Reliable, long-term solutions for your roll force measurement

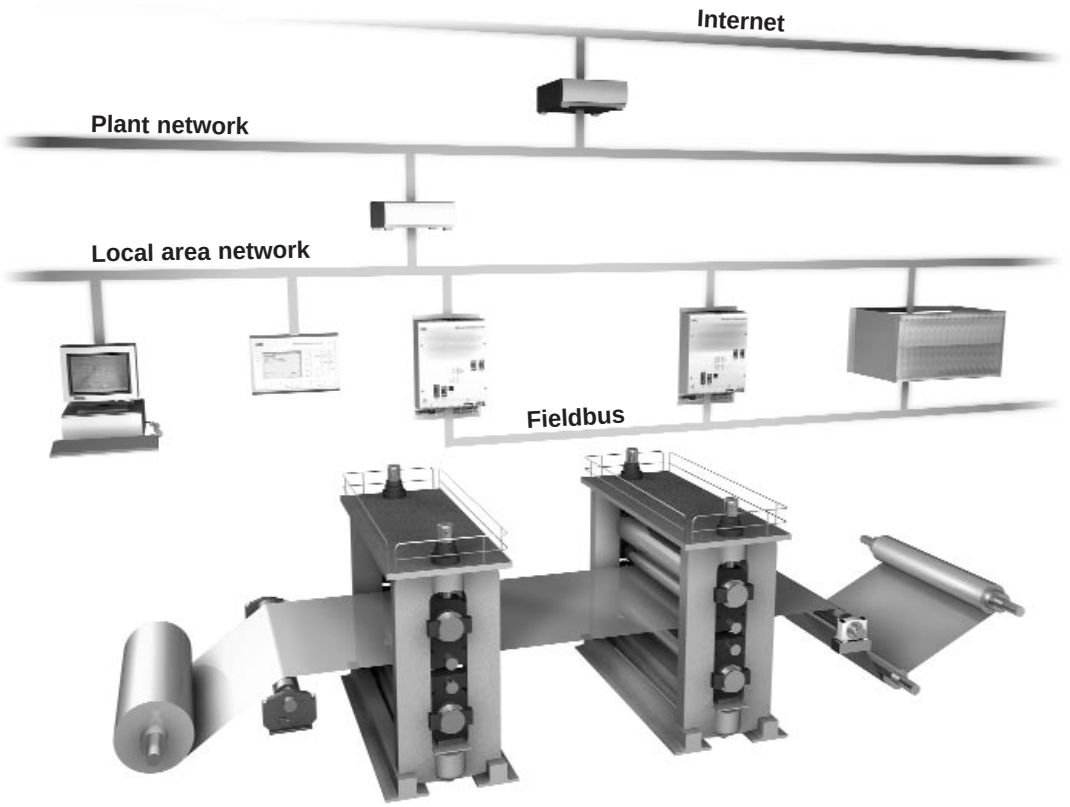
Introduction

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 long experience in the rolling mill industry, we can offer outstanding application know-how in this particular field.



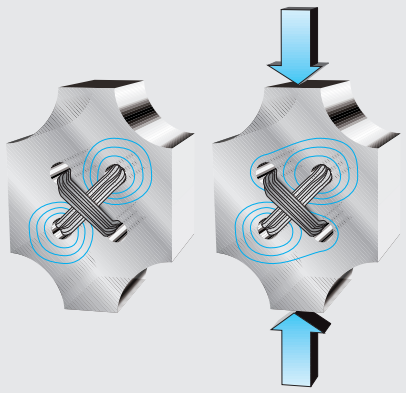
System overview
Building blocks and network for ABB's Force Measurement Systems in rolling mills.

ABB's 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 magneto-elastic 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.



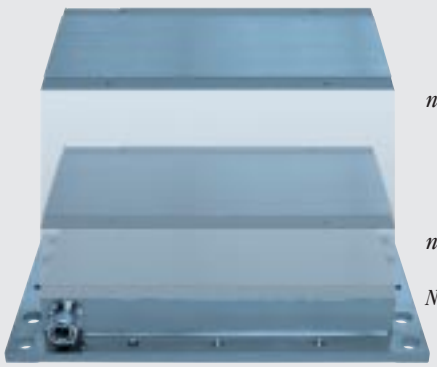
The measurement principle is based on the magneto-elastic effect, according to which the magnetic properties of a material are influenced by mechanical stress. The transducer is magnetized via the primary coil. A voltage proportional to the applied force is induced in the secondary coil.

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 higher than that of other techniques due to the high signal output from the transducer.

The rock-solid design of the Pressductor load cells fulfils 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.

System Building Blocks:

Building Blocks

for 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 building block combinations 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. Choose the best building blocks for your mill. We offer you the superior force measurement systems.

Mill responsible: How do I keep up with my competitors?
ABB representative: *You don't have to look around anymore, ABB can help you.*

↓

Mill responsible: I need to increase the productivity in my mill.
ABB representative: *We have long experience and solid know-how of rolling mill applications.*

↓

Mill responsible: I want to avoid damaging the mill stand and also improve the thickness tolerances.
ABB representative: *You need a reliable roll force measurement system.*

↓

Mill responsible: Today I already have a roll force measurement system, a simple one, but I don't really rely on it.
ABB representative: *We understand your problem and we have a solution you can trust.*

↓

Mill responsible: I also need this equipment to communicate with the rest of my mill.
ABB representative: *MC 400 adapts seamlessly to your specific application.*

↓

Mill responsible: This sounds too good to be true.
ABB representative: *Just pick and choose from our selection guide.*

First Selection of System Building Blocks:
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 kΩ 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.

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.

ABB offers a complete range of roll force load cells.

Installation arrangements

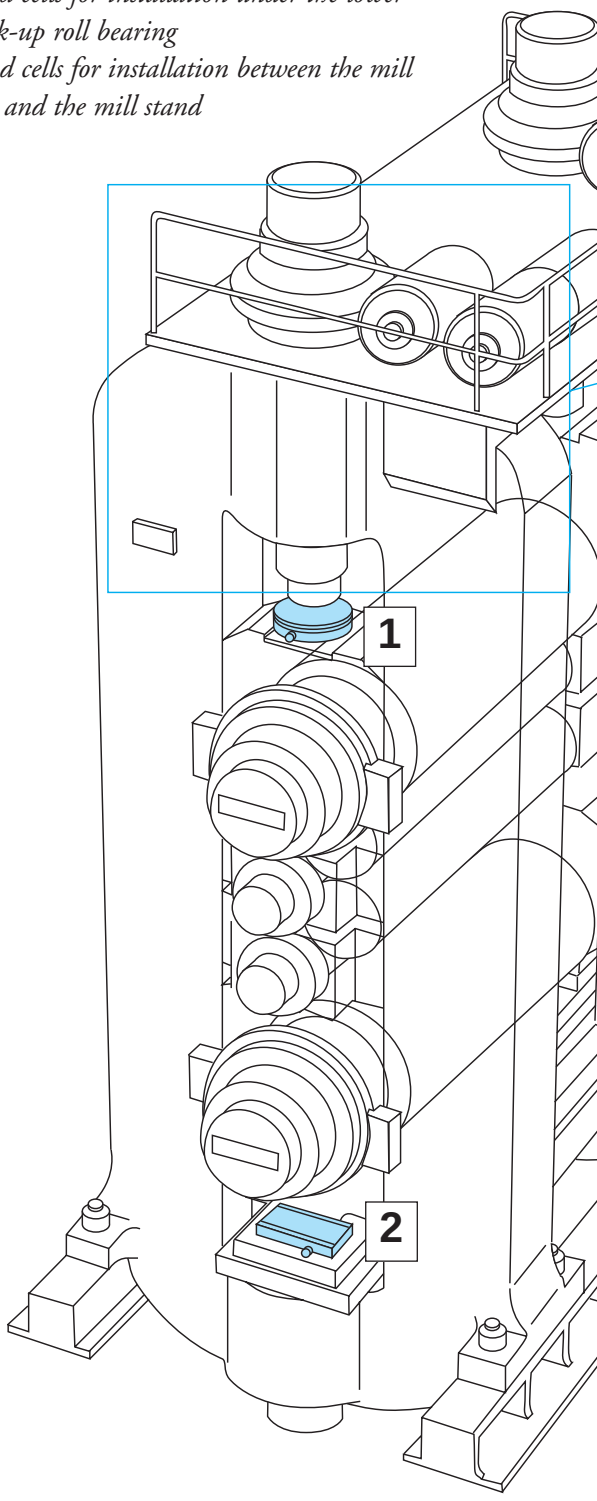
ABB has many years of experience of installing load cells in all types of rolling mill.

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 high bending, lateral and torsional forces.

There are currently three types of load cell 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*



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 movably attached to the mill screw; this makes for easier roll changing. This arrangement gives 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.

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.

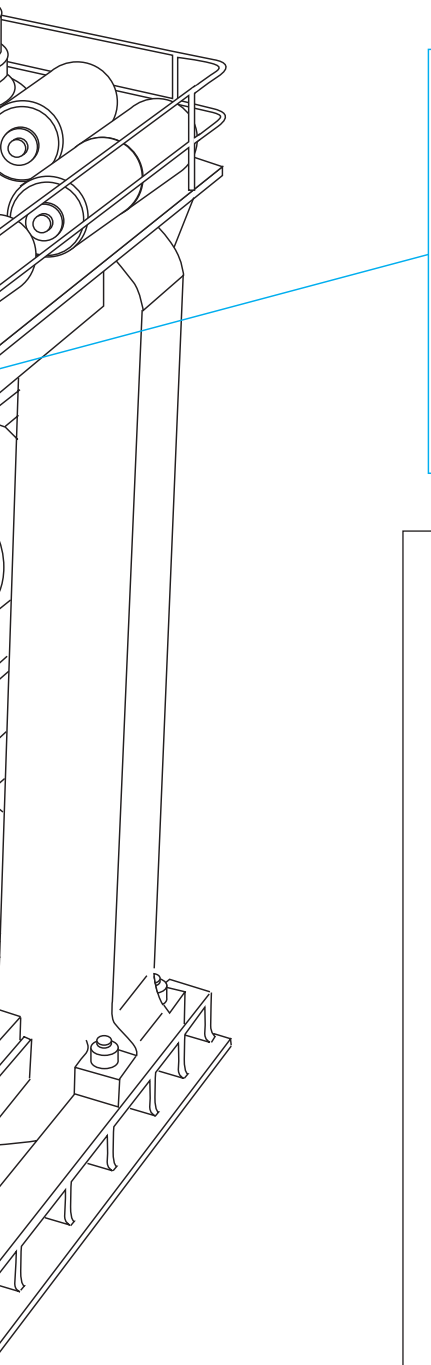
2. Under the lower back-up roll bearing

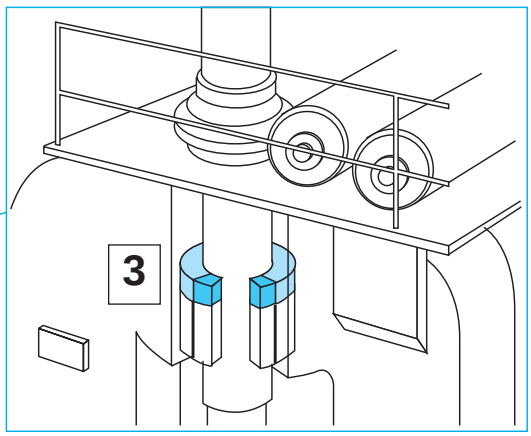
There must be a sufficiently large flat surface on the lower part of the roll stand to allow the installation of the load cell under the lower back-up roll bearing. This arrangement has the advantage that there is no need to pay particular attention to the load cell during roll changing.

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

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

This variant 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.

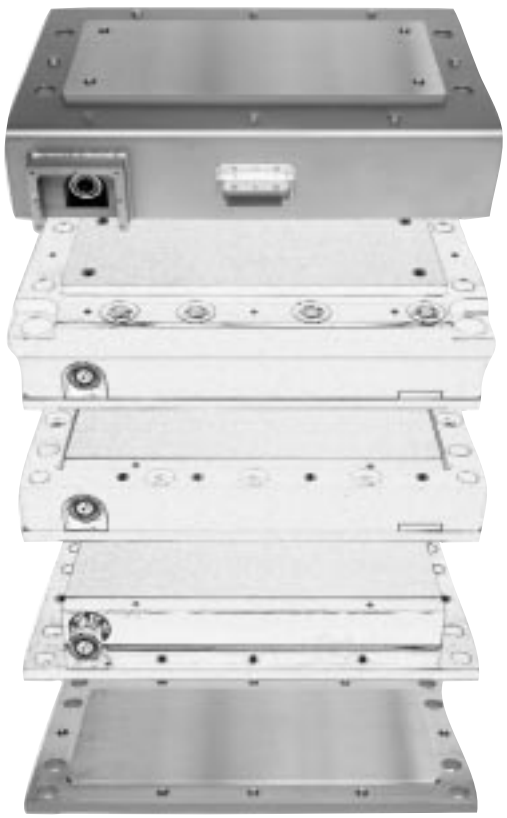




Load Cell Packages

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.



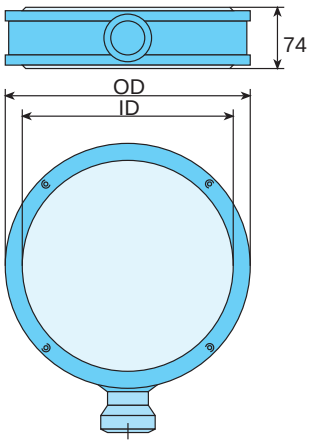
Step-by-step assembly of our prestressed Load Cell Package.

Circular load cells
Measurement range 1.6 - 60 MN
PFVL 141C

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)
1.6	150	210	25
2.5	180	240	24
3.1	210	270	23
4.0	240	290	22
5.0	270	320	21
6.3	300	350	20
8.0	330	380	19
10	360	410	18
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*

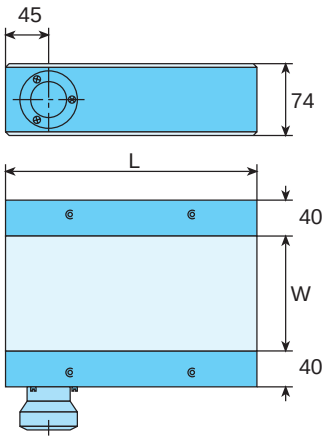
Example
Nominal load 20 MN per load cell. Select 20 MN load cell, dimension OD=560 mm, ID=510 mm

PFVL 141C, 20 MN.

Selection Load Cells:
Rectangular

Nominal load and cable lengths

Nominal load (MN)	Max. cable length (m)
0.63	25
0.80	25
1.0	25
1.25	25
1.6	25
2.0	25
2.5	24
3.1	23
4.0	22
5.0	21
6.3	20
8.0	19
10	18
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 (W) 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 x W x 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.

Rectangular load cells
Measurement range 0.63 - 56 MN
PFVL 141V

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

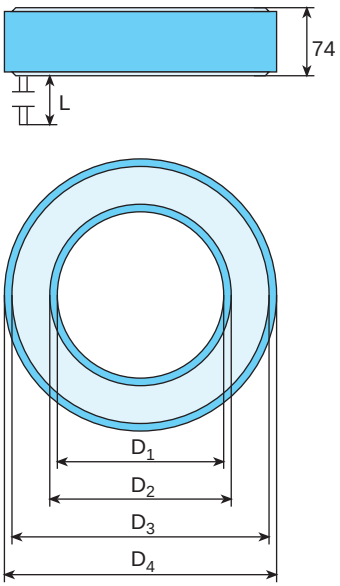
Annular

Annular load cells
Measurement range 2 - 28 MN
PFVL 141R

Standard sizes and cable lengths

Nominal load (MN)	D_1 (mm)	D_2 (mm)	D_3 (mm)	D_4 (mm)	Max. cable length (m)
2	100	130	200	240	75
2.5	100	130	210	250	72
3.1	200	230	300	340	69
4	225	255	340	380	66
5	255	285	380	410	63
6.3	285	315	420	450	60
8.0	320	350	470	500	57
10	355	385	525	555	18
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

Other dimensions on request



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.

When ordering, please state:
- *type designation*
- *nominal load*
- *D_2 and D_3*

Example
PFVL 141R, 10 MN,
D_2=385 mm,
D_3=525 mm.

Load cells
data and definitions

Accuracy class	% of F_{nom}	±0.5	Compensated for min. error		+20 – +80°C
Linearity deviation	% of F_{nom}	≤±0.5	Zero point drift		≤±0.01%/°C
Hysteresis	% of F_{nom}	≤0.2	Sensitivity drift		≤±0.01%/°C
Repeatability error	% of F_{nom}	≤±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.

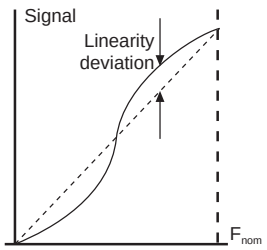
Hysteresis is the maximum deviation of the output signal at the same load during a cycle from zero to nominal load and back to zero, related to the sensitivity at nominal load. The hysteresis is proportional to the cycle.

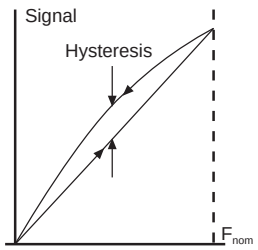
Repeatability error is defined as the maximum deviation between repeated readings under identical conditions. It is expressed as a percentage of the sensitivity at a nominal load.

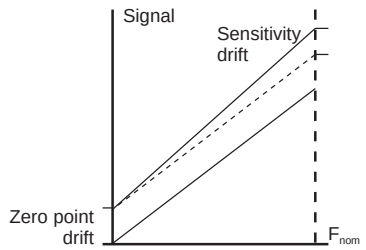
Compression is the total reduction in the height of the load cell when the load is increased from zero to nominal load.

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.

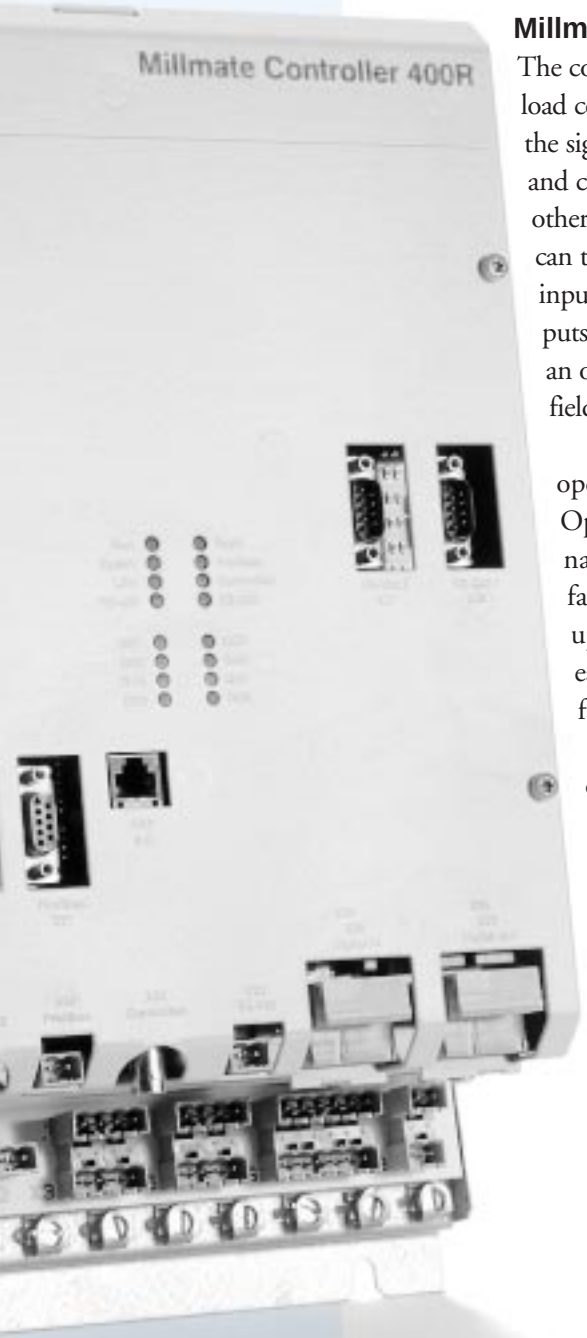






Second Selection of System Building Blocks:

Control Unit



Millmate Controller 400

The control unit supplies the load cells with power, processes the signals from the load cells and communicates them to other systems. Communication can take place via digital inputs/outputs, analog outputs, RS-232, RS-485 and, as an option, via a high-speed fieldbus.

The control unit can be operated using the Millmate Operator Unit 400, external units via a serial interface or digital inputs. Set-up and commissioning are easy due to the user-friendly interface.

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

Basic building blocks

The building blocks required for a basic roll force system are:

Two Pressductor load cells
One Millmate Controller 400
One Millmate excitation unit
Two Matching units

Features

Millmate Controller 400 has been designed to offer a lot of functionalities and at the same time a high degree of user-friendliness.

MC 400 covers most mechanical arrangements. This means the user only has to follow the step-by-step instructions in order to set up the controller 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 500 ms*
- *Easily configurable analog/digital inputs/outputs*
- *Level detectors*
- *Unit selection (N, kN, MN, kp, t, lb, T)*
- *Self-diagnostic test system including transducer test*

External connections:

- Excitation current to the load cells
- 2 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 connection
  Service and multiple control units
- 2 serial interfaces of type RS-232 for external displays, control, etc.
- 1 serial interface of type RS-485 for external display
- High-speed fieldbus (optional)

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.

Data for Control unit with Excitation unit	
Dimensions:	(H × W × D)
Two pieces	380 × 235 × 90 mm
Weight:	5 kg + 7.4 kg
Protection class:	IP 20
Mains voltage:	85 – 264 V
Power consumption:	650 VA
Operating temperature:	0 to + 70 °C
Storage temperature:	-40 to + 70 °C
Analog outputs:	
Voltage	0 – 10 V
Current	0 – 20 mA
	4 – 20 mA
	insulated as groups
Step response	1 ms (0 – 90%)
Digital inputs:	0/+24 V
	insulated 4 + 4
Digital outputs:	0/+24 V
	insulated 4 + 4

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 × W × D) 300 × 200 × 120 mm, IP65, weight 8 kg.

High-speed fieldbus option

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 MC 400 is updated with a new complete set of measuring values every 0.3 millisecond.

Options

Dimensions (H × W × D) 160 × 235 × 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. to IEC 529, EN 60-529, weight 1.3 kg

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 the TCP/IP protocol.

The operator unit is supplied with 24 V DC from either the control unit or via other power sources.

Insulation amplifier PXUB 201

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

Supply voltage		*+24 V (20-253 V)*
Current consumption		*10 mA+external load*
Signal range	*Input*	*0 - +5 V*
		0 - ±10 V
	Output	*0 - ±10 V*
		0 - ±20/4 - +20 mA
Rated insulation voltage		*600 V (basic)*

Relay board PFVK 128

Fitted with four relays with one changeover function per relay. The board is supplied with 24 V DC.

Power consumption		*20 mA/relay*
Contact data	*AC:*	*8 A at 250 V*
	DC:	*1.2 A at 48 V*
		0.2 A at 220 V

Floor Cabinet

The MNS floor cabinet is available in two protection classes. One is ventilated and complies with IEC 529 protection class IP 21. The other has no ventilation and complies with IEC 529 protection class IP 54.

Dimensions (H × W × D) 2,225 × 740 × 656 mm, weight 150 - 200 kg.

Wall Cabinet

One MC 400 with an excitation unit can be installed in the dust- and hose-proof wall cabinet. The operator unit can be mounted on the door.

Dimensions (H × W × D) 600 × 600 × 200 mm, IP65, weight 21 kg.

ABB is a global leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact. ABB has some 155,000 employees in more than 100 countries.

ABB Automation Technology Products is the global market leader in automation technology. We provide products, software and services for the automation and optimization of discrete, process and batch manufacturing operations. Key technologies include measurement and control, instrumentation, process analysis, drives and motors, power electronics, robots and low-voltage products, all geared toward one common Industrial IT architecture for real-time automation and information solutions throughout a business.

ABB Force Measurement is a business unit within ABB Automation Technology Products. It provides equipment for accurate, reliable measurement and control in a broad range of applications from steelmaking to paper converting industries.

Repro: KontaktRepro AB, Västerås – Print: Tryckproduktion AB, Västerås 2002-05

3BSE028041R0001

ABB Automation Technology Products AB
Force Measurement
S-721 59 Västerås, Sweden
Phone: +46 21 34 20 00
Fax: +46 21 34 00 05
Internet: www.abb.com/pressductor

We have local representatives in:

Argentina Buenos Aires, Australia Melbourne, Austria Vienna, Bahrain Manama, Benelux Luxembourg, Brazil São Paulo, Canada Montreal, Chile Santiago, China Beijing, Denmark Odense, Finland Helsinki, France Décines, Germany Düsseldorf, India Bangalore, Indonesia Jakarta, Italy Milan, Japan Tokyo, Korea Seoul, Malaysia Kuala Lumpur, Mexico Guadalajara, South Africa Johannesburg, Spain Bilbao, Taiwan Kaohsiung, Thailand Bangkok, United Kingdom Manchester, USA Brewster N.Y., Venezuela Caracas