High Accurate
Torque Measuring Flange
for rotating Shafts

with digital torque acquisition (16 Bit resolution)

Manner Sensortelemetrie GmbH
Dr. E. Manner

Characteristics:

* Range 5 Nm to 500 kNm
* Short construction technique
* High accurracy 0,05 %
* High speeds up to 20 000 rpm (dep. on size)
* High allowable radial load
* Very stiff
* No bearing
* High overload capacity
* Maintenance-free
* Integrated speed acquisition system (option)

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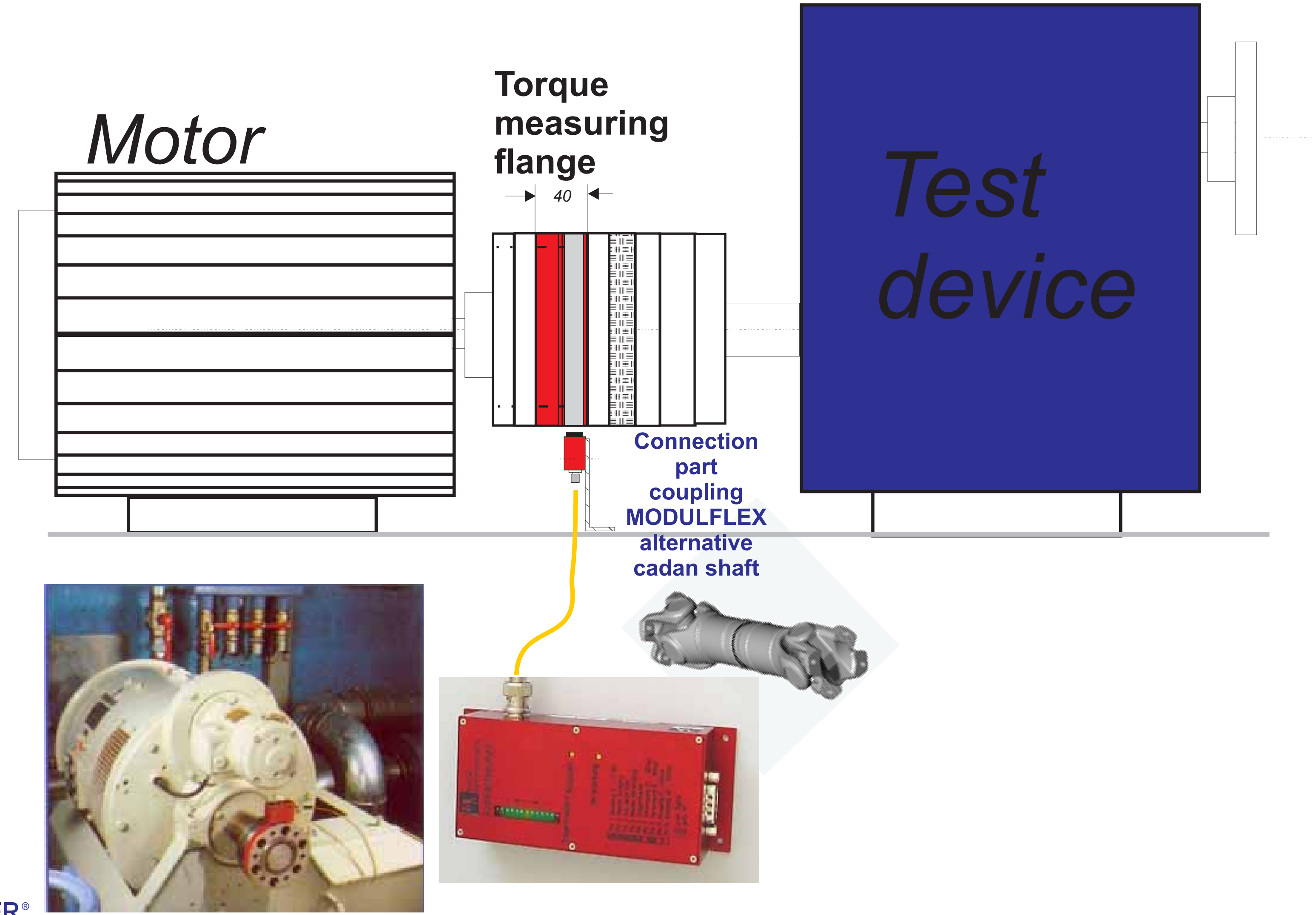
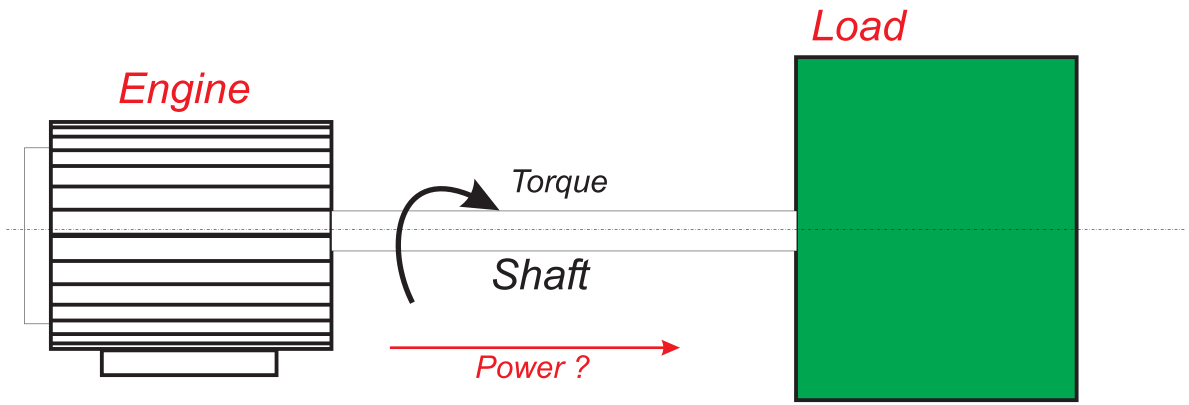
Mounting Example



The Use of the Torque Measuring Flanges

Typical use:

Determining power flow between drive and test device
e.g.: car - wheel, motor - gear, motor - extruder, motor - test stand, gas turbine - generator, etc.



Calculation of power flow

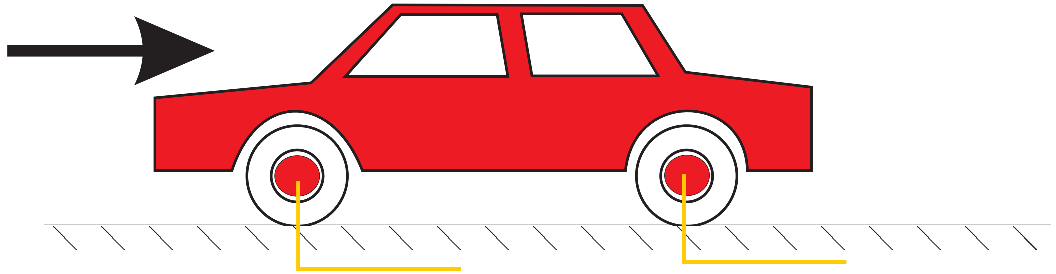
*Power = Torque * Speed / 60 * 2 * PI*

*P = M * N / 60 * 2 * PI*

P Power [Watt]
M Torque [Nm]
N Speed [rpm]
PI = 3,1414

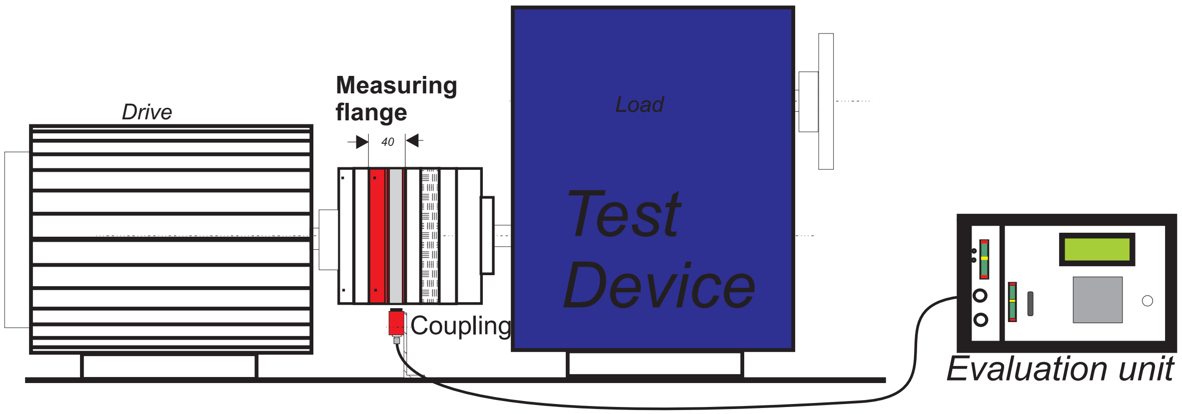
* Roll resistance acquisition / Air drag coefficient acquisition at the car

Big measuring range for normal operation and
Lowest signal values for roll resistance acquisition
> Measuring collars with high dynamic range (resolution)



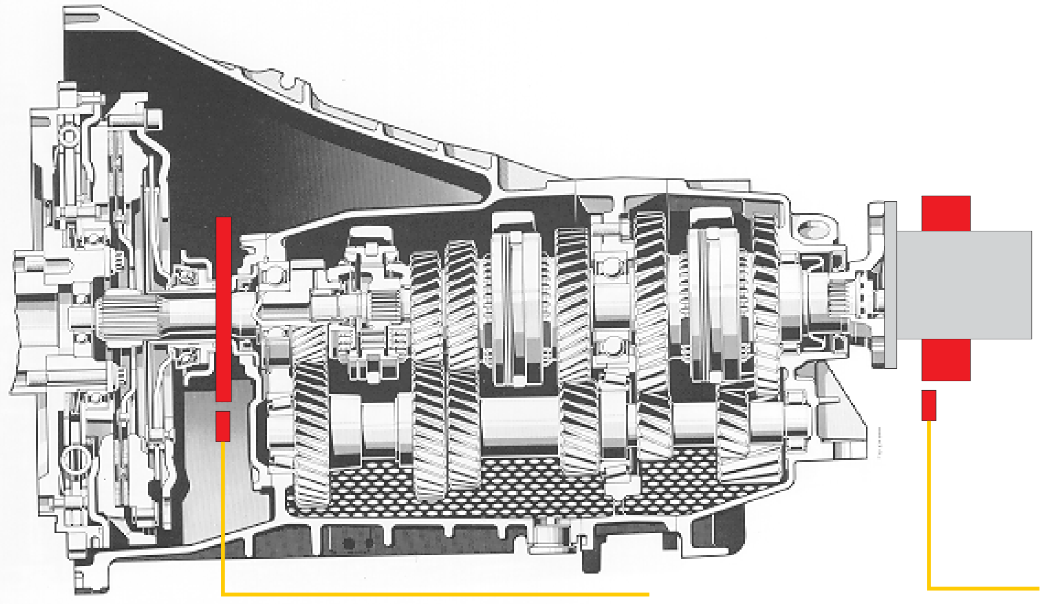
* Frictional resistance acquisition of bearings at the car

Big measuring range for normal operation and
Lowest signal values for frictional resistance acquisition
> Measuring flanges with high dynamic range (resolution)



* Mesuring the efficency of the gear better than 0,3 %

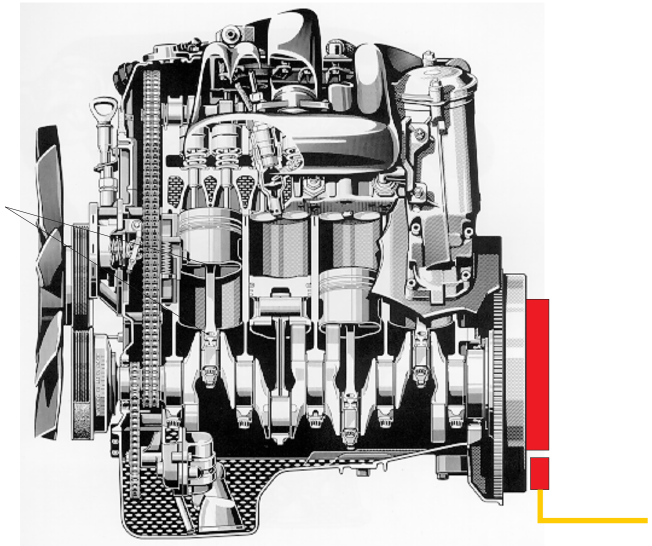
> Accuracy of the measuring unit better than 0,1 %



Basic conditions:

** Environmental temperature up to 150°C,*
** Oil*
** High rotational speed*
** Small mounting space*

*** Measuring the power of the engine**



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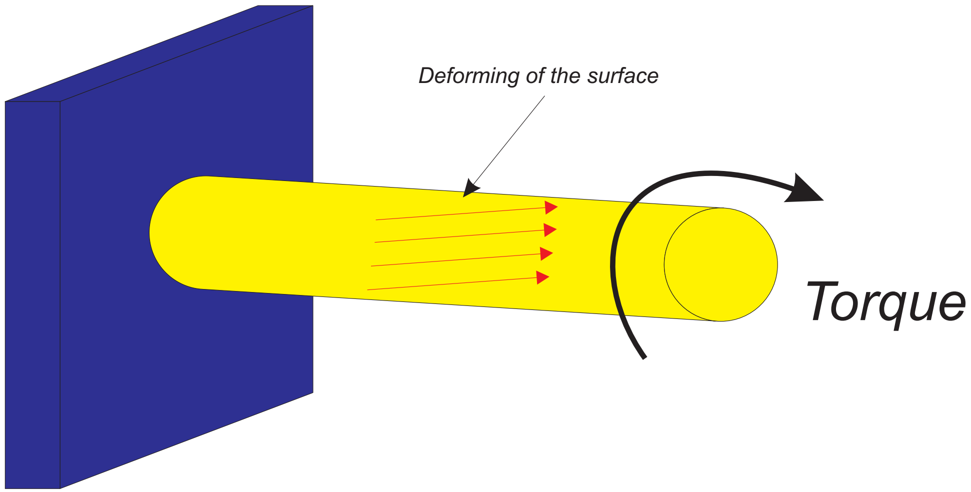
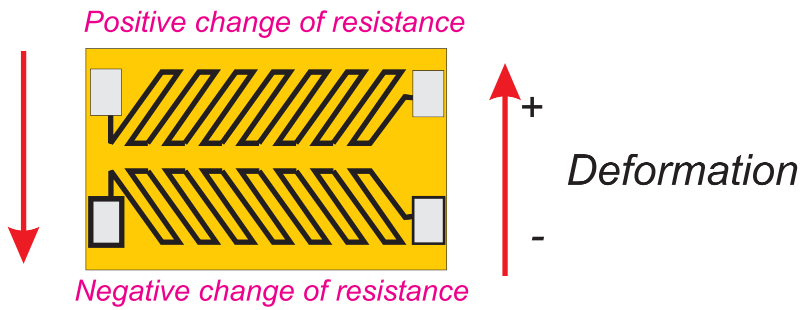
Classical solution

* Separate acquisition of the Torque and the Rotational speed and afterwards calculation of the power

* The rotational speed can easily detected via a toothed rim and an inductive sensor

* The torque is detected via the deformation of the shaft



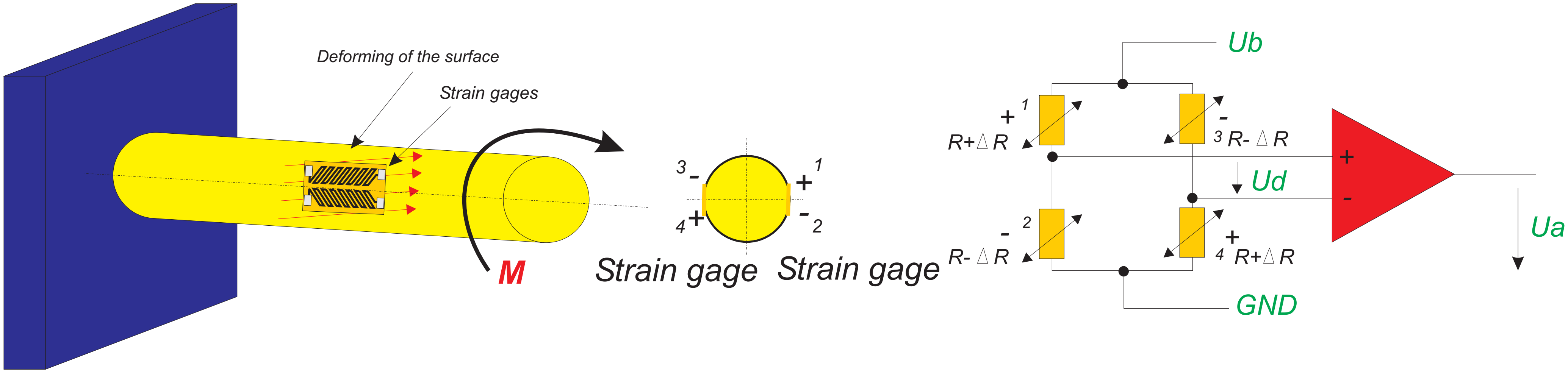


Strain gages for torsion

The deformation of the surface can be measured with strain gages.
The deformation of the surface is proportional to the applied torque.

The strain gage is based on a measuring grid. The resistance changes proprtional to the geometrical deformation.

Strain gageing of the shaft with 2V-type strain gages for torque acquisition (torsion)



For optimal temperature drift compensation normally 2 double strain gages are connected to a Wheatstone bridge configuration.
The Output voltage of the strain gage bridge Ud and the output of the measuring amplifiers Ua are proportional to the torque M

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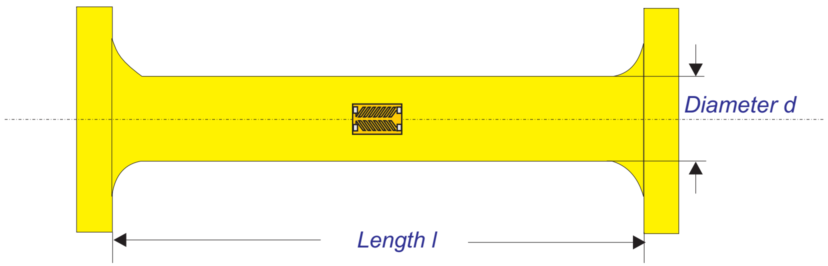
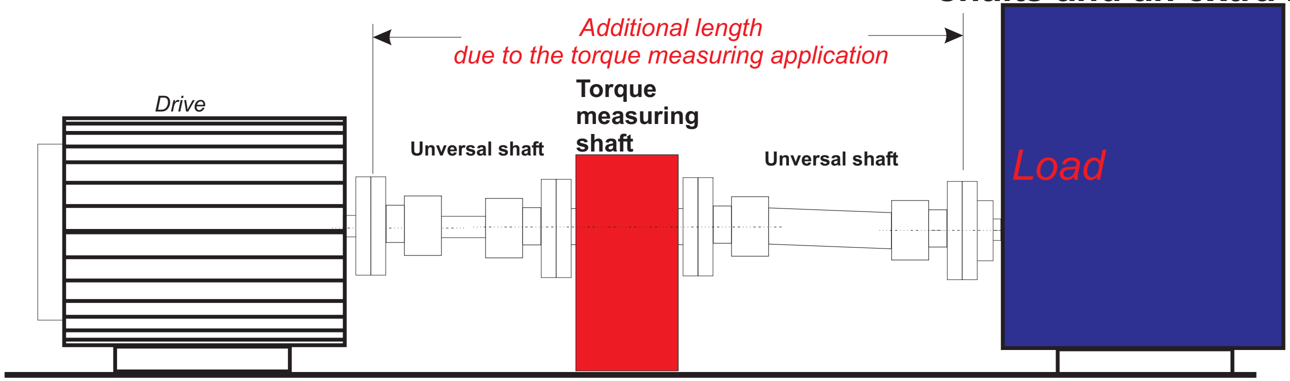
Classical Torque Measuring Sensor



* For a correct torque acquisition and low crosstalk sensitivity the **length l** of the measuring device should be 7 times bigger than the **Diameter d** of the measuring device.

* For this reason the volume of the torqe measuring device increases due to the measuring range.

* Due to the weight and the length a coupling with universal shafts and an extra bearing is often necessary.



Disadvantage of this application:

* Big mounting space, long design
* Weakening of the driving parts
* High frequent torque signals cannot be measured
* Lowering of the critical rotational speed (resonance) due to the long shaft
* Friction losses due to the bearing (not maintenance-free)
* Costs

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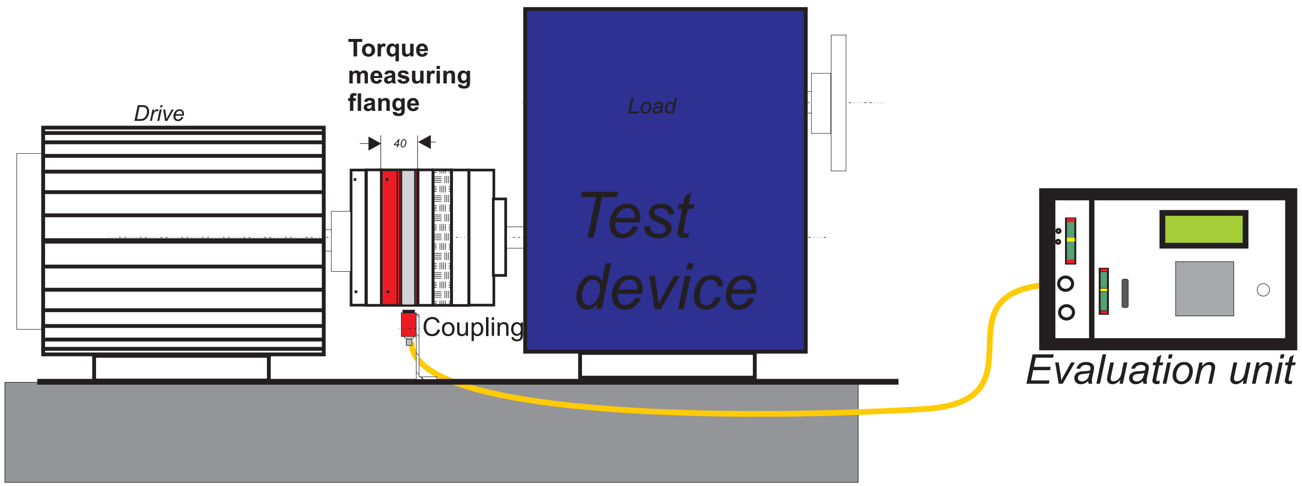
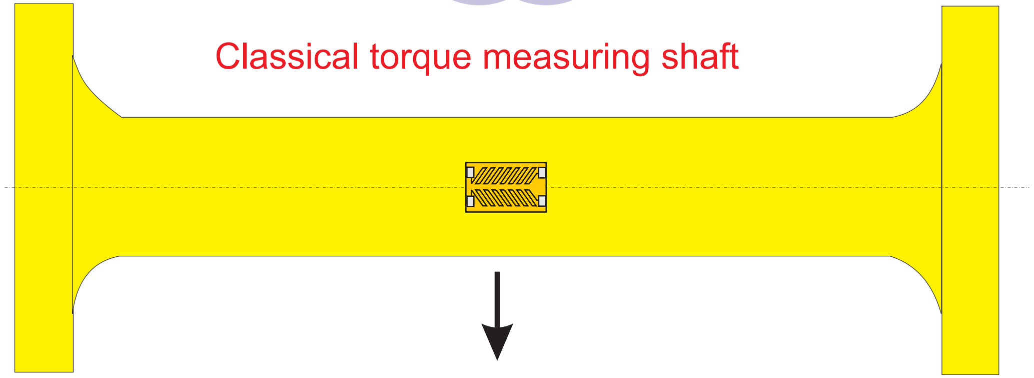
Today's requirements of the market:

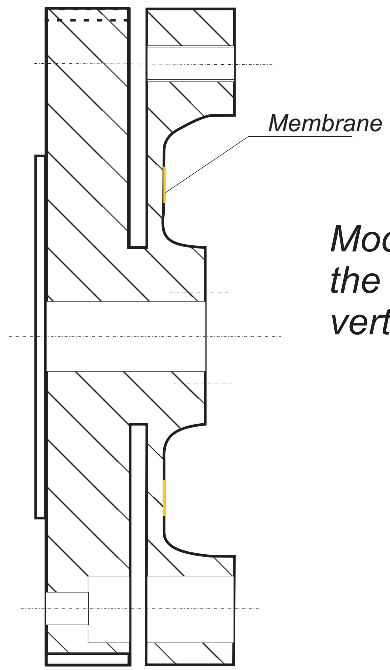
* Small design
* High accuracy
* Low weight
* Low inertia
* Stiff
* Without bearings
* High overload capacity
* Maintenance-free

Power transmission





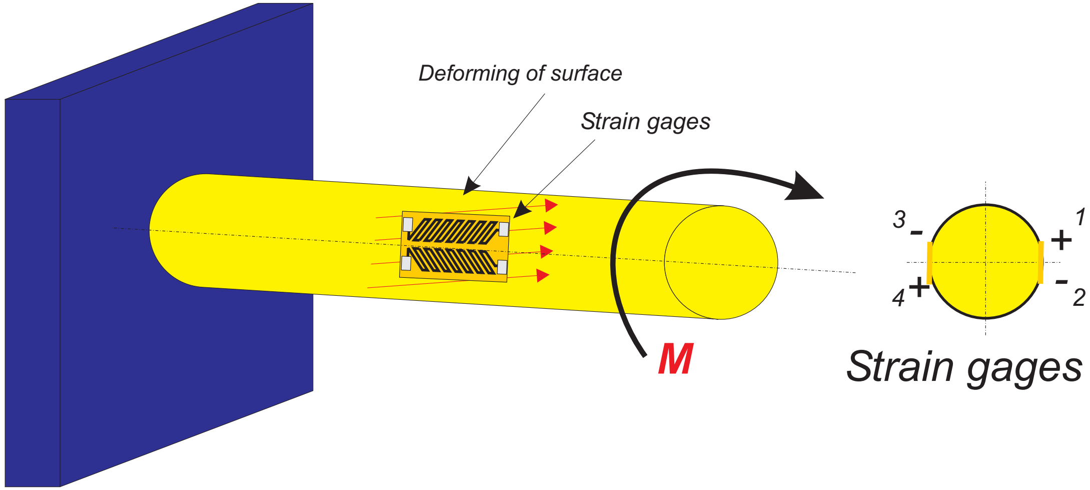
Patented torque measuring flange of Manner

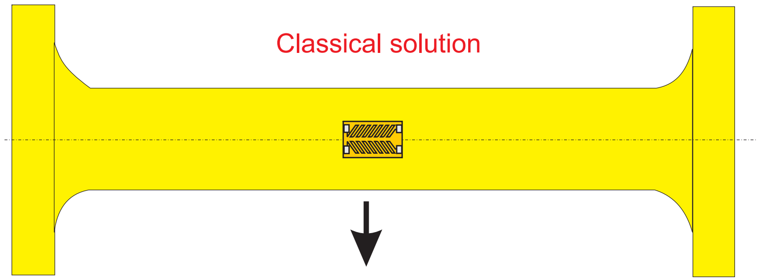


Mode of operation is the measurment of the shearing of a membrane that is vertically located

Detection Principle

Reliable and high accurate acquisition of torque with strain gages





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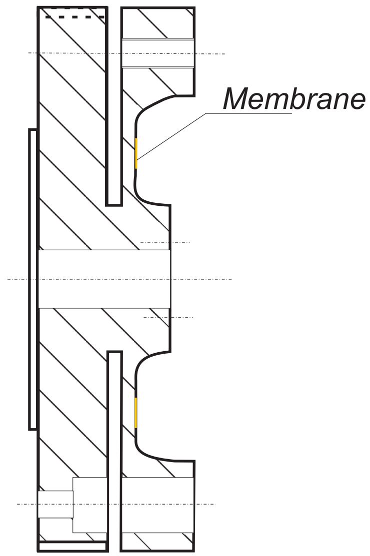

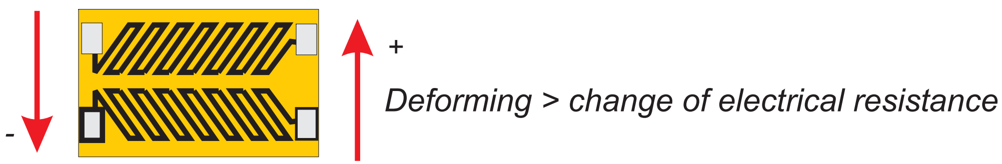

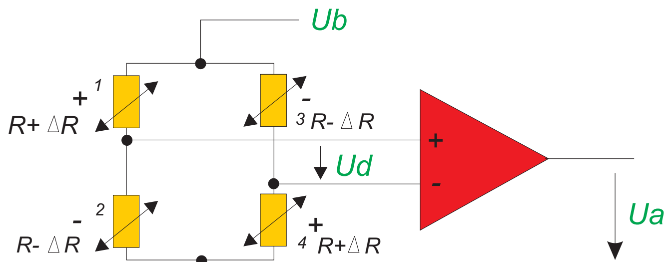

Wheatstone brigde

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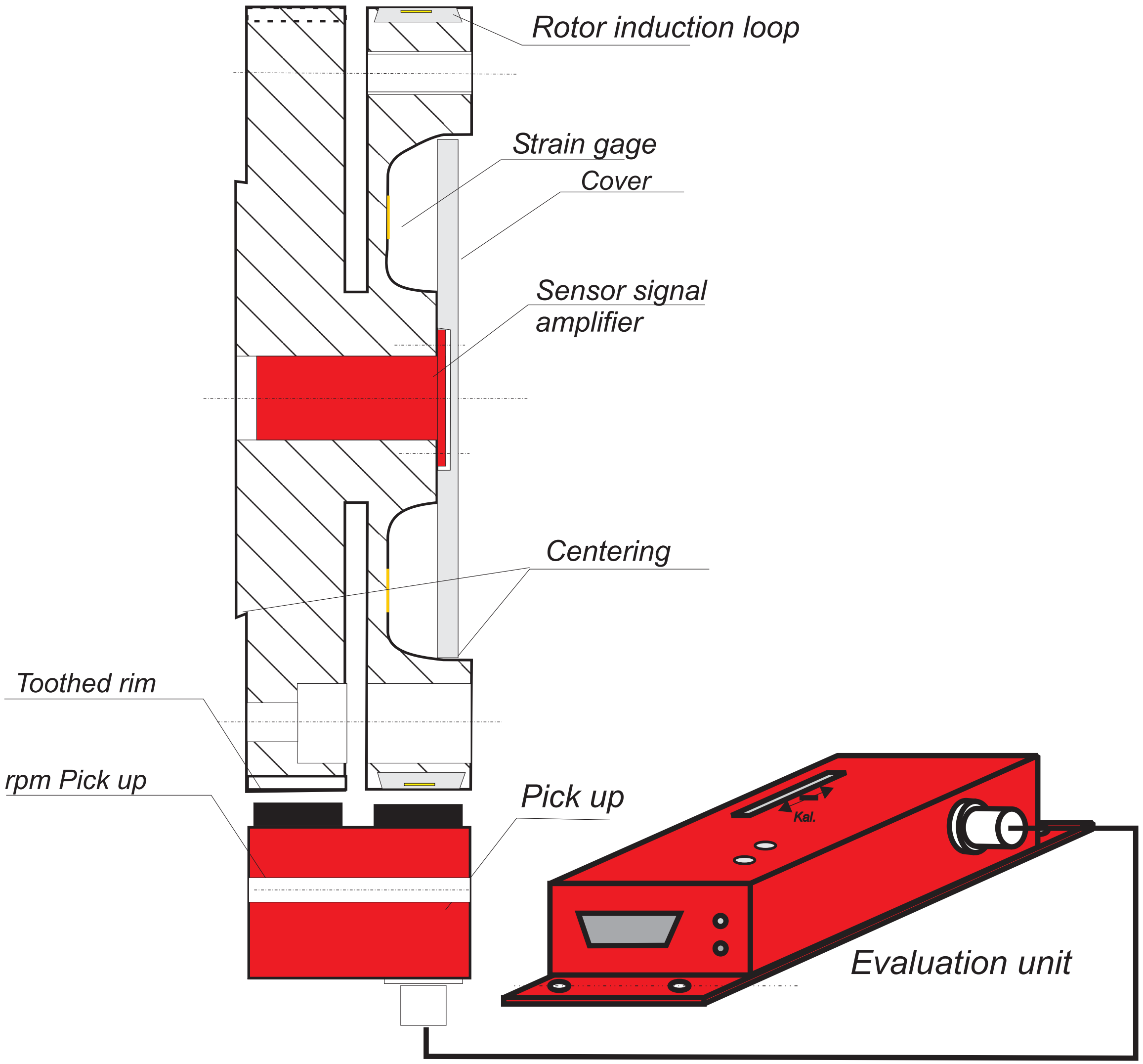
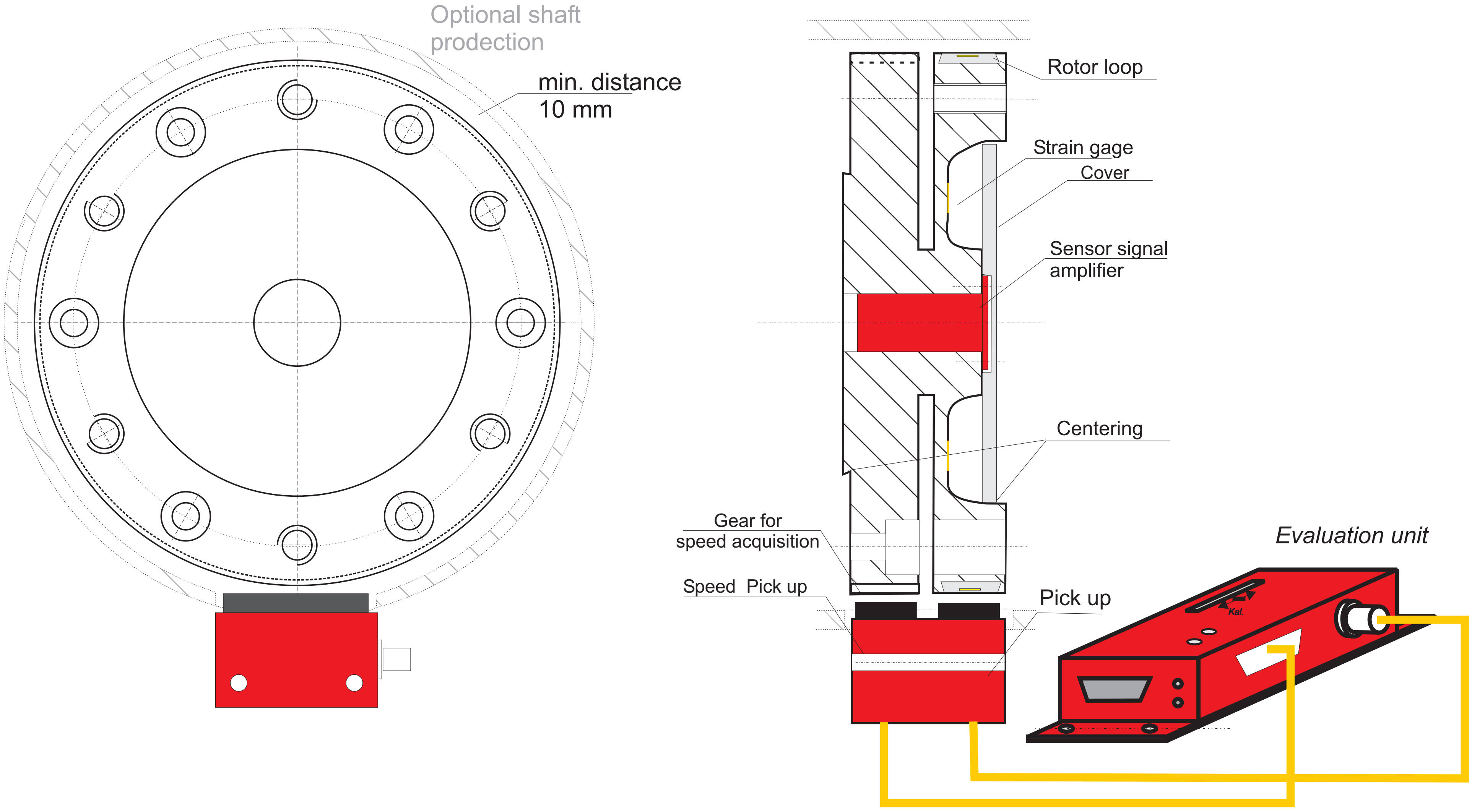
Principle of the Patented Torque Measuring Flange



Principle Buildup of Manner Torque Flange



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Characteristics of the Torque Measuring Flange

* Small design using a vertical measuring membrane
  45 mm at measuring range of 1 kNm

* High accuracy (linearity and hysteresis
  < 0,05 % at 1 mV/V

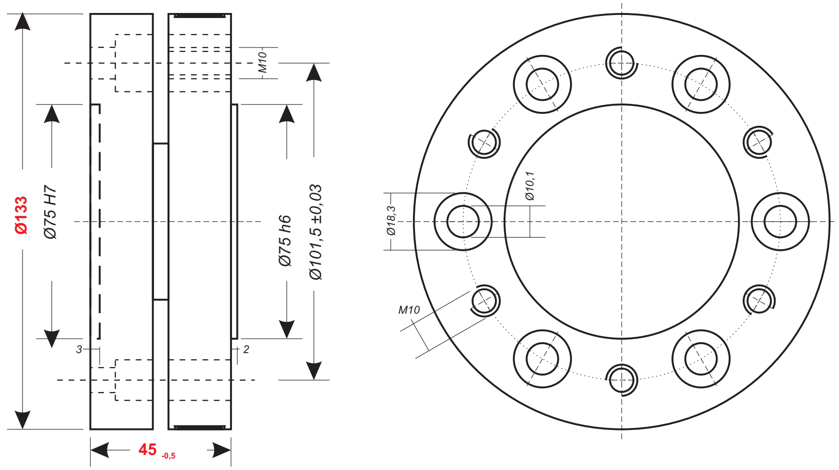
* Extremely stiff by the membrane
  typically 0,005° (suitable for high dynamic
  applications)

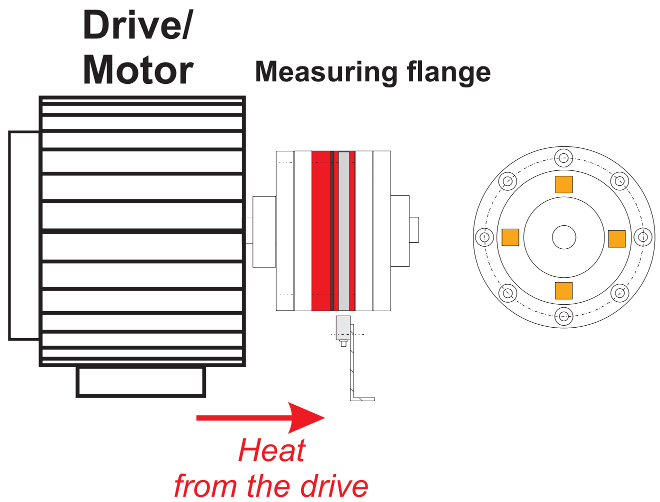
* Compact design D = 133 mm at 1 kNm
  guarantees low weight and inertia

* Low transient falsification of the signal due to
  high temperature changes by using the membrane

* Without bearings (low weight and
  small length possible)

* No force shunts because of the contact-less
  signal transmission





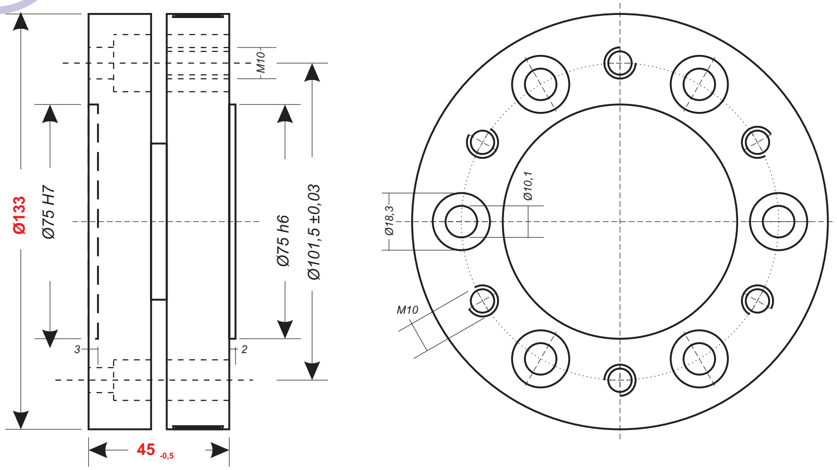
Characteristics of the Torque Measuring Flange

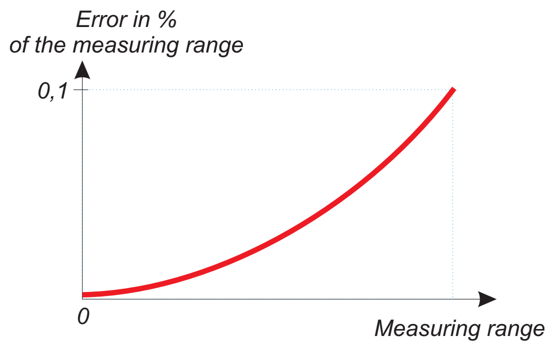
* **High overload capacity of 300 % by using a special measuring membrane**
  Nominal sensitivity 1 mV/V

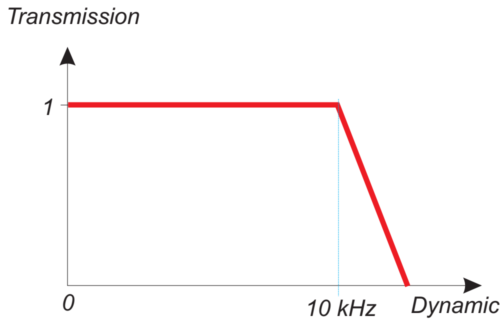
* **High stiffness for load changes (Test rigs for engines, injection pumps, etc. 2,5 times the nominal load)**

* **Measuring of the signal up to 10 kHz signal bandwidth for high dynamic signal analysis**

* **Compact pick up, no surrounding necessary**







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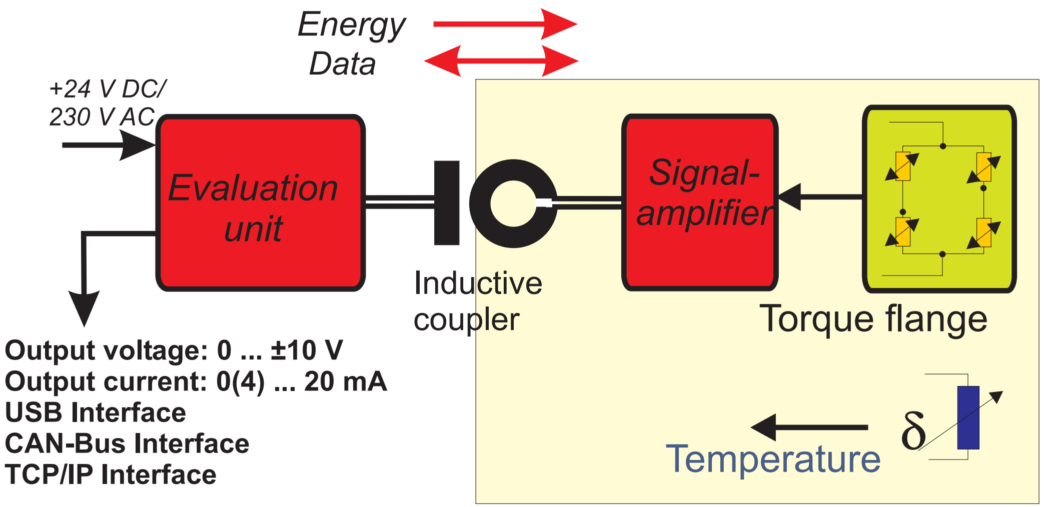
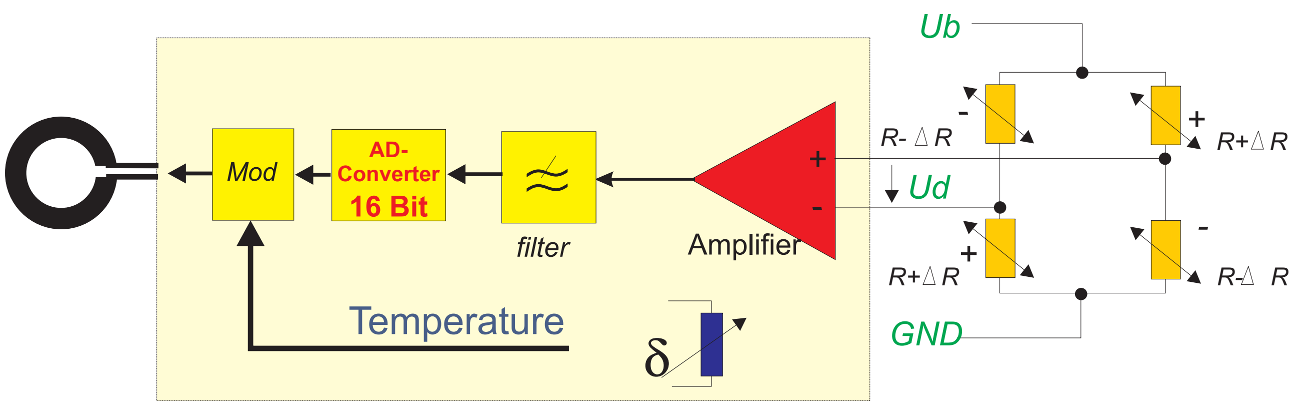
Contact-less Signal Transmitting with Sensortelemetry

* **Contactless and maintainance free signal transmitting (inductive transmitting of energy and torque datas and optional temperature data between rotor and stator**



* **Digitalizing of Torque values with 16 Bit resolution**
* **High precise amplifier**
* **Linearity better < 0,02 %**
* **Zero/gain drift < 0,002 %/°C**
* **EMC proofed according to EG regulation 89/EWG, CE**
* **Temperature acquisation for bearing temperature monitoring (option)**



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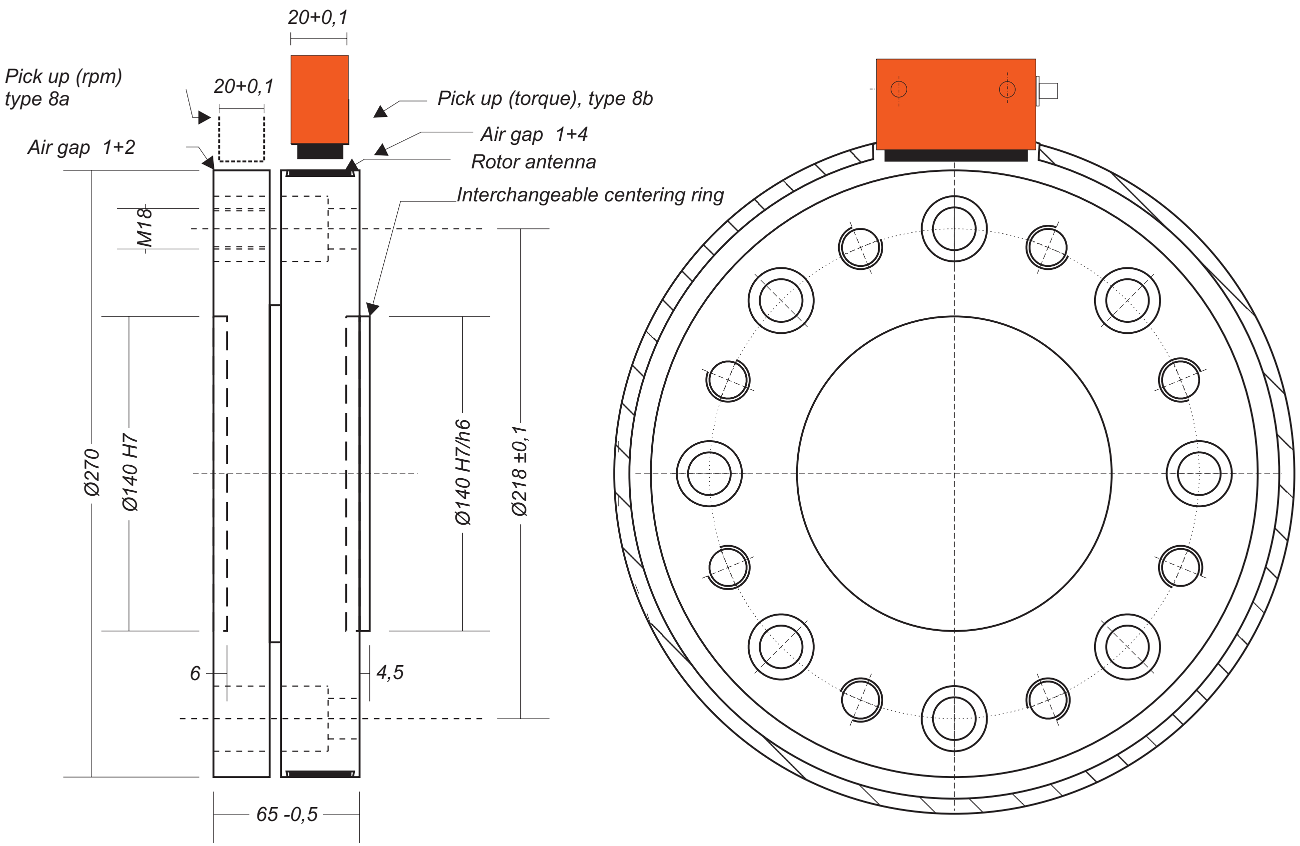
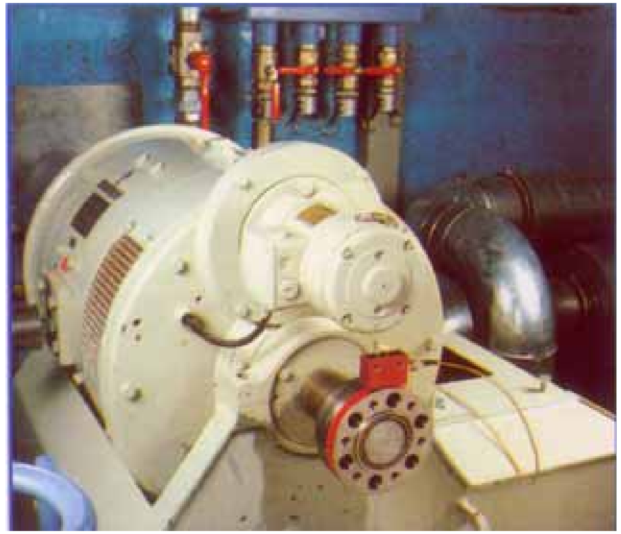
Data Acquisition

* Contact-less transmission of measured data with the principle of Sensortelemetry enables simple detection and a small pick-up **(no problems with shaft protection)**





*** Contact-less transmission of sensor signals with the principle of Sensor telemetry guarantees trouble-free signal transmission even under extrem EMC conditions (variable frequency drives)**

*** EMC proofed according to EG regulations 89/EWG, CE**

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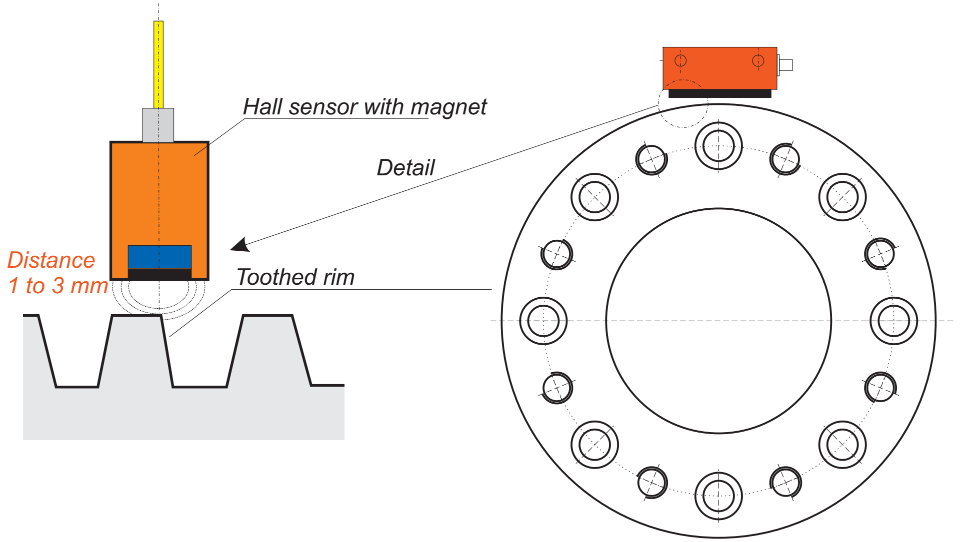
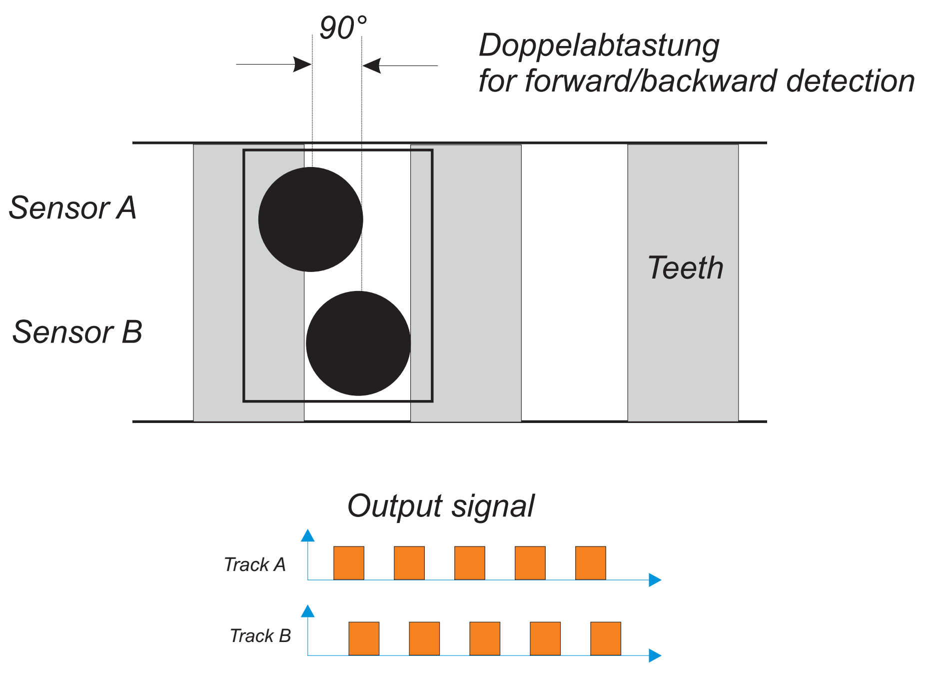
RPM Measurement

* Toothed rim with massive teeth (modul) and the contact-less detection with Hall sensors guarantees reliable and very robust **rotational speed detection**

* The allowable distance of 3 mm guarantees mounting without problems

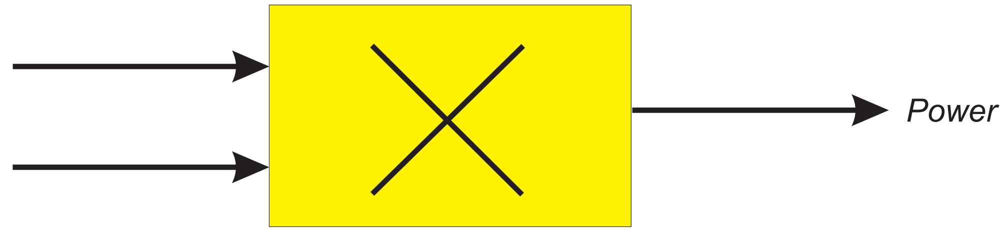


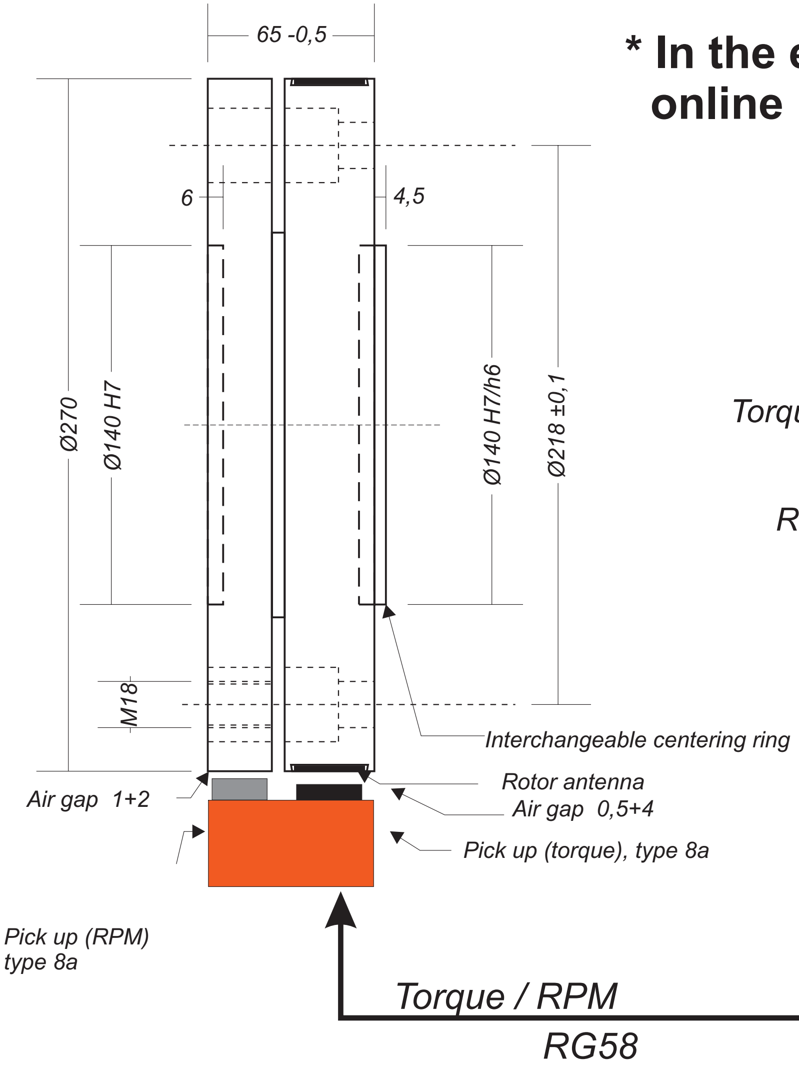
* 2 sensors for forward/backward detection

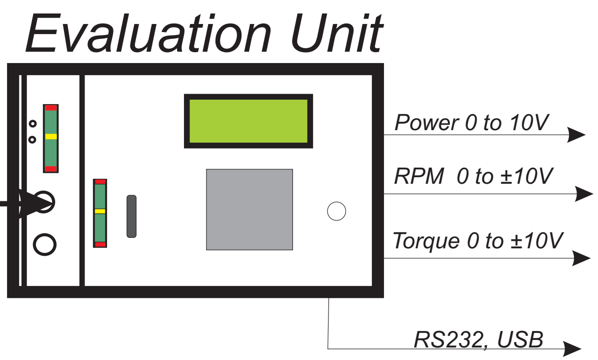


Online Power Calculation

*** In the evaluation unit the power is calculated online by the torque and rotational speed**







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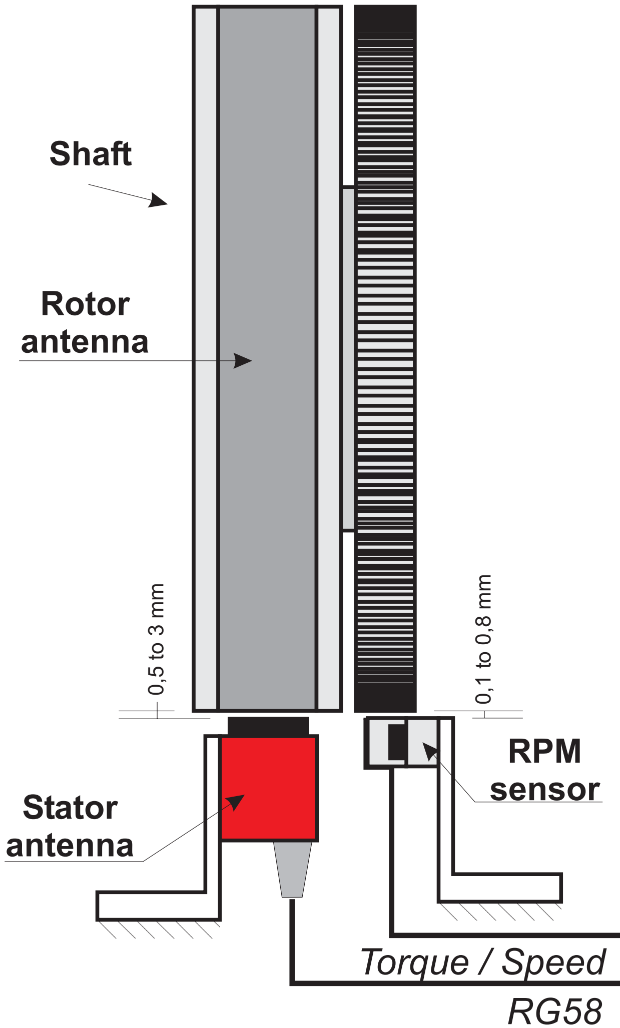
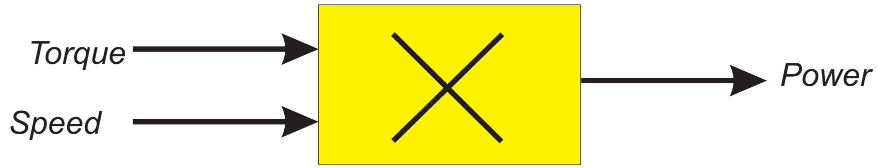
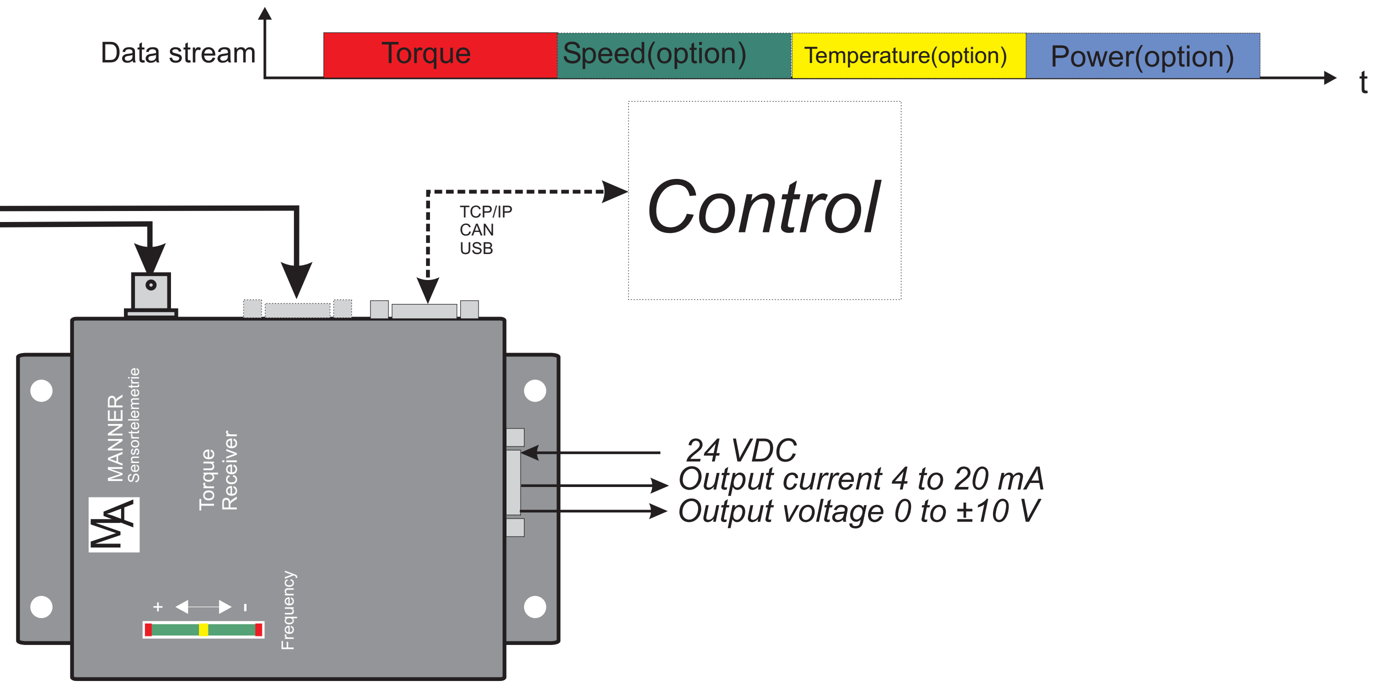
Online Power Calculation



* **Online power calculation by the evaluation unit**
  Online multiplication of torque and speed

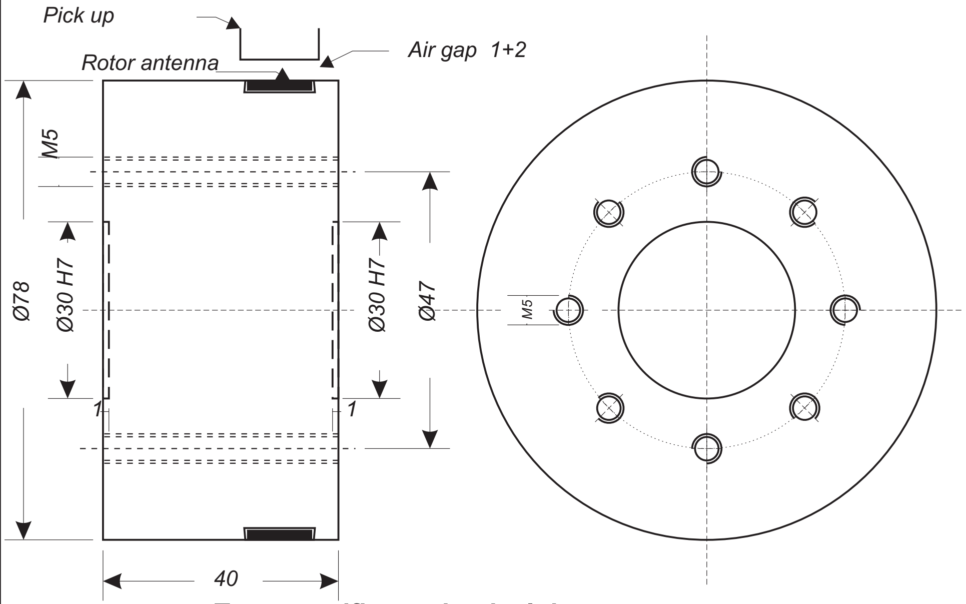




Torque Range

5 Nm to 350 kNm

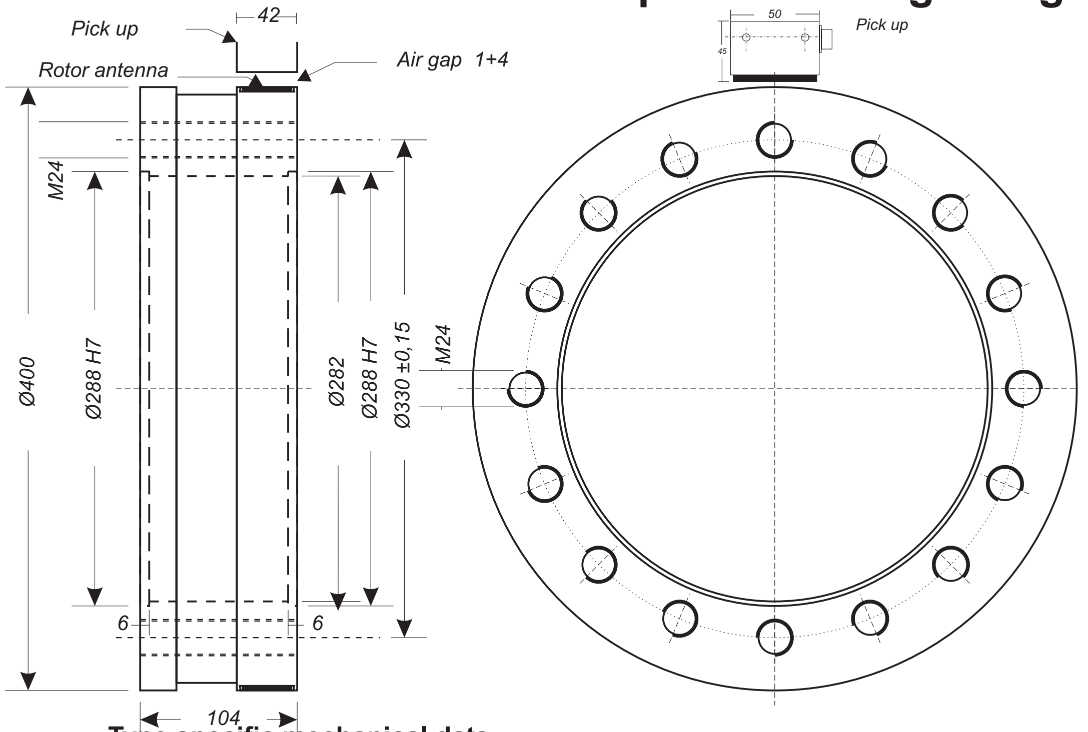
20/50/100 Nm Torque Measuring Flange



Type specific mechanical data

M_{nom} (Nm)	20	50	100
Weight (Rotor) (kg):	1,2	1,2	1,2
Inertia (kgm²): (With/without speed system)	0,0010	0,0010	0,010
Torsional stiffness (kNm/°):	2	5	10
Torsional angle related to M_{nom} (°):	0,01	0,01	0,01
Axial stiffness (kN/mm) c_a:	22	45	90
Radial stiffness (kN/mm) c_r:	50	200	400
Bending moment stiffness (kNm/°) c_b:	0,5	1	2
Max. axial load (kN):	0,18	0,37	0,75
Max. radial load (kN):	0,18	0,37	0,75
Max. bending moment (kNm):	0,18	0,37	0,75
Max. excursion at max. axial force (mm):	<0,04	<0,04	<0,08
Balance quality level (DIN ISO 1940):	G6,3 (G2,5 Option)		
Max. speed (rpm):	14000	14000	14000
Highspeed option (rpm):	18000	18000	18000
Speed acquisition (inductive, teeth/turn):	64	64	64
Hollow shaft (option):	-	-	-

100 kNm Torque Measuring Flange

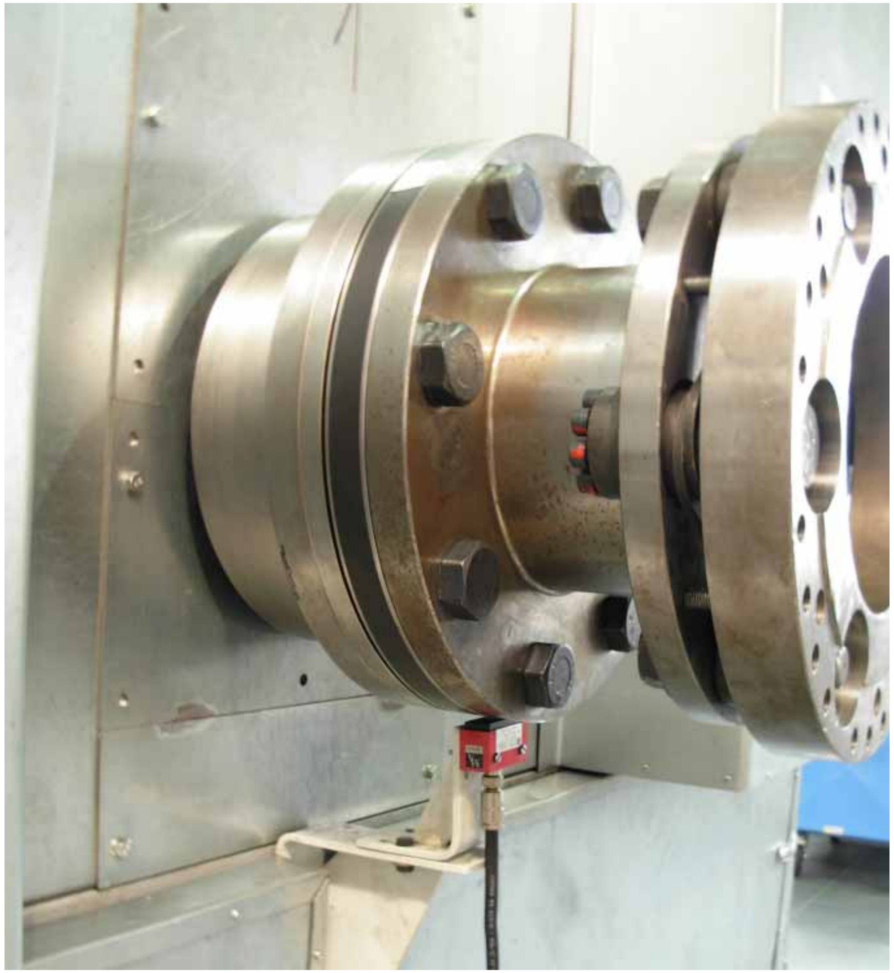


Type specific mechanical data

M_{nom} (Nm)	100000	150000
Weight (Rotor) (kg):	38	40
Inertia (kgm²): (With/without speed system)	1,29	1,45
Torsional stiffness (kNm/°):	10000	15000
Torsional angle related to M_{nom} (°):	0,01	0,01
Axial stiffness (kN/mm) c_a:	5000	7000
Radial stiffness (kN/mm) c_r:	20000	25000
Bending moment stiffness (kNm/°) c_b:	160	240
Max. axial load (kN):	400	600
Max. radial load (kN):	400	600
Max. bending moment (kNm):	400	600
Max. excursion at max. axial force (mm):	<0,15	<0,15
Balance quality level (DIN ISO 1940):	G9,4 (G6,3 Option)	
Max. speed (rpm):	2000	2000
Highspeed option (rpm):	3000	3000
Speed acquisition (inductive, teeth/turn):	360	360
Hollow shaft (option):	---	---

130 kNm Torque Meter
at 5 MW Wind Turbine Test Rig

40 kNm Torque Flange
at 3 MW Wind Turbine



250 kNm Torque Flange
Helicopter Test Rig

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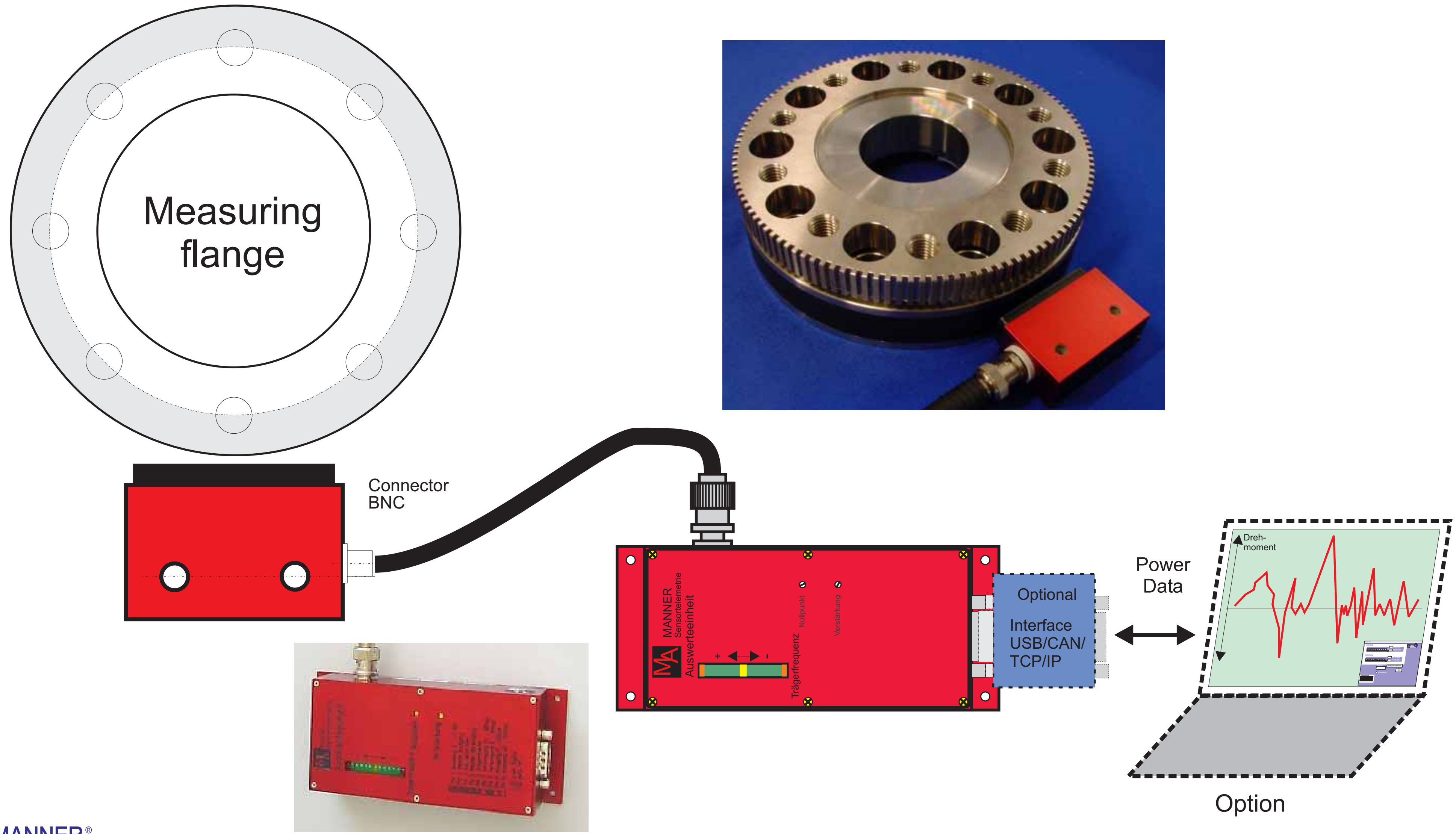
Torque Measuring System with Compact Evaluation Unit



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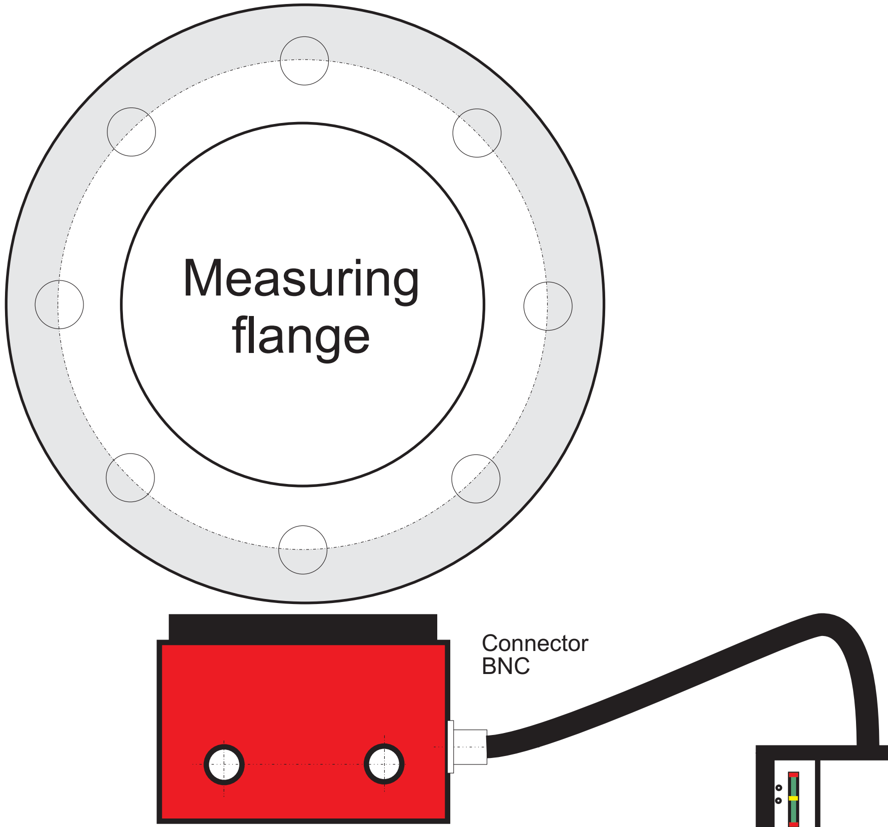
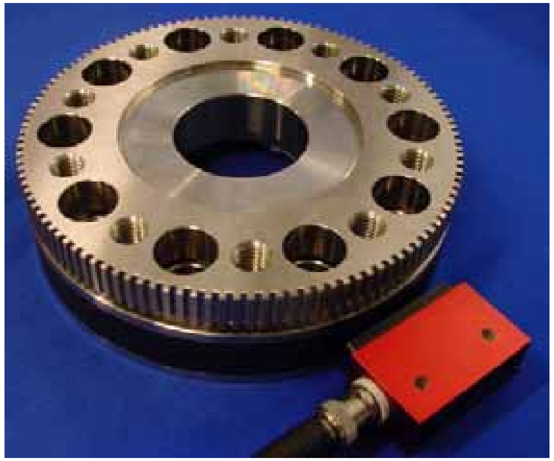
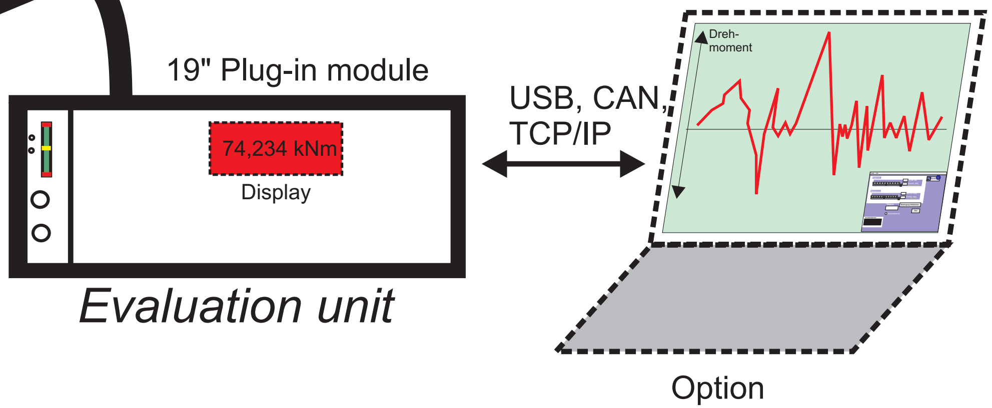
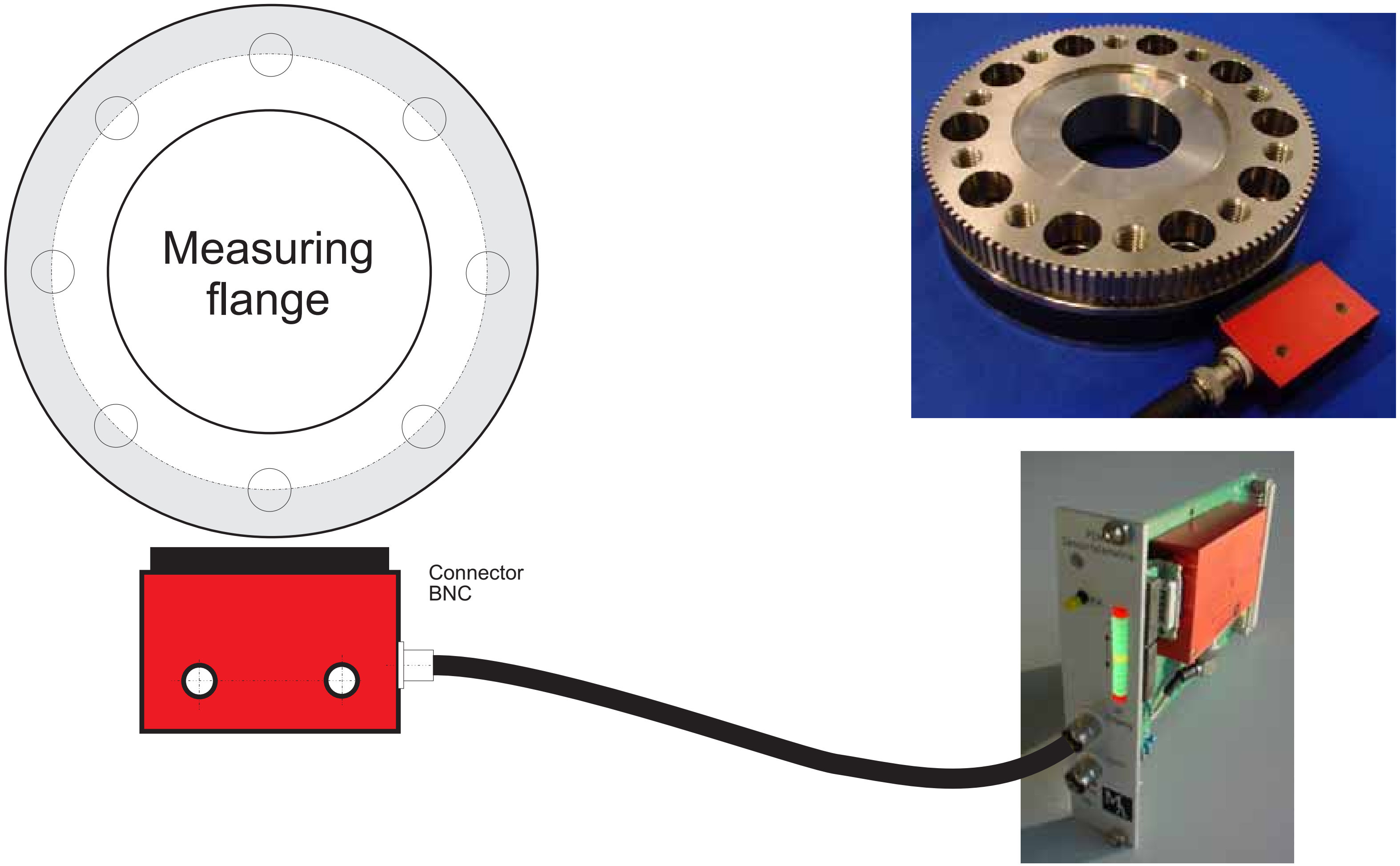
Torque Measuring System with 19" Evaluation Unit



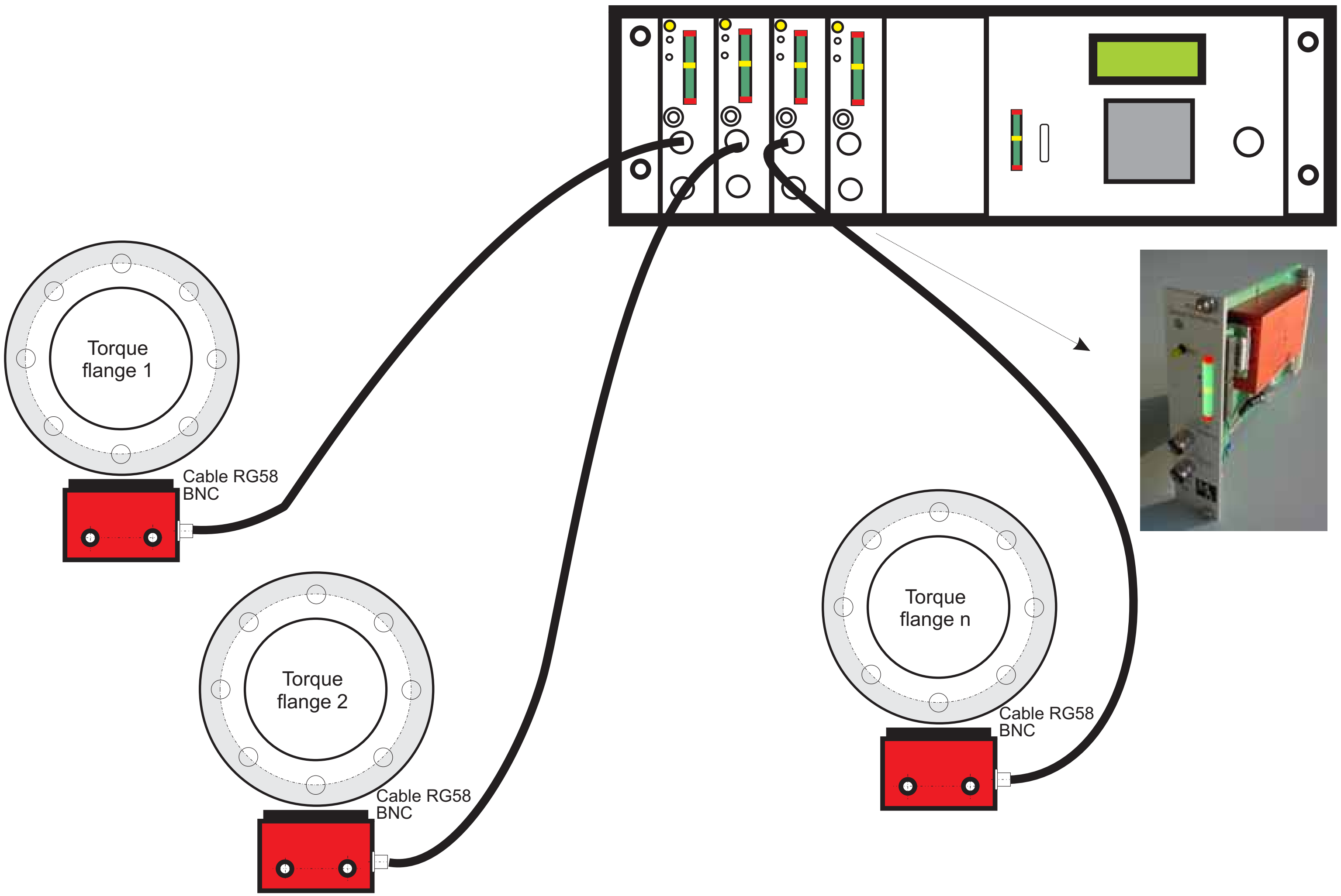




Torque Measuring System with 19" Plug-In Board



Torque Acquisition with 19“Rack



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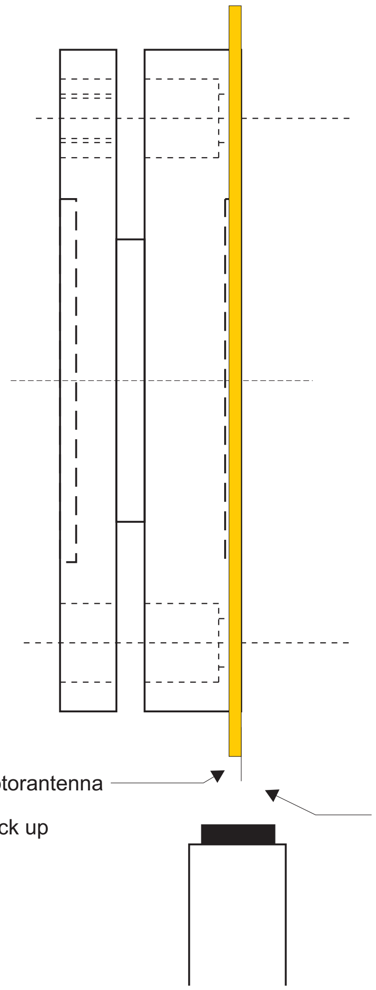
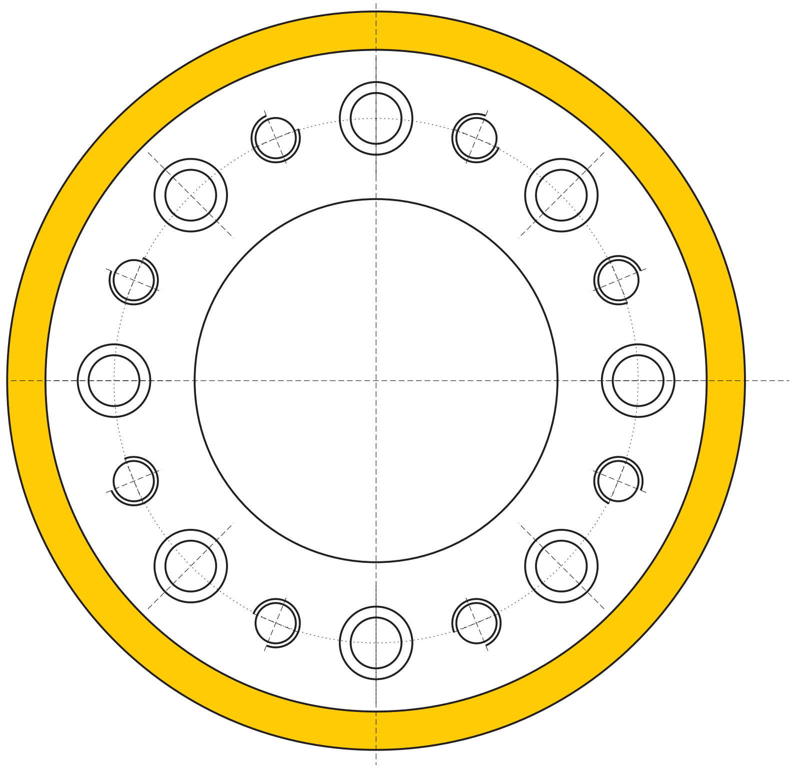
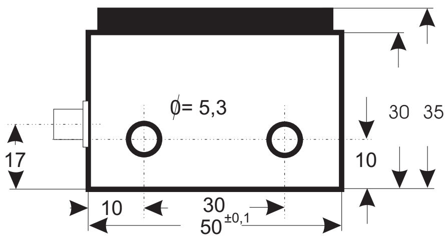
Application for Big Axial Movements and High Speed







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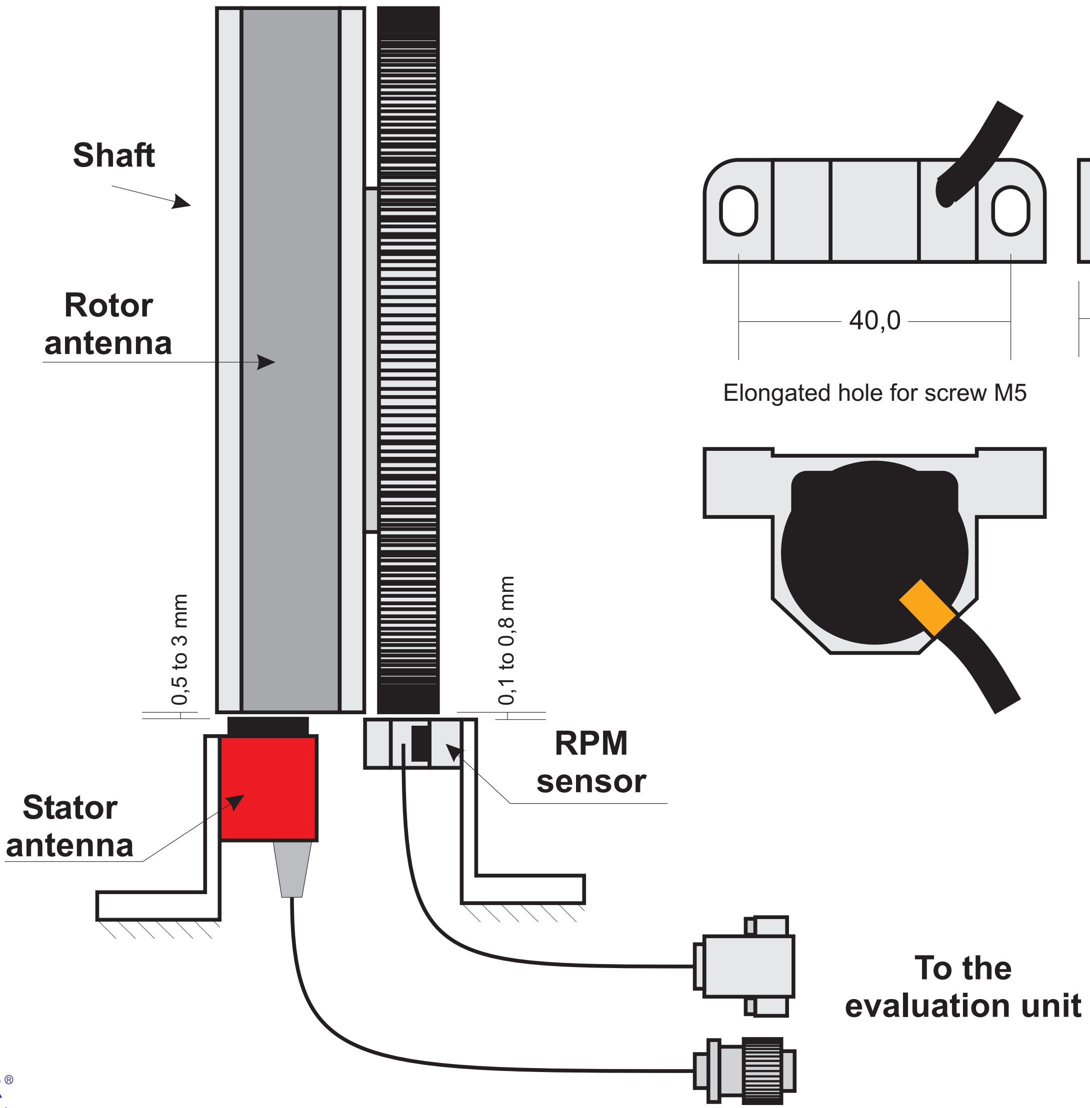
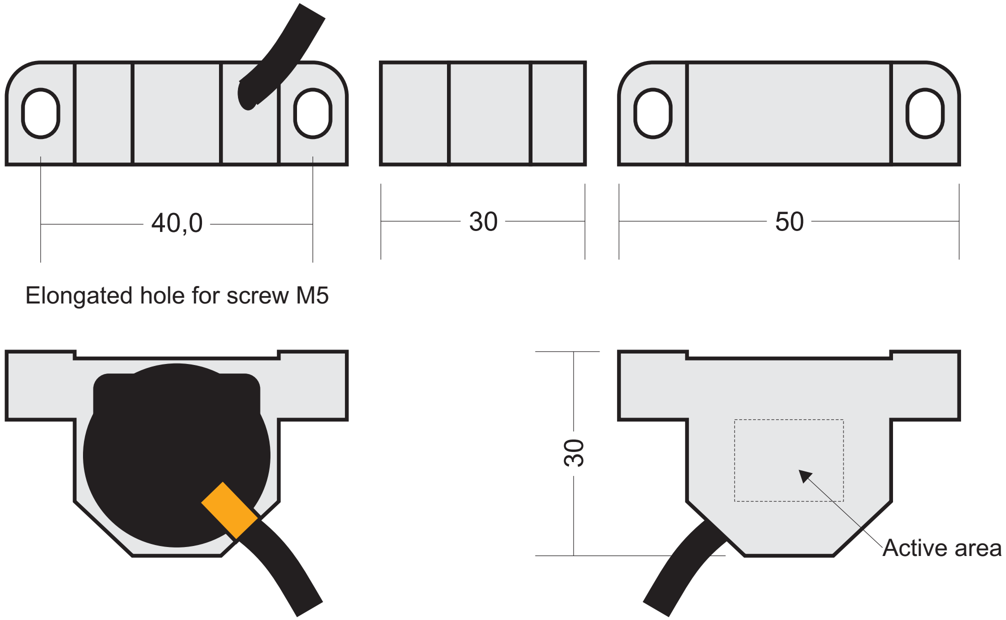
Measuring Rotational Speed





Technical data (rpm)
Phase Sensor 1 to Sensor 2: 90°
Frequency: 0 to 25 kHz
Air gap: 0,5 -0,4;+0,3 mm
Module: 1,5 (others optional)

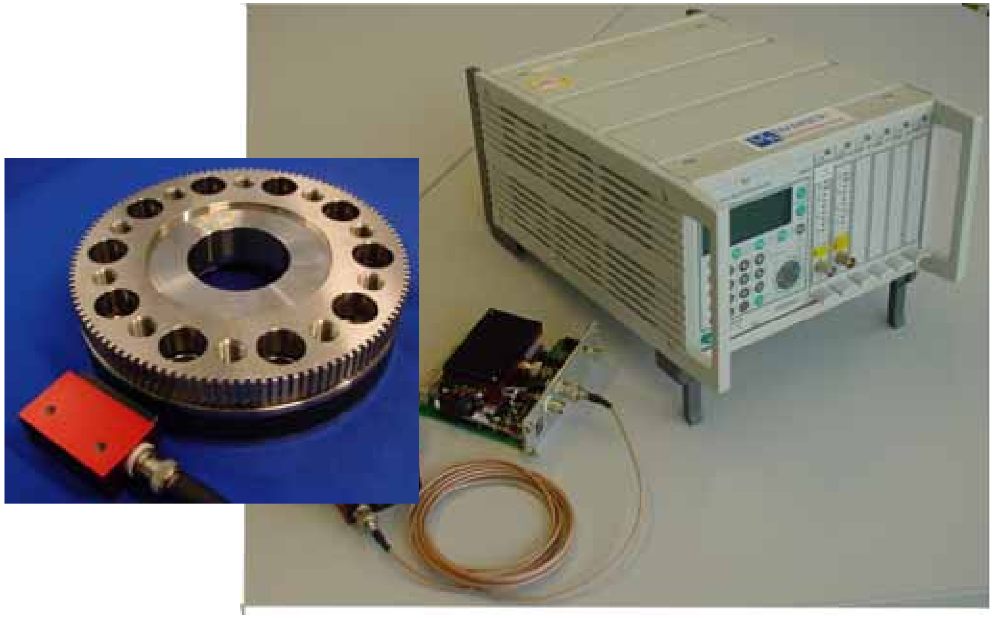
Connectivity

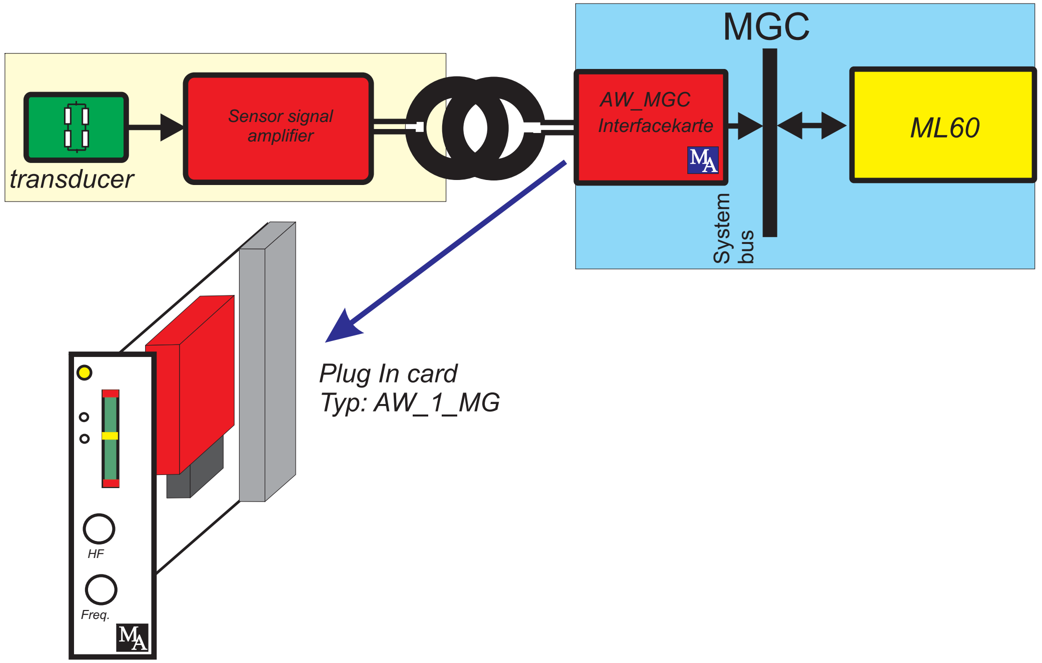
Interface-Box

- CAN-Bus
- USB
- Profibus
- HBM MGC

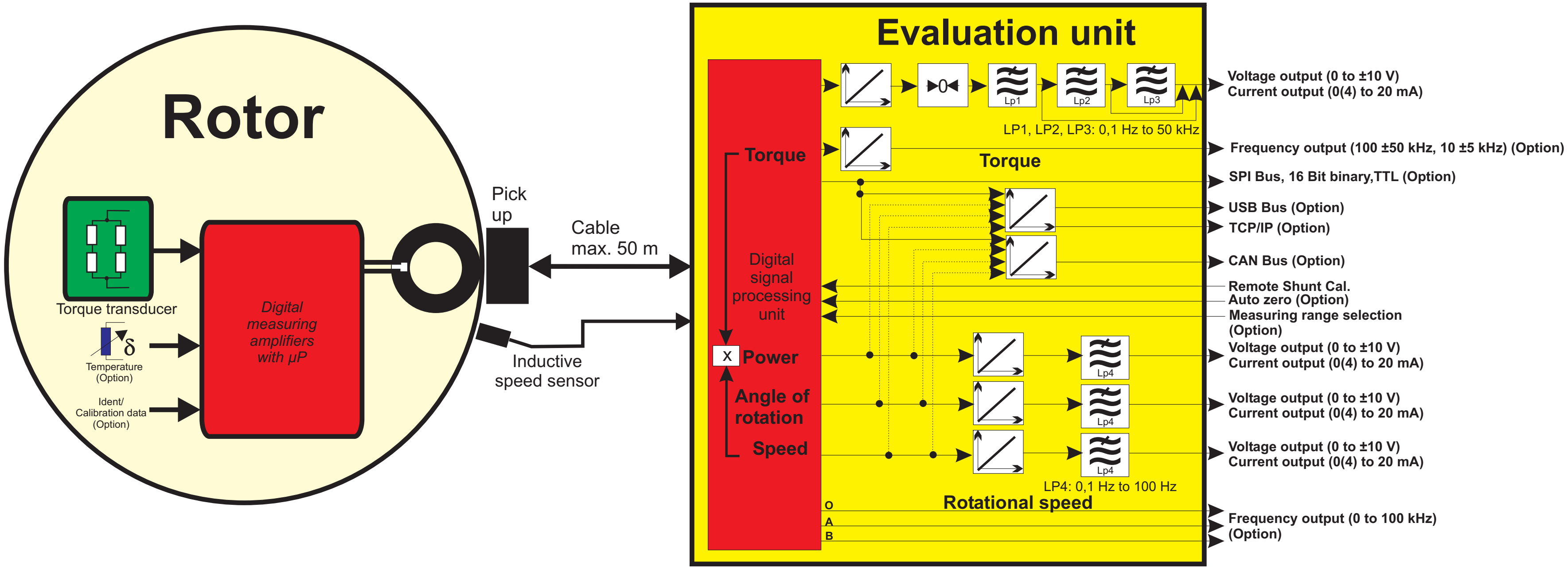
- Frequency output (100 ±50 kHz, 10 ±5 kHz) (option)
- Voltage output (0 to ±10 V)
- Current output (0(4) to 20 mA)
- RS232

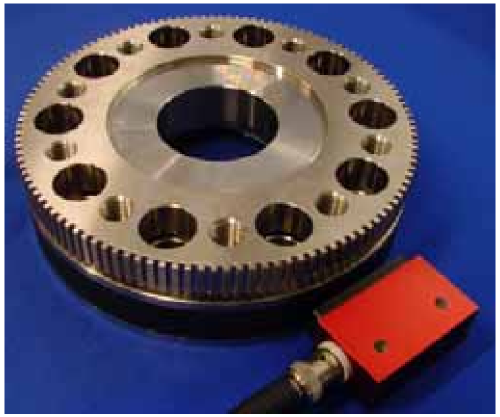
Torque Acquisition with Plug-in Card for HBM MGC





Block Diagram / Signal Flow of Digital Torque Meter





Compact evaluation unit

General Specification Torque Transducer MW...

Torque

Deviation of Linearity including hysteresis (total system, related to M_{Nom})
Digital / analog: <0.2 % (0.1 %, 0.005 % Option)
Repeatability
(DIN 1319, standard deviation): <±0.03 %

Available Output Signals
Voltage: 0 to ±10 V (rated to torque range), $R_{internal}$ = 50 Ω
Current: 0(4) to 20 mA (rated to torque range), max. load = 300 Ω
Frequency: 100 ±50 kHz (rated to torque range), $R_{internal}$ = 50 Ω
SPI Bus (Data, Clock, Frame)
USB Bus
CAN Bus

Available Signal Bandwidth (Low pass filter 5th order Bessel):
Group delay time:

Bandwidth	Frequency / Digital	Analog
10 Hz (-3 dB):	60 ms	100 ms
100 Hz (-3 dB):	6 ms	10 ms
1 kHz (-3 dB):	**600 µs**	**1,000 µs**
10 kHz (-3 dB):	120 µs	200 µs
50 kHz (-3 dB):	20 µs	40 µs

Option switchable low pass filter

Resolution electrical signal: 16 Bit
Residual signal ripple output voltage: <5 mV
Remote controlled shunt signal: 80 % of M_{Nom}

Temperature drift per 10 K of the output signal
Zero point (rated to M_{Nom}, total system)
Analog output: ±0.05 % (±0.01 % Option)
Digital / frequency output: ±0.04 % (±0.005 % Option)
Signal span (rated to M_{Nom}, total system)
Analog output: ±0.05 % (±0.02 % Option)
Digital / frequency output: ±0.04 % (±0.01 % Option)

Long-term drift over 48 hours (votage output): <3 mV

EMC: Emission per EN6126
RFI voltage \ power \ field strength: Class A
Immunity from interference (EN61326-1)
Electromagnetic field: 30 V/m
Magnetic field: 50 A/m
ESD: 10 kV

Degree of protection (EN 60529): IP54 (IP65 Option)

Reference temperature: 23 °C
Working temperature: -10 to +85 °C (-45 to +160 °C Option)
Storage temperature: -25 to +90 °C (-55 to +170 °C Option)

Vibration resistance: 1,000 g for 1 h
Impact resistance: 2,000 g
Balance quality per DIN ISO 1940: see type
Max. axial displacement (flange to pick up): <1.5 mm
Max. radial distance (flange to pick up): 0.3 to 2 mm (0 to 20 mm)

Max. loads
Max. torque (related to M_{Nom}): 400 % (800 % Option)
Breaking torque (related to M_{Nom}): 800 % (1600 % Option)
Oscillation (peak to peak) DIN 50100 (related to M_{Nom}): 300 %

Speed system

Type: massive toothed rim, inductive pick up
Number of increments: see special data sheet
Outputs
1 trace: digital TTL
2 trace: digital TTL, 90° phase shift (Option)
Analog output range: 0 to +10 V, related to $speed_{Nom}$ (Option), $R_{internal}$ = 50 Ω
Bandwidth: 100 Hz (-3dB)
Group delay time (digital): <10 µs
Temperature drift: <0.02 % of related $speed_{Nom}$

Pick up 8a

Weight: 0.1 kg
Dimensions: 50 x 35 x 20 mm (60 x 55 x 40 mm Option)

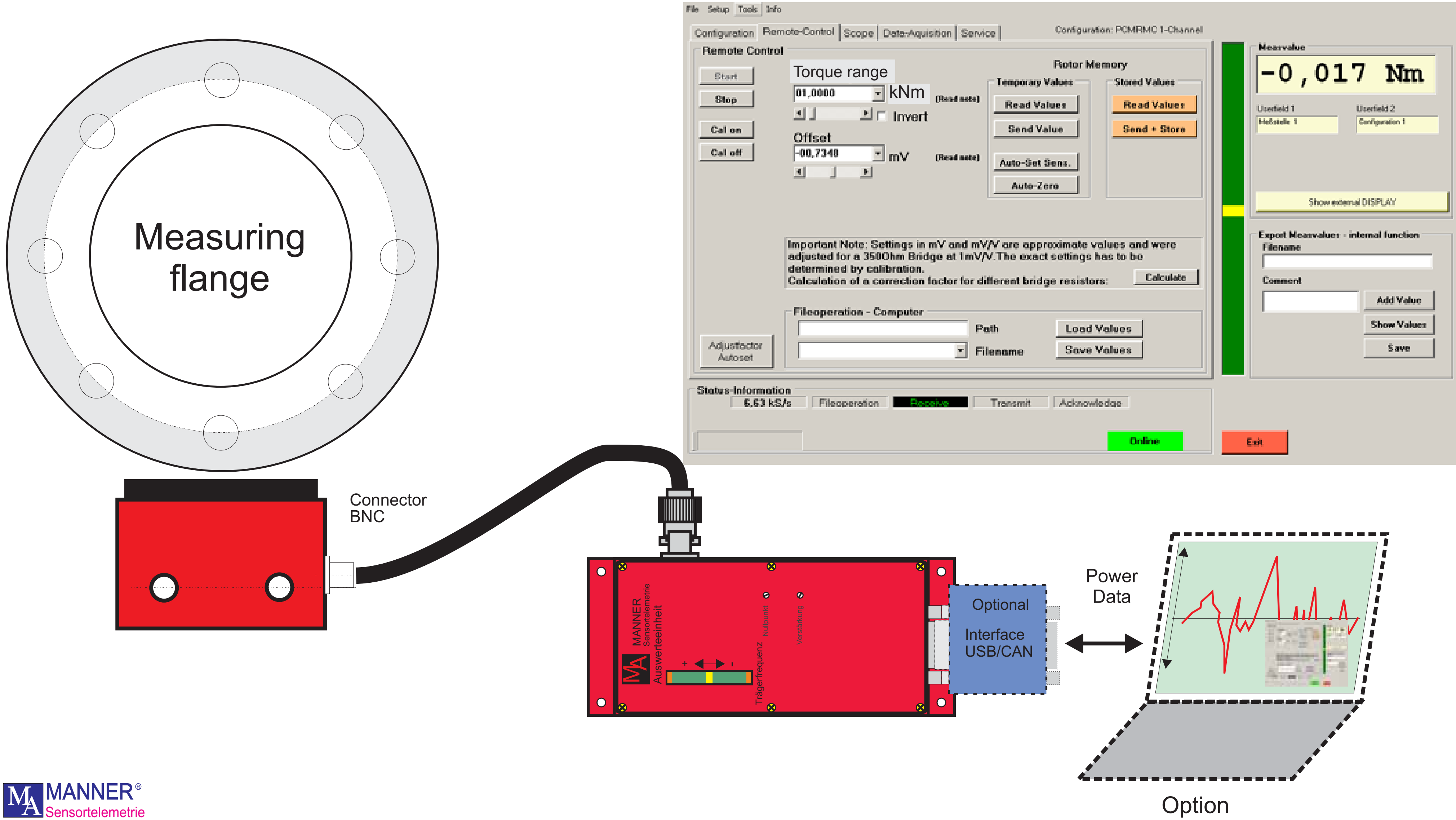
Receivers

(available types)
Receiver compact supply: 24 V DC, 1 A, (9 to 36 V DC Option)
Receiver plug-in card 19" Rack supply: ±15 V DC, 1 A
19" Rack supply: 90 to 270 V AC, 50 / 60 Hz

Special Features of the Manner Torque Measuring Flanges:

* Compact Pick up (not surrounding)
* Integrated rotor loop (no damage possible)
* Big mechanical axial and radial tolerances possible between flange
  and Pick up: 0 to 5 (20) mm
* Big temperature range -25 to +85°C (-50 to +150°C)
* Signal bandwidth 0 to 1 kHz (0 to 50 kHz)
* Customer specific hole patterns
* Extremely stiff by vertical membrane
* Selectable measuring range (Option)

Torque Measuring System with Compact Evaluation Unit



MANNER®
Sensortelemetrie

Most important Customer for Manner Torque Meters

* Renk (high speed test rigs)
* Siemens turbo machines
* Snecma (turbines)
* Winergy (Windmills)
* Eickhoff (test rigs for windmills)
* Flender
* ZF Kassel (helicopter test rigs)
* Teamtechnik (test rigs for gear boxes)
* ZF Friedrichshafen (test rigs for gear boxes)
* University of Munich
* Augusta (helicopter test rigs)
* Techno Mechanica
* Hindustan India (helicopter test rigs)
* Wärtsilä (Finland)
* Daimler Benz (test rigs for cars)
* Daimler (test rigs for trucks)
* Hörbiger
* University of Stuttgart
* Iveco (research switzerland)
* Schindler Schwitzerland
* Sumitomo (Japan)
* Boeing (Helicopter)
* Toyota (Japan)
* Siemens
* Voith
* Liebherr
* Ina
* LuK
* DMT
* TÜV Essen
* Bosch
* Bosch Rexroth
* FM Blickle
* MTU (Ship motors)
* Cendrion
* SMS Buss (chemical)
* Wackerchemie (Chemical)
* MAN (Ship motors)
* Airbus (test rigs)
* DAF (test rigs for trucks)
* BMW formula 1 (test rigs)
* Porsche (test rigs)
* Ford (test rigs)
* Nissan (Japan)
* Voith Howden (China)
* University of Darmstadt
* Siemens railways
* HSVA (research for ship proppellers)
* GE (Nuova Pinigone, Gas turbines)
* Siemens (Gas turbines)
* Gazprom Russia (Gas turbines)
* ATEC (High Speed Couplings)

Deutscher Kalibrierdienst **DKD**

Kalibrierlaboratorium für die Messgröße Drehmoment
Calibration laboratory for the measuring quantity torque

Akkreditiert durch die / *accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB)

DmS Dr. Poschel Service

Deutscher Akkreditierungs Rat DAR
DKD-K-47801

Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration mark

0026
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47801
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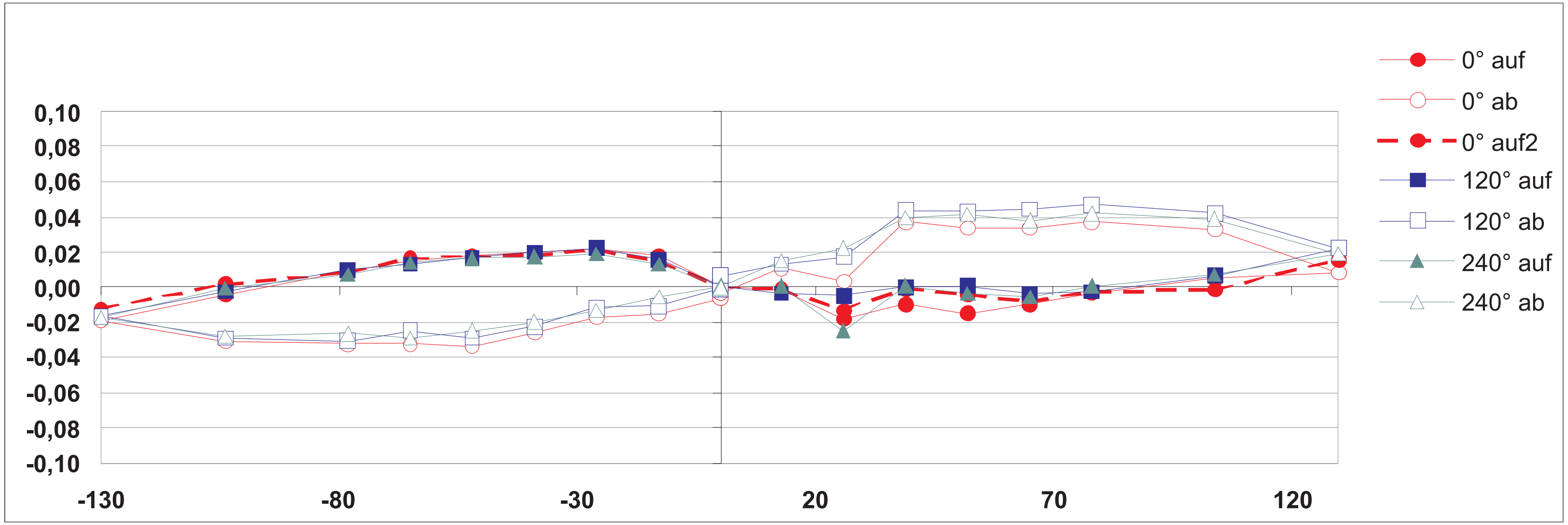

ZERTIFIKAT

Die Moody Q-Zert GmbH bescheinigt hiermit, dass die Firma

MANNER® Sensortelemetrie

Manner Sensortelemetrie GmbH
Eschenwasen 20, D-78549 Spaichingen

ein Qualitätsmanagementsystem entsprechend der Norm

DIN EN ISO 9001:2000

eingeführt hat und anwendet.

Geltungsbereich:

Entwicklung und Herstellung von Elektronischen Geräten - Sensortelemetriesystemen, Bestückung und Inbetriebnahme

Registriernummer:	04074
Gültig bis:	23.03.2007
Mönchengladbach, den	23.03.2004

Geschäftsführer
Uwe Sälzle

TGA-ZM-07-93