



**Reliable and long-term solutions for
your strip tension measurement**

Introduction

A measurement technology with high accuracy is a prerequisite in a modern rolling mill of today. The ever ongoing striving to reach optimum process quality and highest possible productivity is the essential goal of the modern production unit.

One of the crucial parameters in achieving correct strip thickness during cold rolling is the strip tension.

In order to reach the highest possible accuracy, a strip tensiometer is the best and most reliable alternative.

It keeps the strip tension constant within the desired range, during both acceleration and deceleration.

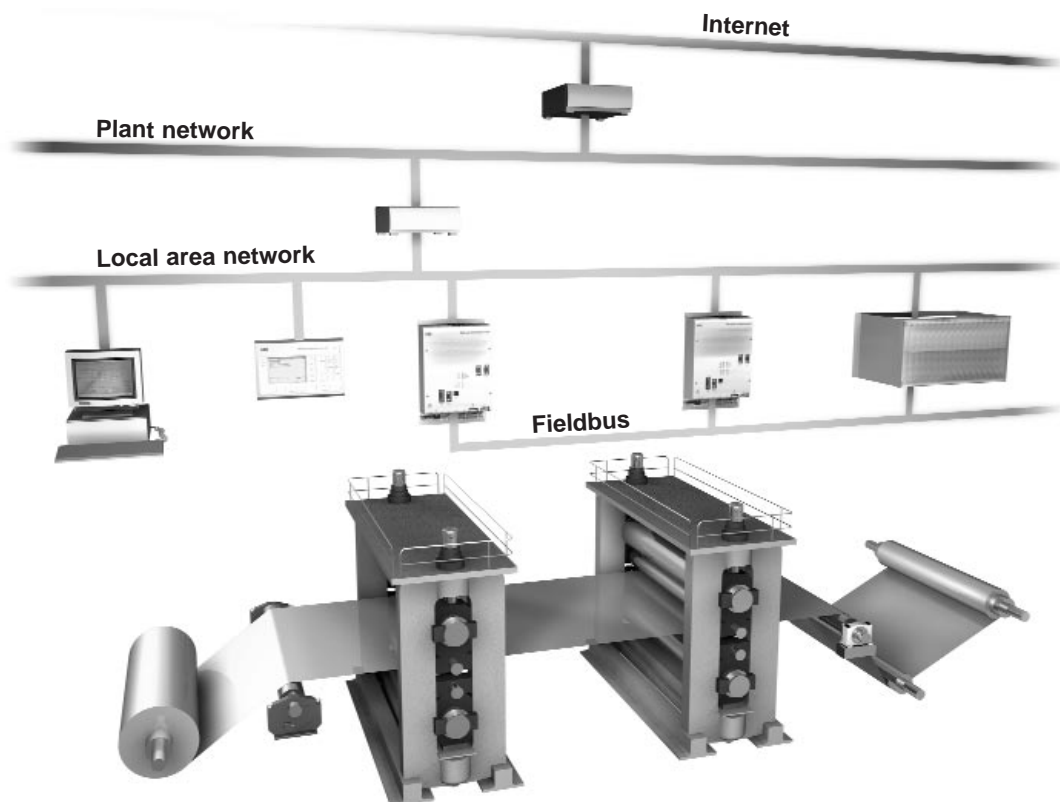
The Millmate Strip Tensiometer System consists of a Millmate Controller 400 (MC 400), a junction box and two load cells matched to the desired measuring range. The load cells are available for measurement in two different directions, one for vertical measurement and the other for horizontal measurement. In order to make it easy to select the correct load cell for your particular application, a

selection guide is available to lead you to the best solution for your mill.

The ABB equipment is easy to install and operate. We offer installation support as well as after sales supply and support for the long-term. Due to ABB's long experience in the field of cold rolling, 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.

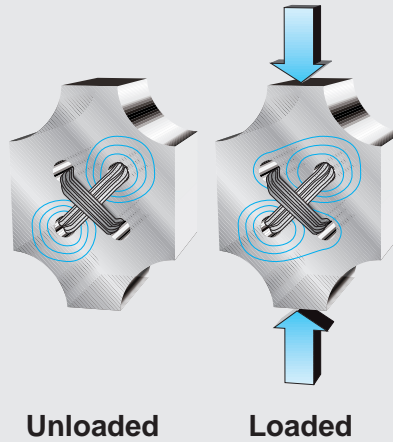


ABB's Pressductor® Technology and the Measurement Principle

ABB's Millmate Strip Tensiometer 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 the windings 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



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.

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.

ABB's Millmate Strip Tensiometer load cells can be used for vertical or horizontal measurement. The strip passes over a deflection roll mounted on two load cells. Depending on the load cells, the strip tension is measured using either the vertical force component or the horizontal force component. The factor T represents the strip tension. The weight of the roll and bearings (Tare) is electronically compensated.

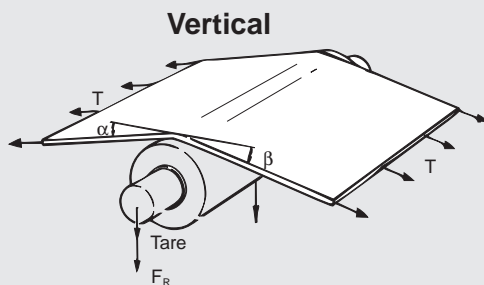
If a load cell for vertical measurement is

selected, the vertical force component is used to measure the force.

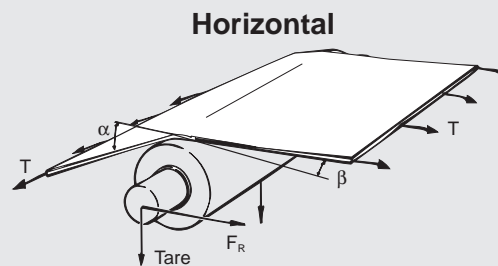
The opposite applies in the case of the horizontal load cell, when the horizontal force measurement is used to measure the force.

With known deflection angles α and β , an output signal fully proportional to the strip tension can be obtained.

The total measured force F_{Rtot} can be calculated as follows:



$$F_{Rtot} = T (\sin \alpha + \sin \beta) + Tare$$



$$F_{Rtot} = T (\cos \beta - \cos \alpha)$$

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 Strip Tensiometer Systems offer a large selection of building block combinations of load cells, control units and options covering your needs for accurate and reliable tension measurement in your mill. You can choose from an ample scope of application adaptations:

The Millmate Strip Tensiometer Systems can be either partly or fully customized to meet your specific requirements.

The PillowBlock load cells are mainly used for strip tension measurement in process lines like pickling, annealing and galvanizing lines, but are also used in rolling mills.

The choice of control unit is made in the light of system requirements and field of application. Choose the best system 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.*

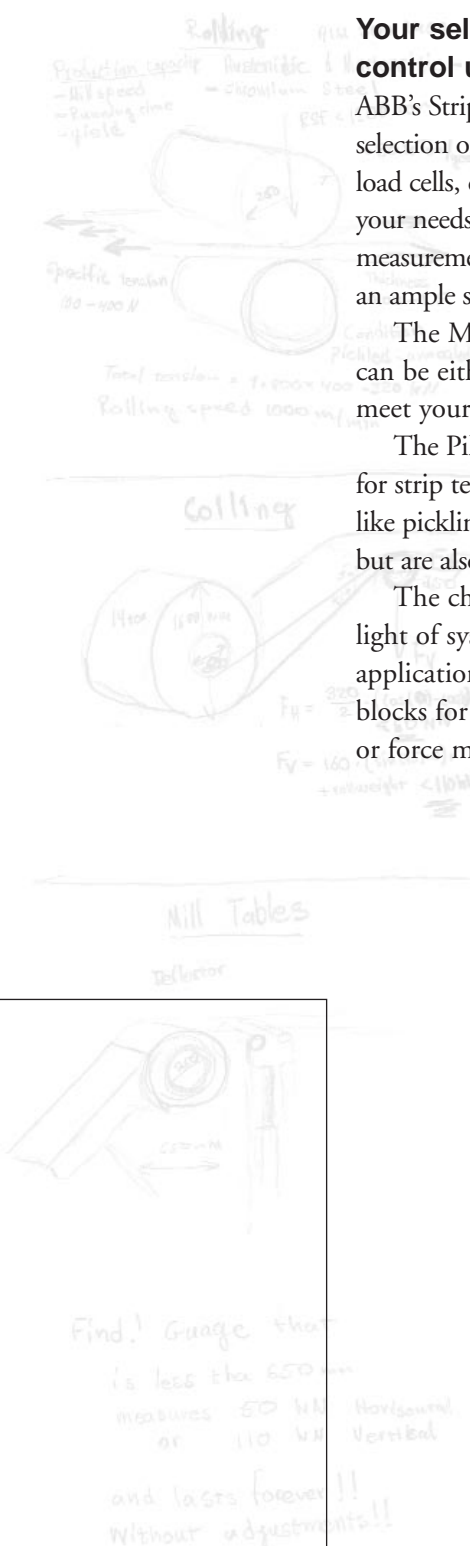
Mill responsible: I need to increase the productivity in my mill.
ABB representative: *We have long experience and solid know-how of rolling mill applications.*

Mill responsible: I need to run my mill at a higher speed but too often I end up with a lot of scrap.
ABB representative: *You have to optimize your strip tension.*

Mill responsible: But my mill is not the ordinary standard one, it is kind of special.
ABB representative: *We have load cells and solutions for any mill geometry.*

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

Different versions

ABB's Strip Tensiometer load cells are made in four versions, two for vertical measurement and two for horizontal measurement. The load cells are available in sizes that cover a wide measuring range and give an output signal proportional to the measurement force F_R .

The housing, containing the Pressductor force transducer, is well protected against harsh mill conditions such as dirt, dust, liquids, steam and corrosive environments.

The magnetoelastic operating principle enables a design of the load cell that does not require physical movement in the transducer to produce a measurement signal.

Mechanically, the load cell is virtually a solid block of stainless steel. Its consequent overall strength and rigidity with a high spring constant are important contributions to applications that put a premium on overload protection or are sensitive to vibrations. Some load cell sizes can handle overloads of up to 30 times their nominal load.

Total solution

In order to achieve true accurate measurement also in very severe conditions, it is not enough to buy only high-quality products. The surroundings and the total installation, too, have to be designed in a correct way.

With ABB's long experience and a large installed base we can support installation proposals for your specific needs and mill geometry. We also offer total solutions including mechanical accessories, such as bearing housings, adapter plates, etc., for the PillowBlock load cells.

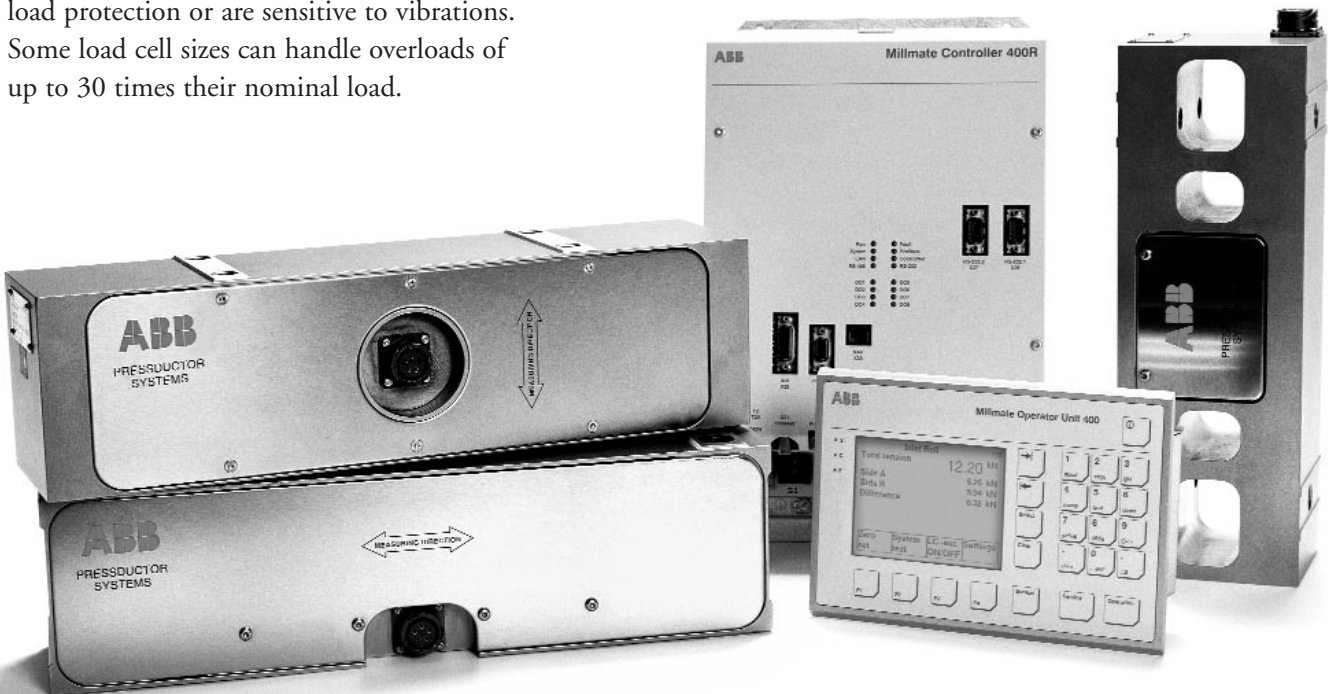


ABB offers a complete range of strip tensiometer load cells.

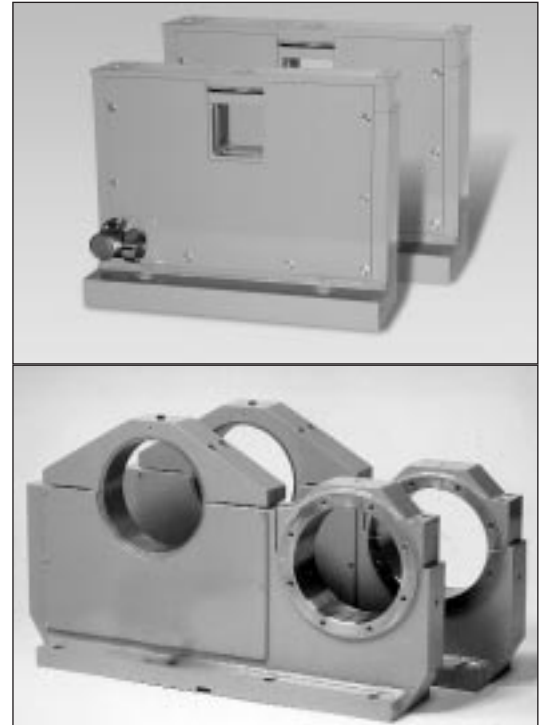
Selection Customized Load Cells: Millmate Strip Tensiometer load cells

Vertical measurement
Measurement range 4 - 400 kN
PFBL 141B
PFBL 141C

Customized load cells – designed for your specific mill and your specific needs.

The vertically measuring Millmate Strip Tensiometer load cells have a well-proven design and have the ability to measure accurately in the most severe environments, such as interstand measurement in tandem cold rolling mills. Another application is in cluster mills, where accurate tension control is essential.

This type of load cell is sensitive to forces in the vertical direction, but insensitive to horizontal forces. The load cells come in two versions, with fixed shaft or with rotating shaft.



Data PFBL 141
kN per load cell

Nominal load	kN	4	6.3	10	25	40	63	100	160	250	400
Overload capacity ¹⁾	kN	120	120	210	210	350	500	500	550	750	1100
Spring constant	kN/mm	1300	1300	2000	2000	3200	5000	5000	8000	12500	20000

¹⁾ without change of data.

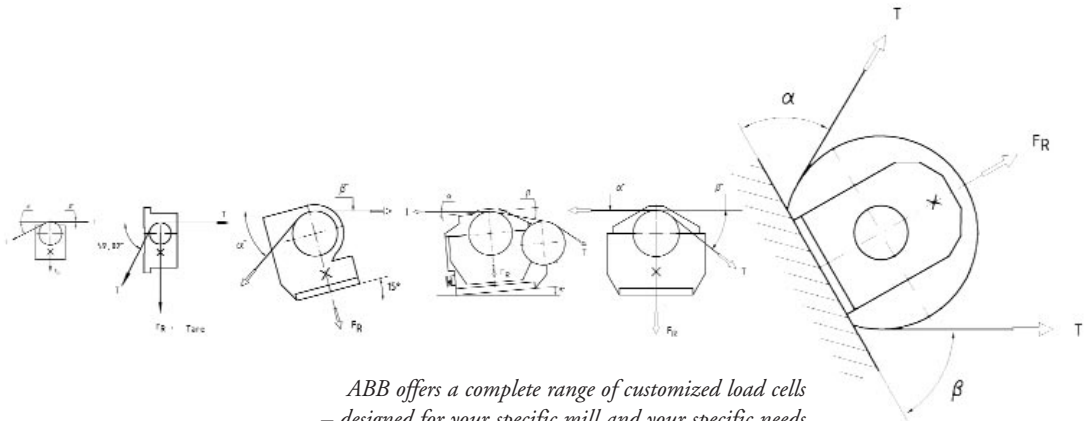
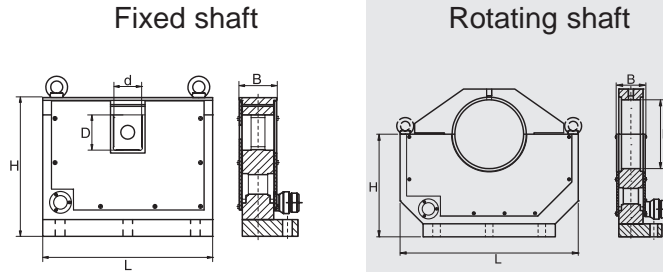


ABB offers a complete range of customized load cells – designed for your specific mill and your specific needs

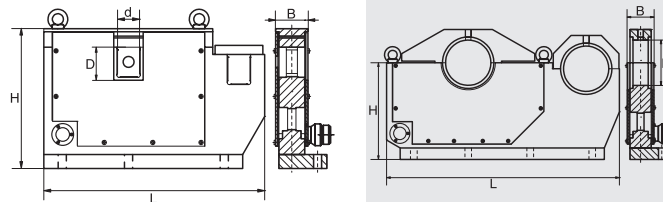
For further data and definitions, see page 11.

Dimensions
Single-roll

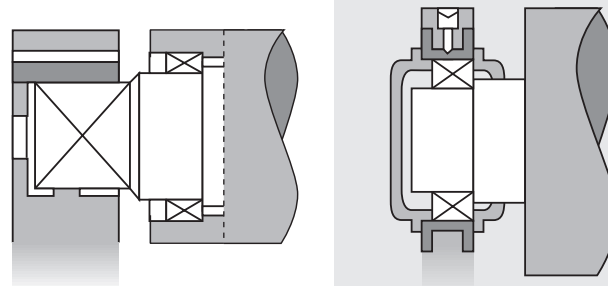


	Rated load kN/load cell	Dimensions (mm)				Dimensions (mm)			
		D×d	L	H	B	D	L	H	B
PFBL 141B min.	10	50×50	430	380	88	100	475	400	88
max.	63	140×140	1200	600	108	400	1200	800	108
PFBL 141C	4-400	Customized				Customized			

Dimensions
Two-roll



	Rated load kN/load cell	Dimensions (mm)				Dimensions (mm)			
		D×d	L	H	B	D	L	H	B
PFBL 141B min.	10	50×50	550	380	88	100	650	400	88
max.	63	140×140	1200	600	108	400	1200	800	108
PFBL 141C	4-400	Customized				Customized			



Typical designs for fixed and rotating shaft.

Selection Standard Load Cells: PillowBlock Tensiometer load cells

Vertical measurement
Measurement range 5 - 50 kN
PFCL 201C
PFCL 201CE

The vertical PillowBlock load cell is the outstanding choice for process lines (annealing, pickling, galvanizing lines, etc.) and can also be used with great advantage in your rolling mill application when you require a compact mill geometry. The load cell is a solid tensiometer made from stainless steel with exceptional ruggedness and a high spring constant. It can be installed under the bearing housing and senses the vertical force, measuring in both directions.

The load cells come in two versions:



- PFCL 201C equipped with a Cannon connector for the connection cable, best suited for process lines, and
- PFCL 201CE, the mill-proof version with fixed connection cable in protective hose.

Data PFCL 201
kN per load cell

		PFCL 201C/CE			
Nominal load, calibrated	kN	5	10	20	50
Extended measuring range		7.5	15	30	75
Overload capacity^{1) 2)}	kN				
-in measuring direction		50	100	200	500
Max. permitted load³⁾	kN				
-in transverse direction (h=300 mm) ⁴⁾		2.5	5.0	10	25
-in axial direction (h=300 mm) ⁴⁾		1.25	2.5	5	12.5
Spring constant	kN/mm	250	500	1000	2500

¹⁾ without change of data.

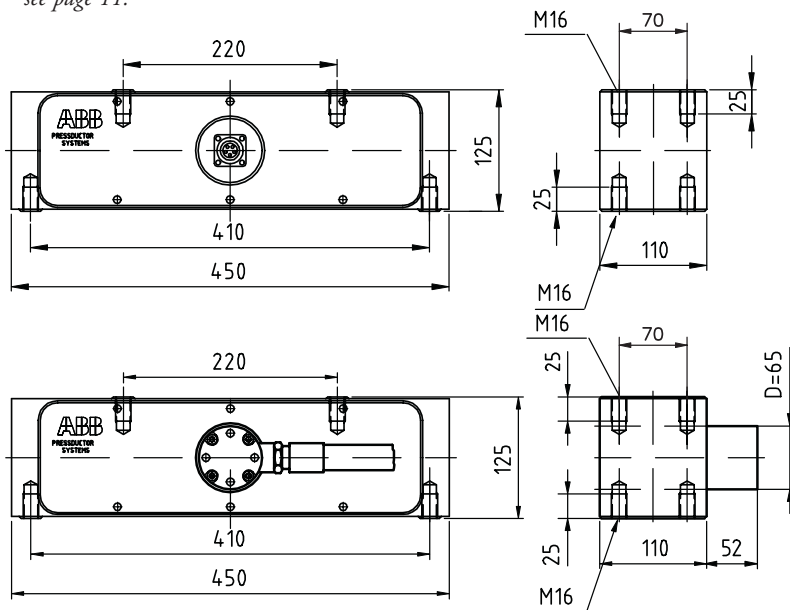
²⁾ for complex applications the screw joints have to be checked.

³⁾ within the accuracy.

⁴⁾ see page 11.

Dimensions (mm)

PFCL 201C



PFCL 201CE

For further data and definitions, see page 11.

The horizontal PillowBlock load cell is mainly used for measurement in process lines, such as annealing, pickling and galvanizing lines.

The horizontal force component can be used to a great advantage to measure strip tension. The load cell can be sized to measure just the strip tension, excluding the tare weight of the roll. The result is the best possible measurement accuracy.

Solid stainless steel design combines sensitivity and accuracy with exceptional ruggedness and a high spring constant.



Horizontal measurement 1
 Measurement range 10 - 100 kN
 PFTL 201C
 PFTL 201CE
 PFTL 201D
 PFTL 201DE

	PFTL 201C/CE			PFTL 201D/DE	
Nominal load, calibrated	10	20	50	50	100
Extended measuring range	15	30	75	75	150
Overload capacity^{1) 2)}					
-in measuring direction	100	200	500	500	1000
Max. permitted load³⁾					
-in transverse direction (h=300 mm) ⁴⁾	100	200	250	500	500
-in axial direction (h=300 mm) ⁴⁾	20	20	50	100	100
Spring constant kN/mm	1000	1000	1000	2000	2000

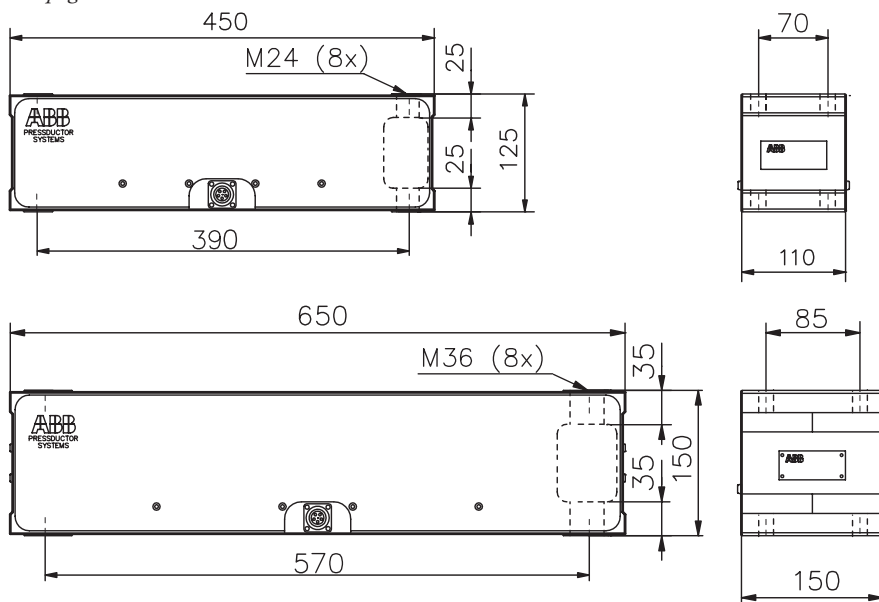
Data PFTL 201
 kN per load cell

¹⁾ without change of data.

²⁾ only valid when pressure plates according to 3BSE008917 are used.

³⁾ within the accuracy.

⁴⁾ see page 11.



Dimensions
 (mm)

PFTL 201C

PFTL 201D

For further data and definitions, see page 11.

Horizontal measurement 2
Measurement range 0.5 – 20 kN
PFTL 101A
PFTL 101B

In process lines, where the tension is rather low, there are smaller sizes of horizontal PillowBlock load cells to choose from. These stainless steel load cells come in two standard sizes and are made for measurement forces between 0.5 and 20 kN. They are machined from a solid steel block to the shape of two steel plates linked by four to six vertical membranes. This makes them insensitive to transverse load, but on the other hand they can measure in both horizontal directions.

PillowBlock type PFTL 101 comes in two versions:



- PFTL 101A/B with Cannon connector
 - PFTL 101 AE/BE with fixed cable
- These PillowBlock load cells have an extremely high accuracy and their linearity is perfect up to double the nominal load.

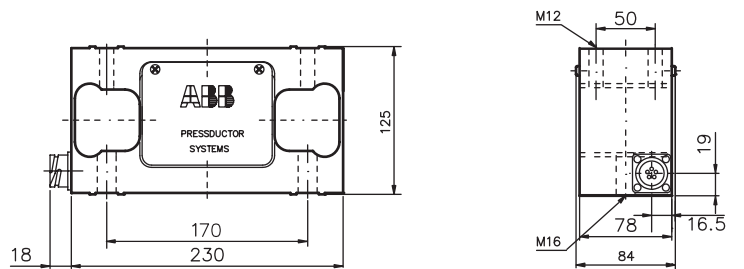
Data PFTL 101
kN per load cell

	PFTL 101A/AE				PFTL 101B/BE			
Nominal load	0.5	1	2	2	5	10	20	
Max. permitted load ¹⁾								
-in measuring direction	2.5	5	10	10	25	50	80	
-in transverse direction	5	10	10	30	30	30	40	
-in axial direction	2	5	5	5	10	10	10	
Spring constant kN/mm	32	65	130	130	325	650	1300	

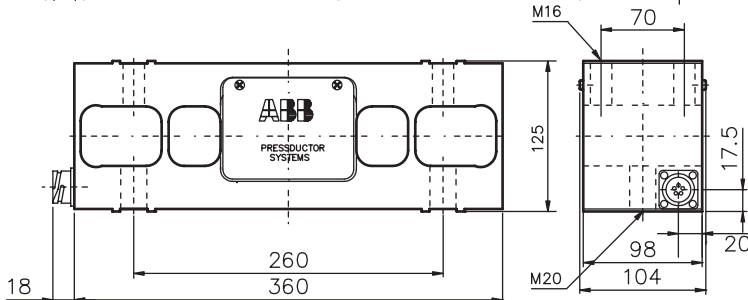
¹⁾ without change of data.

Dimensions (mm)

PFTL 101A



PFTL 101B



For further data and definitions, see page 11.

Load cells

data and definitions

General load cell data		Vertical		Horizontal	
		PFBL 141	PFCL 201	PFTL 101	PFTL 201
Accuracy class	% of F_{nom}	±0.5			
Accuracy class	% of F_{ext}	n/a	±1	n/a	±1
Linearity deviation	% of F_{nom}	±0.5	±0.3	±0.3	±0.3
Hysteresis	% of F_{nom}	0.2			
Repeatability error	% of F_{nom}	<±0.05			
Comp. temp. range	°C	+20°-+80°			
Zero point drift	%/K	0.005	0.005	0.003	0.005
Sensitivity drift	%/K	0.01	0.01	0.015	0.01
Working temp. range	°C	-10°-+90°	-10°-+90°	-10°-+105°	-10°-+90°
Storage temp. range	°C	-40°-+90°	-40°-+90°	-40°-+105°	-40°-+90°
Output impedance	Ω	typically 1-20			

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.

Extended measuring range (F_{ext}) is the maximum load in the measuring direction for which measurement can be performed with a specified accuracy class.

Overload is the max. permitted load in the measuring direction without change of data.

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.

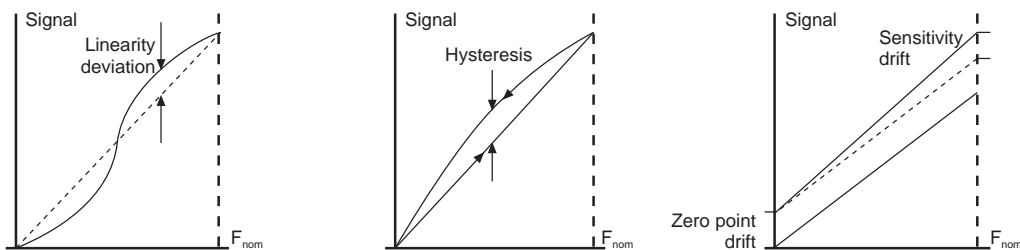
Hysteresis is the maximum deviation of the output signal at the same load during a cycle from zero to nominal load and back to zero, related to the sensitivity at nominal load.

The hysteresis is proportional to the cycle.

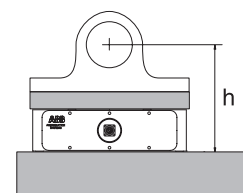
Repeatability error is defined as the maximum deviation between repeated readings under identical conditions. It is expressed as a percentage of the sensitivity at a nominal load.

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

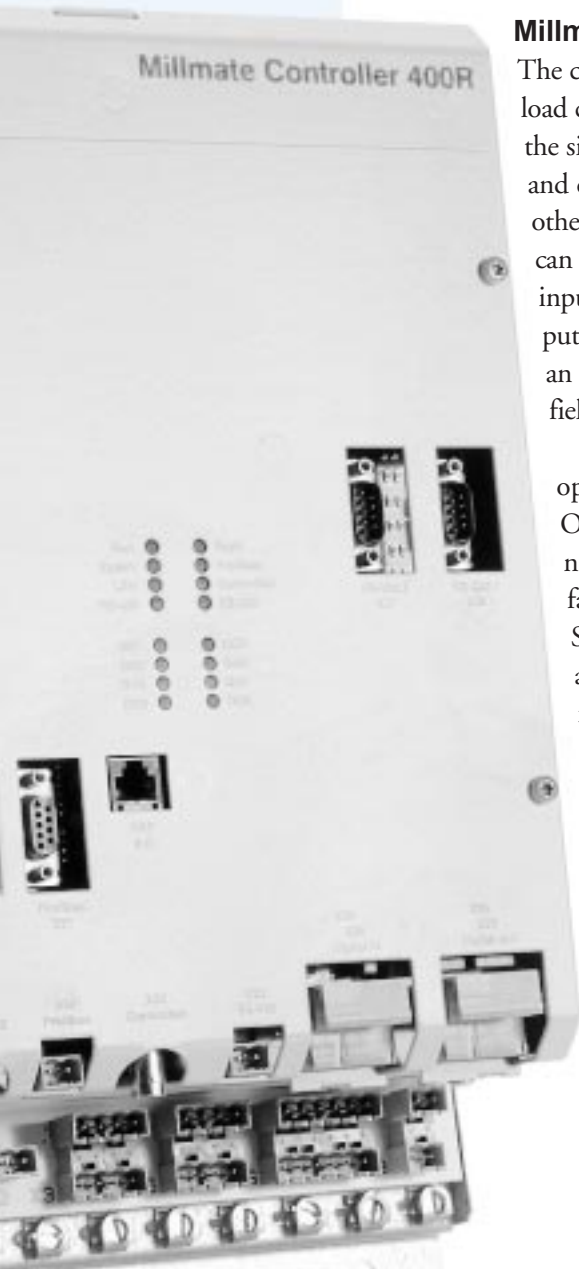
Sensitivity drift is defined as the drift in the output signal at nominal load, excluding the zero point drift.



Height (h) from load cell's bottom surface to roll center line.



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. Setup 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.

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 have a correct strip tension calculated.

Some examples of the built-in functionalities:

- *Predefined standard measurement modes*
- *Prepared to calculate true strip tension from all mechanical arrangements that can be found in your mill and processing line*
- *Built-in load cell tables*
- *Filter times from 5 up to 500 ms*
- *Easily configurable analog/digital inputs/outputs*
- *Feasible for tension and processing lines with interconnected multiple units*
- *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 or 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 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 a group.

Data:

Dimensions:(HxWxD)	380 x 235 x 90 mm
Weight:	5 kg
Protection class:	IP 20
Mains voltage:	85 – 264 V
Power consumption:	140 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 group
Step response	5 ms (0 - 90%)
Digital inputs:	
	0/+24 V
	insulated 4 + 4
Digital outputs:	
	0/+24 V
	insulated 4 + 4

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 1.5 milliseconds.

Third Selection of System Building Blocks: 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

Junction box PFBC 161

The junction box makes it possible to extend the distance between the load cells and the control unit as well as reduce the cabling cost.

Dimensions (H × W × D) 150 × 150 × 80 mm, IP65, weight 1.7 kg.

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
	Output 0 - ±10 V
	0 - ±20/4 - +20 mA
Rated insulation voltage	600 V (basic)

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.

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

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) 2225 × 740 × 656, 150 - 200 kg.



Wall Cabinet

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

Dimensions (H × W × D) 500 × 400 × 200 mm, IP65, weight 22 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.



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