



Force Measurement Products

Millmate Roll Force Systems

Reliable, long-term solutions for your
roll force measurement

Power and productivity
for a better world™



Millmate Roll Force Systems

Introduction

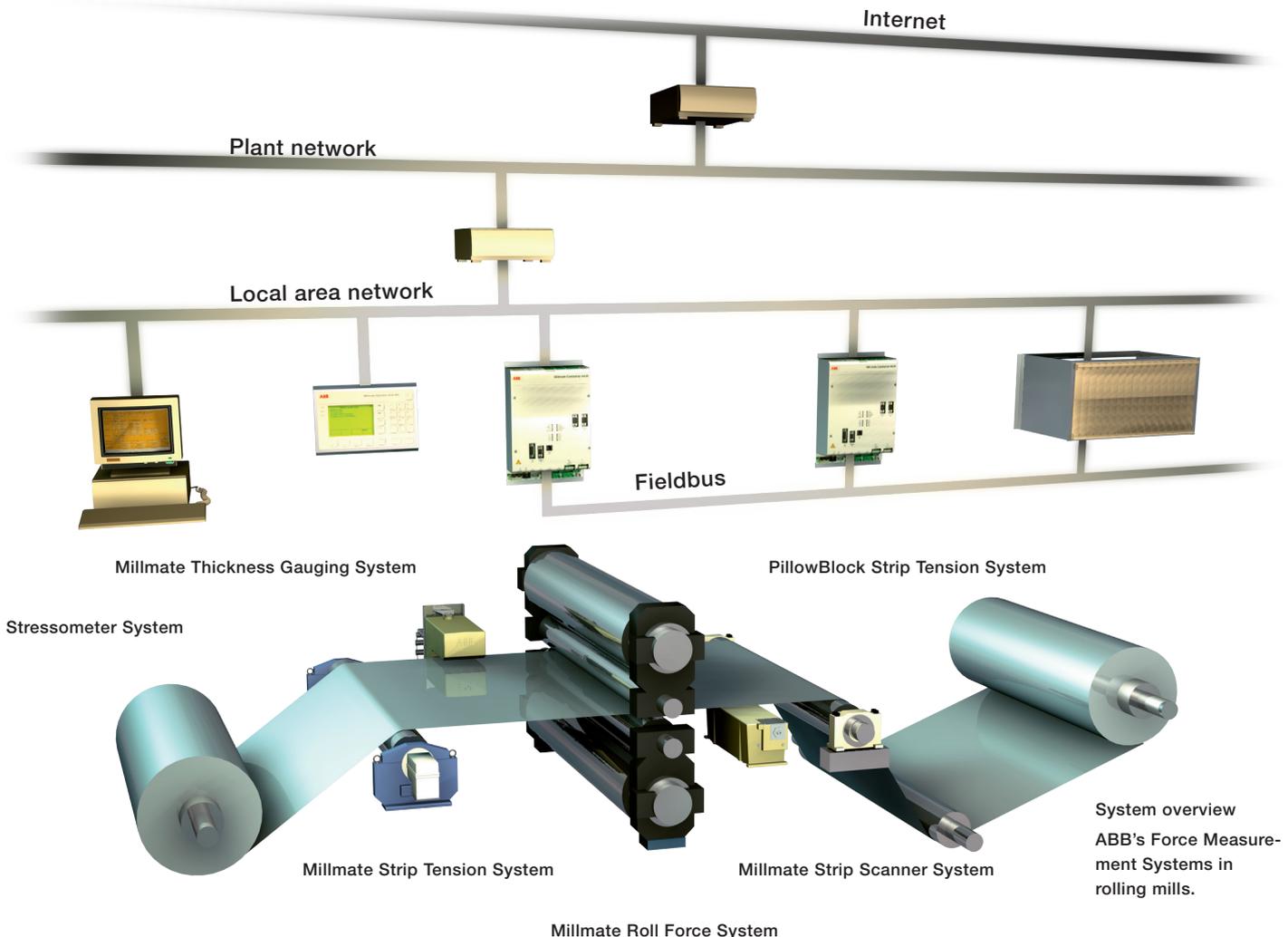
A measurement technology offering high accuracy is a prerequisite today for modern rolling mills. The constant striving to achieve optimum process quality and the highest possible productivity is the essential goal of modern production units.

Rolled products are called upon to meet ever stricter demands, and as a consequence so is rolling mill equipment. A truly measured roll force is crucial in achieving correct roll gap settings, true force distribution from operator side to drive side of your mill and supervision of the backup bearings and roll eccentricity. The Millmate Roll Force System incorporates all these essential features.

The Millmate Roll Force load cells act as integral parts of the mill stand. The rock-solid Pressductor® load cell design in combination with the intelligent, reliable communication functions are crucial keys to true roll force measurement.

The Millmate Roll Force System consists of a Millmate Controller (MC 400) and two load cells with matching units. The various types and the wide load range of Millmate Roll Force load cells cover practically all conceivable roll force measurement applications.

The ABB equipment is easy to install and operate. We offer installation support as well as long-term after sales supply and support. Due to ABB's extensive experience in the rolling mill industry, we can offer outstanding application know-how in this particular field.



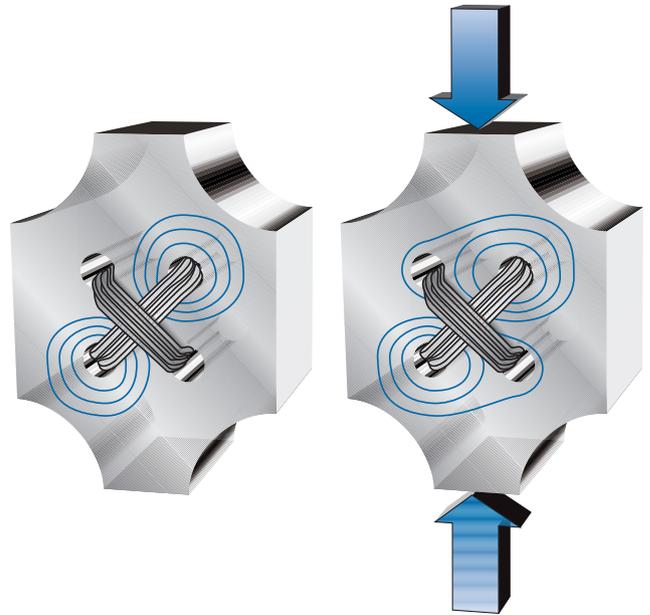
Pressductor® Technology

and the measurement principle

ABB's Millmate Roll Force load cells are based on the well-known Pressductor® principle patented in 1954, the magnetoelastic effect, according to which the magnetic properties of steel are influenced by mechanical forces acting on it.

In the transducer body there are four holes. Two coils at right angles to each other are wound through these holes. One winding (the primary) is supplied with an alternating current; the other winding (the secondary) acts as a measurement winding. Since the two windings are at right angles to each other, there is no magnetic coupling between them as long as there is no load on the transducer body.

If the transducer body is loaded (as shown in the figure), the field pattern changes. The permeability of the steel is reduced in the direction of the force and increases in the direction at right angles. The result is a change in the symmetry of the magnetic flux, so that some of the flux induces a voltage in the secondary winding. The induced voltage is proportional to the load.



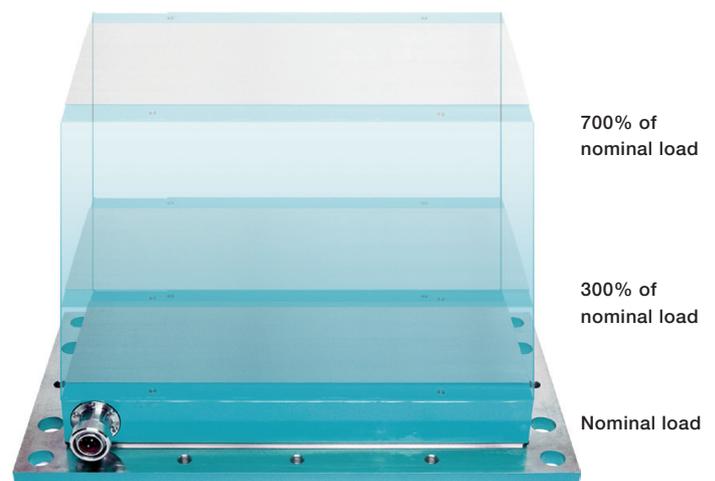
The measurement principle is based on the magnetoelastic effect, according to which the magnetic properties of a material are influenced by mechanical stress. The transducer is magnetized via the primary coil. A voltage proportional to the applied force is induced in the secondary coil.

Right from the beginning of the Pressductor era a transducer based on this measurement principle turned out to be perfect for the rolling mill environment.

The key factors are:

- No compression of the transducer is needed to achieve a reliable signal corresponding to the applied force.
- An overload capacity of up to 700% is achieved by utilizing only a small part of the elasticity of steel.
- The standard load cell consists of 1,500 transducers, always ensuring a true roll force measurement, even if the load is unevenly distributed.
- Signal-to-noise level is outstanding due to the high signal output from the transducer (500 mV).

The rock-solid design of the Pressductor load cells fulfills these key factors and will assure you many years of accurate measurements in your rolling mill.



700% of nominal load

The highest permissible single loading without mechanical damage to the load cell.

300% of nominal load

The highest permissible load without permanent change of data.

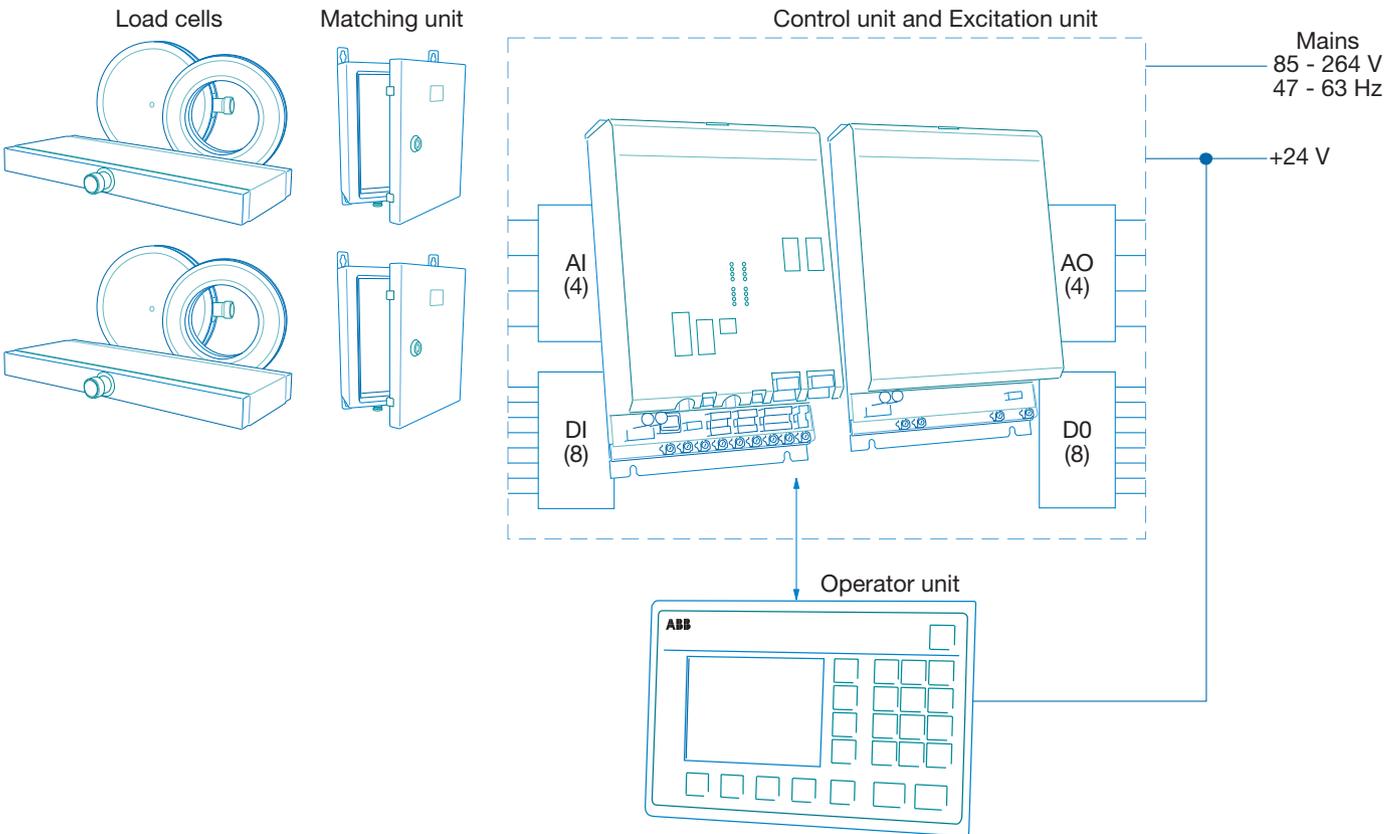
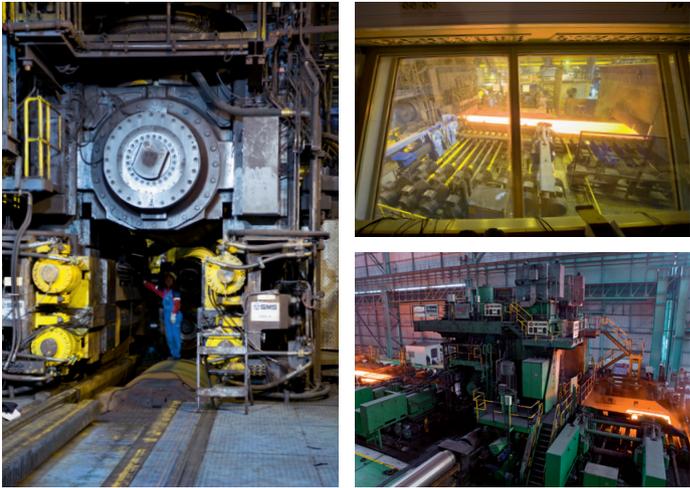
ABB's force measurement systems in rolling mills

Your selection of load cells, control units and options

ABB's Roll Force Systems offer a comprehensive selection of load cells, control units and options covering your needs for accurate and reliable roll force measurement in your rolling mill.

You choose from the Millmate Roll Force load cells coming in three different versions: Circular, Rectangular and Annular. The most common installation application for the circular version is under the mill screw. The rectangular version is normally installed under the lower back-up roll bearing. The annular version is installed between the mill nut and the mill stand.

The choice of control unit is made in the light of system requirements and according to your communication needs.



Load Cells

The heavy-duty Millmate Roll Force load cells have high-stability components encased in a protective stainless steel box providing the built-in calibration and temperature compensation of the load cell.

Due to its low impedance and high output signal power the Millmate Roll Force load cell has an extremely low sensitivity to insulation defects and maintains its measuring accuracy down to a 10 k Ω insulation level.

The load cell output signal is calibrated for full interchangeability between load cells of the same type and size. The various types and the wide load range cover practically all conceivable roll force measurement applications.

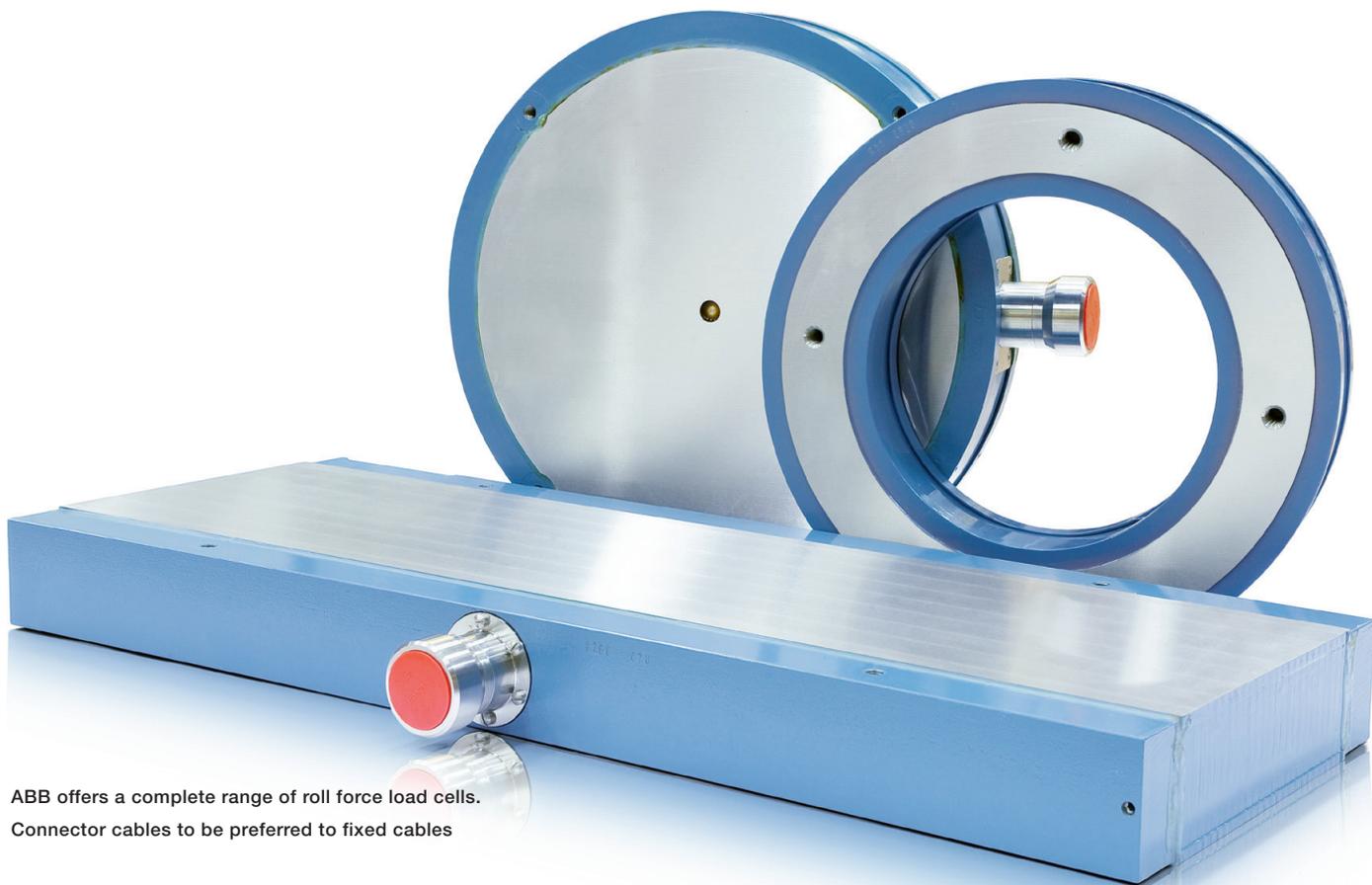


ABB offers a complete range of roll force load cells.

Connector cables to be preferred to fixed cables

Circular load cells PFVL 141C

The circular load cells are machined from a quadratic core. Shrunk-on stainless steel rings protect the load cell windings and underlying components.

There is a choice of core diameters in multiples of 30 mm, giving 23 different standard sizes for forces between 1.6 to 60 MN.

Rectangular load cells PFVL 141V

The load cell can be adapted to the required dimensions, and the length is chosen as a multiple of 30 mm. For load cells longer than 900 mm, the chosen length must be a multiple of 60 mm. The width is chosen as a multiple of 30 mm. Stainless steel side-bars protect the load cell windings and underlying components.

This load cell type is available in standard sizes from 0.63 to 56 MN.

Annular load cells PFVL 141R

The annular load cell consists of stainless steel laminations wound on an annular stainless steel core, after which an outer stainless steel ring is shrunk on to the load cell to protect the load cell windings and underlying components.

Standard sizes of annular load cells are available from 2 to 28 MN. Load cells with other dimensions can be manufactured to order.

Load cells

Installation arrangements

ABB has many years of experience of installing load cells in all types of rolling mill.

To achieve the best possible measurement results, certain basic rules must be observed during the installation of the load cell:

- The entire force must pass through the load cell.
- The force must be measured as close to the source of the force (the roll gap) as possible.
- The load cells must be protected to the greatest possible extent from large bending, lateral and torsional forces.

1. Under the mill screw

For installation under the mill screw, the load cell can be combined with thrust bearings and pressure plates into a package attached to the mill screw. This arrangement results in good force distribution, simple, inexpensive installation and easy servicing. In addition, there is no need to machine any surfaces on the roll stand. However, this arrangement does take up space in the roll window.

2. Under the lower back-up roll bearing

There must be a sufficiently large flat surface on the lower part of the roll stand to allow the installation of the load cell under the lower back-up roll bearing. This arrangement has the advantage that there is no need to pay particular attention to the load cell during roll change.

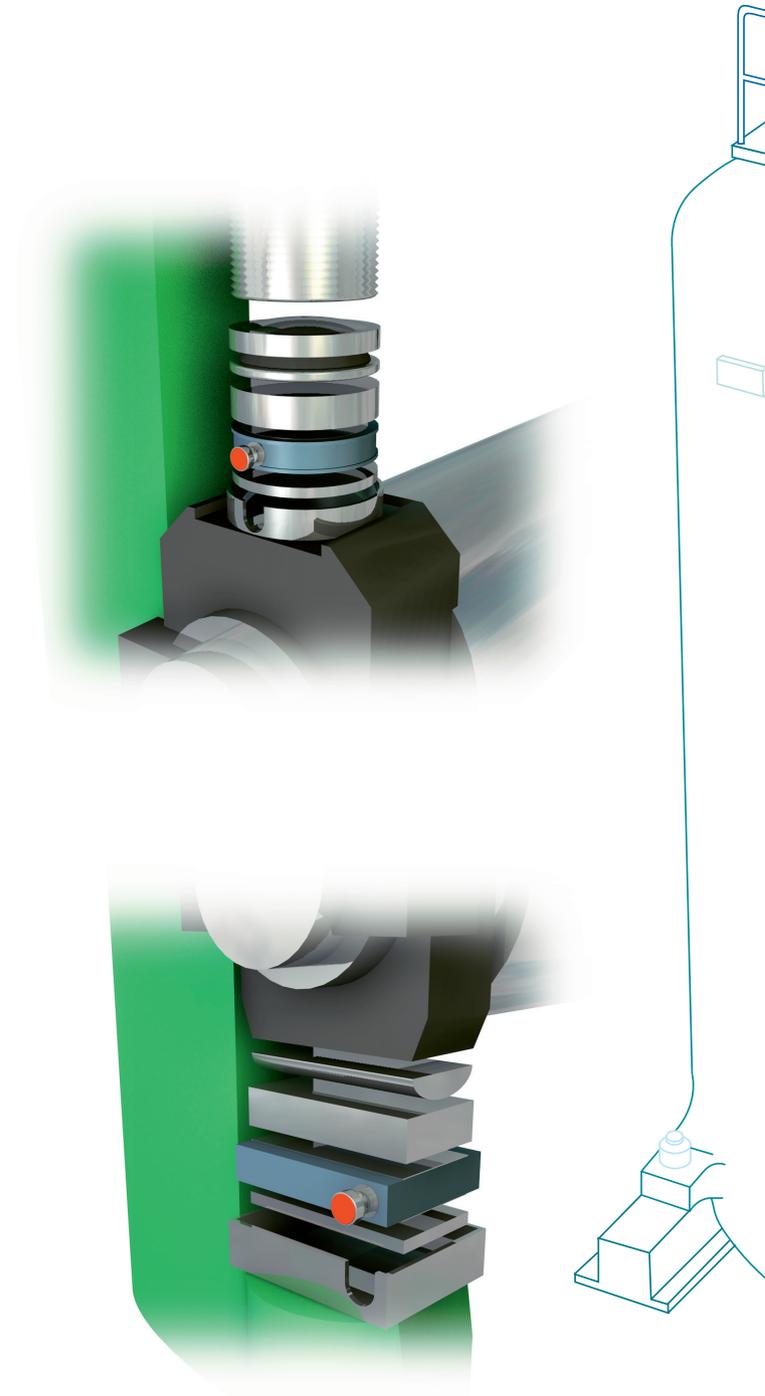
See also our offer regarding Load Cell Packages on the next page.

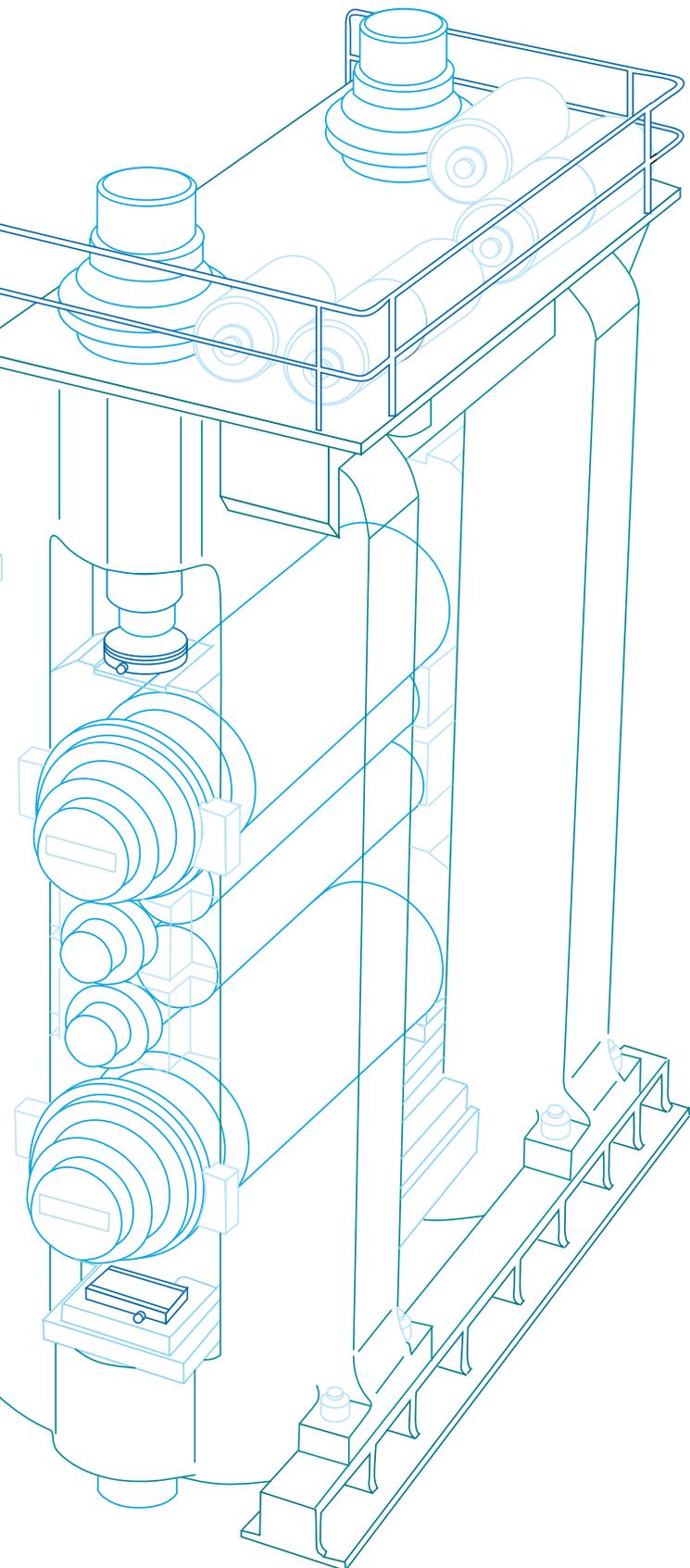
Application hint

Load cells can be installed in several different ways, but the preferred arrangement, from both the economical and technical points of view, is usually to install the load cell under the mill screw.

There are currently three types of load cells in the product range:

1. Load cells for installation under the mill screw
2. Load cells for installation under the lower back-up roll bearing
3. Load cells for installation between the mill nut and the mill stand





3. Annular load cell between the mill nut and the mill stand

This version makes measurement possible even if the space under the mill screw and under the lower back-up roll bearing is insufficient. This arrangement also has the advantage that there is no need to pay particular attention to the load cell during roll changing, and it is well protected.



Load cell packages

When the load cell is positioned under the lower back-up roll bearing, which is the most exposed position, we can offer a prestressed package with lower pressure plate, load cell and upper pressure plate.

The safe and compact Load Cell Package secures easy and correct installation. You increase the possibility of accurate measure, and can count on a longer lifetime and lower maintenance costs.



Step-by-step assembly of our prestressed Load Cell Package.

Circular load cells

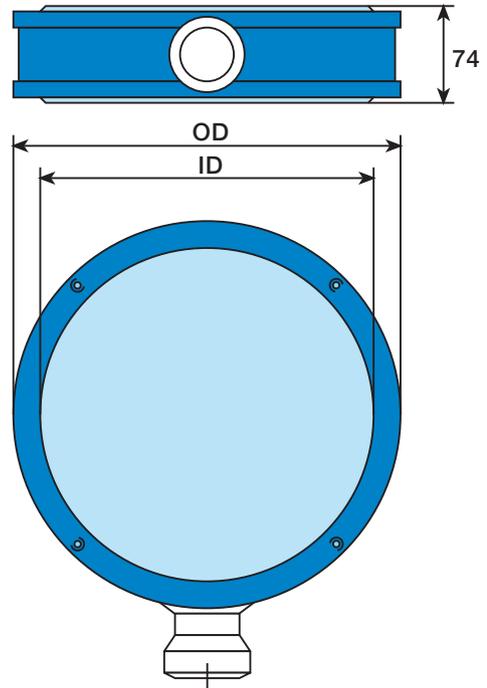
PFVL 141C

Measurement range 1.6 – 60 MN

Standard sizes and cable lengths

Load cells are manufactured in the standard range as below:

Nominal load (MN)	ID (mm)	OD (mm)	Max. cable length (m) 2 Load cells ¹⁾	Max. cable length (m) 4 Load cells ¹⁾
1.6	150	210	25	10
2.5	180	240	24	10
3.1	210	270	23	10
4.0	240	290	22	10
5.0	270	320	21	10
6.3	300	350	20	6
8.0	330	380	19	6
10	360	410	18	6
12.5	390	440	17	-
14	420	470	16	-
16	450	500	16	-
18	480	530	15	-
20	510	560	15	-
22	540	590	14	-
25	570	620	13	-
28	600	650	12	-
31	630	710	11	-
35	660	740	10	-
40	720	800	8	-
45	750	830	8	-
50	780	860	6	-
51.5	810	890	6	-
60	810	890	6	-



Select as follows:

- Determine the load for which the load cell is to be used and choose from the table the next higher value in the standard range.

When ordering, please state:

- type designation
- Nominal load

Example

Nominal load 20 MN per load cell. Select 20 MN load cell, dimension OD=560 mm, ID=510 mm
PFVL 141C, 20 MN

¹⁾ Max cable length between load cell and matching unit if 2 or 4 load cells are connected to the same control unit.

Rectangular load cells

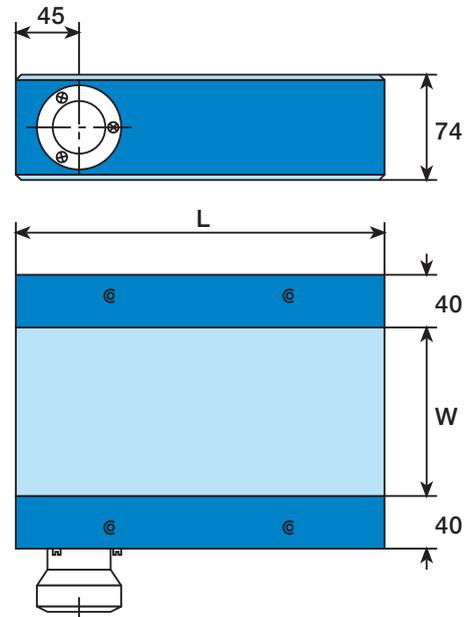
PFVL 141V

Measurement range 0.63 – 56 MN

Standard sizes and cable lengths

Load cells are manufactured in the standard range as below:

Nominal load (MN)	Max. cable length (m)	Max. cable length (m)
	2 Load cells ¹⁾	4 Load cells ¹⁾
0.63	25	10
0.80	25	10
1.0	25	10
1.25	25	10
1.6	25	10
2.0	25	10
2.5	24	10
3.1	23	10
4.0	22	10
5.0	21	10
6.3	20	6
8.0	19	6
10	18	6
12.5	17	-
14	16	-
16	16	-
18	15	-
20	15	-
22	14	-
25	13	-
28	12	-
31	11	-
35	10	-
40	8	-
45	8	-
50	6	-
56	6	-



Length (L) mm		
120	480	840
150	510	870
180	540	900
210	570	960
240	600	1020
270	630	1080
300	660	1140
330	690	1200
360	720	1260
390	750	1320
420	780	
450	810	

Width (L) mm	
70	430
100	460
130	490
160	520
190	550
220	580
250	610
280	
310	
340	
370	
400	

Select as follows:

- Determine the load for which the load cell is to be used and choose from the table the next higher value in the standard range.
- Determine either the width or length of the load cell and calculate the other dimension using the following formula:

$$L \times W \times 0.0001 = F$$

L = load cell length in mm

W = load cell width in mm

F = nominal load of load cell in MN

(taken from the standard series in the table)

The width and length are rounded up to the next higher value in the table.

When ordering, please state:

- Type designation
- Nominal load
- Width and length

Example

With a nominal load of 14 MN and a width of 370 mm the length will be 390 mm (rounded up from 378 mm).

PFVL 141V, 14 MN

L=390 mm, W=370 mm

¹⁾ Max cable length between load cell and matching unit if 2 or 4 load cells are connected to the same control unit.

Annular load cells

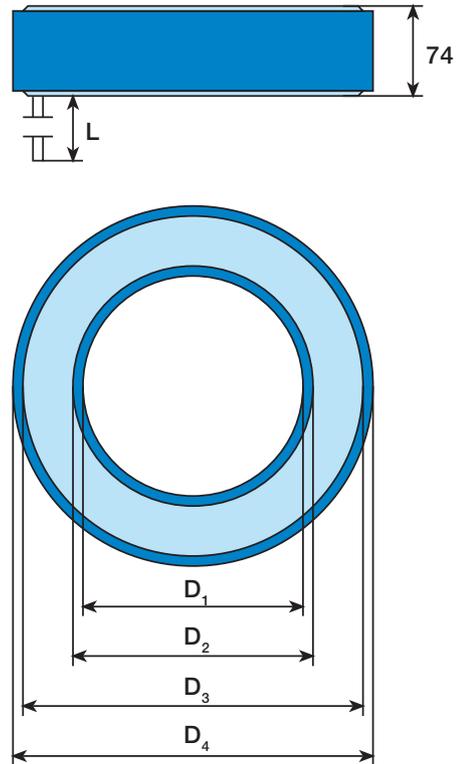
PFVL 141R

Measurement range 2 – 28 MN

Standard sizes and cable lengths

Load cells are manufactured in the standard range as below. Dimensions can be designed to order on request.

Nominal load (MN)	D ₁ (mm)	D ₂ (mm)	D ₃ (mm)	D ₄ (mm)	Max. cable length (m) 2 Load cells ¹⁾	Max. cable length (m) 4 Load cells ¹⁾
2	100	130	200	240	75	25
2.5	100	130	210	250	72	25
3.1	200	230	300	340	69	25
4	225	255	340	380	66	25
5	255	285	380	410	63	25
6.3	285	315	420	450	60	25
8.0	320	350	470	500	57	25
10	355	385	525	555	18	6
11.2	375	405	550	580	17	-
12.5	400	430	590	620	17	-
14	420	450	620	650	16	-
16	450	480	660	690	16	-
18	480	510	700	730	15	-
20	505	535	735	765	15	-
22.4	535	565	775	805	14	-
25	565	595	820	850	13	-
28	595	625	865	895	12	-



Select as follows:

- Determine the load for which the load cell is to be used and choose from the table the next higher value in the standard range. We can customize load cells if a standard load cell is not suitable for a particular application.
- To calculate the load F for non-standard load cells

$$F = \left(\frac{D_3^2 \pi}{4} - \frac{D_2^2 \pi}{4} \right) \times 0.0001 \text{ MN.}$$

For even smaller forces than 2 MN, we also have the annular load cell QGPR 102/104 in the range 0.1 – 1.6 MN.

Example

PFVL 141R, 10 MN

D₂=385 mm

D₃=525 mm

¹⁾ Max cable length between load cell and matching unit if 2 or 4 load cells are connected to the same control unit.

Load cells

Data and definitions

Accuracy class	% of F_{nom}	± 0.5	Compensated for min. error	+20 – +80°C
Linearity deviation	% of F_{nom}	$\leq \pm 0.5$	Zero point drift	$\leq \pm 0.01\%/^{\circ}\text{C}$
Hysteresis	% of F_{nom}	≤ 0.2	Sensitivity drift	$\leq \pm 0.01\%/^{\circ}\text{C}$
Repeatability error	% of F_{nom}	$\leq \pm 0.1$	Working temperature range*	-10 – +90°C
Compression	(mm at F_{nom})	0.05	Storage temperature range	-40 – +90°C
Calibration error		0.1%	*) Max. permitted short-term temp.	+110°C

Nominal load (F_{nom}) is the load for which the load cell is dimensioned and calibrated, i.e. the sum of the stationary load and the maximum measured load in the measuring direction.

Accuracy class is defined as the maximum deviation and is expressed as a percentage of the sensitivity at nominal load. This includes linearity deviation, hysteresis and repeatability error.

Linearity deviation is the maximum deviation from a straight line drawn between the output values of zero and nominal load, related to the nominal load.

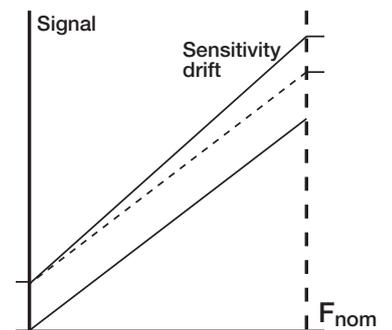
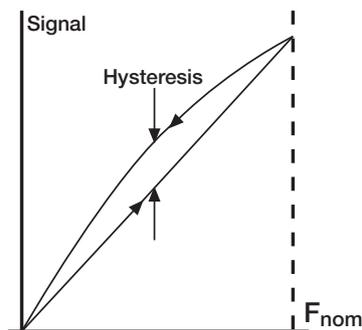
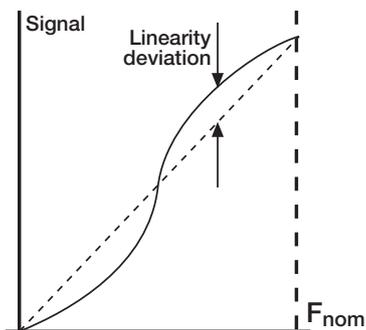
Hysteresis is the maximum deviation of the output signal at the same load during a cycle from zero to nominal load and back to zero, related to the sensitivity at nominal load. The hysteresis is proportional to the cycle.

Repeatability error is defined as the maximum deviation between repeated readings under identical conditions. It is expressed as a percentage of the sensitivity at a nominal load.

Compression is the total reduction in the height of the load cell when the load is increased from zero to nominal load.

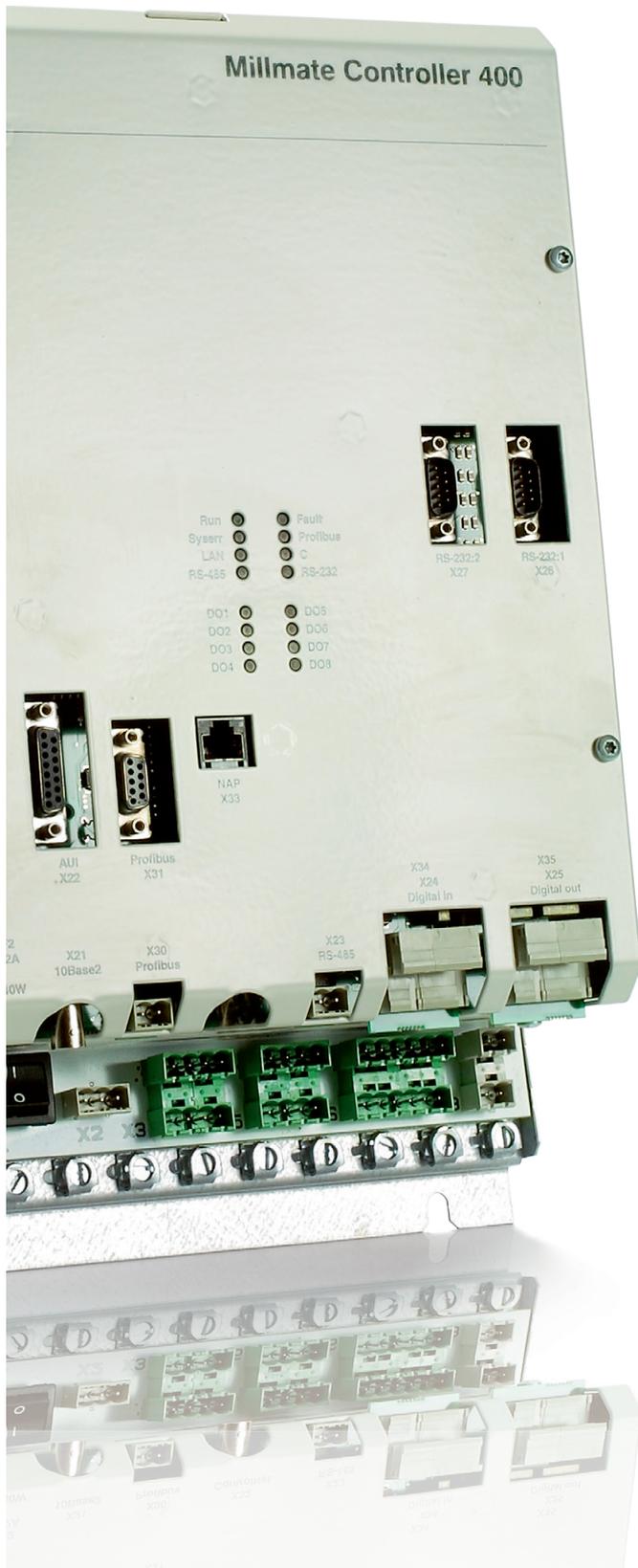
Zero point drift is defined as the drift in the output signal when there is no load on the load cell.

Sensitivity drift is defined as the drift in the output signal at nominal load, excluding the zero point drift.



Control Unit

Millmate Controller 400



The control unit supplies the load cells with power, processes the signals from the load cells and communicates the result to other systems. Communication can take place via digital inputs/outputs, analog inputs/outputs, TCP/IP-communication, RS-232 and as an option, via high-speed fieldbus.

The control unit can be manually operated using the Millmate Operator Unit 400 and by external units via a serial interface or digital/analog inputs. Setup and commissioning are easy following step-by-step menus.

Measured values are displayed on the operator unit, connected to analog outputs or transmitted via a serial interface to an external display or to other external units.

Features

The Millmate Controller 400 has been designed to offer a lot of functionalities and at the same time very easy to use.

The control unit covers most mechanical arrangements. This means the user only has to follow the step-by-step menus in order to set up the control unit and to obtain correct roll force measurement.

Some examples of the built-in functionalities:

- Predefined standard measurement modes
- Built-in load cell tables
- Filter times from 1 up to 2000 ms
- Easy configurable analog/digital inputs/outputs
- Level detectors
- Unit selection (N, kN, MN, kp, t, lb, T)
- Self-diagnostics test system including transducer test
- Simulation mode for easy check of system integration

Data

External connections

- Excitation current to the load cells
- 2/4 analog inputs for load cell signals
- 4 analog outputs, voltage or current
- 8 digital inputs for control signals
- 8 digital outputs
- +24 V supply for external units, max 0.5 A
- Ethernet for connection to:
 - other Millmate control and operator unit
 - other control systems with VIP protocol
- 2 serial interfaces of type RS-232 for external displays, control, etc.
- High-speed fieldbus (optional)

If 4 load cells are connected to the same control unit the nominal load is max. 10 MN for each load cell. Load cells requiring different types of excitation cannot be mixed in the same control unit. Analog/digital inputs and outputs are galvanically insulated as groups.

Vendor Internet Protocol (VIP)

Other control systems can send control data and monitor measurement data with TCP/IP-communication. The Ethernet connection together with the Vendor Internet Protocol (VIP) is used for communication. The protocol uses configurable pre-defined data telegrams and the Millmate Controller 400 acts as a server. The sending procedure is cyclic and the receiving procedure reacts on incoming messages.

The PROFIBUS option

As an option the control unit can be equipped with PROFIBUS – a vendor-independent, open communication standard for automation in manufacturing and process control.

The Profibus interface in the Millmate Controller 400 is updated with a new complete set of measuring values every 0.3 milliseconds.

Millmate Controller 400		
Type	PFVA 401	
Dimensions (HxWxD) Two pieces	380 x 235 x 90 mm	
Weight	5 kg + 7.4 kg	
Protection class	IP 20	
Main voltage	85 - 264 V	
Power consumption	650 VA	
Operating Temperature	0 - +70°C	
Storage temperature	-40 - +70°C	
Analog inputs	0 - 10 V, ±10 V differential inputs	
Analog outputs	Voltage	0 - ±10 V
	Current	0 - ±20 mA, 4 - 20 mA insulated as group
	Step response	1 ms (0 - 90%)
Digital inputs	0/+24 V insulated 4 + 4	
Digital outputs	0/+24 V insulated 4 + 4	

VIP	
Network	10 Mbit/s Ethernet
Communication rate	10 messages/sec
Error handling	Automatic retransmission

Profibus-DP	
Station type	Slave
Max. speed	12 Mbit/s
Configuration	Printable GSD-file in control unit

Control unit options



Millmate Operator Unit 400

The Millmate Operator Unit 400 provides communication with the control unit and is designed for panel mounting.

The operator unit(s) and control unit(s) are interconnected on a common network. This common network can be a separate network for measuring objects or it can be part of a local area network (LAN).

The communication on the network is in accordance with the IEEE 802.3 standard and uses TCP/IP protocol.

Dimensions (H x W x D) 160 x 235 x 60 mm, IP 65 from the front when mounted on a panel acc. to IEC 529, EN 60-529, IP 20 in all other directions acc. IEC 529, EN 60-529, weight 1.3 kg



Relay board PFVK 128

Fitted with four relays with one changeover function per relay.



Media converter PXUB 231

To facilitate connection of MC400 to LAN an optional media converter 10Base2 to 10Base-T can be used.



Insulation amplifier PXUB 201

The insulation amplifier can be used when improved electrical insulation is required.

Installation options

Wall cabinet

A control unit can be installed in the dust- and hose-proof wall cabinet. The operator unit can be mounted on the inside of the door.



Floor cabinet

The MNS floor cabinet can contain a combination of control units with Roll Force, Strip Tensiometer and Strip Scanner applications. They can be operated by one operator unit, optionally mounted through the door or inside the cabinet.



Matching Unit PFVO 142/143

Each load cell requires one matching unit, which is interchangeable between load cells. It can be located up to 25 m away from the relevant load cell (depending on the nominal load).

Dimensions (H x W x D) 300 x 200 x 120 mm, IP 65. weight 8 kg



Contact us

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