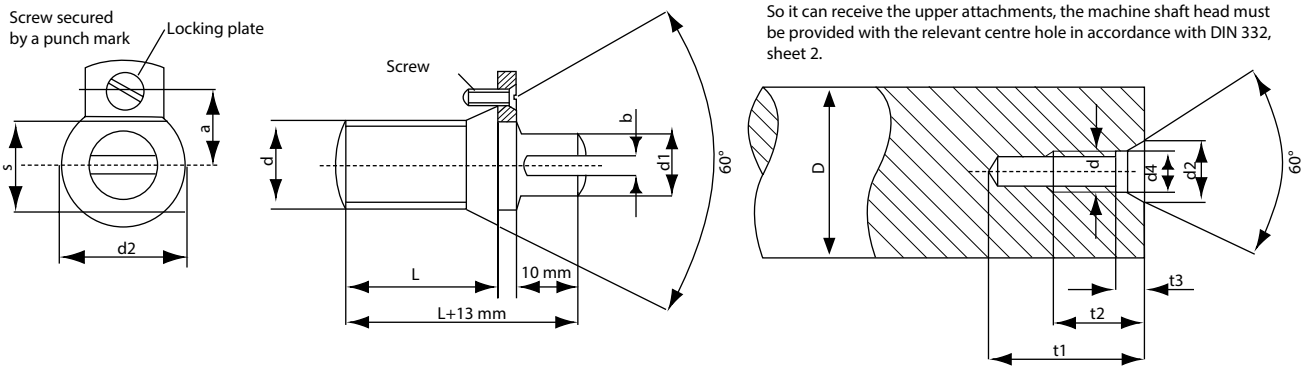


Drawing number: 55.311.

Accessories
Rubber coupling and attachment

Speed pickups are connected to the shaft by means of a rubber coupling and an attachment.

Attachment with locking plate

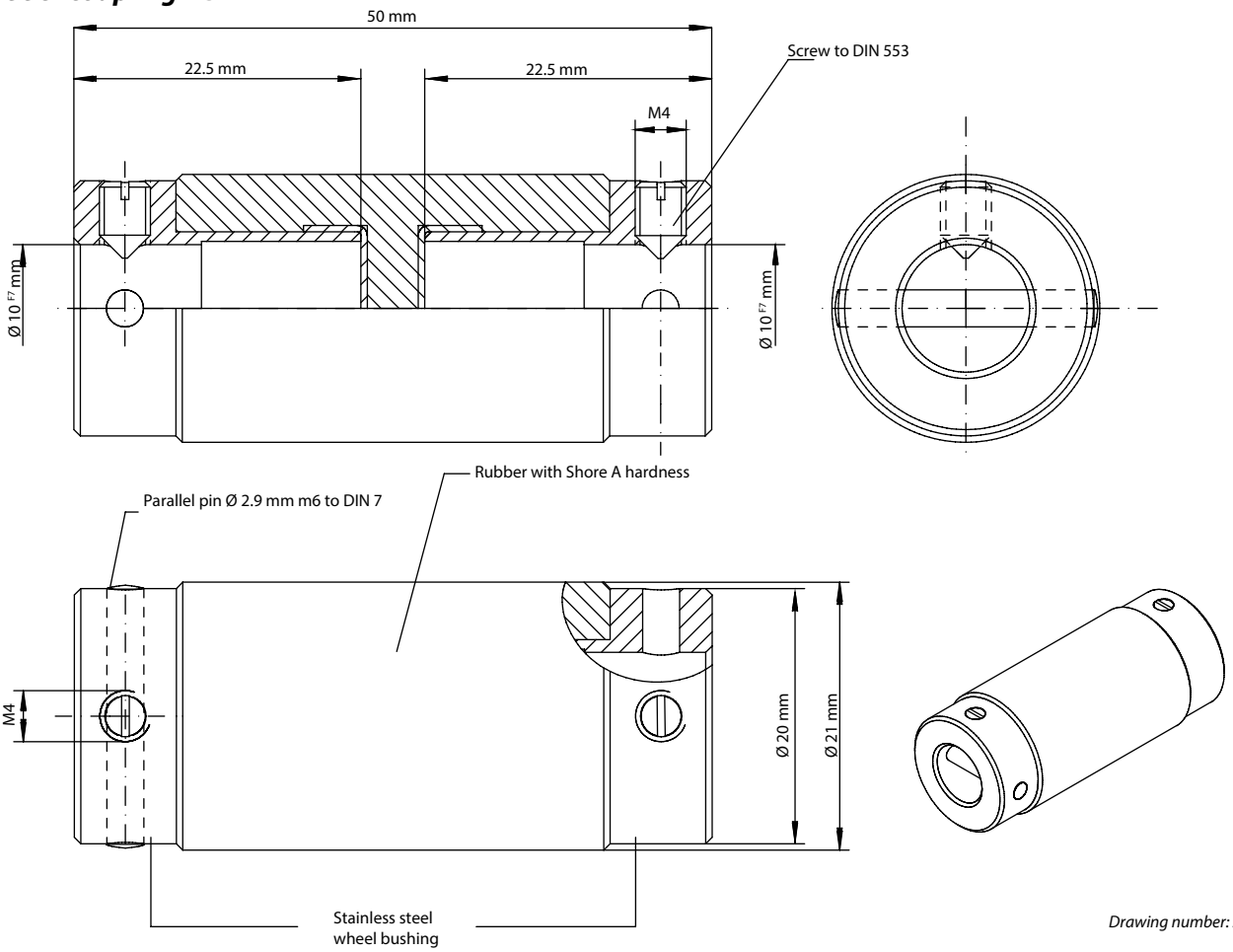


Drawing number: 53.001

d	*L*	*d2*	*s*	*a*	*Screw*	*Coupl.*	*d1*	*b*	*Order no.*
M12	24	18	14	11	M3x10 DIN63	Nr. 2	10	3,2	AN2-2G

Shaft Ø D	*d*	*d2*	*d4*	*t1*	*t2*	*t3*
von 22...30 mm	M8	12	8,4	25	16,5	5,5 $^{+0,5}$
über 30...38 mm	M12	18	13	38	26	8 $^{+1}$
über 38...50 mm	M16	24	17	45	32	10 $^{+1}$
über 50...85 mm	M20	29	21	53	39	12 $^{+1}$
über 85...130	M24	35	25	63	48	14 $^{+1}$

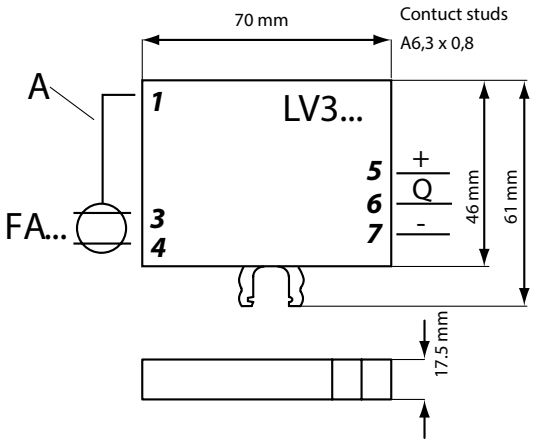
Rubber coupling KG2-1



Drawing number: 53.043

Accessories
Line drivers

Line drivers are used to boost the level of a signal provided by a speed pickup or tachogenerator and to produce a defined signal shape (square wave) through pulse shaping. This results in a higher signal-to-noise ratio during transmission, thereby increasing the transmission range.

Technical data for LV3 / LV31 line drivers	
Principle	Noise signals at 90 dB are filtered out by a symmetrical input. Line drivers increase the signal by 20 dB.
Connection	Ife the cable shielding is connected to the enclosure of the pickup, connectio A is not required. 
Mounting	TS32 mounting rail to DIN EN 50035 or TS35 top-hat rail to DIN EN 50022
Dimensions	See illustration above
Input	AC voltage or pulses: LV3: 20 mV...20 V, R_i = 10 kΩ LV31: 600 mV...60 V, R_i = 60 kΩ Overload capacity: 2.5 x
Output	Square wave signal
Supply voltage U_S	10...32 VDC, max. 5% harmonic content (from NORIS speed measuring transducer)
Switching voltage	Corresponds roughly to U_S
Max. switching current	50 mA
Frequency range	1 Hz to 10 kHz
Voltage peaks	Max. 2 ms, 2.5 x U_S
Current consumption	20 mA + switching current
Operating temperature	0...+70 °C
Storage temperature	-45...+85 °C
Climatic test	IEC 60068-2-30
Vibration rating	10 g IEC 60068-2-6, characteristic curve 2 (10...100 Hz)
Enclosure	Flame-retardant green Makrolon
Degree of protection	IP20, terminals IP00
Weight	< 100 g

Miscellaneous formulae and information concerning speed measurement systems

The formulae below are intended to assist with the process of dimensioning the speed measurement system.

Frequency, speed, number of teeth

It is important to specify the frequency for the purpose of calibrating the measuring transducers and limit value switches or so that the multifunctional device can be programmed. The frequency can be calculated with the following formulae:

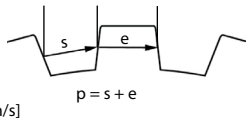
$$F = \frac{n \cdot p}{60} \qquad F = \frac{n \cdot z}{60} \qquad F = \frac{n \cdot k}{60}$$

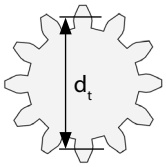
F = frequency in [Hz]; n = max. speed in [rpm], z = number of teeth, p = number of pulses, k = number of pulse blocks

Module size and circumferential velocity

If 2-channel sensors are used, the module size must be identified. The module size determines how the two sensor elements are positioned inside the sensor at the factory so that there is a phase offset of 90° between the two output signals. At circumferential velocities of 10 m/s or above, safety precautions must be taken (protective cover over pulse band).

$$M = \frac{d_t}{z} \qquad M = \frac{p}{\pi} \qquad V = \frac{d \cdot \pi \cdot n}{60 \times 1000}$$





M = module size; dt = pitch circle diameter in mm, z = number of teeth, p = pitch, V = circumferential velocity in [m/s]

Calculating the number of pulse blocks for the various pulse bands

We produce the pulse bands according to customer requirements so that they have the appropriate number of pulse blocks. If the length exceeds 635 mm, split pulse bands are used. If there is an uneven number of pulse blocks, two pulse bands with different lengths are produced. If possible, an even number of pulse blocks should always be selected and, likewise, two pulse bands of the same length.

For pulse band IB3-1 for shaft diameters of 50...150 mm

Optimum number of pulse blocks for pulse band $K = \frac{d_W \cdot \pi}{9}$

For pulse band IB1-1 for shaft diameters 150...636 mm

Optimum number of pulse blocks for pulse band $K = \frac{d_W \cdot \pi}{30}$

Maximum number of pulse blocks for pulse band $K = \frac{d_W \cdot \pi}{20}$

For pulse band IB1-11 for shaft diameters 636...1272 mm

If the shaft diameter exceeds 636 mm, split pulse band IB1-11 is used.

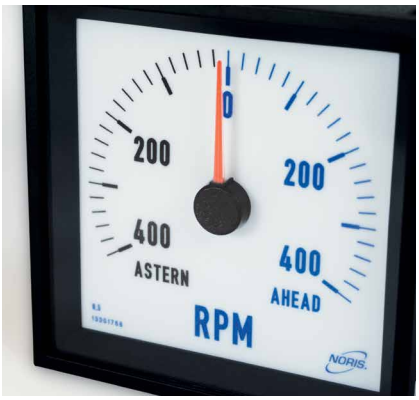
Optimum number of pulse blocks for pulse band $K = \frac{d_W \cdot \pi}{30}$

Maximum number of pulse blocks for pulse band $K = \frac{d_W \cdot \pi}{20}$

Ordering information

- Mounting situation: Space available? Accessories required? What accessories do you have already?
- One or two rotational directions to be indicated (rotational direction detection)?
- Speed of shaft? Diameter of shaft?
- How many speed indicators are required? Size of speed indicators?
- Are other speed-dependent contacts required (e.g. overspeed, ignition speed)?
- If there is a gearwheel: Number of teeth? Module size? What material is the gearwheel made of?
- Approvals? Classification?

Notes



NORIS Automation GmbH
Muggenhofer Straße 95
90429 Nuremberg
Germany

Tel.: +49 911 3201-0
Fax: +49 911 3201-150
info@noris-group.com
www.noris-group.com

Nuremberg Rostock Rotterdam Singapore Shanghai

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