ABB MEASUREMENT & ANALYTICS

# Web Tension Systems with Tension Electronics PFEA113

User Manual

**3BSE029382R0101 en Rev D**

Use of **DANGER**, **WARNING**, **CAUTION**, and **NOTE**

This publication includes, **DANGER**, **WARNING**, **CAUTION** and **NOTE** information where appropriate to point out safety related or other important information.

| | |
|---|---|
| **DANGER** | Hazards which could result in severe personal injury or death |
| **WARNING** | Hazards which could result in personal injury |
| **CAUTION** | Hazards which could result in equipment or property damage |
| **NOTE** | Alerts user to pertinent facts and conditions |

Although **DANGER** and **WARNING** hazards are related to personal injury, and **CAUTION** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all **DANGER**, **WARNING**, and **CAUTION** notices.

**TRADEMARKS**

Pressductor® is a registered trademark of ABB AB.

**NOTICE**



**CE and UK regulations marking**

Provided that the installation is carried out in accordance with the installation instructions given in this manual this product meets the requirements for CE-marking specified in: the RoHS directive 2011/65/EU + AD 2015/863/EU, EMC directive 2014/30/EU and the Low Voltage Directive 2014/35/EU and Conformity to UK regulations: The Electrical Equipment (Safety) Regulations 2016, S.I.2016:1101, The Electromagnetic Compatibility Regulations 2016, S.I.2016:1091 and The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012, S.I. 2012:3032.

The Tension Electronics PFEA113 fulfills the requirements of safety approval for USA and Canada according to the standard UL61010C-1 for Process Control Equipment and CSA C22.2 No. 1010-1. Certificate No. 170304-E240621 and No. 240504-E240621, provided that the installation is carried out in accordance with the installation instructions given in Chapter 2 Installation, included in this User Manual.

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# Chapter 1 Introduction

## 1.1 About this Manual

This User Manual describes your new Web Tension System. When you have read the manual, you will have the necessary knowledge for mechanical and electrical installation, commissioning, operation, preventive maintenance and basic fault tracing of your measurement system.

To get the best reliability and precision out of your measurement system, study this User Manual first.

## 1.2 Cyber security disclaimer

This product has been designed to be connected and communicate data and information via a network interface which should be connected to a secure network. It is the sole responsibility of the person or entity responsible for network administration to ensure a secure connection to the network and to take the necessary measures (such as, but not limited to, installation of firewalls, application of authentication measures, encryption of data, installation of antivirus programs, etc.) to protect the product and the network, its system and interface included, against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB is not liable for any such damages and/or losses.

## 1.3 China RoHS Marking

*Table 1-1. 有害物质 Hazardous Substances*

| 产品名称 **Product name** | 铅 **Lead (Pb)** | 汞 **Mercury (Hg)** | 镉 **Cadmium (Cd)** | 六价铬 **Hexavalent Chromium (Cr (VI))** | 多溴联苯 **Polybrominated biphenyls (PBB)** | 多溴二苯醚 **Polybrominated diphenyl ethers (PBDE)** |
|---|---|---|---|---|---|---|
| 金属部件 Metal Parts | O | O | O | O | O | O |
| 电路板组件 Printed Circuit Board Assemblies | X | O | O | O | O | O |
| 电缆 Cables | O | O | O | O | O | O |

本表格依据SJ/T 11364 标准的规定编制。

This table is prepared in accordance with the provisions of SJ/T 11364.

O: 表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572 标准规定的限量要求以下。

O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572 标准规定的限量要求。

X: Indicates that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.

电子电器产品的环保使用期限依据SJT/ 11388 标准的规定确定。

The EPUP value of EEP is defined according to SJ/T 11388 standard.

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环保使用期限仅在产品使用说明书规定的条件下才有效
The Environment Protection Use Period is valid only when the product is operated under the conditions defined in the product manual.


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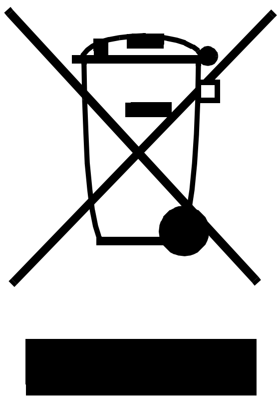
## 1.4 WEEE: Waste Electrical and Electronic Equipment



The crossed – out wheeled bin symbol on the product(s) and / or accompanying documents means that used electrical and electronic equipment (WEEE) should not be mixed with general household waste.

If you wish to discard electrical and electronic equipment (EEE), in the European Union, please contact your dealer or supplier for further information.
Outside of the European Union, contact your local authorities or dealer and ask for the correct method of disposal.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

## 1.5 How to Use this Manual

This user manual comprises two main parts.

1. **Information about the Tension Electronics**
   - System and safety information (Chapter 1)
   - Installation, commissioning, maintenance, operation and fault tracing (Chapters 2-6)
   - Technical data (Appendix A)

2. **Information about Designing the Load Cell Installation**
   - Vertical-force sensing load cell PFCL 301E (Appendix B)
   - Horizontal-force sensing load cell PFTL 301E (Appendix C)
   - Radial Tensiometer PFRL 101 (Appendix D)
   - Horizontal-force sensing load cell PFTL 101 (Appendix E)
   - Vertical-force sensing load cell PFCL 201 (Appendix F)
   - Horizontal-force sensing load cell PFTL 201 (Appendix G)

   Each appendix contains detailed information about one of the above load cell types when used in web tension systems with Tension Electronics PFEA113.

### 1.5.1 Getting Started

You can use the Fast Setup sequence to set up your system for basic measurement.
The Fast Setup guides you through a minimum number of steps to set up the tension electronics. Perform the actions in the following sections:

- Section 3.6 Step-by-step Commissioning Guide
- Section 3.7 Performing Basic Settings
- Section 3.8 Performing a Fast Setup (Only for One or Two Rolls)

For extended functionality, use “Performing a Complete Setup”.
See Section 3.11 Performing a Complete Setup.

### 1.5.2 Saving Actual Data and Settings at Commissioning

When commissioning is completed, you can use the form in Appendix H Actual Data and Settings at Commissioning, where actual commissioning data and settings can be filled in and saved for future use.

## 1.6 About this System

Your system for tension measurement consists of:

- Tension Electronics PFEA113
- Load cells of type PFCL 301E, PFTL 301E, PFRL 101, PFTL 101, PFCL 201 and PFTL 201
- Junction Box PFXC 141

This advanced tension electronics can supply up to four load cells and has six configurable analog outputs for control and/or monitoring of web tension. The output signals are also available on Profibus-DP. Another useful feature is the possibility to, via the digital input or Profibus, switch the gain for two different web paths (gain scheduling) and zero set. This unit also includes a self-diagnostic function and four configurable digital outputs for alarms and level detection. Status of self-diagnostic functions are also available on Profibus-DP. By combining up to three PFEA113 the system can handle segmented roll applications, for example winders, with up to 12 load cells. The high level of functionality and user friendliness make the PFEA113 one of the most complete tension electronics on the market.

Covering a wide range of applications the Tension Electronics comes in three versions (PFEA 111 and PFEA 112 are described in a separate manual), with different levels of performance and functionality. All three versions have multi-language digital display and configuration keys. The configuration keys being used for setting different parameters and to check the status of the tension system. The 2 x 16-character display can present sum, difference or individual load cell signals. All three versions are available in both DIN-rail version (IP 20-version, unsealed) and enclosed IP 65-version (NEMA 4) for mounting in more severe environments.

The equipment is intended for use in a wide range of manufacturing processes where web material of any kind, for example paper, plastic or textile, is transported in a machine. The only requirement is that the web is wrapped over a roll. The force on the roll is proportional to the web tension. The resulting force is transferred through the bearing housings into the load cells. The load cells create a signal that is proportional to the force acting in the measuring direction of the load cells. This signal is processed and amplified in the tension electronics and can be used as an input signal for process control, presentation on a display or for registration.

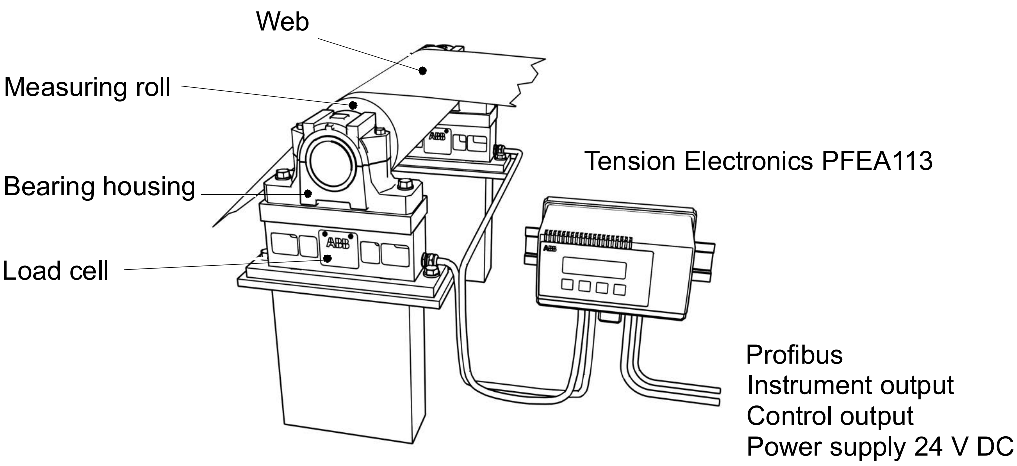



*Figure 1-1. Typical Tension Measurement System with Tension Electronics PFEA113 (IP 20-version)*

# 1.7 Safety Instructions

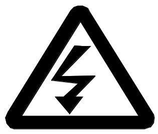
Read and follow the safety instructions given in this section before starting any work. However, local statutory regulations, if stricter, are to take precedence.

The tension measurement system contains no moving parts. However, the load cells are mounted close to a rotating roll over which a web is running.

## 1.7.1 Personnel Safety

**WARNING**

Never work with the load cells, or nearby, when the production line is in service. Before starting any work, switch off and lock the operating switch of the drive section for the measuring roll.



**DANGER**

Switch off and lock the mains operating switch to the tension electronics before performing any work on the tension electronics. When the work is completed, check that there are no loose wires, and that all units are properly secured.

**NOTE**

All personnel working with the installation must know the location of the main power supply switch to the measurement system and how it is operated.

## 1.7.2 Equipment Safety

**CAUTION**

Always switch off the mains supply voltage to the measurement system before replacing a unit.

**CAUTION**

Handle the electronic unit carefully to reduce the risk of damage from Electric Static Discharge (ESD). Note the warning label on the circuit boards.

## 1.8 The Measuring Technique Based on Pressductor® Technology

The operating principle of a force transducer has a great effect on how well it will perform. It also affects how stiff and vibration-free the entire load cell will be, as well as its robustness and tolerance to overload. All of these factors impact on the design, operation, and maintenance of the web processing machinery.

ABB's Pressductor® transducer technology produces a signal as a result of changes in an electromagnetic field when the load cell is subjected to mechanical force. It is an operating principle that has its origin in a metallurgical phenomenon according to which mechanical forces alter the ability of some steels to convey a magnetic field. Unlike other types of load cell technologies, physical movement such as compression, bending or stretching is not required for signal generation.

A Pressductor® transducer (the sensor inside the load cell) is a simple and elegant design. Essentially, two perpendicular windings of copper wire around a steel core combine to provide a measurement signal.

An electromagnetic field is created by continuously feeding an alternating current to one of the windings. The field is positioned in such a way that, since the windings are at right angles to each other, there is no magnetic coupling between them when the load cell is unstressed.

However, when the transducer is subjected to a force, as shown in the figure, the magnetic field pattern changes. A portion of the field couples with the second winding and induces an AC voltage that reflects the tension exerted by the web on the measurement roll. This voltage - a comparatively strong transducer signal - is converted by the load cell system's tension electronics into a system output.

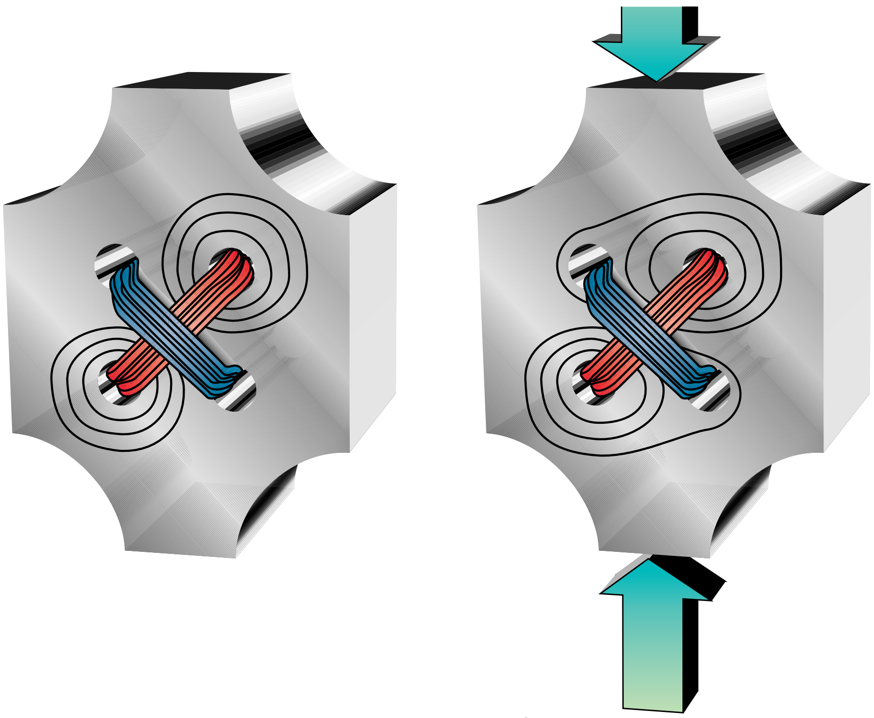


*Figure 1-2. The Sensor Based on Pressductor® Technology*

# Chapter 2 Installation

## 2.1 About this Chapter

The way you install your system has more influence on its functionality, accuracy and reliability than you might think. The more accurate the installation, the better the measurement system. By following the instructions in this chapter, you will fulfill the most important requirements for proper mechanical and electrical installation.

The equipment is a precision instrument which, although intended for severe operating conditions, must be handled with care.

## 2.2 Safety Instructions

Read and follow the safety instructions given in Chapter 1 Introduction, before starting any installation work. However, local statutory regulations, if stricter, are to take precedence.

## 2.3 Mounting the Load Cells

Installation requirements and mounting instructions are given in:


- Appendix B PFCL 301E - Designing the Load Cell Installation
- Appendix C PFTL 301E - Designing the Load Cell Installation
- Appendix D PFRL 101 - Designing the Load Cell Installation
- Appendix E PFTL 101 - Designing the Load Cell Installation
- Appendix F PFCL 201 - Designing the Load Cell Installation
- Appendix G PFTL 201 - Designing the Load Cell Installation

## 2.4 Installing the Electronic Unit

### 2.4.1 Selecting and Routing the Cabling

#### 2.4.1.1 Recommended Cabling

The cabling between the load cells and the electronic unit and electrical connections must be carefully carried out in accordance with connection diagram 3BSE028144D0065 (See the appendix for your type of load cell) or according to order-specific documentation.

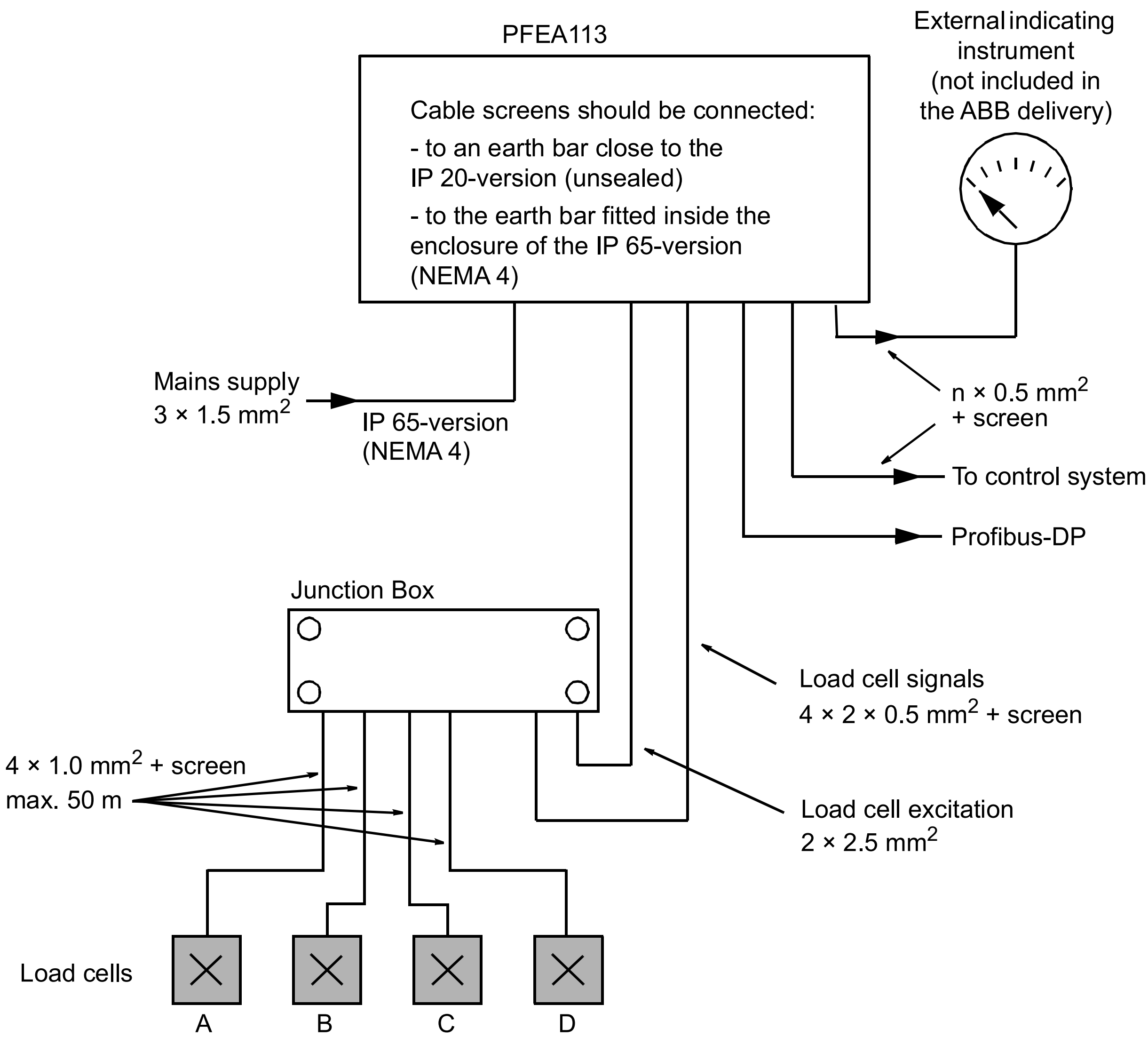



*Figure 2-1. Recommended Cabling*

- The maximum permitted cable resistance in the excitation circuit is shown in Table 2-1. Before commissioning, check cable resistance in the load cell excitation circuit.

*Table 2-1. Maximum Permitted Cable Resistance*

| Load cell | Max. permitted cable resistance |
|---|---|
| PFCL 301E | 10 Ω |
| PFTL 301E | 10 Ω |
| PFRL 101 | 10 Ω |
| PFTL 101 | 10 Ω |
| PFCL 201 | 10 Ω |
| PFTL 201 | 10 Ω |

- Solid conductors should not be connected to terminals. Pins should not be crimped to stranded cores.
- The cable from the load cell **must be a robust four core cable**, see Figure 2-2. Diagonal pairs must be used for the signal circuits and excitation circuit.

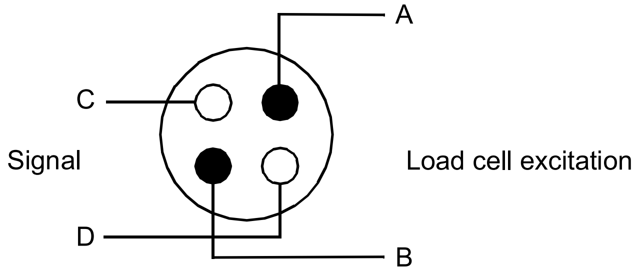



*Figure 2-2. Core Arrangement in Load Cell Cable*

- Between the junction box and the tension electronics, signal and excitation must be routed in separate cables. For example: a 2 × 2.5 mm$^2$ cable for the excitation and a shielded 4 × 2 × 0.5 mm$^2$ cable with twisted pair cores for the load cell signals.
- Cable for synchronization of two of more tension electronics IP-20 version (unsealed) must be screened or a twisted pair.
- The signal cable between the tension electronics and instruments, or process equipment, must be a screened 0.5 mm$^2$ cable.
- Cable screens must be connected to the copper earth bar. The screen connection maximum length is 50 mm.
- The protective earth conductor of the incoming mains supply must be connected to the copper earth bar in the cabinet IP-65 version (NEMA 4).

### 2.4.1.2 Interference

For immunity to interference, the load cell cables should be separated as far as possible from noisy power supply cables. A minimum distance of 0.3 m (12 inches) is recommended. Where the measuring system cables meet noisy cables, they must cross at right angles.

### 2.4.1.3 Synchronization

Synchronization is not required for the wall mounted IP 65-version (NEMA 4) of the tension electronics.

If two or more IP 20-version (unsealed) tension electronics are mounted in the same cabinet, they must be synchronized.

Synchronization is done by interconnecting the “SYNC” terminals, screw terminal X3:15, of all the units and interconnecting screw terminal X3:16 of all units. A twisted pair cable or a screened cable must be used.

If one unit is turned off or removed the remaining units are still synchronized.

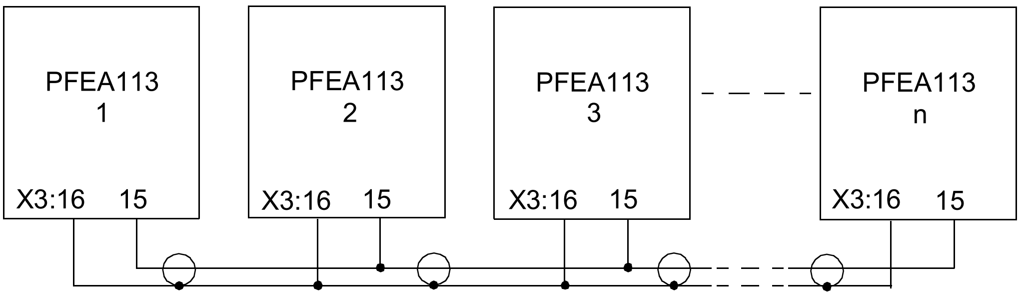



*Figure 2-3. Connection for Synchronization*

## 2.4.2 Mounting the Tension Electronics PFEA113

### 2.4.2.1 IP 65-version (NEMA 4)

The electronic unit is delivered in an enclosure intended for wall mounting.

When choosing a place for installation, make sure that there is enough space to open the enclosure lid fully. Also check that there is enough working space in front of the enclosure.

The enclosure is fitted with 13 cable glands.

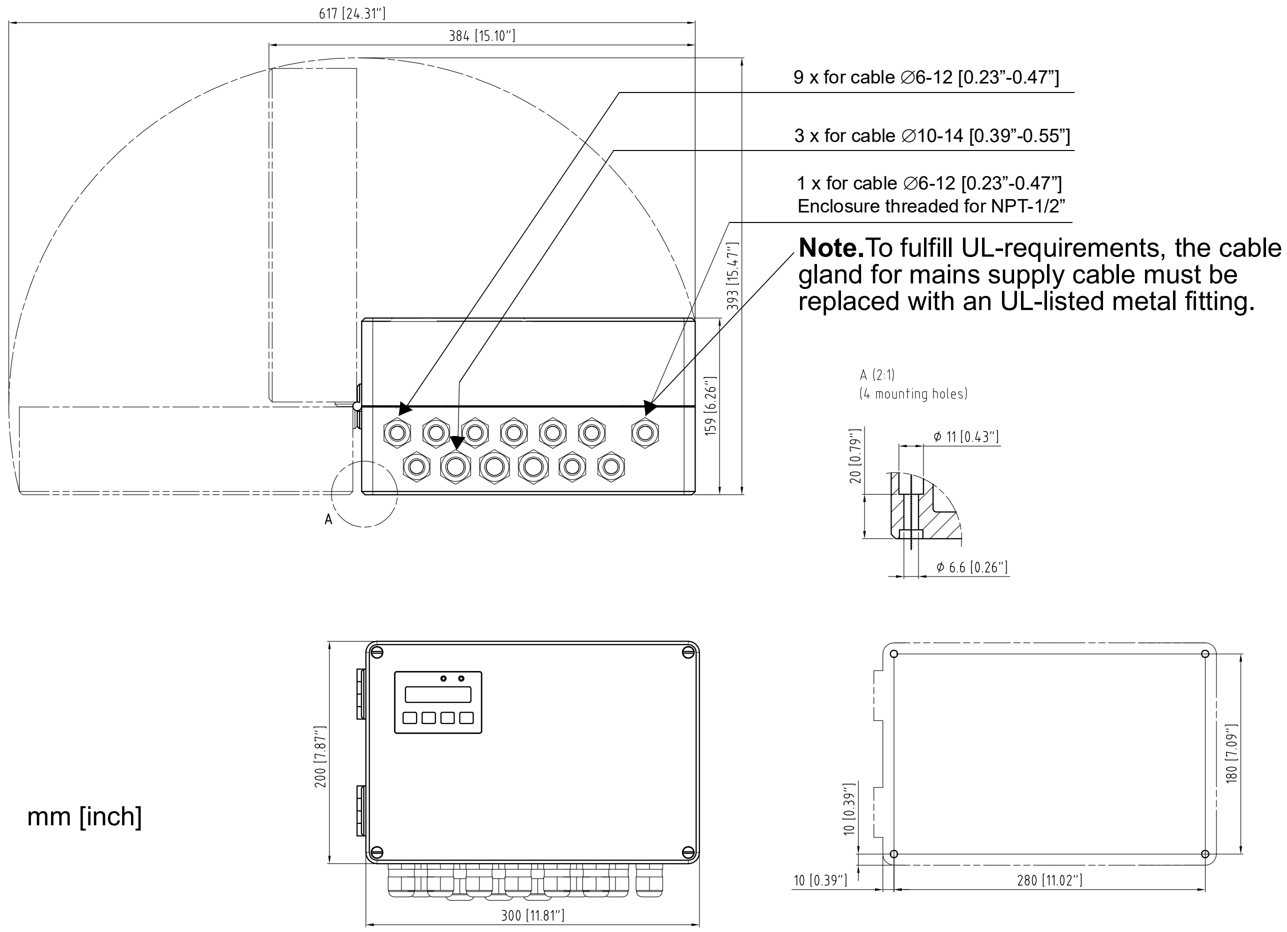



*Figure 2-4. Installation Dimensions*

Connect the cables to terminals according cable diagrams in Appendix (B, C, D, E, F or G) depending on installed load cell type.

**NOTE**

Do not connect solid conductors to terminals. Do not crimp pins to stranded cores.

**NOTE**

The incoming mains voltage must be provided with fuses and a means of disconnection outside the tension electronics.

## 2.4.2.2 IP 20-version (Unsealed)

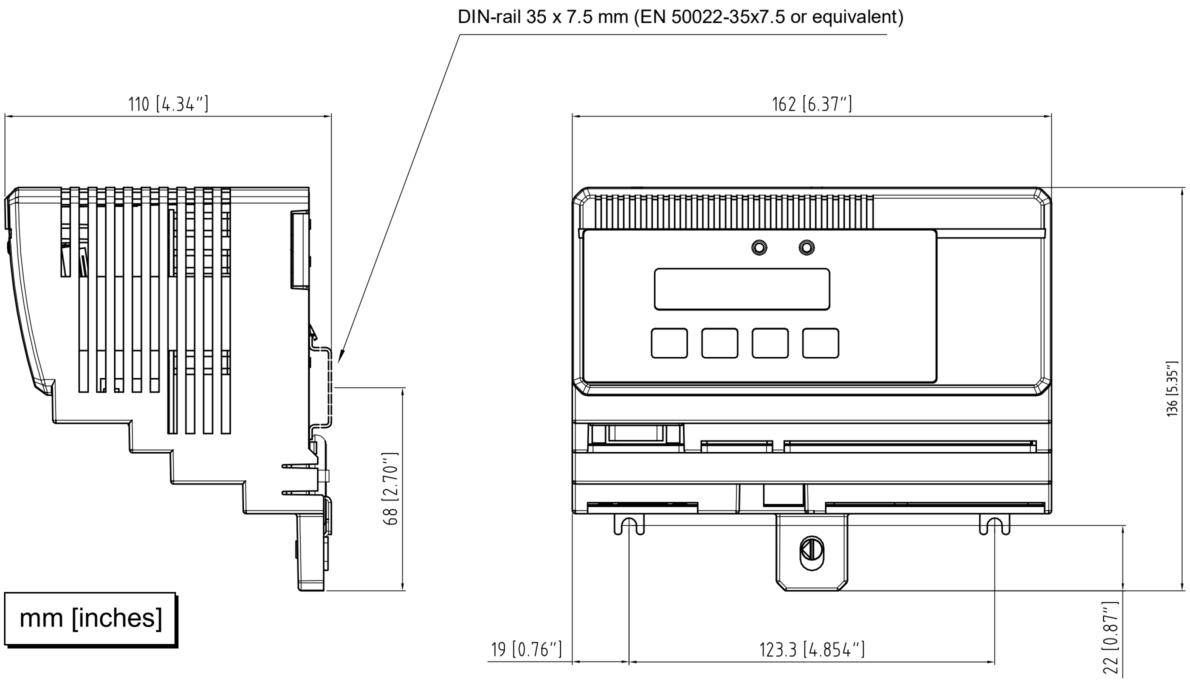



*Figure 2-5. Installation Dimensions*

Connect the cables to the terminals according to cable diagrams in Appendix (B, C, D, E, F or G) depending on the type of load cell installed.

**NOTE**

Do not connect solid conductors to terminals. Do not crimp pins to stranded cores.

**Earthing**

The metal bottom of PFEA113-20 connects to the metallic DIN-rail which serves as the Tension Electronics earth connector.
This is to ensure a good earth connection both for internal logic and for the EMI immunity and RF emission of the electronics.
The DIN-rail must have a good connection to the PE (Protective Earth) of the cabinet.

To achieve the best possible corrosion resistance, DIN-rails should be chromium plated, for instance, yellow chromium treated. Use star washers with each screw used to fasten the DIN-rail to the mounting plate.
To fasten the DIN-rail onto the mounting plate, the minimum screw diameter is 5 mm and the maximum distance between screws is 100 mm.

## 2.4.3 Earthing

For trouble free operation, the earthing must be properly done. Note the following:

- If the free (unscreened) length exceeds 0.1 m (4 in.) the individual pairs of power and signal conductors must be twisted separately
- The external protective earth (PE) cable must be attached to one of the earthbar screw clamps.
- All the cable screens have to be connected to the earth bar and the length of the screen connection must be less than 50 mm (2 in.).

**NOTE**

The cable screens must be earthed at one end only.

- Since the signal earth of the measurement system is connected to the chassis earth of the tension electronics, the input of a superior system connected to the control system must not be earthed. The best ways of interconnecting the measurement system and a superior system to achieve optimal function are shown in Figure 2-6 and Figure 2-7.

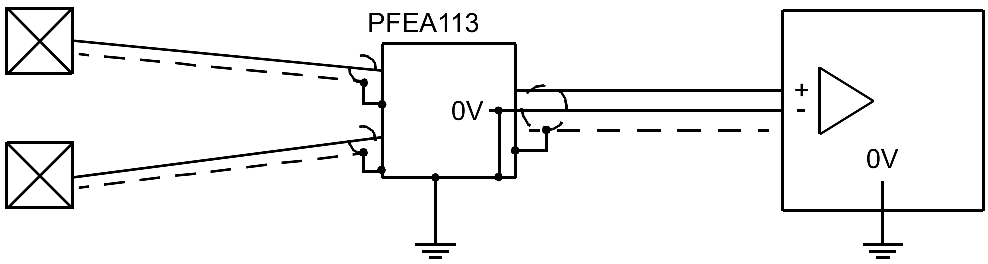



*Figure 2-6. Connection to a superior system with an insulated or differential input*

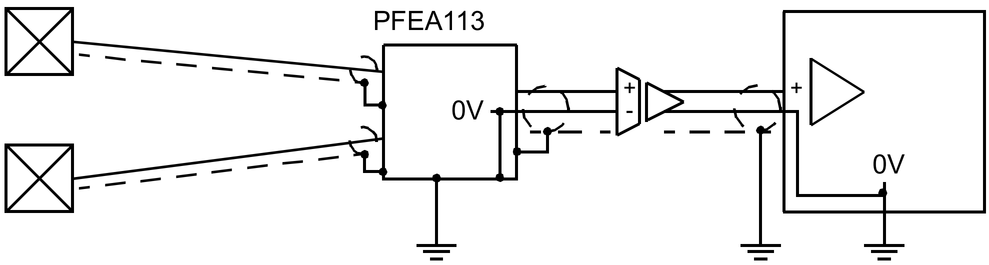



*Figure 2-7. Connection to a superior system through a separate insulation amplifier*

## 2.5 Installing MNS Select Floor Cabinet

### 2.5.1 Mounting Cabinets Together

If cabinets are to be mounted to each other use the included screw/bolt kit. The four M8 screws, with washers and nuts, in the angle hinges and six M6 screws at about Z1=500, Z2=1000, Z3=1500 mm height from the floor, see Figure 2-8. Tighten the M8 screws to 20 Nm maximum and the M6 screws to 10 Nm maximum.

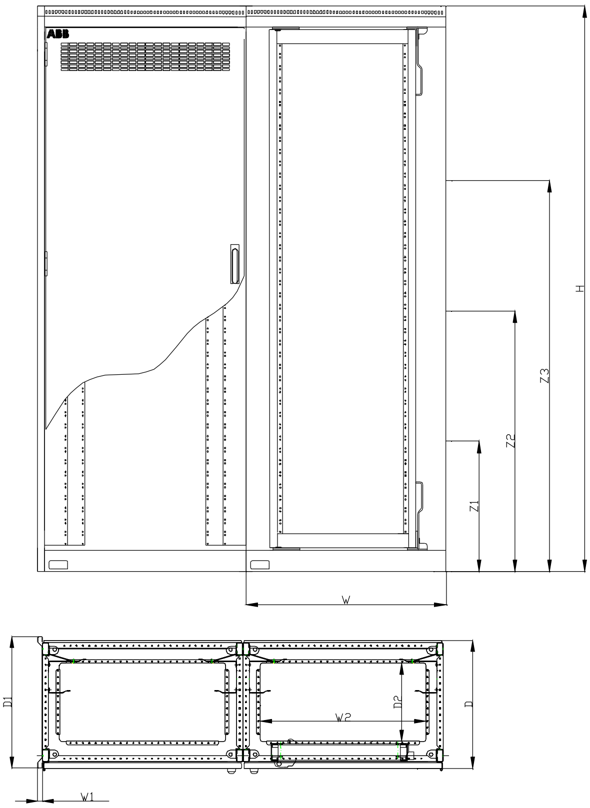



*Figure 2-8. Mounting Cabinets together - Screw Position*

### 2.5.2 Mounting Cabinets to the Floor

When fixing the cabinet to the floor use four or six M12 screws where Figure 2-9 indicates, one at each corner in the first left hand cabinet in a row of cabinets and screw the following cabinets with two screws each at the right hand side. The bottom angle hinges features holes, 14 mm (0.6”) in diameter. These holes permit you to adjust the cabinet location after holes are drilled in the floor. If drilling is necessary, make sure that no dust or other foreign matter enters the equipment in the cabinet. Please notice the minimum distances from cabinet to walls and ceiling. Use washers between the floor and the cabinet bottom to level the cabinet floor into a horizontal position.

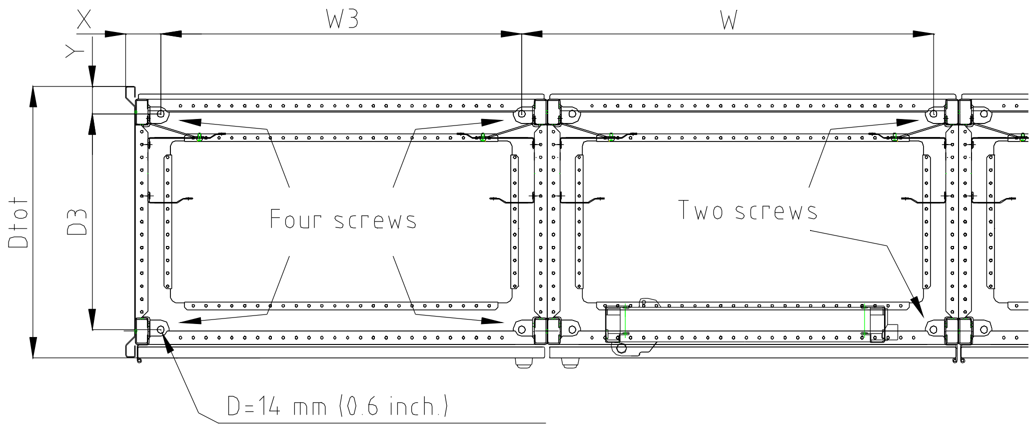



*Figure 2-9. Position of the Holes for fixing the Cabinet(s) to the Floor*

*Table 2-2. Distances in Figure 2-9*

| Symbol | Distance |
|---|---|
| X | 69 mm (2.7”) |
| W3 | 602 mm (23.7) |
| W | 700 mm (27.6”) |
| Y | 56 mm (2.2”) |
| D3 | 544 mm (21.4”) |
| Dtot | 655 mm (25.8”) |

## 2.5.3 Space Requirements

The overall dimensions of the cabinet are shown in a dimension diagram in Appendix A.7 Drawings.

The following rules apply to locating and positioning of the cabinet:

- The distance between the top surface of the cabinet and the roof, soffit of a beam or ventilation duct etc. must be at least 250 mm. If cables enter from above, this distance is increased to 1000 mm.
- There must be a clearance of at least 40 mm between the rear of the cabinet and the wall, and between the sides of the cabinet and the wall.
- To permit a frame with hinge, or a door to an outer encapsulation to open fully without catching on the adjacent wall, the distance to the wall must be increased to 500 mm on the hinge side (left) of the frame, or 300 mm on the hinge side (right) of the door.
- There must be at least 1 meter of free space in front of the cabinet. It must be possible to open the door completely, in order not to restrict access for check-out and servicing.

## 2.6 Installing Junction Box PFXC 141

PFXC 141 are normally used for connection of Pressductor® load cells. The cables fixed to the load cells and the cable to the control unit are to be connected to the junction box.

The junction box PFXC 141 shall be mounted adjacent to the load cells and located in a protected position easily accessible for service.

The junction box is mounted according to an order-specific drawing.

The dimensions of the junction box are shown in Figure 2-10.

Holes not used must be plugged.

For circuit diagram see Appendix A.6.4 Junction Box PFXC 141.

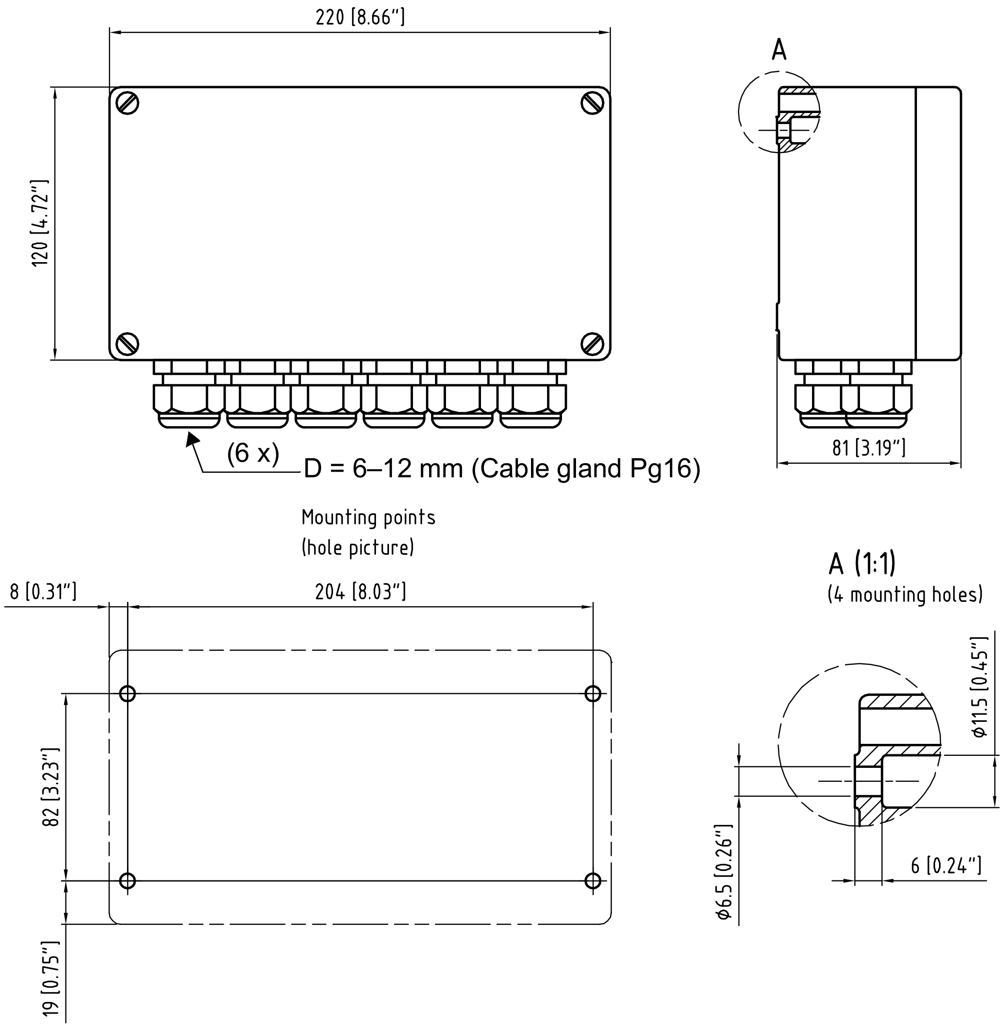



*Figure 2-10. Dimensions of Junction Box PFXC 141*

## 2.7 Connectors on the PFEA113

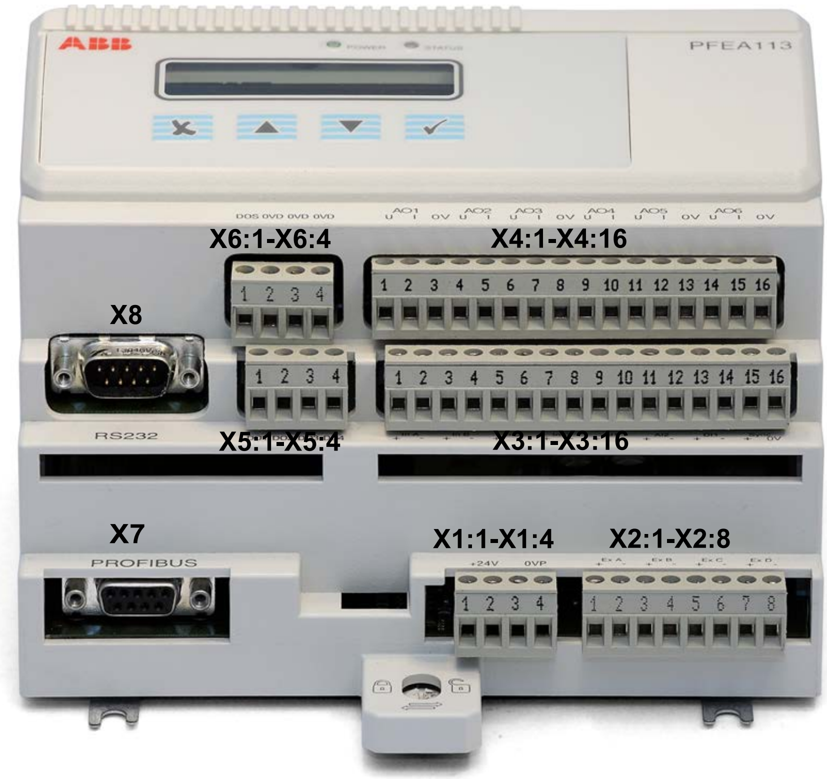



*Figure 2-11. Connectors on the PFEA113*

*Table 2-3. Description of PFEA113 connectors*

| Connector number | Description |
|---|---|
| X1:1-X1:4 | 24 V Supply connections (X1:1-X1:2), 0V (X1:3-X1:4) |
| X2:1-X2:8 | Connectors for the wiring to the load cell excitation circuits |
| X3:1-X3:16 | X3:1-X3:8 Connectors with signals from load cells.<br>X3:9-X3:12 are AI1 and AI2.<br>X3:13-X3:14 is DI1. X3:15-X3:16 is the Synchronization Signal Input. |
| X4:1-X4:16 | Analog outputs |
| X5:1-X5:4 | Digital outputs |
| X6:1-X6:4 | Digital out supply (1), and three 0VD |
| X7 | PROFIBUS D-Sub connector |
| X8 | RS232 Connector |

## 2.8 Connecting the Load Cells

Information for connecting the load cells is given in the appendix for each load cell type, see table below.

| Type of load cell | Cable diagrams in Appendix |
|---|---|
| PFCL 301E | B |
| PFTL 301E | C |
| PFRL 101 | D |
| PFTL 101 | E |
| PFCL 201 | F |
| PFTL 201 | G |

## 2.9 Connecting Analog Outputs (AO1-AO6)

There are six analog outputs. Each output can be set either for voltage or current. Each analog output from the digital/analog converter is a voltage. This is split into two outputs, one of which is converted into a current output and the other kept as voltage. This is illustrated in Figure 2-12 where for example X4:1 is the voltage output and X4:2 is the current output.
The allowed load current of the voltage output is max. 5 mA.
The allowed load resistance of the current output is max. 550 Ω..
Figure 2-12 shows AO1 connected for voltage output and AO2 for current output.

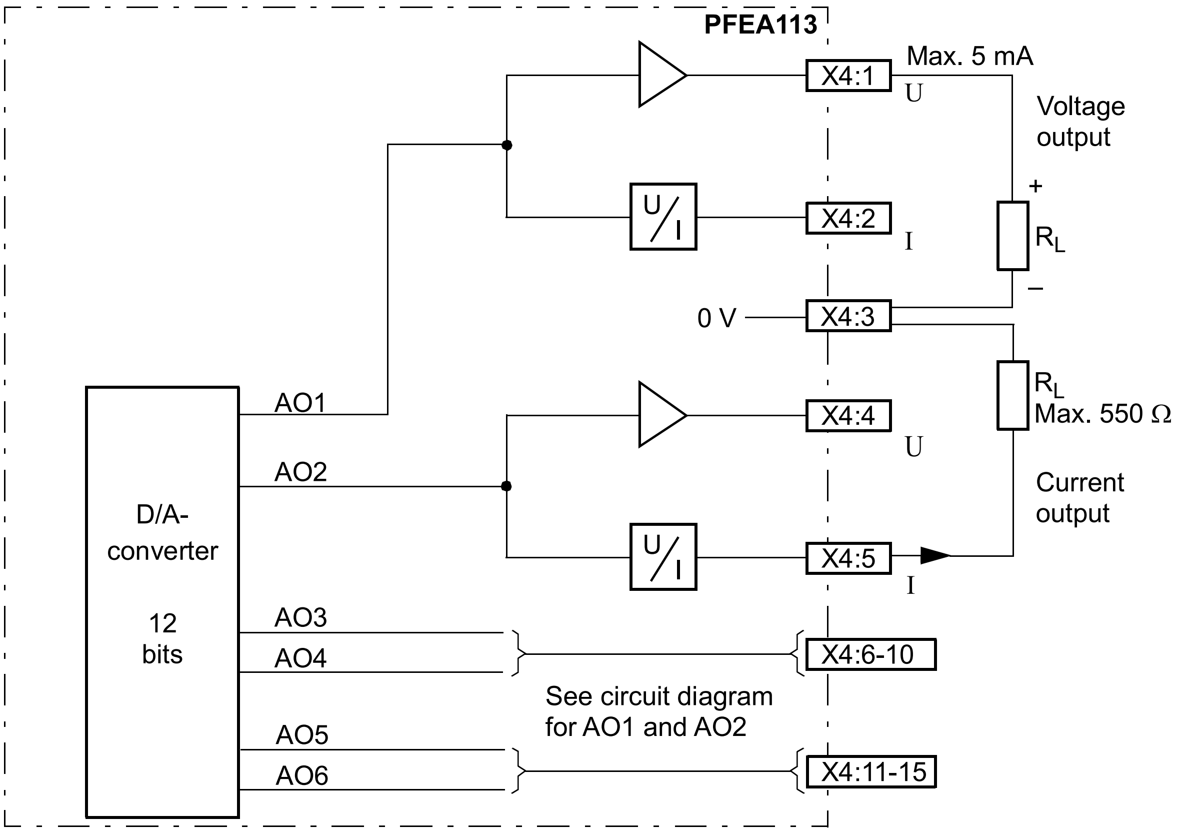



*Figure 2-12. Connecting Analog Outputs*

## 2.10 Connecting Analog Inputs (AI1-AI2)

The two analog inputs, AI1 and AI2, are differential inputs with a signal range of 0-10 V.

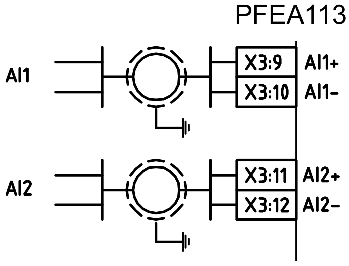



*Figure 2-13. Connecting Analog Inputs*

## 2.11 Connecting Digital Outputs (DO1-DO4)

The four digital outputs, DO1-DO4, are insulated as a group. See Figure 2-14.

The digital outputs are current driving and can be supplied from an external 24 V DC or from the 24 V DC supply used for PFEA113.

The current at state “1” is maximum 0.1 A per output.

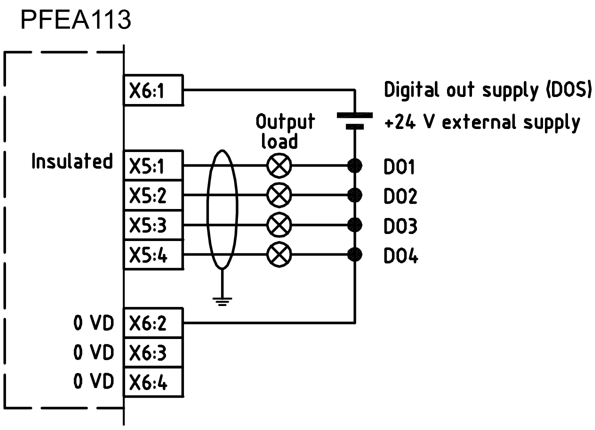



*Figure 2-14. Connecting Digital Outputs*

## 2.12 Connecting the Digital Input (DI)

The digital input is a differential input with the following data:

Passive: -36 V to +5 V

Active: >16 V (maximum +36 V)

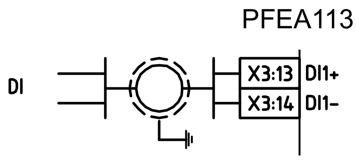



*Figure 2-15. Connecting the Digital Input*

# 2.13 Connecting Optional Units

## 2.13.1 Insulation Amplifier PXUB 201

Insulation amplifier PXUB 201 is used when galvanic insulation between input and output, or between power supply and input/output, is required. See Section A.6.1 Insulation Amplifier PXUB 201.

Insulation amplifier PXUB 201 is intended for installation on a DIN-rail. The PXUB 201 is connected by screw terminals.

PXUB 201 is normally supplied from the same +24 V DC supply that supplies the tension electronics.

If PXUB 201 is mounted close to the terminal group, it is not necessary to use a screened cable between the tension electronics and PXUB 201.

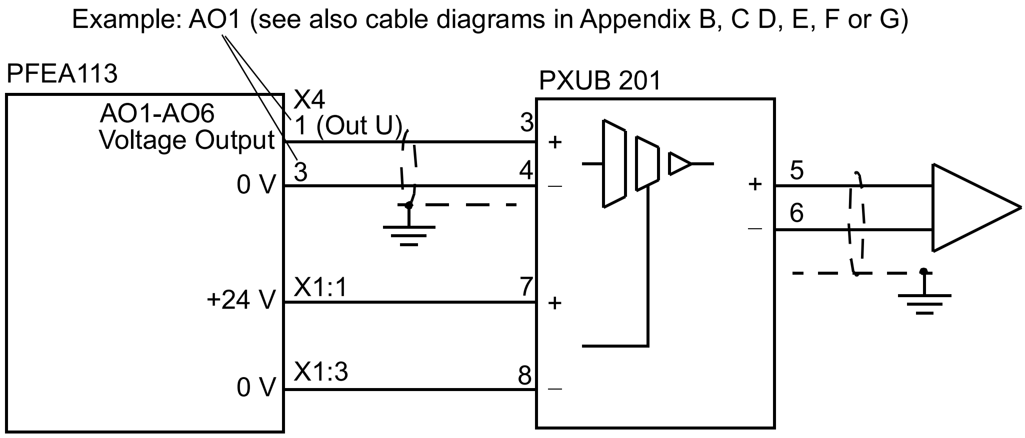



*Figure 2-16. Typical Connection of Insulation Amplifier PXUB 201*

## 2.13.2 Relay Board PXKB 201

The digital outputs on PFEA113 are isolated as a group and should not be connected to more than 24 V DC. In the following applications should relays be connected to the digital outputs:

- The digital outputs must be isolated from each other.
- The signal to the superior system is higher than 24 V DC or an AC signal.

The PXKB 201 is intended for mounting on a DIN-rail.

*Table 2-4. Truth table PXKB 201.*

| Input signal to A1(+) and A2(-) | Connection between |
|---|---|
| Digital input low (0 V) | 11 and 12 |
| Digital input high (24 V) | 11 and 14 |

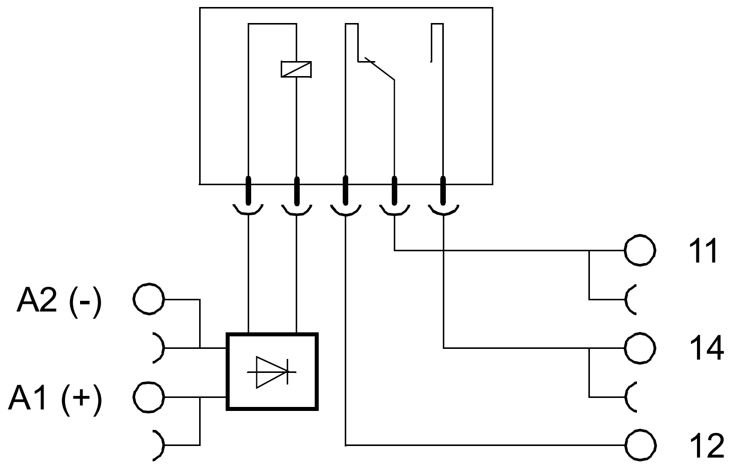



*Figure 2-17. Circuit diagram PXKB 201*

## 2.13.3 Power Supply Unit SD83x

If no 24 V is available, the power supply units SD 831, SD 832 and SD 833 can be used as power supplies for the IP 20-versions.

The power supply unit is intended to be installed on a DIN-rail.

The main supply voltage for all the three power supply units are:

- 115 V AC (90 - 132 V), 100 V -10% to 120 V + 10%

- 230 V AC (180 - 264 V), 200 V -10% to 240 V + 10%

*Table 2-5. Number of PFEA113 that can be supplied*

| Power Supply Unit | PFEA113 | Remarks |
|---|---|---|
| SD 831 (3 A) | 3 | Supply of digital outputs not included |
| SD 832 (5 A) | 6 | Supply of digital outputs not included |
| SD 833 (10 A) | 12 | Supply of digital outputs not included |

# Chapter 3 Commissioning

## 3.1 About this Chapter

This chapter contains the information needed to commission a Web Tension System.

It is assumed that the Web Tension System has been installed according to the instructions given in Chapter 2 Installation and Appendix (B, C, D, E, F or G) depending on installed load cell type.

You must have the following data before starting commissioning:

1. Load cell type and nominal load, see Appendix for installed load cell type
2. System definition, see Section 3.12.2.

- Load cell combination
  - One roll (load cells A and B)
  - Two rolls (Roll 1 connected to A and B, Roll 2 connected to C and D) or
  - Segmented roll
- Gain scheduling (switching wrap gain for two different web paths).
  - One roll, Two rolls (only Roll 1) and Segmented roll.

3. Object type, see Section 3.12.3.

- Standard roll (Roll 1, load cells A and B or Roll 2, load cells C and D)
- Single side measurement (Roll 1, load cell A or B and Roll 2, load cell C or D)
- Segmented roll

  Up to 12 load cells connected to max. three PFEA113 can be handled. The load cell inputs must be connected to PFEA113 as follows:

  - One input, load cell connected to A
  - Two inputs, load cells connected to A and B
  - Three inputs, load cells connected to A, B and C
  - Four inputs, load cells connected to A, B, C and D

4. Desired output data at given web tension
5. Communication data, see Section 3.13.

## 3.2 Safety Instructions

Read and follow the safety instructions described in Chapter 1 Introduction, before starting any commissioning work. However, local statutory regulations, if stricter, are to take precedence.

## 3.3 Necessary Equipment and Documentation

The following items are required:

- Cable diagram
- Service tools

# 3.4 Using the Panel Buttons

## 3.4.1 Navigating and Confirming

| Display | Button | How to use it |
|---|---|---|
|  |  | Returns to previous menu. Sometimes this button must be pressed repeatedly to get back to the desired menu. |
| |  | Steps up in a list. |
| |  | Steps down in a list.<br>Steps to next main menu. |
| |  | OK (acknowledgment) button. Confirms a selection or a parameter setting. |

## 3.4.2 Changing Numerical Values and Parameters

**SetTensionAt10V**
**XXXXXX N**

**NominalLoad**
**ZZ kN ZZ lbs**

- X indicates a numerical value.
- Z indicates that a parameter can be chosen from a list.

**SetTensionAt10V**
**[XXXXXX] N**

**Nominal load**
**[ZZ kN ZZ lbs]**

To change a numerical value, **X**, or parameter, **Z**, press . The numerical value or parameter is then placed within brackets [XXXXXX] or [ZZ] to show that it can be changed.

If it is a **"Z"** parameter, use and to move up or down in the list. When the desired value is shown on the display press . When is pressed the new parameter value is saved and the brackets around the value disappear.

If you have pressed so that the parameter is enclosed by brackets, you can cancel the entering mode by pressing . The selections made with and will not be stored. If is pressed the old value is displayed without brackets.

To change a numerical value, press so that brackets appear around the value. Then the first digit can be changed with and . When the first digit has the desired value press , then the second digit can be changed with and . When pressing after the last digit has been set, the new value is saved and displayed without brackets.

Using when entering a numerical value means returning to the previous digit. By pressing a sufficient number of times you will leave the entering mode and the old value will be displayed without brackets.

## 3.5 Menu Overview

**Operator Menus** See Section 4.7.

| |
|---|
| **TensionRoll 1** N |
| **Tension A** N |
| **Tension B** N |
| **TensionDiff A-B** N |
| **TensionRoll 2** N |
| **Tension C** N |
| **Tension D** N |
| **TensionDiff C-D** N |
| **AO 1 - AO 6** N |
| **Error and warning messages** See Section 6.6. |

Press > 5 s

**Complete setup**

See Section 3.11.

**Configuration and Service Menus**

| | |
|---|---|
| **FastSetUp** See 3.8 | The fast setup can be made in two ways depending on how the wrap gain is set. |
| **PresentationMenu** See 3.12.1 | Language, Unit, Web Width 1) and desired number of decimals are set in the presentation menu. |
| **SystemDefinition** See 3.12.2 | Select load cell combination and set Segmented Roll Scale factor (SRSF) 2) and Gain scheduling in this menu. |
| **ObjectType** 3) See 3.12.3 | Select Standard roll, Single side measurement or number of inputs for segmented roll applications. |
| **SetNominalLoad** See 3.12.4 | Check the nominal load on the load cell name plate. Select nominal load from the list with or . Confirm with . |
| **ZeroSet** See 3.12.5 | Zero set is used to compensate for load cell zero signal and tare weight. |
| **SetWrapGain** See 3.12.6 | Wrap gain can be determined by using hanging weights or by calculating. |
| **AO 1 - AO 6** See 3.12.7 | Select Off, U (Voltage), I (Current) or Profibus only. Connect signals and set filter settings, high and low Tension, Output and Limit. |
| **DO 1 - DO 4** See 3.12.8 | Set level detectors (4) and "Status OK" |
| **AI 1 - AI 2** See 3.12.9 | For connection of multiple electronics. |
| **DI** See 3.12.10 | Select Off, Zero set or Gain scheduling. |
| **Miscellaneous-Menu** See 3.12.11 | This menu is used to set profibus parameters or to set factory default. |
| **ServiceMenu** See 3.12.12 | Show PFEA113 software version.<br>View maximum load and current offset settings for load cell A, B, C and D.<br>Reset maximum load memory and offset.<br>Simulation of load cell signals. |

1) This menu appears if unit is set to N/m, kN/m, kg/m or pli.
2) This menu appears if load cell combination is set to segmented roll.
3) Depending on load cell combination.

**Note!** Some sub menus asking confirmation questions are not shown in this overview. In these menus you have to confirm that your settings should be performed.

## 3.6 Step-by-step Commissioning Guide

| Step | Measurement | See section |
|---|---|---|
| 1 | Check that the main supply voltage is switched off. | |
| 2 | Check all cabling according to the cable diagrams. | Appendix B, C, D, E, F or G |
| 3 | Check the supply voltage<br><u>DIN-rail mounted IP20-unit (unsealed)</u><br>Nominal 24 V DC, Working range 18 - 36 V DC, **X1:1-2**<br><u>Wall mounted IP65-unit (NEMA 4)</u><br>85 - 264 V AC (100 V - 15% to 240 V + 10%), 45-65 Hz, **X9:1-2**<br>Nominal 24 V DC, Working range 18 - 36 V DC, **X1:1-2** | 3.7 |
| 4 | Perform basic settings (if necessary) | 3.7 |
| 5 | Perform setup<br>Fast setup<br>Complete setup | <br>3.8<br>3.11 |
| 6 | Check load cell signal polarity | 3.9 |
| 7 | Check load cell function | 3.10 |

## 3.7 Performing Basic Settings

When the tension electronics has been powered on for the first time after delivery, you are asked to ***SetLanguage*** and then to ***SetUnit***. These two settings must be made to be able to proceed with the rest of the setup. Language and unit can be changed later on if desired.

| | | |
|---|---|---|
| 1 | **SetLanguage [English]** | Select desired language from the list with  and . ***English*** is set as default.<br>Confirm with . |
| 2 | **SetUnit [N]** | Select desired presentation unit from the list with  and . ***N (Newton)*** is set as default.<br>Confirm with . |
| 3 | **SetWebWidth [XXXXXX]** | The menu SetWebWidth will only be available when the selected unit is N/m, kN/m, kg/m or pli.<br>Default Web Width is 2m (78,740 inch). |
| 4 | **SetDecimals [X]** | Select number of decimals from the list with  and , confirm with .<br>See Section 4.6. |
| 5 | **FastSetUp** | Press  to start the fast setup sequence.<br>See Section 3.8.<br>If you want to make a complete setup, go to the separate setup menus by pressing .<br>See Section 3.11. |

## 3.8 Performing a Fast Setup (Only for One or Two Rolls)

The fast setup guides you through a minimum number of steps to set up the tension electronics. You are asked to answer some questions and to enter desired values. These selections and parameter settings must be made to prepare the tension electronics for measurement.

Only a limited number of selections and parameter settings are set in fast setup. All other parameters are set as factory default values. See Appendix A.5 Factory Default Settings.

Fast setup can be done in two ways, depending on how the wrap gain is set.

The wrap gain can be set by selecting “HangWeight” or “EnterWrapGain”.

- Using Hanging Weights, see Section 3.8.1.
- Using Wrap Gain, see Section 3.8.2.

Hanging Weights and Wrap Gain are explained in Section 3.12.6.

## 3.8.1 Performing Fast Setup using Hanging Weights

The simplest method to set the wrap gain in this tension system is to use a known weight that loads the center of the roll with a rope that follows the web path exactly.

All rolls must be free turning idlers. To keep friction losses low, only use the closest rolls to define web path.

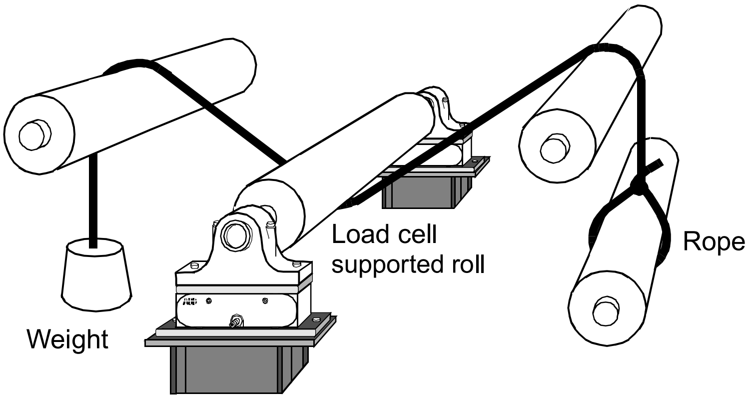



*Figure 3-1. Setting Wrap Gain with Hanging Weights (example of installation)*

Follow the steps below to run a fast setup using hanging weights.

| | | |
|---|---|---|
| 1 | **WebTension** <br> > 5 seconds | Press for 5 seconds to go to the ***FastSetUp*** menu. |
| 2 | **FastSetUp** | Press to start the fast setup sequence. |
| 3 | **SetWebWidth** <br> **XXXXXX** | Select web width if the unit is set to N/m, kN/m, kg/m or pli. The same width is applied to Roll 1 and Roll 2. |
| 4 | **NumberOfRolls** <br> **[2]** | Select number of rolls (1 or 2) |
| 5 | **Roll 1 or 2** <br> **[1]** | Select roll (1 or 2). <br> The menu is hidden if NumberOfRolls is set to [1]. |
| 6 | **ZeroSet A, B** <br> **[ZZ]** | Zero set is used to compensate for load cell zero signal and tare weight. <br> Zero set must be done with no tension applied to the roll. |
| 7 | **WithNoTension** <br> **PressOkToZeroSet** | **1.** Check that no load is applied on the roll. <br> **2.** Press to zero set. "***ActionDone***" is shown on the display for one second to confirm the zero setting action. |
| 8 | **SetWrapGain** <br> **[HangingWeights]** | Select ***HangingWeights*** from the list with and . <br> Confirm with . |

| | | |
|---|---|---|
| 9 | **CellsOnRoll 1**<br>**[2]** | Select the load cells (2, SingleSideA or SingleSideB) that support the roll from the list with or . Confirm with . |
| 10 | **NominalLoad**<br>**[1 kN 225 lbs]** | Check the nominal load on the load cell name plate.<br>Select nominal load from the list with or .<br>Confirm with . |
| 11 | **HangWeight**<br>**[XXXXXX] N** | **1.** Apply a known weight on the roll (see Figure 3-1).<br>**2.** Enter the value of the known weight. Confirm with . |
| 12 | **AnalogOut 1**<br>**[ZZ]** | Select ***Voltage*** or ***Current*** from the list with or . Confirm with . |
| 13 | **SetTensionAt10V**<br>**[XXXXXX] N**<br><br>**SetTensionAt20mA**<br>**[XXXXXX] N** | ***Voltage*** selected:<br>Enter the tension value corresponding to 10 V.<br>or<br>***Current*** selected:<br>Enter the tension value corresponding to 20 mA.<br>Confirm with . |
| 14 | **FilterSettings**<br>**[250 ms 1.5Hz]** | Select filter setting (5, 15, 30, 75, 250, 750 or 1500 ms) from the list with or . Confirm with . |
| 15 | To Operator Menu<br>**Finished**<br>**PressOk** | ***FastSetUp*** of a system with one roll is now completed. Press to finish the fast setup and go to the operator menu.<br><br>Proceed with the FastSetUp for Roll 2. In step 4, select the load cells (2, SingleSideC or SingleSideD) that support Roll 2 from the list with or . Confirm with . |

**NOTE**

When using ***HangWeight*** the wrap gain value is calculated by the tension electronics.
To be able to read the wrap gain value, go to menu ***EnterWrapGain*** of the desired roll.

## 3.8.2 Performing Fast Setup using Wrap Gain

Follow the steps below to run a fast setup using Wrap Gain.

| | | |
|---|---|---|
| 1 | **WebTension**<br>> 5 seconds | Press for 5 seconds to go to the ***FastSetUp*** menu. |
| 2 | **Fast SetUp** | Press to start the fast setup sequence. |
| 3 | **SetWebWidth**<br>**XXXXXX** | Select web width if the unit is set to N/m, kN/m, kg/m or pli.<br>The same width is applied to Roll 1 and Roll 2. |
| 4 | **NumberOfRolls**<br>**[2]** | Select number of rolls (1 or 2) |
| 5 | **Roll 1 or 2**<br>**[1]** | Select roll (1 or 2).<br>The menu is hidden if NumberOfRolls is set to [1]. |
| 6 | **ZeroSet A, B**<br>**[ZZ]** | Zero set is used to compensate for load cell zero signal and tare weight.<br>Zero set must be done with no tension applied to the roll. |
| 7 | **WithNoTension**<br>**PressOkToZeroSet** | **1.** Check that no load is applied on the roll.<br>**2.** Press to zero set. “***ActionDone***” is shown on the display for one second to confirm the zero setting action. |
| 8 | **SetWrapGain**<br>**[WrapGain]** | Select ***WrapGain*** from the list with and .<br>Confirm with . |
| 9 | **CellsOnRoll 1**<br>**[2]** | Select the load cells (2, SingleSideA or SingleSideB) that support the roll from the list with or . Confirm with . |
| 10 | **NominalLoad**<br>**[1 kN 225 lbs]** | Check the nominal load on the load cell name plate.<br>Select nominal load from the list with or .<br>Confirm with . |
| 11 | **EnterWrapGain**<br>**[XX.XX]** | Enter the calculated wrap gain. For calculating wrap gain, see Appendix (B, C, D, E, F or G) for installed load cell type. Confirm with . |
| 12 | **AnalogOut 1**<br>**[ZZ]** | Select ***Voltage*** or ***Current*** from the list with or .<br>Confirm with . |

| | | |
|---|---|---|
| 13 | **SetTensionAt10V**<br>**[XXXXXX] N**<br><br>**SetTensionAt20mA**<br>**[XXXXXX] N** | ***Voltage*** selected:<br>Enter the tension value corresponding to 10 V.<br>or<br>***Current*** selected:<br>Enter the tension value corresponding to 20 mA.<br>Confirm with . |
| 14 | **FilterSettings**<br>**[250 ms 1.5Hz]** | Select filter setting (5, 15, 30, 75, 250, 750 or 1500 ms) from the list with  or . Confirm with . |
| 15 | To Operator Menu<br>**Finished**<br>**PressOk** | ***FastSetUp*** of a system with one roll is now completed. Press  to finish the fast setup and go to the operator menu.<br><br>Proceed with the FastSetUp for Roll 2. In step 4, select the load cells (2, SingleSideC or SingleSideD) that support Roll 2 from the list with  or . Confirm with . |

## 3.9 Checking Load Cell Signal Polarity

This is a simple method to check that the load cells are connected to give a positive output signal change from the tension electronics for increased web tension.

1. Push with your hand to apply a force corresponding to increased web tension on one load cell at a time (as close to the load cell as possible) and check if the display reading is positive. If the display reading is negative, invert the load cell signal connection to the tension electronics.

   **NOTE**

   If you don't know in which direction the force is acting:

   – Connect load cells A and B with the same force direction.

   – Connect load cells C and D with the same force direction.

   To change the polarity of load cell A, invert X3:1 and 2 (In A+ and In A-).
   To change the polarity of load cell B, invert X3:3 and 4 (In B+ and In B-).

   To change the polarity of load cell C, invert X3:5 and 6 (In C+ and In C-).
   To change the polarity of load cell D, invert X3:7 and 8 (In D+ and In D-).

2. After changing load cell polarity, check that the display reading is positive for increased web tension.

## 3.10 Checking Load Cell Function

The “Hanging Weight” procedure can also be used as a function test on load cells, see Section 3.8.1.

The rope should then be placed in the web path but as close as possible to one of the load cells. The output signal should be noted, and the rope moved close to the other load cell. Check that the difference in output signal is small.

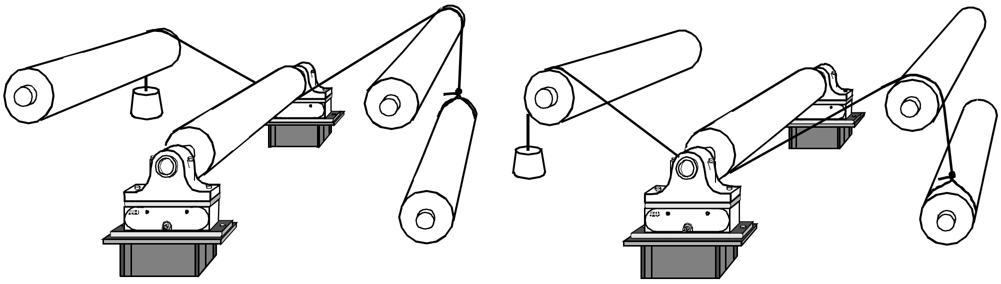


*Figure 3-2. Load Cell Function Test*

# 3.11 Performing a Complete Setup

## 3.11.1 Overview

The complete setup is built up by a number of main and sub menus. The table below shows the main menus in order of appearance when stepping through the complete setup. The table also gives an overview of the selections and parameter settings you can do below in each main menu.

The complete setup sequence is described in Section 3.12.

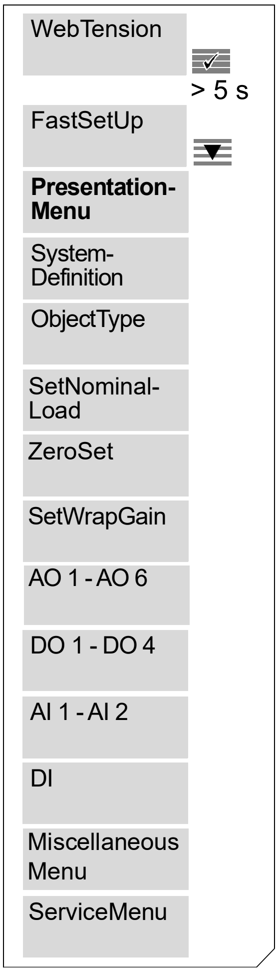
| Main menus | Selections and parameter settings | See details in section ... |
|---|---|---|
| **PresentationMenu** | Set language<br>Set unit/web width<br>Set decimals | 3.12.1 |
| **SystemDefinition** | Load cell combination:<br>- One roll<br>- Two rolls or<br>- Segmented roll<br>Gain scheduling: Yes/No | 3.12.2 |
| **ObjectType** | Set object type:<br>- Standard roll (Roll 1, load cells A and B or Roll 2, load cells C and D)<br>- Single side measurement (Roll 1, load cell A or B Roll 2, load cell C or D)<br>- Segmented roll | 3.12.3 |
| **SetNominalLoad** | Set nominal load | 3.12.4 |
| **ZeroSet** | Zero set load cells | 3.12.5 |
| **SetWrapGain** | Hang weight (actual force) or<br>Enter wrap gain (calculated value) | 3.12.6 |

| | | |
|---|---|---|
| **AO 1 - AO 6** | Select Voltage, Current or Profibus only<br>Connect AO1- AO6 to tension signals or a combination of tension signals<br>Set filter settings<br>Set high tension value and high output voltage<br>Set low tension value and low output voltage<br>Set high and low output voltage limit | 3.12.7 |
| **DO 1 - DO 4** | Set indication outputs for Level detectors 1-4<br>Set “Status OK” to indicate that the system is running normally | 3.12.8 |
| **AI 1 - AI 2** | Used to connect PFEA113 units to one another when 2 or 3 are used.<br>- Set High Tension (N, kN, kg, lbs, N/m, kN/m, kg/m, pli)<br>- High Input V | 3.12.9 |
| **DI** | Can be used for:<br>- Zero set or<br>- Gain scheduling | 3.12.10 |
| **Miscellaneous Menu** | Set Profibus address and measuring range<br>Reset all values to factory default | 3.12.11 |
| **ServiceMenu** | Read service information<br>Reset maximum load for load cell A<br>Reset maximum load for load cell B<br>Reset maximum load for load cell C<br>Reset maximum load for load cell D | 3.12.12 |

# 3.12 Complete Setup Sequence

This section provides a step-by-step description with detailed information about all available setup menus with related parameters, data and settings.

## 3.12.1 Presentation Menu



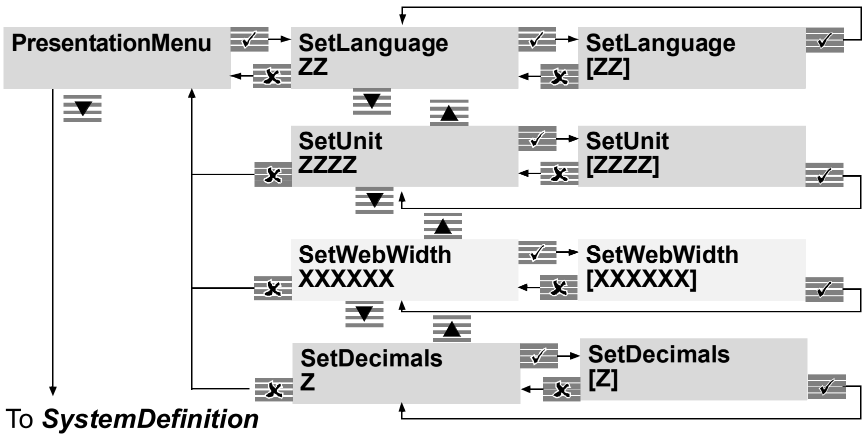




*Figure 3-3. Main and Sub Menus of the Presentation Menu*

Use up and down keys to select language [ZZ], unit [ZZZZ] and number of decimals [Z] from list.

The menu SetWebWidth will only be available when unit N/m, kN/m, kg/m or pli is selected.

### 3.12.1.1 Set Language

The following languages are available:

- English, German, Italian, French, Portuguese and Japanese

### 3.12.1.2 Set Unit

The following units can be set:

- N (Newton)
- kN (kiloNewton)
- kg (kilogram)

- lbs (US pounds)
- N/m
- kN/m
- kg/m
- pli

If the selected unit is N/m, kN/m, kg/m or pli, the Web Width needs to be set.

Default Web Width is 2m (78,740 inch).

### 3.12.1.3 Set Web Width

The menu SetWebWidth will only be available when the selected unit is N/m, kN/m, kg/m or pli.

Default Web Width is 2m (78,740 inch).

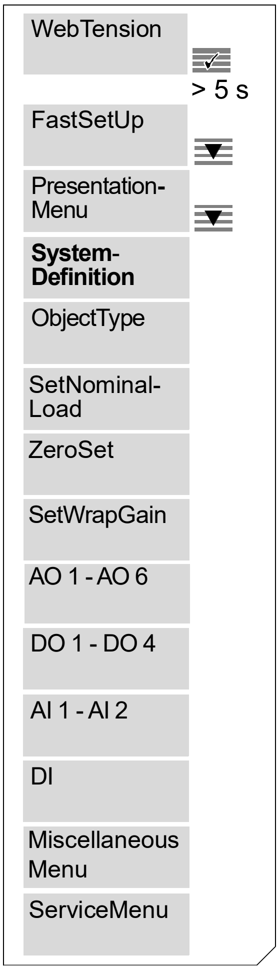
The format is XX.XXX if the width is entered in meter and XXXX.XX if the width is entered in inch. Maximum Web Width is 50m (1968,5 inch)

### 3.12.1.4 Set Decimals

The number of displayed decimals can be set in this menu. The number of decimals may be set to a number between 0 - 5 depending on the load cell nominal load and presentation unit.

Set decimals function is further explained in Section 4.6.

## 3.12.2 System Definition




In menu SystemDefinition the following must be set:

- ***LoadCellComb*** (load cell combination)
  - One roll (load cells A and B)
  - Two rolls (Roll 1 connected to A and B; Roll 2 connected to C and D)
  - Segmented roll
- ***GainScheduling*** (wrap gain scheduling). Available for One roll, Two rolls (only Roll 1) and Segmented roll.
  - Yes/No

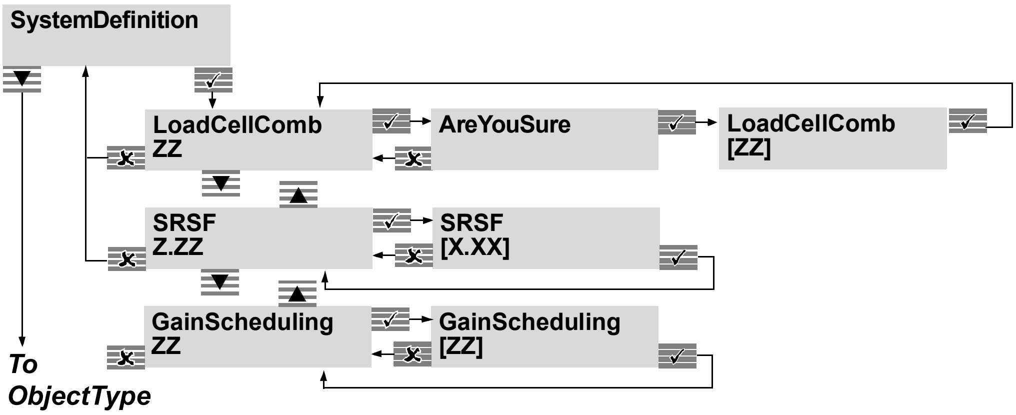
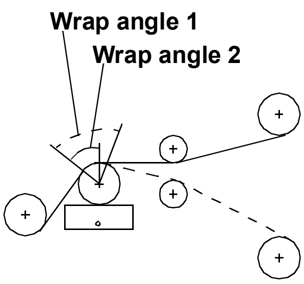



*Figure 3-4. Setting system definition*

The menu SRSF will only be available when the selected load cell combination is set to segmented roll.

Segmented Roll Scale Factor (SRSF) is used to compensate the total measured tension and present an estimate of total tension when not all rolls are supported by load cells in a segmented roll application. For calculations of SRSF, refer to Appendix A.3 Segmented Roll Scale Factor (SRSF).

### 3.12.2.1 Wrap Gain Scheduling




Gain scheduling enables the use of two different web paths on one measuring roll. Two pre-defined values for wrap gain can be set.

Wrap gain 1 is used for wrap angle 1 and wrap gain 2 for wrap angle 2.

Which of the two wrap gains that is to be used is selected with a digital input signal or via Profibus.

For load cell combination ***TwoRolls*** gain scheduling is available only for ***Roll 1***.

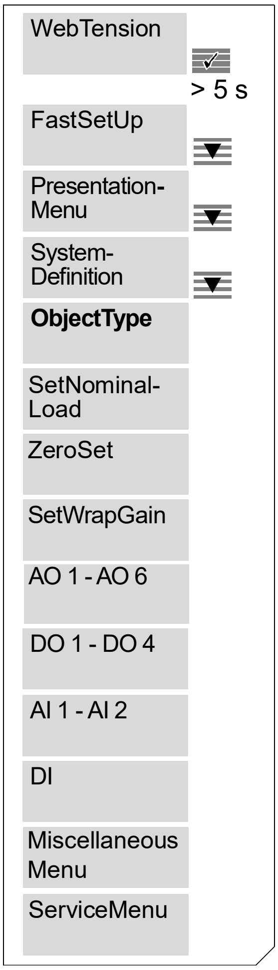
Wrap gain parameter 1 is used if the digital input is set to “0”, or if the specified field in Profibus is set to “0”.

Wrap gain parameter 2 is used if the digital input is set to “1”, or if the specified field in Profibus is set to “1”.

If the digital input is used for wrap gain scheduling the wrap gain scheduling field in Profibus is disabled.

If the digital input is used for remote zero set or set to “Off”, wrap gain scheduling is controlled from Profibus.

## 3.12.3 Setting Object Type




Depending on which load cell combination, ***LoadCellComb***:

- one roll
- two rolls or
- segmented roll

that is selected in menu "SystemDefinition" the following object types are available.

### Setting Object Type for One Roll

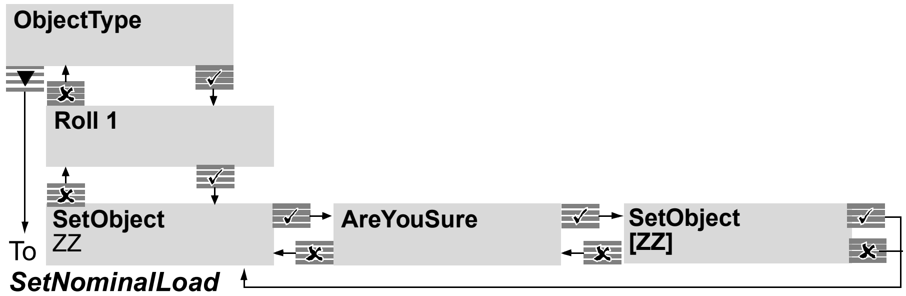



*Figure 3-5. Setting Object Type for One Roll*

Use up and down keys to select type of object [ZZ] from list.

1. ***StandardRoll*** (two load cells, A and B connected)
2. ***SingleSideA*** (only load cell A connected)
3. ***SingleSideB*** (only load cell B connected)

When single side measurement is selected the measured signal is multiplied by two and presented as web tension on display and analog output.

### 3.12.3.1 Object Types for One Roll

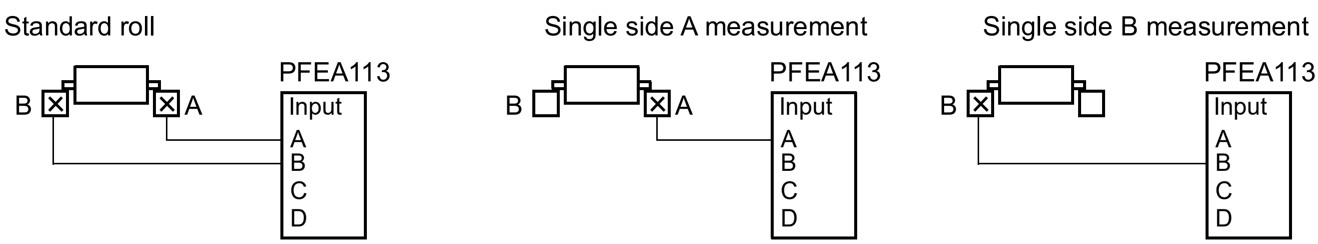
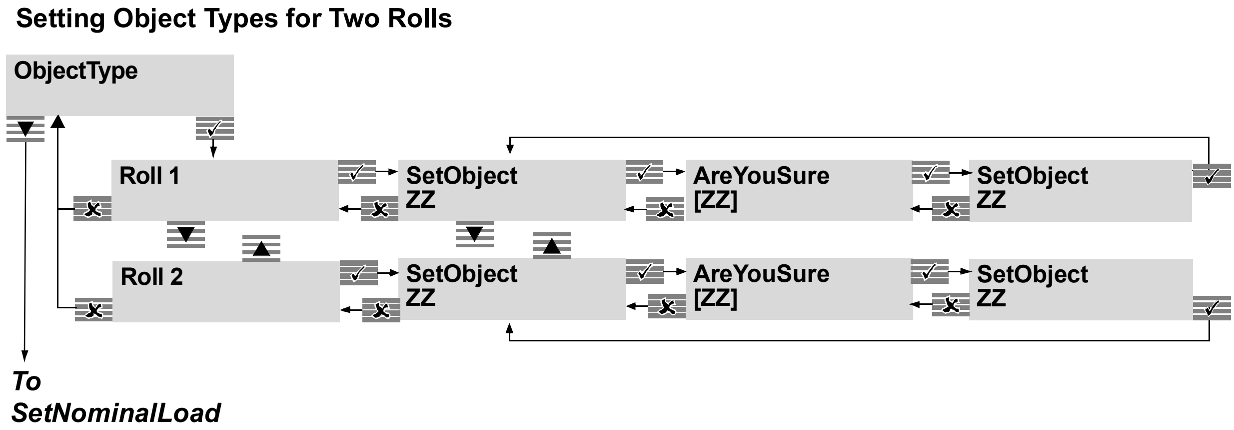



*Figure 3-6. Object Types for One Roll*

## 3.12.3.2 Setting Object Types for Two Rolls




Use up and down keys to select type of object [ZZ] from list.

Roll 1: ***StandardRoll*** (load cells A and B), ***SingleSideA*** or ***SingleSideB*** (load cell A or B)

Roll 2: ***StandardRoll*** (load cells C and D), ***SingleSideC*** or ***SingleSideD*** (load cell C or D)

When single side measurement is selected the measured signal is multiplied by two and presented as web tension on display and analog output.

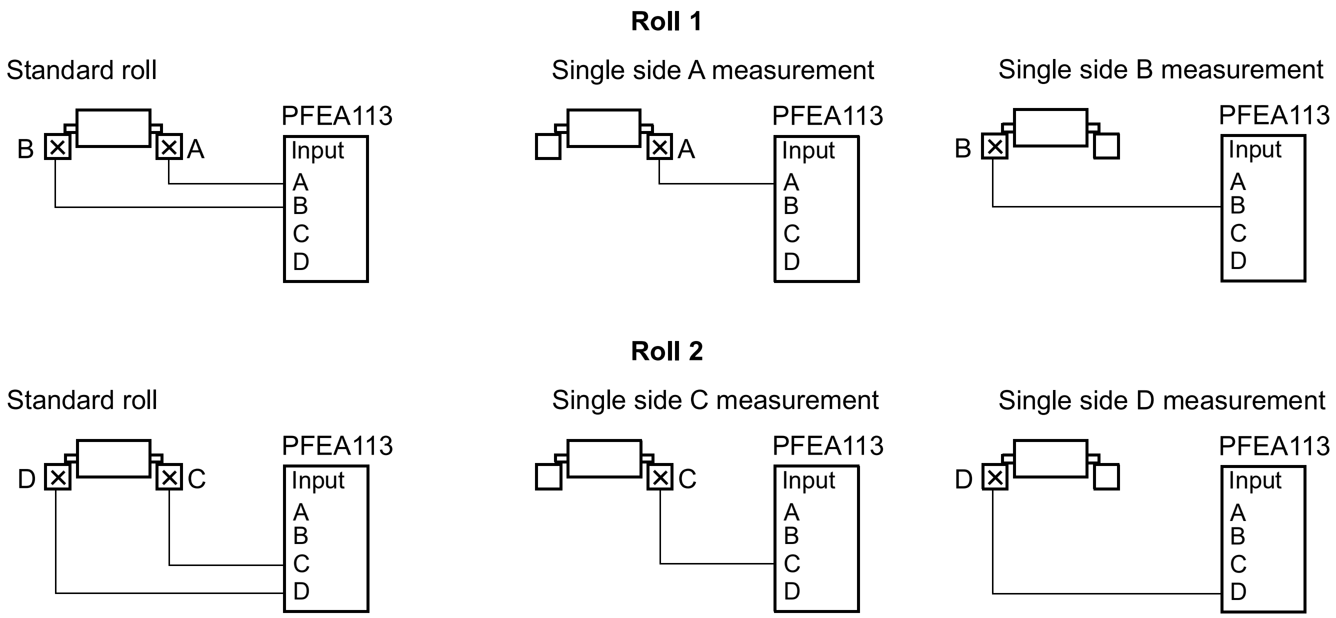
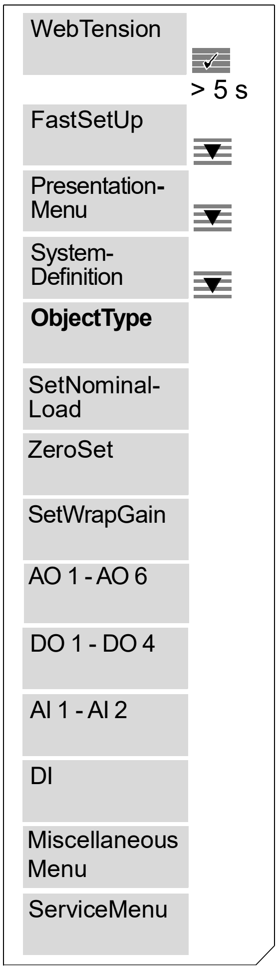



*Figure 3-7. Object Types for Two Rolls*

### 3.12.3.3 Setting Object Types for Segmented Roll




Object type ***SegmentedRoll*** can be used for up to 12 load cells that are connected to one, two or three Tension Electronics PFEA113.
Each PFEA113 must be set up for:

- one input (load cell connected to A)
- two inputs (load cells connected to A and B)
- three inputs (load cells connected to A, B and C) or
- four inputs (load cells connected to A, B, C and D)

**Setting Object Types for Segmented Roll**

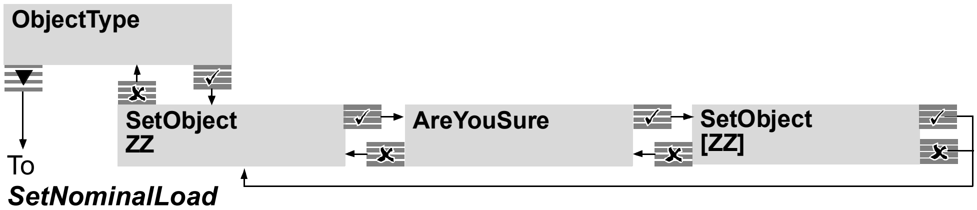



*Figure 3-8. Setting Object Types for Segmented Roll*

Use up and down keys to select type of object [ZZ] from list.

- ***OneInput***
- ***TwoInputs***
- ***ThreeInputs*** or
- ***FourInputs***

Segmented Roll Scale Factor (SRSF) is used to compensate the total measured tension and present an estimate of total tension when not all rolls are supported by load cells in a segmented roll application. For calculations of SRSF, refer to. Appendix A.3.1 Segmented Roll Scale Factor (SRSF).

**Segmented Roll** (three or four load cells connected to one PFEA113)

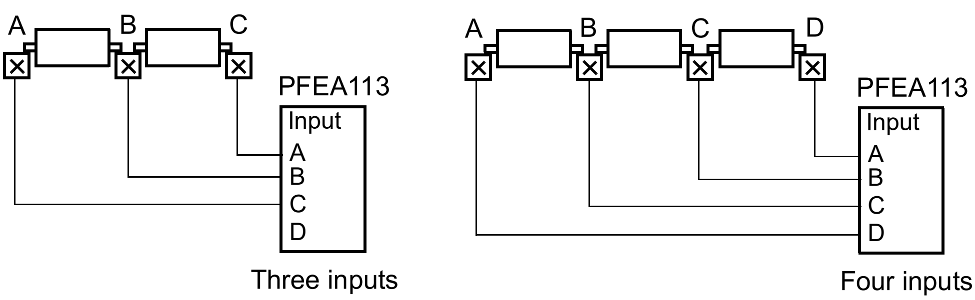



*Figure 3-9. Segmented Roll Connected to One PFEA113*

**Segmented Roll** (11 roll segments) with the maximum number of load cells (12) connected

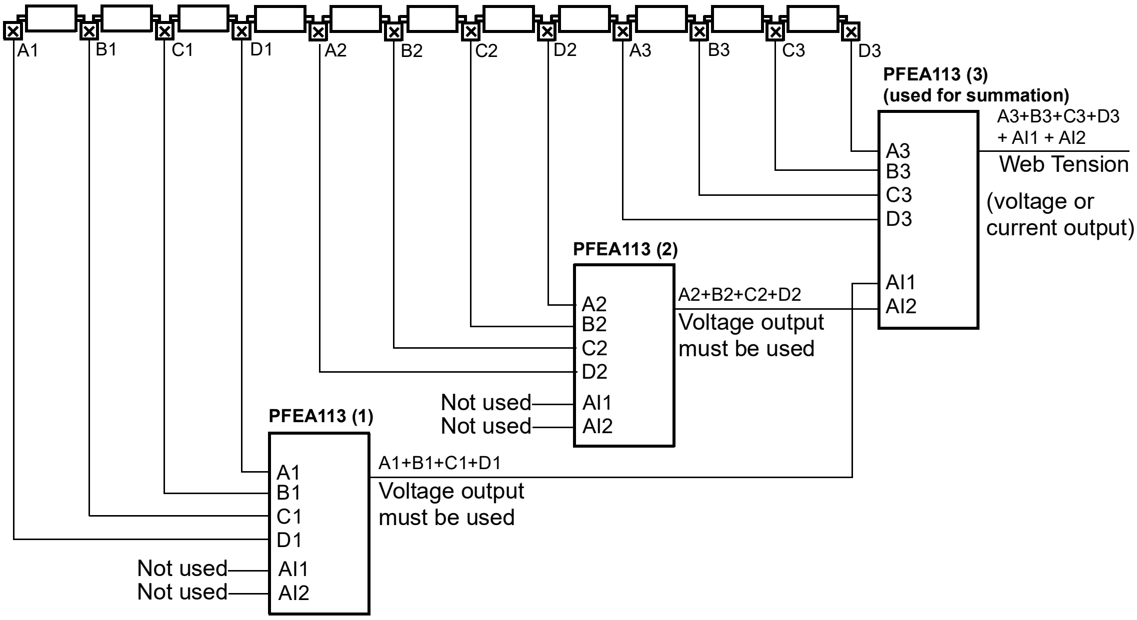



*Figure 3-10. Three PFEA113 Connected to Segmented Roll with 12 (max.) Load Cells*

**Connecting Multiple Electronics (two or three PFEA113 connected together)**

Analog inputs AI1 and AI2, see Figure 3-10, are used for connecting two or three PFEA113 electronics together. The configuration example below is based on Figure 3-10.

If N/m, kN/m, kg/m or pli is chosen as presentation unit, the total web width must be entered in all three electronics.

The same wrap gain value must be entered in all three electronics.

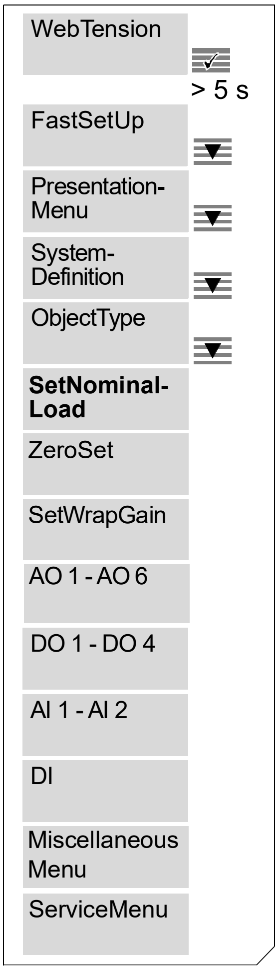
If the scale factor SRSF is used, the SRSF must be calculated and set separately for each electronic unit, see also Appendix A.3 Technical Data for Tension Electronics PFEA113.

1. **Configuration rules for analog outputs(AO) on PFEA113 (1) and PFEA113 (2) to be connected to AI1 and AI2 on PFEA113 (3):**
   - Choose voltage output, since AI1 and AI2 can only be connected to voltage signals.
   - Use the ***ConnectSignals*** alternative that includes the load cell signals you want to connect to the output, see Section 3.12.7.
   - Set the filter settings to 5 ms (the shortest selectable time).
   - Set ***HighTension*** (N, kN, kg, lbs, N/m, kN/m, kg/m or pli) and ***HighOutput*** (V).
2. **Configuration rules for the AI1 and AI2 on PFEA113 (3)**
   - Set ***HighTension*** (N, kN, kg, lbs, N/m, kN/m, kg/m or pli) of AI1 = ***HighTension*** of PFEA113 (1).
   - Set ***HighInput*** (V) of AI1 = ***HighOutput*** *(V)* of PFEA113 (1).
   - Set ***HighTension*** (N, kN, kg, lbs, N/m, kN/m, kg/m or pli) of AI2 = ***HighTension*** of PFEA113 (2).
   - Set ***HighInput*** (V) of AI2 = ***HighOutput*** *(V)* of PFEA113 (2).
3. **Configuration rules for the output (used for summation) on PFEA113 (3)**
   - Choose voltage output or current output.
   - Use the ***ConnectSignals*** alternative that includes all signals you want to connect to the summation output, see Section 3.12.7.
   - Set the desired filter settings.
     **Note!** If the Step Response time is set to 5 ms and analog inputs (AI1 and/or AI2) are included in the summation output the filter settings will increase to 6 ms.

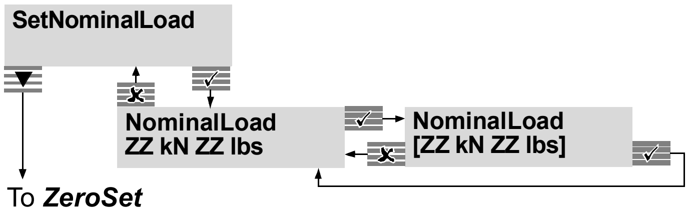
## 3.12.4 Nominal Load

This section describes how to set nominal load for:

- One roll and Segmented roll
- Two rolls




Setting nominal load for **One Roll** and **Segmented Roll**




Setting nominal load for **Two Rolls**

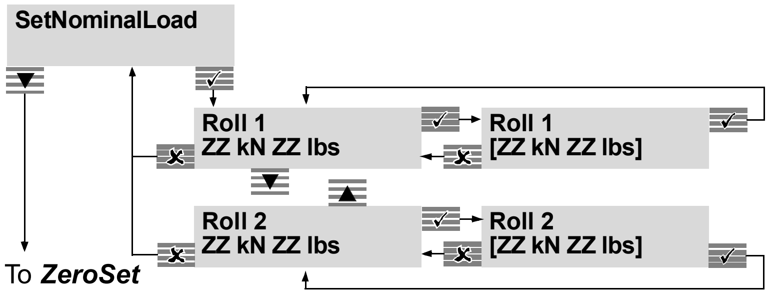



*Figure 3-11. Nominal Load Menus*

The nominal load is selected from the list below and must be the same as the nominal load on the load cell name plate. The load cell nominal load is displayed in kN and lbs on the same row.

The following nominal loads can be selected:

*Table 3-1. Nominal Loads*

| [kN] | [lbs] |
|---|---|
| 0.1 | 22 |
| 0.2 | 45 |
| 0.5 | 112 |
| 1.0 | 225 |
| 2.0 | 450 |
| 5.0 | 1125 |
| 10 | 2250 |
| 20 | 4500 |
| 50 | 11250 |
| 100 | 22500 |
| 200 | 45000 |

## 3.12.5 Zero Set

Zero set is used to compensate for load cell zero signal and tare weight.

The zero setting range is ±2 x $F_{nom}$ (load cell nominal load).

Zero set menus are described in the following order for:

1. One roll
2. Two rolls
3. Segmented roll

**NOTE**

Zero set must be done with no web tension applied to the rolls.

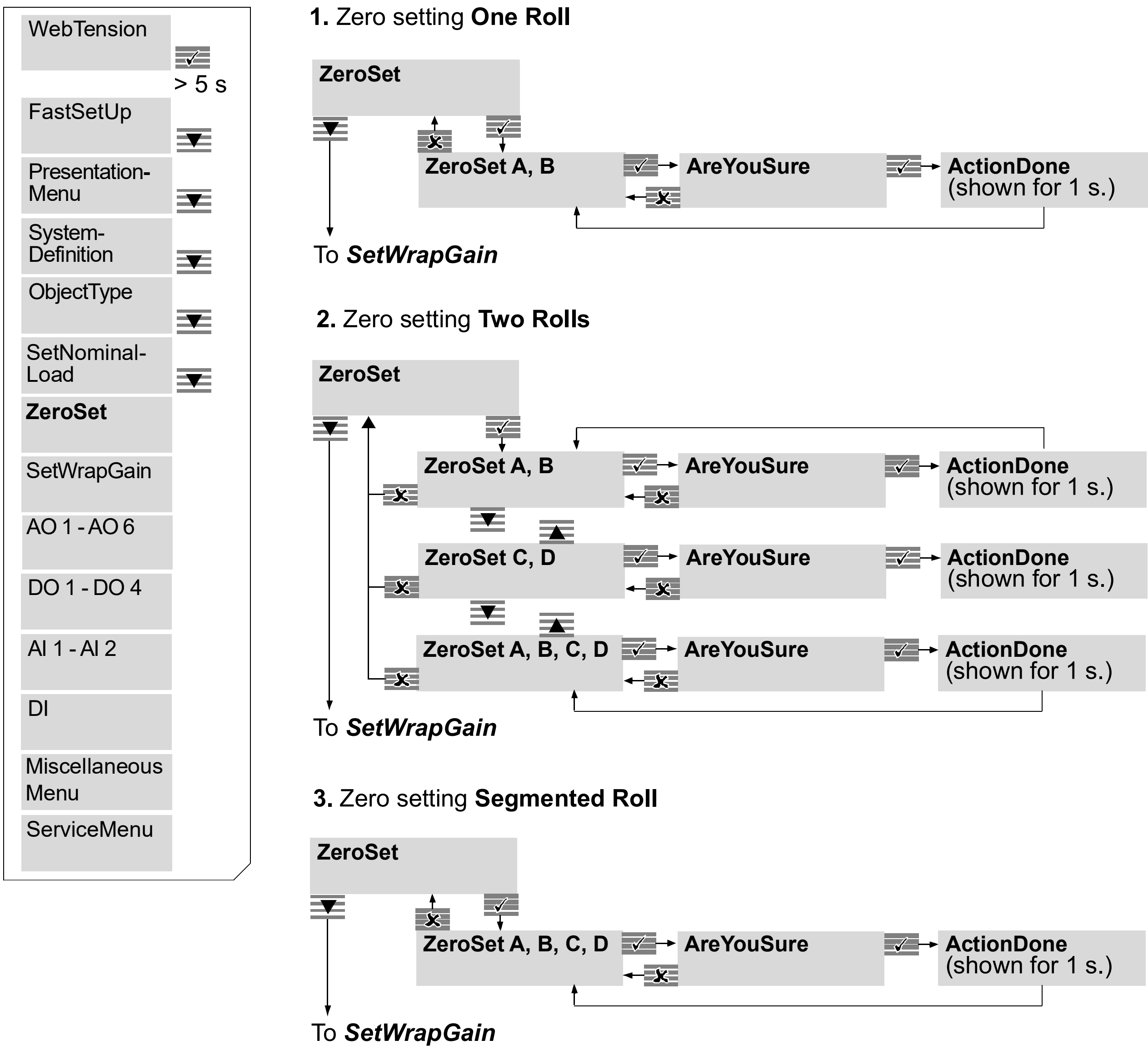



*Figure 3-12. Zero Set Menus*

## 3.12.6 Set Wrap Gain

To be able to present actual web tension on the display, the ratio between web tension and measured force on the load cell must be determined.

This ratio is a scaling factor called Wrap Gain.

The Wrap Gain depends on the web's wrap angle on the measuring roll and the orientation of the load cells. Therefore, Wrap Gain depends on the actual installation.

This gives:

**T** (tension) = Wrap Gain × $\mathbf{F_R}$ (force of web tension in load cell measuring direction)

There are two ways to find out the ratio between web tension and measured force on the load cells, by Hanging weights or by Calculation.

- **With hanging weights (**Menu *HangWeight***)**

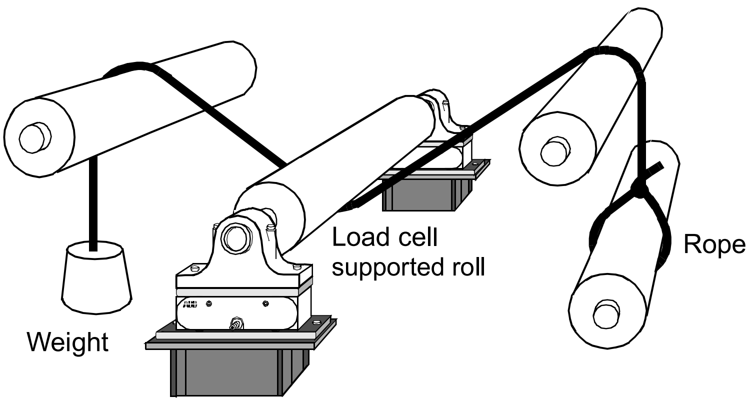
  String a rope that follows the web path exactly and apply a known weight.

  The applied known weight simulates the actual web tension and the electronics measures the resulting force on the load cells caused by the applied weight.

  When both web tension (T) and the corresponding measured force ($F_R$) are known the tension electronics calculates the ratio T / $F_R$ and stores the value as Wrap Gain.

  When web tension is applied to the roll the tension electronics calculates web tension by multiplying the measured force on the load cells with the Wrap Gain.

  After the hanging weight procedure the wrap gain calculated by the tension electronics can be found in the EnterWrapGain menu.




All rolls must be free turning idlers. To keep friction losses low, only use the closest rolls to define web path.

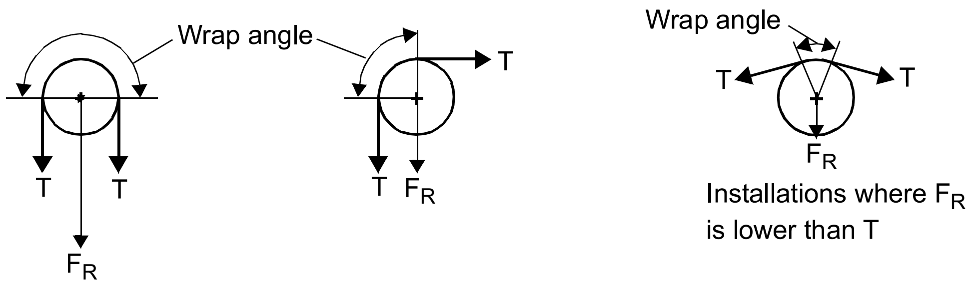
*Figure 3-13. Setting Wrap Gain with Hanging Weights (example of installation)*

- **By calculation (**Menu *EnterWrapGain***)**

  Wrap Gain is a scaling factor which corresponds to the ratio between Web Tension (T) and the force component ($F_R$) from web tension that is acting in the load cell measuring direction.

  The Wrap Gain range is 0.5 - 20. If you try to set the wrap gain outside this range, the message "***WrapGainTooLow***" or "***WrapGainTooHigh***" will be shown on the display. The wrap gain can be set with a resolution of 0.01.

  Examples describing the principle of calculating Wrap Gain:




**$F_R$ = 2T**

Wrap gain = $\frac{T}{F_R}$

Wrap gain = $\frac{T}{2T}$ = 0.50

**Wrap gain = 0.50**
(Min. value of Wrap Gain)

**$F_R$ = T**

Wrap gain = $\frac{T}{F_R}$

Wrap gain = $\frac{T}{T}$ = 1.00

**Wrap gain = 1.00**

**$F_R$ < T**

Wrap gain = $\frac{T}{F_R}$

**Wrap gain = > 1**
(Max. permitted value of Wrap Gain is 20)

See calculation of Wrap Gain in Appendix (B, C, D, E, F, G or H) for installed load cell type.

## 3.12.6.1 Wrap Gain Menus for One Roll, Two Rolls and Segmented Roll

Setting Wrap Gain is described in the following order:

1. One roll. Gain scheduling "No"
2. One roll. Gain scheduling "Yes"

3. Two rolls. Gain scheduling "No"
4. Two rolls. Gain scheduling "Yes"

5. Segmented roll. Gain scheduling "No"
6. Segmented roll. Gain scheduling "Yes"

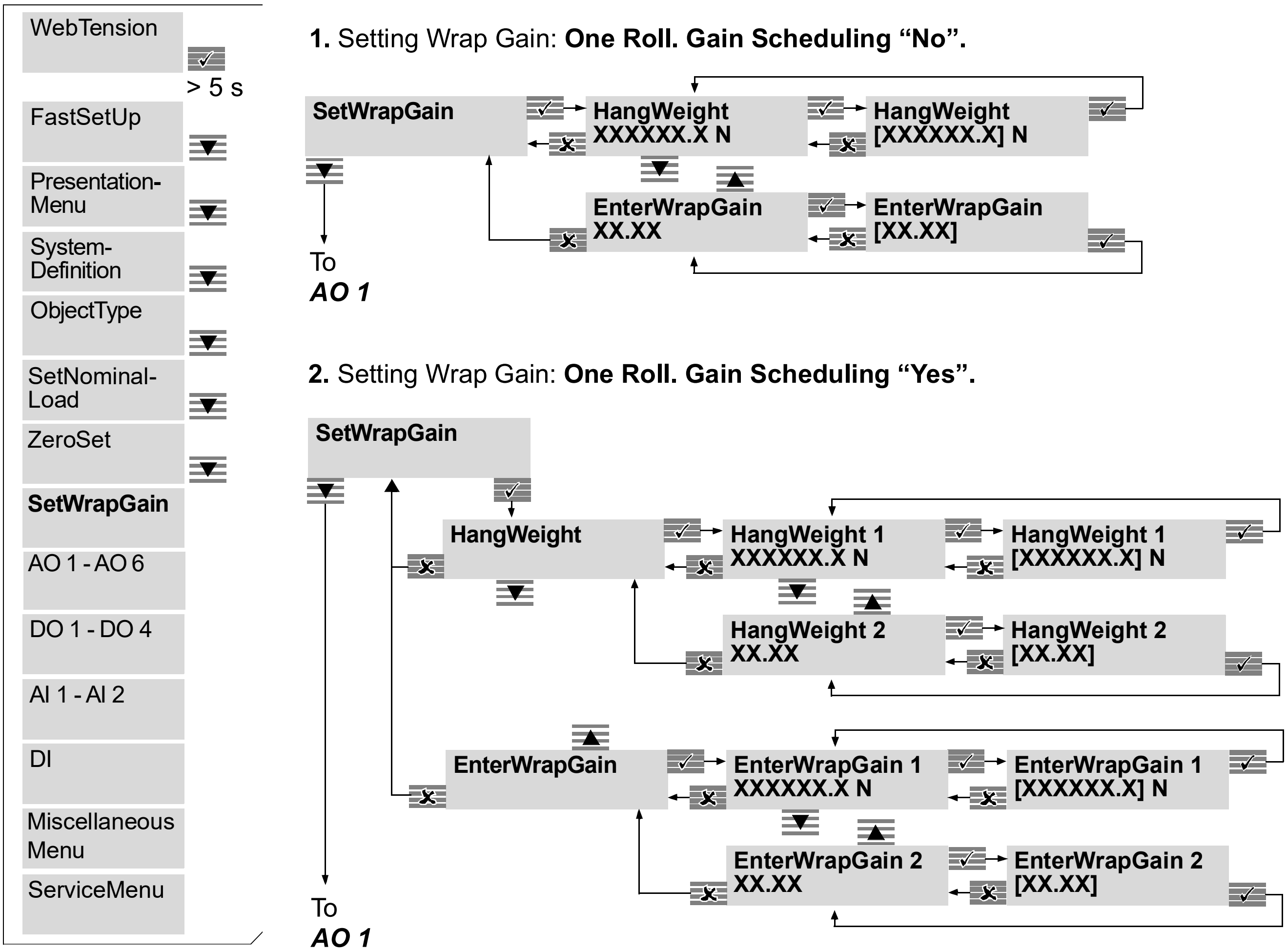



*Figure 3-14. Setting Wrap Gain for One Roll*

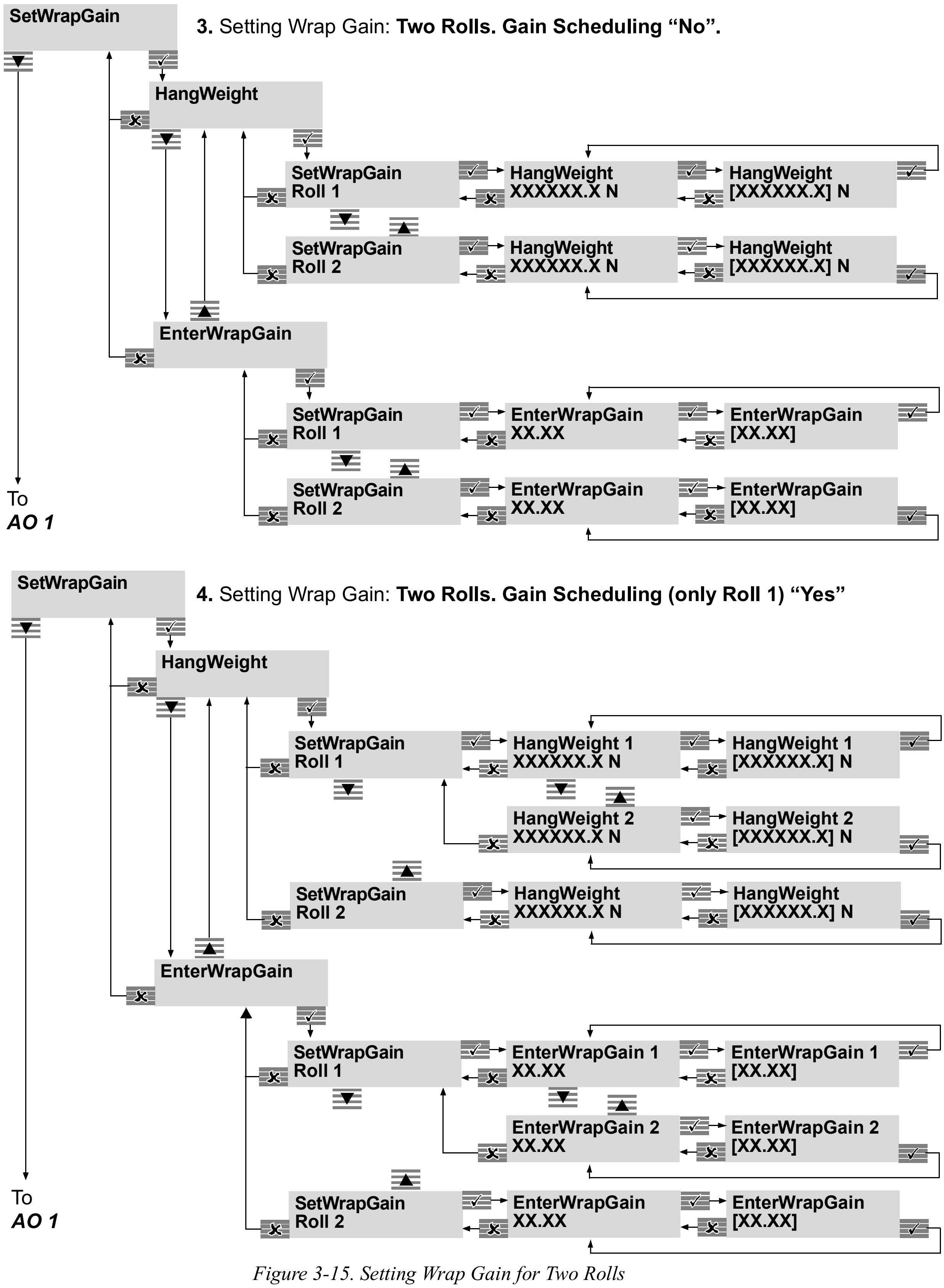
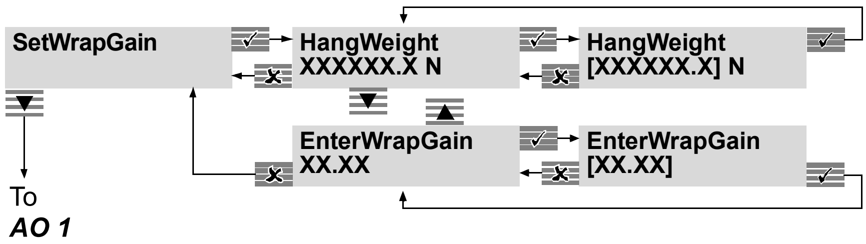



*Figure 3-15. Setting Wrap Gain for Two Rolls*

**5.** Setting Wrap Gain: **Segmented Roll. Gain Scheduling "No".**




**6.** Setting Wrap Gain: **Segmented Roll. Gain Scheduling "Yes".**

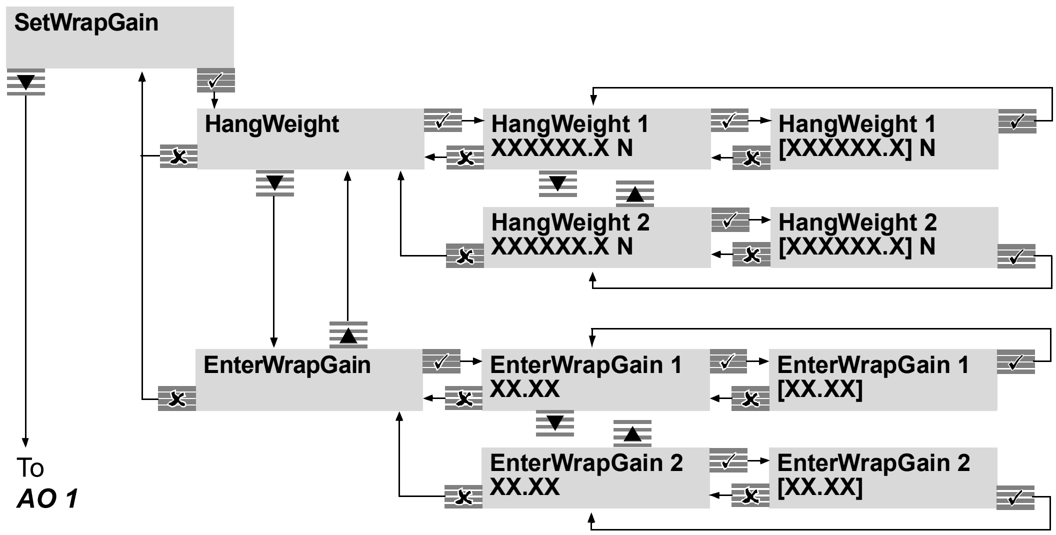



*Figure 3-16. Setting Wrap Gain for Segmented Roll*

## 3.12.7 Setting Analog Outputs (AO1-AO6)

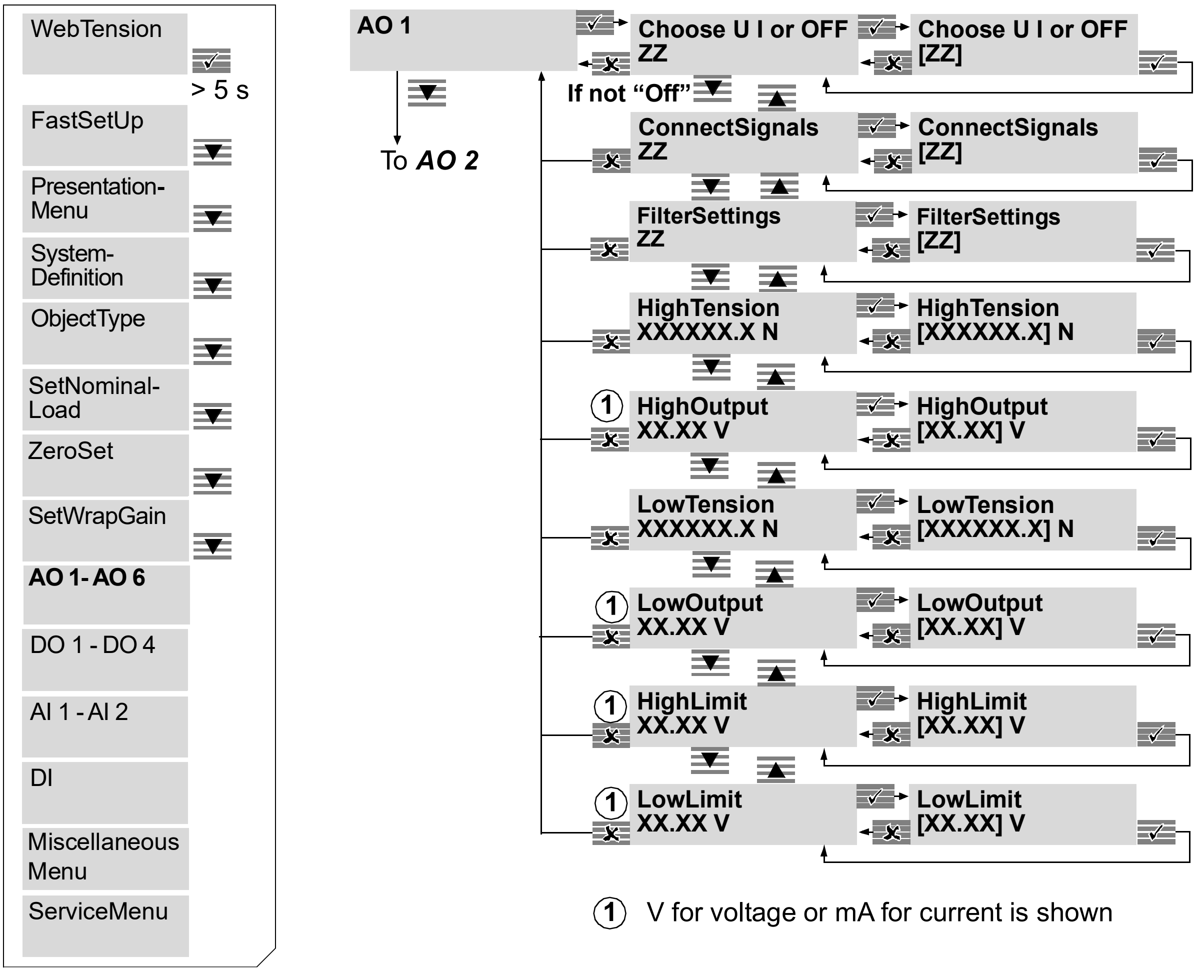



*Figure 3-17. Menus for Analog Outputs (AO1-6)*

In menu **Choose U I or OFF**, use up and down keys to select:

- ***Off***
- ***U*** (voltage)
- ***I*** (current) or
- ***PROFIBUS only***

The following can be selected in:

1. Menu ***SystemDefinition***
   – ***OneRoll***
   – ***TwoRolls***
   – ***SegmentedRoll***
2. Menu ***ObjectType***
   – ***Roll1 (StandardRoll, SingleSideA*** *or* ***SingleSideB***
   – ***Roll2 (StandardRoll, SingleSideC*** *or* ***SingleSideD***
   – Segmented roll ***(OneInput, TwoInputs, ThreeInputs, FourInputs)***

Based on what has been selected in ***SystemDefinition*** and ***ObjectType***, the following alternatives of "***ConnectSignals"*** can be used:

| System definition | Object Type | AO1 - AO6 can be connected to .... |
|---|---|---|
| **One roll** | **Standard roll** | ***A, B, A+B, A-B*** |
| | **Single side** | ***TensionRoll 1*** |
| **Two rolls** | Roll 1: **standard roll**<br>Roll 2: **standard roll** | ***A, B, A+B, A-B***<br>***C, D, C+D, C-D*** |
| | Roll 1: **single side**<br>Roll 2: **single side** | ***TensionRoll 1***<br>***TensionRoll 2*** |
| | Roll 1: **standard roll**<br>Roll 2: **single side** | ***A, B, A+B, A-B***<br>***TensionRoll 2*** |
| | Roll 1: **single side**<br>Roll 2: **standard roll** | ***TensionRoll 1***<br>***C, D, C+D, C-D*** |
| **Segmented roll** | **One input** | ***A***<br>***A+AI1***<br>***A+AI1+AI2***<br>***A-AI2***<br>***AI1-AI2*** |
| | **Two inputs** | ***A, B***<br>***A+B***<br>***A-B***<br>***A+B+AI1***<br>***A+B+AI1+AI2***<br>***B-AI2***<br>***AI1-AI2*** |
| | **Three inputs** | ***A, B, C***<br>***A+B+C***<br>***A-C***<br>***A+B+C+AI1***<br>***A+B+C+AI1+AI2***<br>***C-AI2***<br>***AI1-AI2*** |
| | **Four inputs** | ***A, B, C, D***<br>***A+B+C+D***<br>***A-D***<br>***A+B+C+D+AI1***<br>***A to D+AI1+AI2*** (A+B+C+D+AI1+AI2)<br>***D-AI2***<br>***AI1-AI2*** |

The following parameters can be set:

- Filter settings

  See Table 3-2.
- High Tension (N, kN, kg, lbs, N/m, kN/m, kg/m, pli), (factory default = 2000 N)
- High Output, (factory default = +10 V or 20 mA)
- Low Tension (N, kN, kg, lbs, N/m, kN/m, kg/m, pli), (factory default = 0 N)
- Low Output, (factory default = 0 V or 4 mA)
- High Limit, (factory default = +11 V or 21 mA)
- Low Limit, (factory default = -5 V or 0 mA)

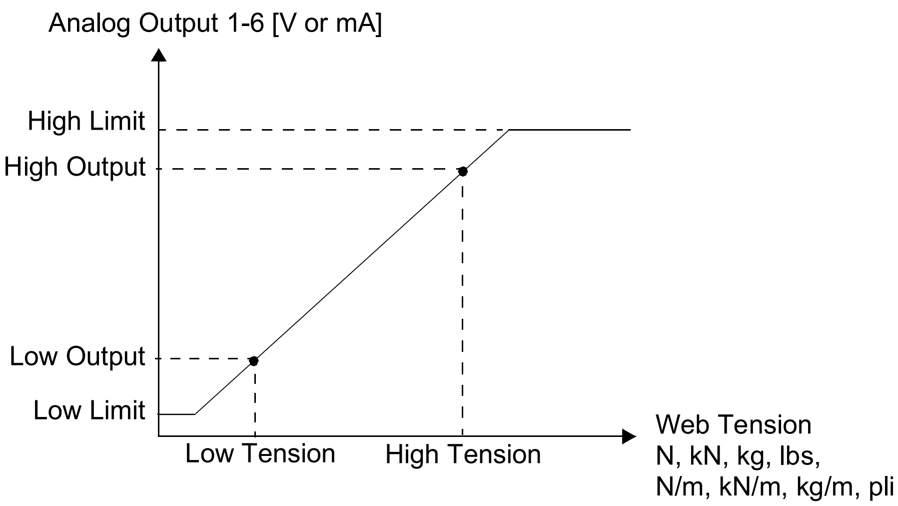



*Figure 3-18. Parameter Definitions*

Filtering may be used if the voltage or current output signal is too fast or if roll imbalance needs to be compensated.

The filters are of type linear phase, maximum flat, 20 dB/decade.

*Table 3-2. Filter settings*

| Step Response time 0 - 90% | Cut-off frequency –3dB |
|---|---|
| 15 ms | 35 Hz |
| 30 ms | 15 Hz |
| 75 ms | 5 Hz |
| 250 ms | 1.5 Hz |
| 750 ms | 0.5 Hz |
| 1500 ms | 0.25 Hz |

## 3.12.8 Setting Digital Outputs (DO1-DO4)

There are four digital outputs, which can be used as:

- Indication outputs for level detectors that can be connected to any of AO1-AO6
- “Status OK” to indicate that the system is running normally

The following parameters can be set for any of the outputs to be used as a level detectors:

1. Connect Signals (AO1 to AO6 can be connected)
2. Define Function by selecting one of the following functions:
   - ***Off*** (The digital output is not used)
   - ***HiActive***
     (Level detector: **Hi**gh level detection set to **Active**)
   - ***LoActive***
     (Level detector: **Lo**w level detection set to **Active**)
   - ***HiAndLoActive***
     (Level detector: **Hi**gh **And Lo**w level detection set to **Active**)
   - ***Status***
     The digital output indicates “Status OK”, when the system is running normally.

     States when a digital output is set up for status indication:

     When the system is running normally (no warnings or errors)
     DO is set to high (state "1").

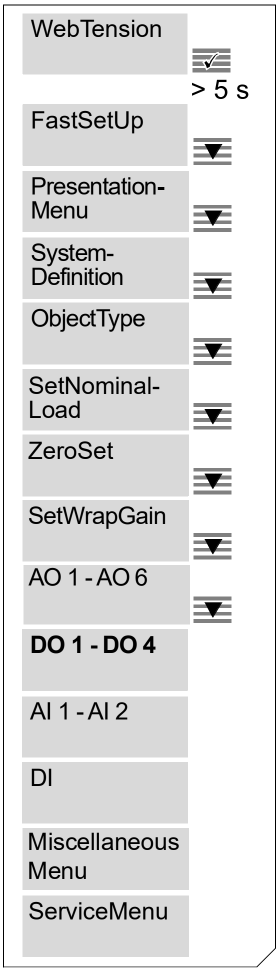
     When a warning or error is detected (level detectors will also affect the status signal), DO is set to low (state "0").

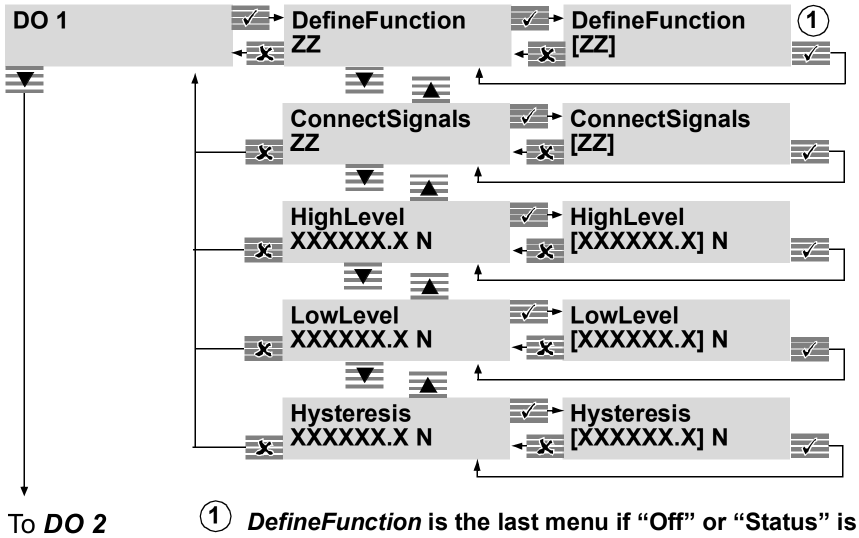
If the digital output is set to ***Off*** or set to ***Status*** the parameters in steps 3 and 4 are not shown:

3. Enter level detector value (N, kN, kg, lbs, N/m, kN/m, kg/m, pli) for:
   - High level, if ***HiActive*** is set
   - Low level, if ***LoActive*** is set
   - High Level and Low level, if ***HiAndLoActive*** is set
4. Enter Hysteresis value (N, kN, kg, lbs, N/m, kN/m, kg/m, pli)
   If ***HiAndLoActive*** is set, the hysteresis value is the same for High level and Low level.

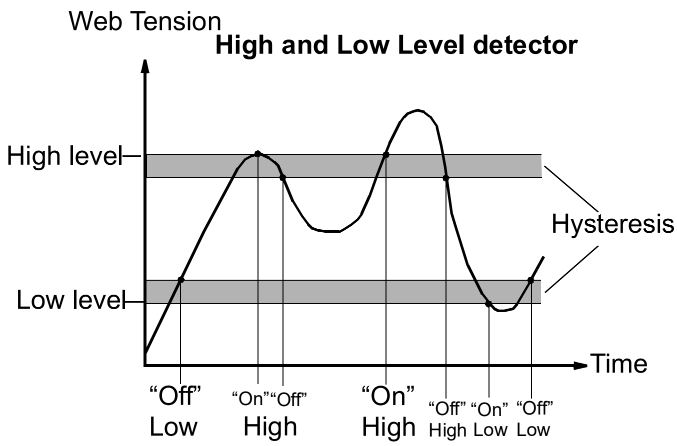
**NOTE**

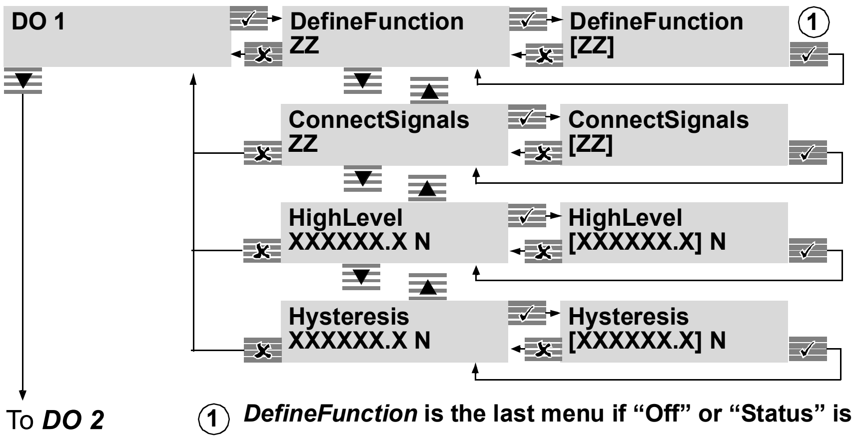
Menus for DO1 are described in the following examples. Use menus for DO2-DO4 in the same way.



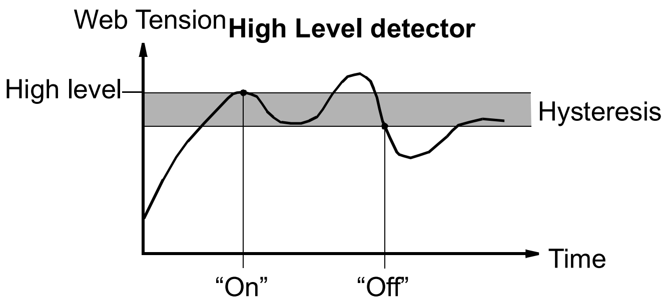



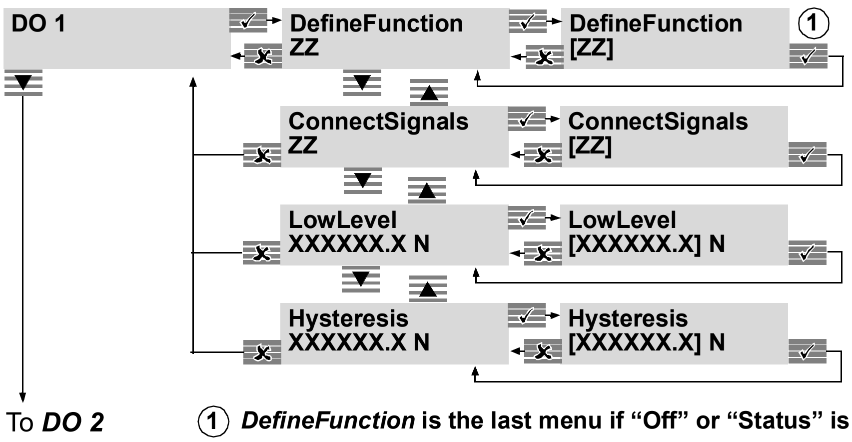

1 ***DefineFunction*** **is the last menu if “Off” or “Status” is selected**



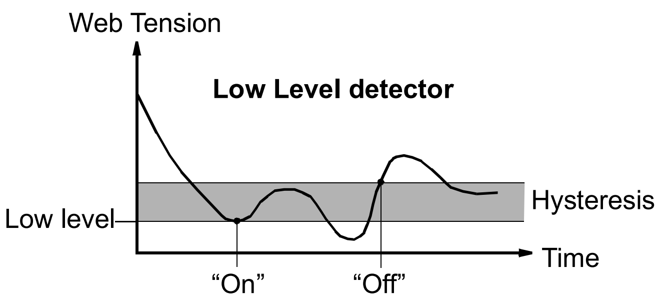



1 ***DefineFunction*** **is the last menu if "Off" or "Status" is selected**

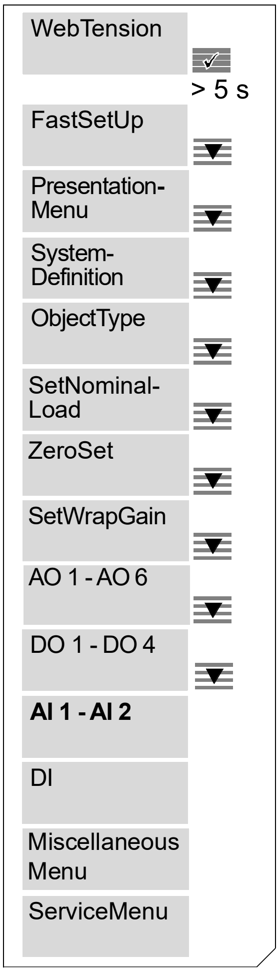



1 ***DefineFunction*** **is the last menu if "Off" or "Status" is selected**



## 3.12.9 Setting Analog Inputs (AI1 and AI2)




There are two analog inputs.

The input signal range is 0 to 10 V.

Analog inputs are used to connect two or three PFEA113 together.

To scale the analog inputs the following must be set:

- High Tension (N, kN, kg, lbs, N/m, kN/m, kg/m, pli)
- High Input V

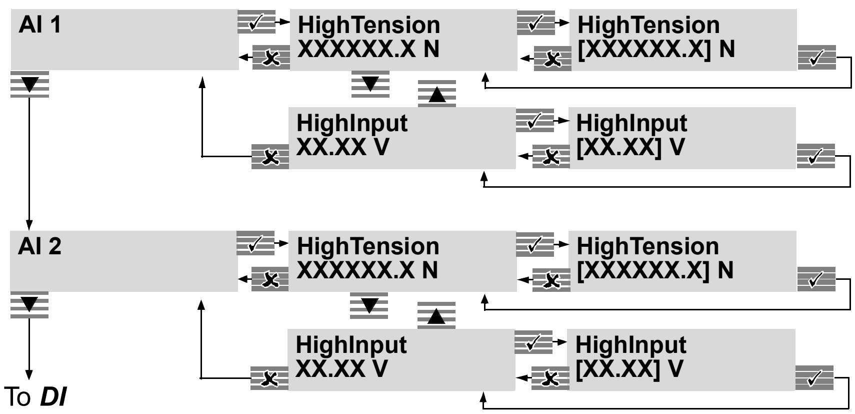



*Figure 3-19. Menus for Analog inputs*

See also Section 3.12.3.3 for segmented roll application.

## 3.12.10 Setting the Digital Input

The digital input is used for Zero Set or Gain Scheduling. The input is set to Off, if not used.


Use up and down keys to select:

- ***Off***
- ***ZeroSet*** or
- ***GainScheduling***

## 3.12.11 Miscellaneous Menu

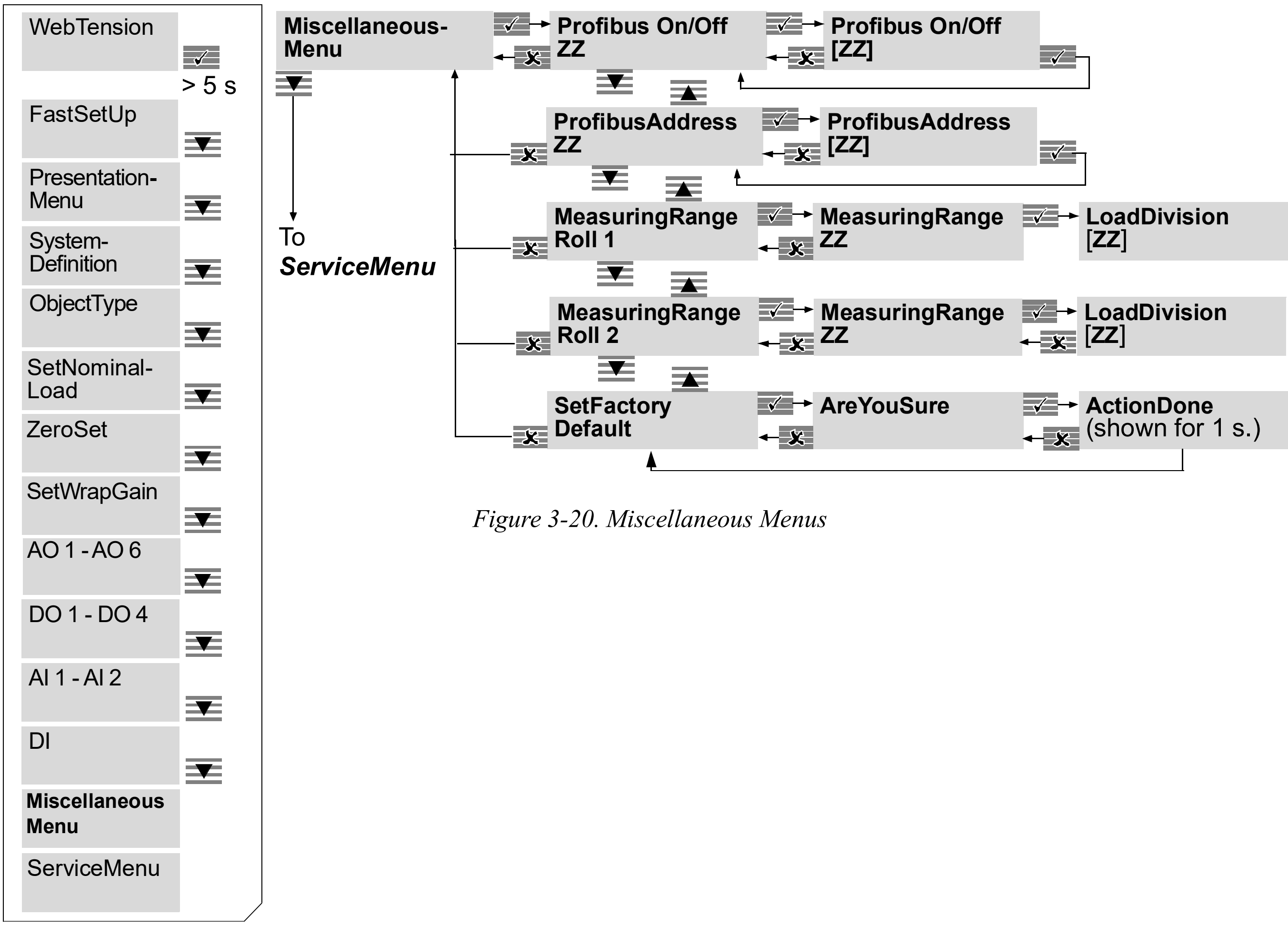



*Figure 3-20. Miscellaneous Menus*

### 3.12.11.1 Profibus

- Profibus On/Off

  The Profibus can be enabled or disabled.

- Profibus address

  If the Profibus is enabled, the Profibus address must be set in the range 000 - 125.

Read more about the Profibus in Section 3.13.

### 3.12.11.2 Set Factory Default

- Set factory default

  The parameters are set as on delivery except ***Maximum load A***, ***Maximum load B***, ***Maximum load C and Maximum load D.***

Read more in Appendix A.5 Factory Default Settings.

## 3.12.12 Service Menu

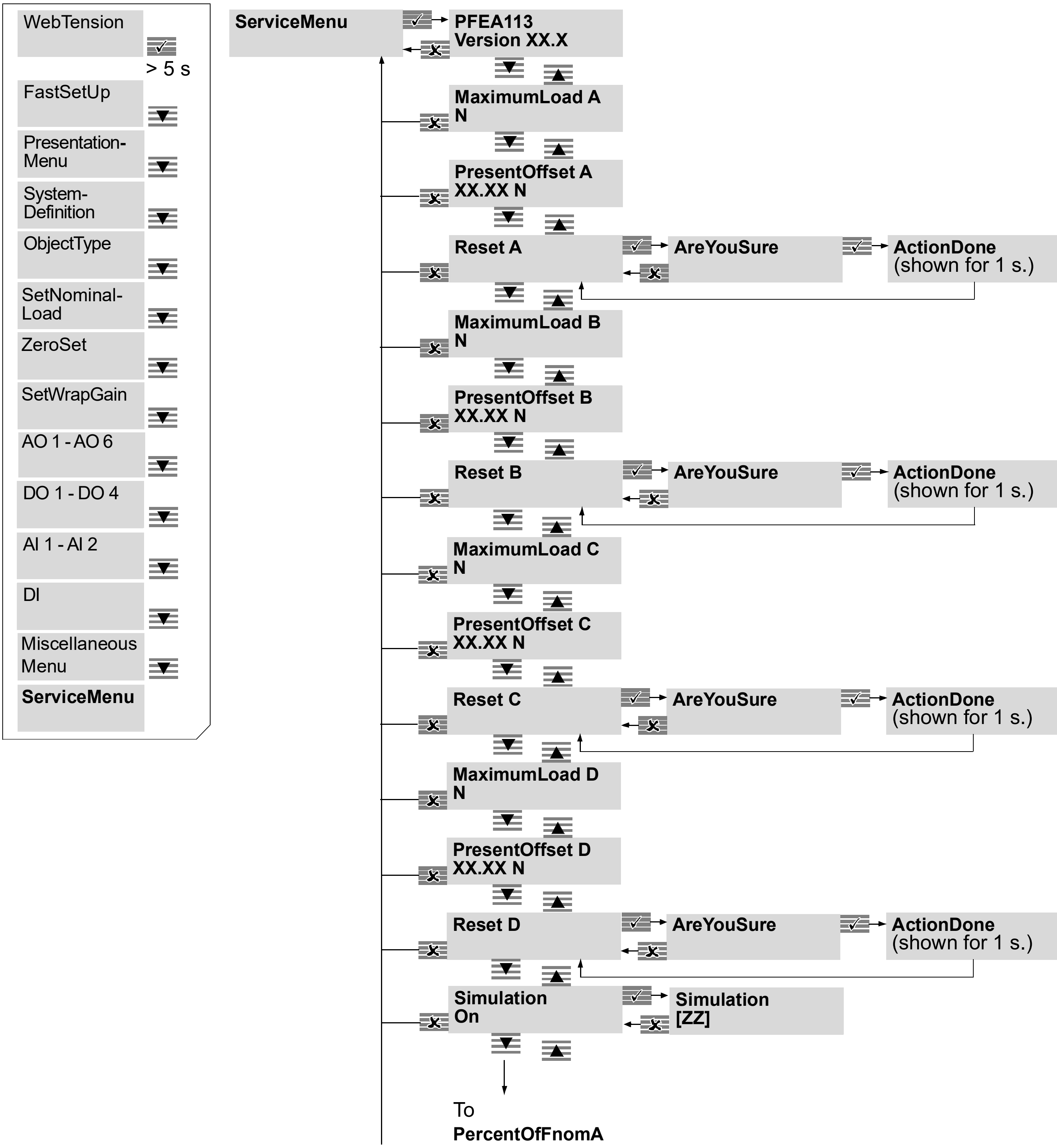



*Figure 3-21. Service Menus*

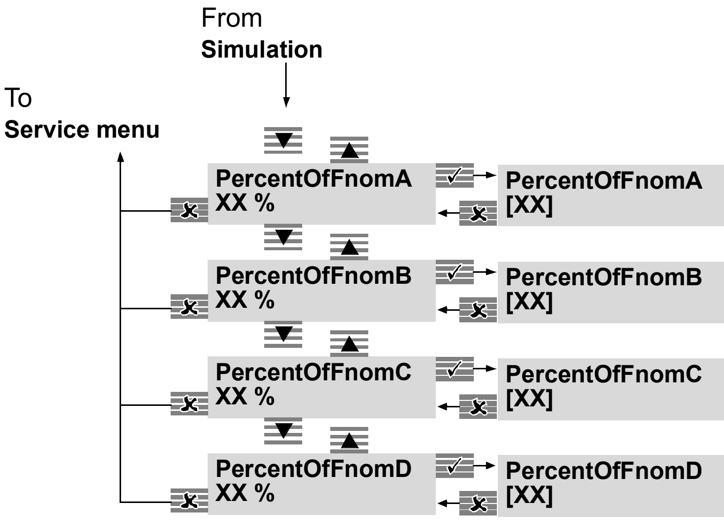



*Figure 3-22. Service Menus (continued)*

**NOTE**

Only menus for connected load cells are shown.

The service menu has parameters that can be viewed (displayed) only and parameters that can be set.

- Parameters that can be viewed only:
  - ***Version: XX.X***

    Displays PFEA113 software version.
  - ***MaximumLoad A***, ***MaximumLoad B***, ***MaximumLoad C***, ***MaximumLoad D***

    Displays maximum load (for connected load cells) since last reset.
  - ***PresentOffset A, PresentOffset B, PresentOffset C, PresentOffset D***

    Displays zero offset (for connected load cells) at last zero set.
  - Parameters that can be set for connected load cells:
    ***Reset A*** zero sets ***MaximumLoad A***
    ***Reset B*** zero sets ***MaximumLoad B***
    ***Reset C*** zero sets ***MaximumLoad C***
    ***Reset D*** zero sets ***MaximumLoad D***

### 3.12.12.1 Maximum Load / Present Offset

For each load cell connected to the web tension electronics PFEA113, a maximum load memory, with the range ±6.5 x $F_{nom}$, will store the highest load that is applied to the load cell.

The maximum load consists of:

- load cell zero signal (with no load on the load cell)
- $F_{RT}$, applied force component of tare in the measuring direction of the load cell

  and
- $F_R$, measured force (force component of tension in the measuring direction of the load cell)

The maximum load memory can be reset if a load cell is replaced.

### 3.12.12.2 Reset Load Cells

Reset A sets “Maximum load A” to zero.

Reset B sets “Maximum load B” to zero.

Reset C sets “Maximum load C” to zero.

Reset D sets “Maximum load D” to zero.

### 3.12.12.3 Simulation function

Simulation can be set to ON or OFF.

If simulation is set to ON, the parameters PercentOfFnomA and PercentOfFnomB will be displayed. PercentOfFnomB is not shown if Single side A has been selected in ObjectType and PercentOfFnomA is not shown if Single side B has been selected in ObjectType.

The parameter PercentOfFnom can be set between –100 and +200 in steps of one. When simulation is set to ON, it replaces the measured value from the load cells. The value +100 means that the value is the same as load cell loaded to Fnom.

Zero set cannot be used when simulation is activated. When simulation is set to ON, the red status led is lit and on the display the message “Simulation” is shown. If “ok” is pressed, the message is moved to the bottom of the Operator menu in the same way as failure and warning messages.

SetFactory Default sets the simulation to OFF.

When simulation is set to ON, the default values are:

- PercentOfFnomA = 55%
- PercentOfFnomB = 45%
- PercentOfFnomC = 55%
- PercentOfFnomD = 45%

# 3.13 Profibus DP Communication with PFEA113

## 3.13.1 General Data about Profibus DP

The purpose of the Profibus DP communication in PFEA113 is to provide a high-speed communication link between superior systems and the PFEA113.

Profibus DP is a multidrop communication protocol intended to connect PLCs to sensors (DP means “Distributed Peripherals”).

The physical interface is RS 485 (two wire cable).

The maximum transfer rate is 12 Mbit/s.

The protocol is based on a master-slave principle. The PFEA113 is a slave. A Profibus master polls the slaves all the time, that means the polling is going on with a fixed time interval even when no new data is available from the PFEA113.

Each slave has an address in the range 0 to 125.

Profibus requires that the message format, communication parameters and error codes of slaves are made available in a so called type file, also known as GSD file (See Appendix A.8 Profibus DP - GSD File for PFEA113). This file is then stored in the Profibus Master.

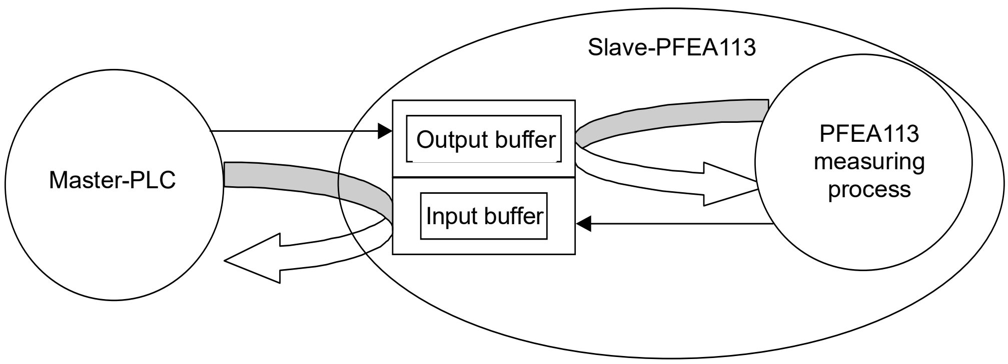
At start-up the Profibus Master verifies that the Slave with the given type file is indeed available on the bus.

## 3.13.2 Master-slave Communication

The Master and the slave communicate via an output buffer and an input buffer.

The master reads the input buffer and writes to the output buffer once every scan cycle for Profibus.

The slave polls the output buffer and updates values in the input buffer.



## 3.13.3 Profibus Physical Media

The bus line is specified in EN 50170 as line type A. Line type B should be avoided. The physical properties of the media are shown in Table 3-3 and Table 3-4.

*Table 3-3. Line Parameters*

| **Parameter** | **Line type A** | **Line type B** (Avoid if possible) |
|---|---|---|
| Impedance in Ω | 135 to 165 | 100 to 130 |
| Capacitance per unit length (pF/m) | <30 | <60 |
| Loop resistance (Ω /km) | 110 | --- |
| Core diameter (mm) | 0.64 | > 0.53 |
| Core cross section (mm$^2$) | > 0.34 | > 0.22 |

The specified line parameters result in the following lengths of a bus segment.

*Table 3-4. Maximum Cable Lengths per Segment*

| **Maximum bus segment length (m)** | **Transmission rate in kbit/s** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **9.6** | **19.2** | **93.75** | **187.5** | **500** | **1500** | **12000** |
| Wire A | 1200 | 1200 | 1200 | 1000 | 400 | 200 | 100 |
| Wire B | 1200 | 1200 | 1200 | 600 | 200 | - | - |

Stub lines up to 1500 kbit/s < 6.6 m.
If you are using 12 Mbits/s you should avoid stub lines.

If you are using line A as specified by EN 50 170, the bus terminating resistance combination is as shown in Figure 3-23, so that a defined idle state potential is ensured on the line.

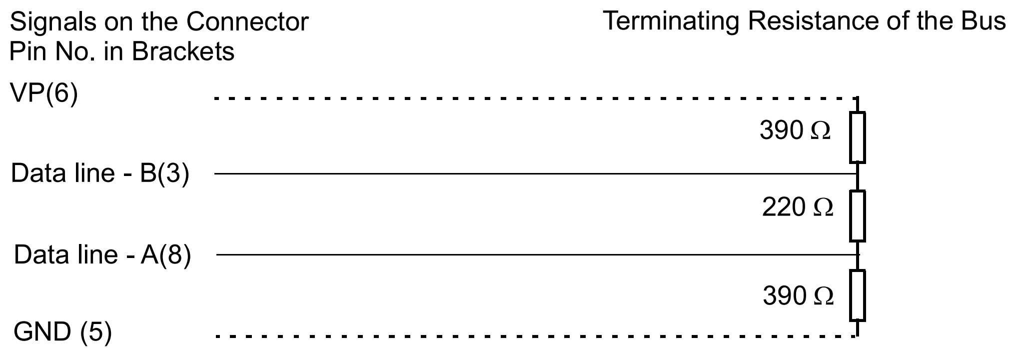



*Figure 3-23. Line Termination of Wire A in Accordance with EN 50170*

To bridge longer distances and bypass EMC interference, transmission with optical fiber conductors (glass or plastic) is also specified.
Standard bus plug connectors are available for transmission with optical fiber conductors. These connectors convert RS 485 signals to optical fiber conductor signals and vice versa. (OLP = optical link plug).
In addition, repeaters are available to handle this signal conversion.
This gives you the option of switching between the two transmission techniques within one system if necessary.

You can connect up to 126 stations to one Profibus system.
To be able to handle this number of participants on the bus, the bus system must be divided into individual segments, containing maximum 32 stations each.
These segments are linked by repeaters.

x

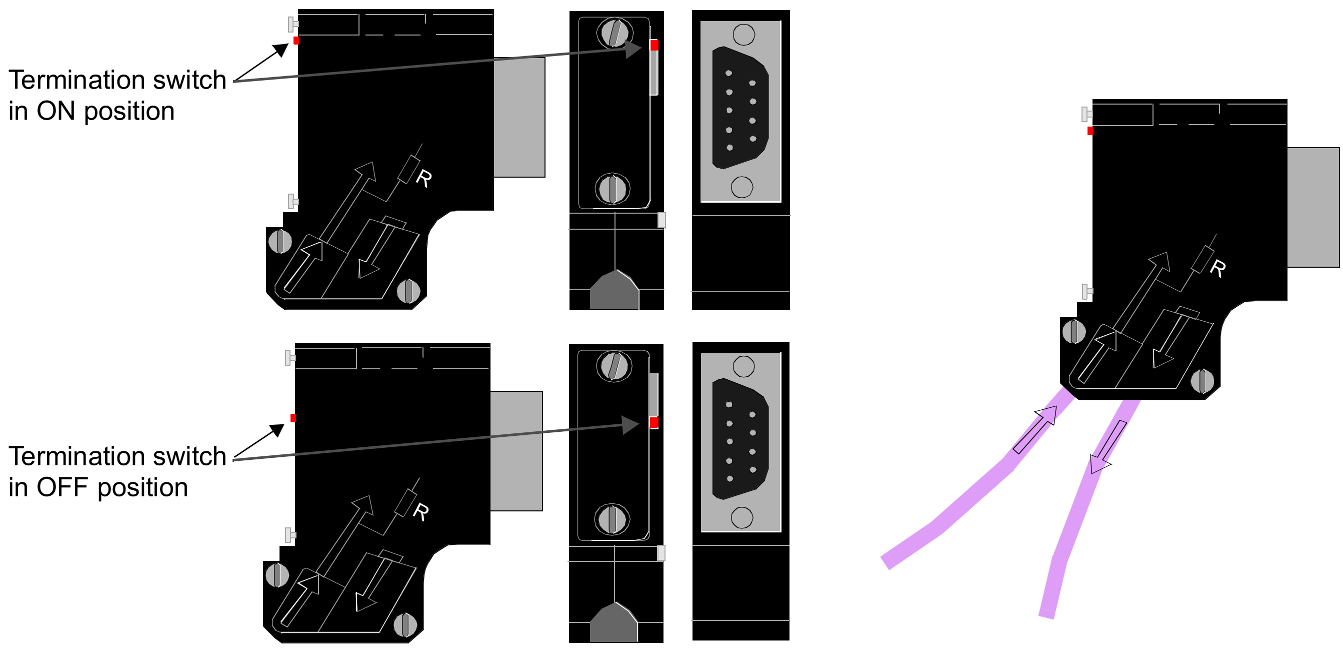



*Figure 3-24. Profibus Cable Connector*

## 3.13.4 Commands through Profibus

Commands that can be performed through Profibus are:

- Zero set
- Gain scheduling

## 3.13.5 Handling of Measurement Data through Profibus

Six web tension measurement values are transferred through Profibus:

Load cell combinations and filter settings for values 1-6 are the same as for AO1-AO6.

The scaling of analog outputs does not affect the measurement values transferred through Profibus.

If zero set has been performed, the zero set values are transferred through Profibus.

Scaling of Profibus measurement values, see Section 3.13.5.2.

Each measurement value has 16 bit, 2-complement representation (Integer 16).

### 3.13.5.1 Miscellaneous Menu

Use this menu to scale Profibus measurement values.

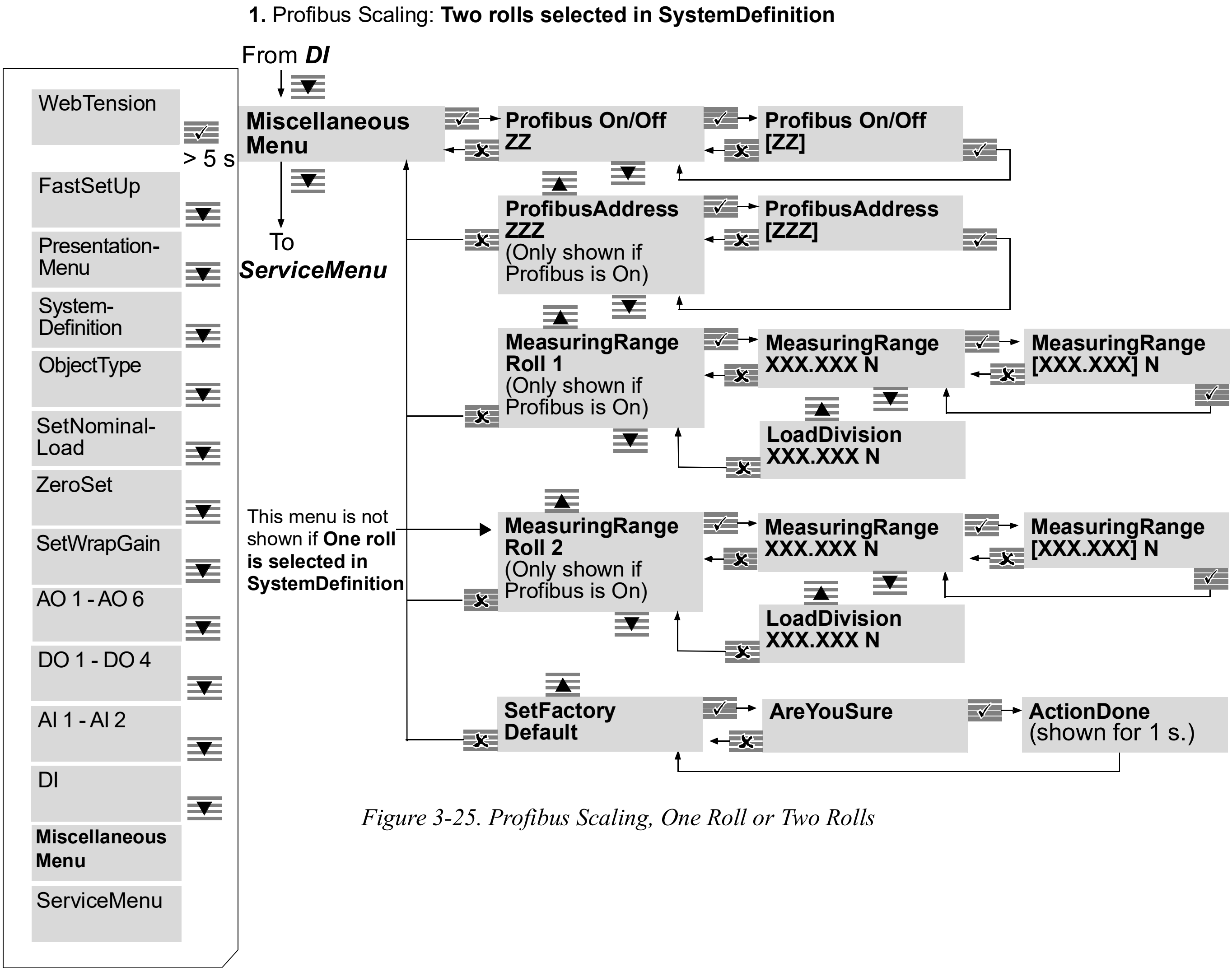



*Figure 3-25. Profibus Scaling, One Roll or Two Rolls*

**2.** Profibus Scaling: **Segmented roll selected in SystemDefinition**

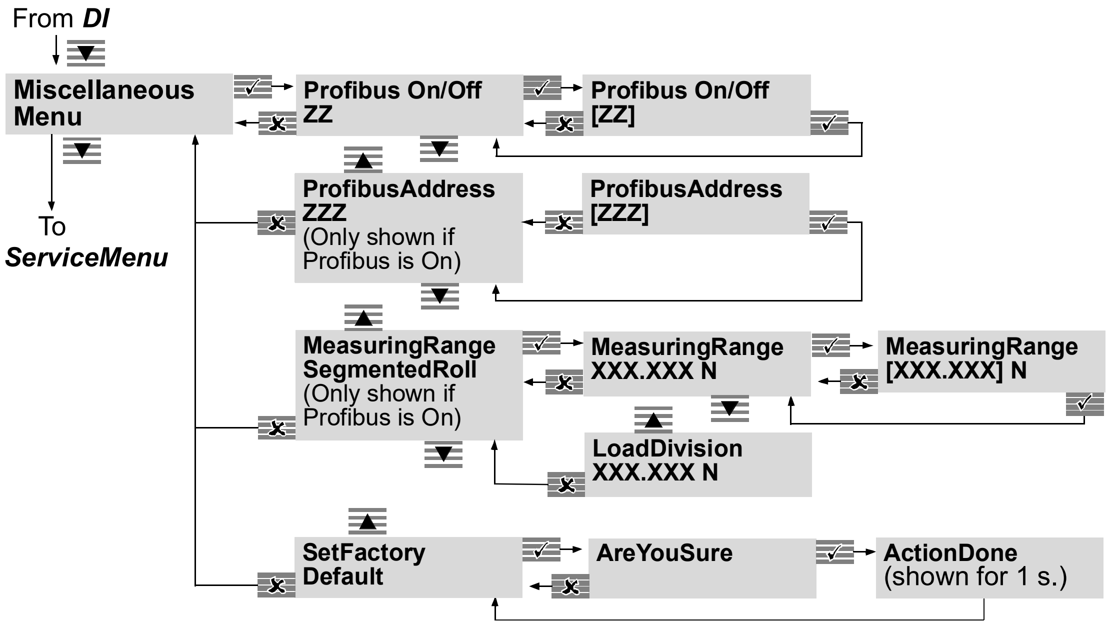



*Figure 3-26. Profibus Scaling, Segmented Roll*

*Table 3-5. Profibus parameters*

| Parameter | Description |
|---|---|
| Profibus On/Off | The Profibus can be enabled and disabled. |
| Profibus Address | If the Profibus is enabled, the Profibus address must be set in the range 000 - 125. |
| Measuring Range | If the Profibus is enabled, the Profibus Measuring Range and load division can be set for Roll1 and Roll2 separately. |

## 3.13.5.2 Scaling of Profibus Measuring Values

The Profibus values can be scaled in two ways:

- **Default Scaling** – scaling that only depends on load cell nominal load.
- **User defined Scaling** – the scaling of the Profibus values can be set by the user.

## Default Scaling

**Load Cell Combination, LoadCellComb: One or two rolls**

SW 1.0-1.7 differs slightly from SW1.8 and later. The difference signal in SW1.0-1.7 has a different scaling factor as illustrated in Table 3-6. In SW1.8 or later, all signals for each measurement object have the same scaling. When replacing an older unit with an SW1.8 or later -unit the load scaling for difference signals must be adjusted in the Profibus master.

**Load Cell Combination, LoadCellComb: Segmented roll**

As Table 3-6 illustrates the load scaling must be adjusted in the Profibus master when replacing an old unit with SW1.8 or later -unit.. In the case of 9-12 load cells the scaling is the same for all

| Number of load cells connected to the analog output channel | Value of least significant bit, Load Division (Resolution) ($F_{nom}$ = Load cell nominal load) | |
|---|---|---|
| | SW 1.0-1.7 | SW1.8 and later |
| **One or Two rolls** | | |
| • 1 or 2 load cells | $0.001 \times 2 \times F_{nom}$ | $0.001 \times 2 \times F_{nom}$ |
| • Difference signal | $0.001 \times F_{nom}$ | $0.001 \times 2 \times F_{nom}$ |
| **Segmented roll** | | |
| • 3 load cells | $0.001 \times 3 \times F_{nom}$ | $0.001 \times 12 \times F_{nom}$ |
| • 4 load cells | $0.001 \times 4 \times F_{nom}$ | $0.001 \times 12 \times F_{nom}$ |
| • 5 to 8 load cells (1 to 4 load cells + AI1) | $0.001 \times 8 \times F_{nom}$ | $0.001 \times 12 \times F_{nom}$ |
| • 9 to 12 load cells (1 to 4 load cells + AI1 + AI2) | $0.001 \times 12 \times F_{nom}$ | $0.001 \times 12 \times F_{nom}$ |
| • Difference signal | $0.001 \times F_{nom}$ | $0.001 \times 12 \times F_{nom}$ |

SW.

*Table 3-6. Scaling of Profibus Measurement Values*

Example for 1 kN load cells (SW1.8):

With 1 kN load cells, and with AI1+A+B (AI1 + 2 load cells) connected to the AO 1, the value of the least significant bit is:

$0.001 \times 12 \times 1000 = 12$ N

Measuring range: 60 000 N

## User Defined Scaling

The Profibus Measuring Range and Load Division can be adjusted according to user preferences.

**Profibus Measuring Range**

Profibus Measuring Range (**estimated web tension during normal operation**) is a parameter entered by the user. After the user has changed the Measuring Range value, changing Load cell nominal load does not affect the Profibus scaling. The value of the least significant bit is defined as Load Division.

**Load Division**

Load Division is the resolution that will be used on Profibus. The Load Division value is calculated by PFEA113 and depends on the set measuring range.

The measuring range is divided into a limited number of divisions in the range 2001 - 5000.

The Load Division value = one division, contains only one significant digit (1, 2 or 5).

The Profibus can handle max. –32768 to +32767 ($2^{16}$) divisions.

Example 1:

a. Profibus Measuring Range (set by user) = 15 500 N
(estimated web tension during normal operation)

b. Load Division calculated by PFEA113 = 5 N
(value of least significant bit on Profibus)

c. Profibus Measuring Range/Load Division = 15500/5 = 3100
(the measuring range is divided into 3100 divisions)

Example 2:

If the Load Division, 5 N, in Example 1 is not sufficient, the Load Division can be adjusted. This can be done by setting (decreasing) **MeasuringRange** in the Miscellaneous Menu to a value that gives a sufficient Load Division (resolution).

a. Measuring Range = 9000 N
(New, lower measuring rangesetting)

b. New Load Division calculated by PFEA113 = 2 N
(New value of least significant bit on Profibus)

With the setting 9000 N in PFEA113, the Profibus measuring range 0 – 15500 N (divided into 7750 divisions) can still be used, now with the Load Division (resolution) 2 N.

Normally, there is no need to set the measuring range lower than 1/3 of the estimated web tension during normal operation.

The max. value that can be transmitted via Profibus, for a given Load Division, is:

– Max. value = Load Division x 32767

**NOTE**

**After the user has changed the Measuring Range value, the only way to return to Default scaling, is to use the function Set Factory default in the Miscellaneous Menu.**

### 3.13.5.3 Filtering of Profibus Measuring Values

Measuring values 1-6 have the same filtering as AO1-AO6.

### 3.13.5.4 Input Buffer, Communication Block from PFEA113 to PLC

This section specifies measurement values and Boolean values in the input buffer communication block.

| Data | Byte No. | Bit No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Value 1 | 01 | MSB | | | | | | | |
| | 02 | LSB | | | | | | | |
| Value 2 | 03 | MSB | | | | | | | |
| | 04 | LSB | | | | | | | |
| Value 3 | 05 | MSB | | | | | | | |
| | 06 | LSB | | | | | | | |
| Value 4 | 07 | MSB | | | | | | | |
| | 08 | LSB | | | | | | | |
| Value 5 | 09 | MSB | | | | | | | |
| | 10 | LSB | | | | | | | |
| Value 6 | 11 | MSB | | | | | | | |
| | 12 | LSB | | | | | | | |
| Boolean in | 13 | No. 7 | No. 6 | No. 5 | No. 4 | No. 3 | No. 2 | No. 1 | No. 0 |
| Boolean in | 14 | No. 7 | No. 6 | No. 5 | No. 4 | No. 3 | No. 2 | No. 1 | No. 0 |

**Data**
Value 1: AO1 (16 bit 2-complement)
Value 2: AO2 (16 bit 2-complement)
Value 3: AO3 (16 bit 2-complement)
Value 4: AO4 (16 bit 2-complement)
Value 5: AO5 (16 bit 2-complement)
Value 6: AO6 (16 bit 2-complement)

**Boolean in** (not used bits are set to zero)

**Byte No. 13:**
The error or warning is active when the corresponding bit is set to “1”.

Bit No. 0: Flash memory error
Bit No. 1: EEPROM memory error
Bit No. 2: Supply error
Bit No. 3: Load cell excitation error
Bit No. 4: Synchronization problem

**Byte No. 14**
Bit No. 0: Level detector 1 is active
Bit No. 1: Level detector 2 is active
Bit No. 2: Level detector 3 is active
Bit No. 3: Level detector 4 is active

### 3.13.5.5 Output Buffer, Communication Block from PLC to PFEA113

This section specifies Boolean values in the output buffer communication block.

| Data | Byte No. | Bit No. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Boolean out | 01 | No. 7 | No. 6 | No. 5 | No. 4 | No. 3 | No. 2 | No. 1 | No. 0 |
| | 02 | Spare for future use | | | | | | | |

Bit No. 0: **Zero Set**. Zero set is performed when the bit is changed from “0” to “1”.

- Zero set of Roll 1 or
- Zero set of all load cells if Segmented roll is selected.

Bit No. 1: **Zero Set**. Zero set is performed when the bit is changed from “0” to “1”.

- Zero set of Roll 2

Bit No. 2: **Gain Scheduling**.

- Wrap gain parameter 1 is used if the bit is set to “0”
- Wrap gain parameter 2 is used if the bit is set to “1”

## 3.14 Commissioning of Optional Units

### 3.14.1 Insulation Amplifier PXUB 201

The insulation amplifier is connected to the tension electronics voltage output.
S1 is normally set for voltage 1:1 ratio.

The output is selected to generate a voltage or current output by means of switch S1 and S2.

Slower response is selected by means of switch S2, position 3.

The switches are located inside the unit.

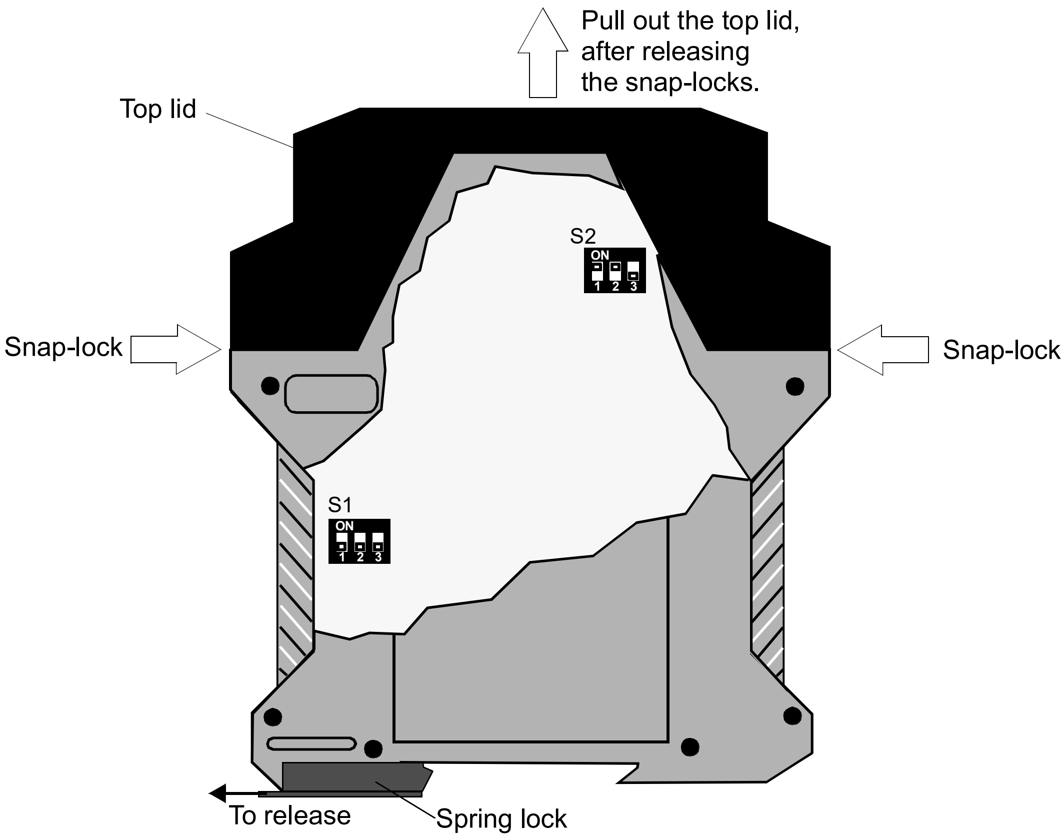



*Figure 3-27. Insulation Amplifier PXUB 201*

You must open the insulation amplifier to be able to set the switches S1 and S2.

1. Demount the insulation amplifier from the DIN rail.

   Use a screw driver to unload the spring at the bottom of the insulation amplifier.
2. Press down the snap-locks on both sides of the insulation amplifier.
3. Pull the top lid open, until you see both the switches S1 and S2.

4. Set the switches S1 and S2.
5. Slide back the top lid to locked position.
6. Remount the insulation amplifier on the DIN rail.

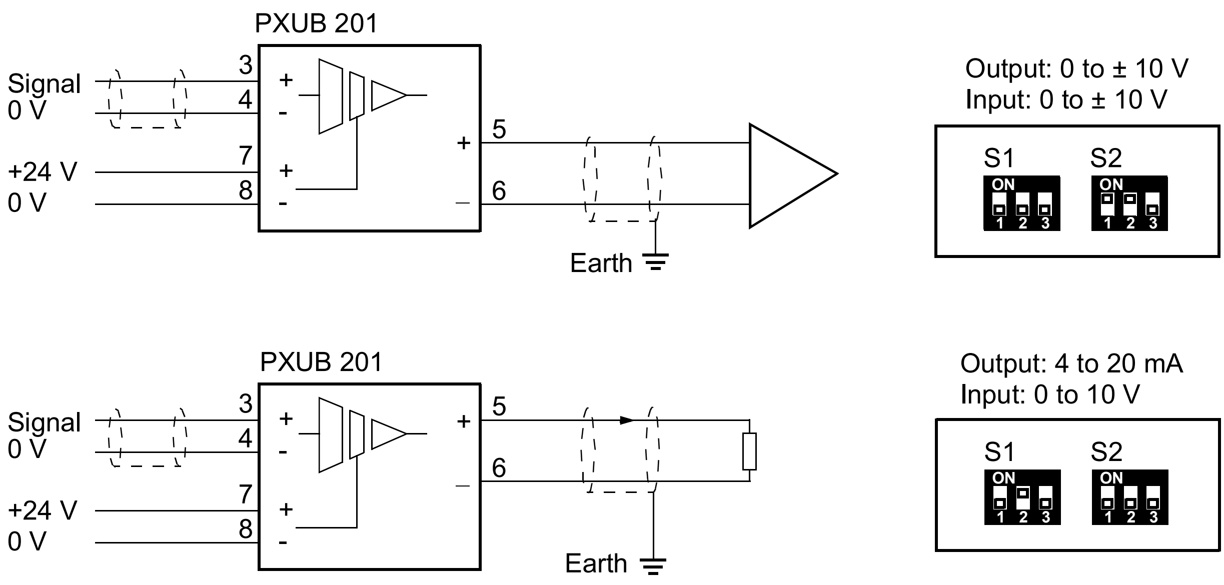



*Figure 3-28. Typical Connection of the Insulation Amplifier*

*Table 3-7. Setting of Input and Output Range*

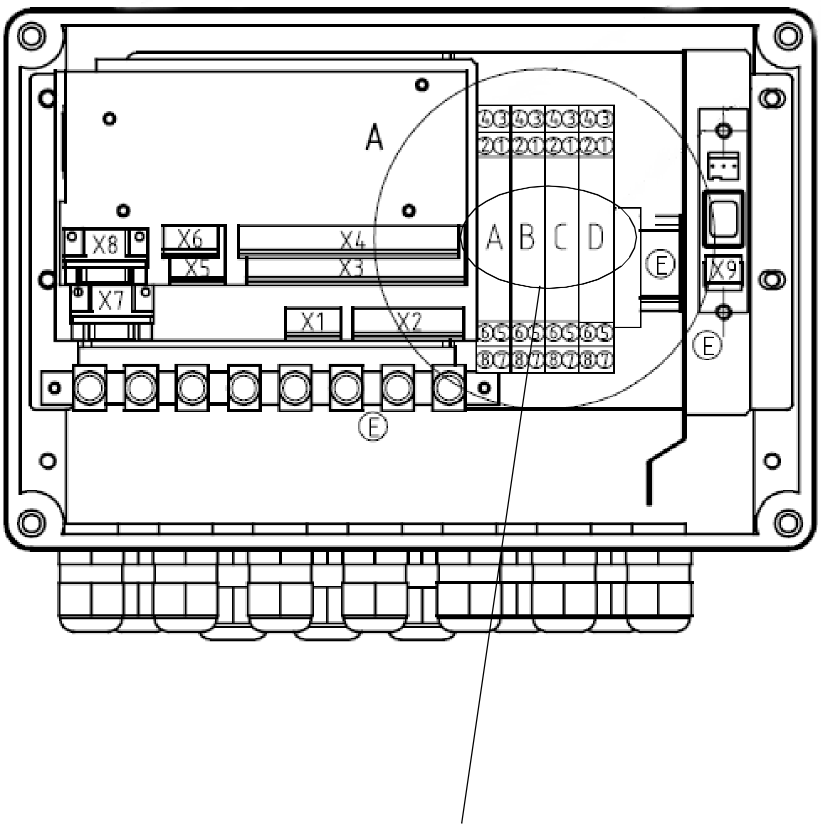
| Default | Range | | S1 | | | S2 | | |
|---|---|---|---|---|---|---|---|---|
| | Input | Output | 1 | 2 | 3 | 1 | 2 | 3 |
| × | 0 to ±10 V | 0 to ±10 V | | | | × | × | |
| | 0 to 5 V | 4 to 20 mA | × | | | | | |
| | 0 to 10 V | 4 to 20 mA | | × | | | | |
| | 0 to 5 V | 0 to 20 mA | × | × | | | | |
| | 0 ± 10 V | 0 ± 20 mA | | | × | | | |

*Table 3-8. Setting of Bandwidth*

| **Default** | **Bandwidth** | **S2, position 3** (× = ON) |
|---|---|---|
| × | 10 kHz | |
| | 10 Hz | × |

Up to Four PXUB 201 or PXKB 201 (A, B, C and D), see the figure below, can be mounted inside the PFEA113 (IP65-version).

The PXUB 201 outputs are pre-set to either voltage or current from factory according to order information.




Four PXUB 201 or PXKB 201

# Chapter 4 Operation

## 4.1 About this Chapter

Your measurement system does not need any attention during normal operation. Measurement runs continuously as long as the system is switched on. However, you need to know how to start and shut down the system, see Section 4.4 Start-up and shut-down.

## 4.2 Safety Instructions

Read and follow the safety instructions given in Chapter 1 Introduction, before starting any operation work. However, local statutory regulations, if stricter, are to take precedence.

## 4.3 Operating Devices

The LED-indicators and operator keys are described in Figure 4-1.

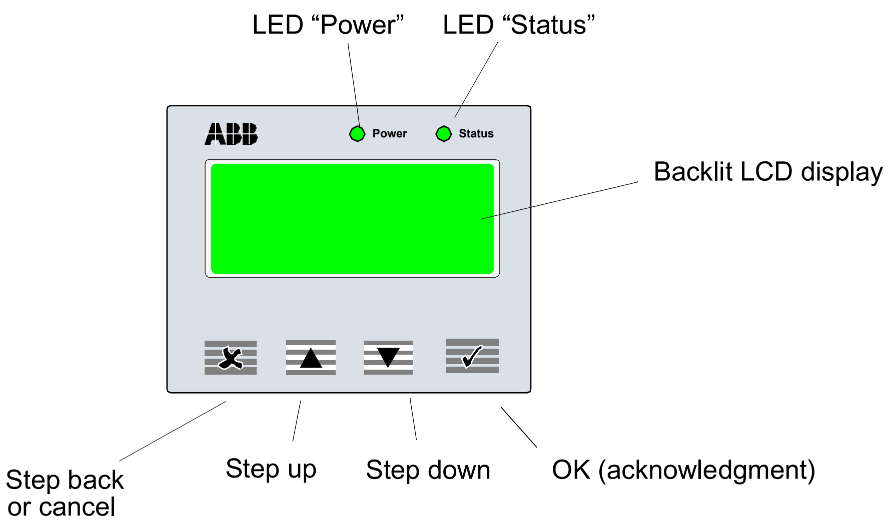



*Figure 4-1. Operating Devices*

# 4.4 Start-up and shut-down

## 4.4.1 Start-up

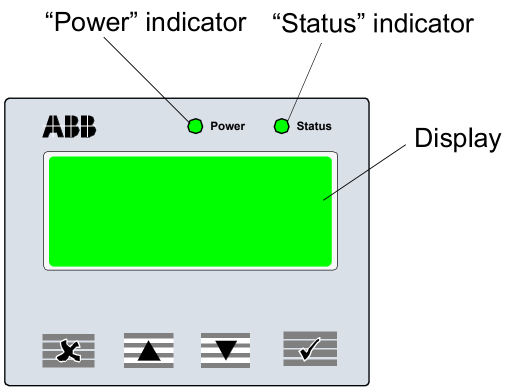
The tension electronics is started and shut down using an external ON/OFF switch (not supplied by ABB). During normal operation no action from the operator is required.

1. Check that the main tension control machinery is ready for normal run.
2. Switch on the tension electronics by setting the external ON/OFF switch to position ON. For the IP 65-version (NEMA 4) also set the internal switch to "ON".
3. Check that:

   - the display is illuminated

   - the "Power" indicator is lit

   - the "Status" indicator is lit (green light). Red light indicates an error.




## 4.4.2 Shut-down

Shut-down the tension electronics by setting the external ON/OFF switch to position OFF.

# 4.5 Normal Run

The measurement equipment should be on permanently to achieve the best measurement results. This allows the load cells and electronics to operate under stable temperature conditions.

The measuring equipment is designed for continuous operation.

## 4.6 Measuring values on the display

Depending on the selected unit, the measuring values will be presented differently, see Table 4-1 and Table 4-2.

| Load cell nominal load | [N] | [kN] | [kg] | [lbs] |
|---|---|---|---|---|
| 0.1 [kN] | XX XXX.X | XX.XXXX | X XXX.XX | X XXX.XX |
| 0.2 [kN] | XX XXX.X | XX.XXXX | X XXX.XX | X XXX.XX |
| 0.5 [kN] | XX XXX.X | XX.XXXX | X XXX.XX | X XXX.XX |
| 1 [kN] | XXX XXX | XXX.XXX | XX XXX.X | XX XXX.X |
| 2 [kN] | XXX XXX | XXX.XXX | XX XXX.X | XX XXX.X |
| 5 [kN] | XXX XXX | XXX.XXX | XX XXX.X | XX XXX.X |
| 10 [kN] | X XXX XX0 | X XXX.XX | XXX XXX | XXX XXX |
| 20 [kN] | X XXX XX0 | X XXX.XX | XXX XXX | XXX XXX |
| 50 [kN] | X XXX XX0 | X XXX.XX | XXX XXX | XXX XXX |
| 100 [kN] | X XXX X00 | X XXX.X | XXX XX0 | X XXX XX0 |
| 200 [kN] | X XXX X00 | X XXX.X | XXX XX0 | X XXX XX0 |

*Table 4-1. Measuring values presented on the display*

| Load cell nominal load | [N/m] | [kN/m] | [kg/m] | [pli] |
|---|---|---|---|---|
| 0.1 [kN] | XX XXX.XX | XX.XXXXX | X XXX.XXX | X XXX.XXXX |
| 0.2 [kN] | XX XXX.XX | XX.XXXXX | X XXX.XXX | X XXX.XXXX |
| 0.5 [kN] | XX XXX.XX | XX.XXXXX | X XXX.XXX | X XXX.XXXX |
| 1 [kN] | XXX XXX.X | XXX.XXXX | XX XXX.XX | XX XXX.XXX |
| 2 [kN] | XXX XXX.X | XXX.XXXX | XX XXX.XX | XX XXX.XXX |
| 5 [kN] | XXX XXX.X | XXX.XXXX | XX XXX.XX | XX XXX.XXX |
| 10 [kN] | X XXX XXX | X XXX.XXX | XXX XXX.X | XXX XXX.XX |
| 20 [kN] | X XXX XXX | X XXX.XXX | XXX XXX.X | XXX XXX.XX |
| 50 [kN] | X XXX XXX | X XXX.XXX | XXX XXX.X | XXX XXX.XX |
| 100 [kN] | X XXX XX0 | X XXX.XX | XXX XXX | XXX XXX.X |
| 200 [kN] | X XXX XX0 | X XXX.XX | XXX XXX | XXX XXX.X |

*Table 4-2. Measuring values presented on the display*

X in Table 4-1 and Table 4-2 indicates that the figure is changed if the value is changed. 0 indicates that the value is not changed if the value changes.

**Examples of measuring values displayed:**

*Example 1:*

Selected unit [N], Load cell nominal load 100 kN, Measured value 987654 N.
Value presented on display: 987600 N.

*Example 2:*

Selected unit [kN], Load cell nominal load 100 kN, Measured value 987654 N.
Value presented on display: 987.6 kN.

**Examples of measuring values displayed together with the Set Decimals function:**

*Example 1:*

Selected unit [pli], Load cell nominal load 1 kN, Measured value 46.5987 pli.
Set Decimals = 2
Value presented on display: 46.60 pli.

*Example 2:*

Selected unit [pli], Load cell nominal load 1 kN, Measured value 46.5987 pli.
Set Decimals = 0
Value presented on display: 47 pli.

## 4.7 Operator Menus

This section describes the operator menus. The updating time for displayed values is 500 ms. Use up and to switch between menus.

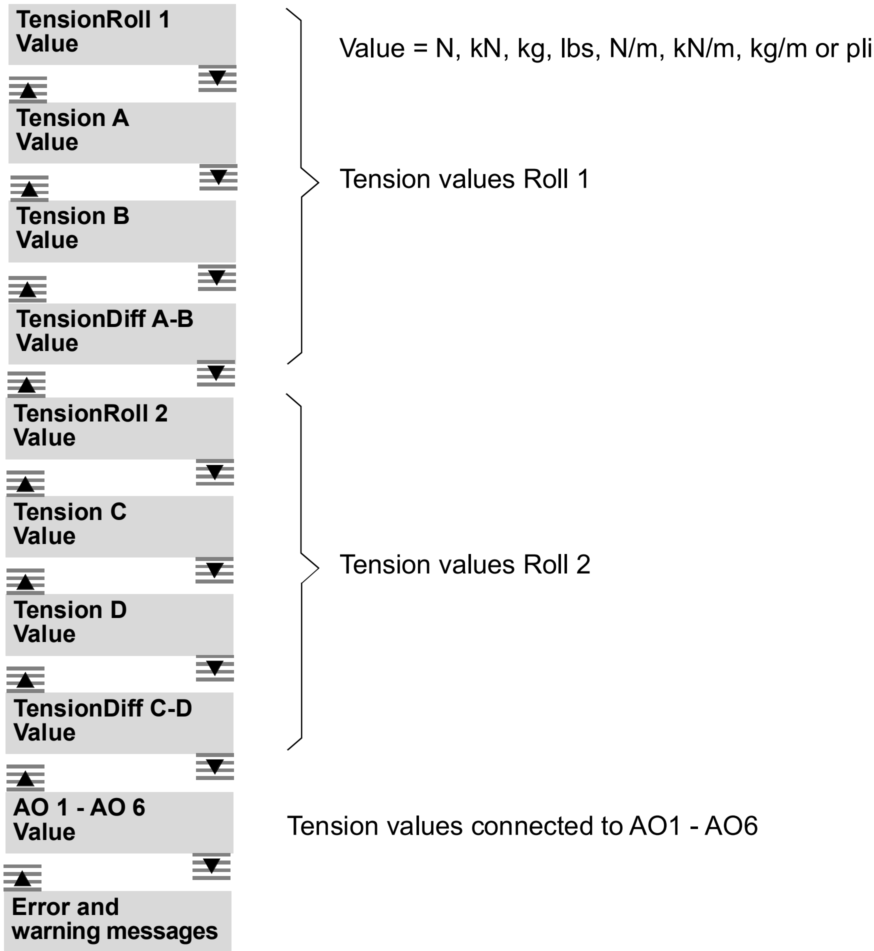



*Figure 4-2. Operator Menus*

## 4.7.1 Web Tension

### 4.7.1.1 Standard Roll (two load cells), One or Two Rolls

The following menus are available when a standard roll (two load cells) is connected to the tension electronics:

- **One roll**
  - ***WebTension***

    Shows the total web tension measured by load cell A and load cell B
  - ***Tension A***

    Shows the part of web tension measured by load cell A
  - ***Tension B***

    Shows the part of web tension measured by load cell B
  - ***TensionDiff A-B***

    Shows the difference between Tension A and Tension B
- **Two rolls**

Tension menus, Roll 1:

- ***TensionRoll 1***

  Shows the total web tension measured by load cell A and load cell B
- ***Tension A***

  Shows the part of web tension measured by load cell A
- ***Tension B***

  Shows the part of web tension measured by load cell B
- ***TensionDiff A-B***

  Shows the difference between Tension A and Tension B

Tension menus, Roll 2:

- ***TensionRoll 2***

  Shows the total web tension measured by load cell C and load cell D
- ***Tension C***

  Shows the part of web tension measured by load cell C
- ***Tension D***

  Shows the part of web tension measured by load cell D
- ***TensionDiff C-D***

  Shows the difference between Tension C and Tension D

### 4.7.1.2 Segmented Roll

Segmented Roll Scale Factor (SRSF) is used to compensate the wrap gain to get a correct measurement reading when not all rolls are supported by load cells in a segmented roll application. For simplified calculations of SRSF, refer to Appendix A.3.1 Segmented Roll Scale Factor (SRSF).

- **Segmented roll (one input)**
  - ***Tension A***
- **Segmented roll (two inputs)**
  - ***WebTension*** (total web tension = A+B)
  - ***Tension A, Tension B, TensionDiff A-B***
- **Segmented roll (three inputs)**
  - ***WebTension*** (total web tension = A+B+C)
  - ***Tension A, Tension B, Tension C, TensionDiff A-C***
- **Segmented roll (four inputs)**
  - ***WebTension*** (total web tension = A+B+C+D)
  - ***Tension A, Tension B, Tension C, Tension D, TensionDiff A-D***

### 4.7.1.3 Single Side Measurement (One Load Cell)

The following menus are shown when only one load cell per roll (single side measurement) is connected to the tension electronics:

- ***Web Tension*** (One roll, load cell A or B)
- ***TensionRoll 1*** (Two rolls, Roll 1, load cell A or B)
- ***TensionRoll 2*** (Two rolls, Roll 2, load cell C or D)

***Web Tension***, ***TensionRoll 1 or TensionRoll 2*** is the tension measured by a single load cell multiplied by 2.

#### 4.7.1.4 Tension Values Connected to Analog Outputs, AO1 - AO6

Analog outputs, AO1-6, can be connected to different tension values corresponding to a number of tension signal combinations.
See Section 3.12.7 Setting Analog Outputs (AO1-AO6).

Analog output tension menus:

***AO1, Value***

***AO2, Value***

***AO3, Value***

***AO4, Value***

***AO5, Value***

***AO6, Value***

### 4.7.2 Error and Warning Messages

An **ERROR** is something that causes the tension electronics to function incorrectly.

A **WARNING** is something that might affect the accuracy of the measurement.

When a warning or an error occurs, a warning or an error message is displayed on the Operator Panel and the “Status” indication turns from green to red.

When is pressed the message disappears from the display.

If the problem that activated the warning or error message has disappeared the “Status” indication turns to green.

If the error or warning remains the “Status” indication is red. Use the to step to the last menu, where you can read the error or warning message.

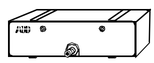
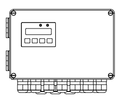
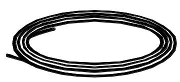
For handling Error and Warning messages, see Chapter 6 Fault-tracing.

# Chapter 5 Maintenance

## 5.1 About this Chapter

Under normal operating conditions, your system does not require any maintenance. However, we recommend you to perform regular checks. The following preventive measures may be taken depending on the type of environment in which your system operates.

## 5.2 Preventive Maintenance

| Unit | Measures |
|---|---|
| Load cells | Protect the load cells from prolonged contact with corrosive elements. |
|  | Check the fixing screws and re-tighten if necessary. |
| | Check the gaps between load cell and adapter plates to ensure that they are not clogged with dirt, which can cause a shunt force into the load cell.<br>Clean the gaps with compressed air if necessary. |
| Tension Electronics<br> | Check that the circuit boards are properly secured and that cables or wires are not damaged. |
| | Check that all terminal screws and cable glands are properly tightened. |
| Connection cables<br> | Check that the connection cables between the load cells and the tension electronics are not damaged. |

# Chapter 6 Fault-tracing

## 6.1 About this Chapter

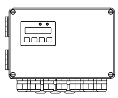
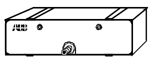
During the working life of your measurement system, events may occur that disturb it and your process. These disturbances may appear in many different ways and the reason for the fault can be difficult to find. However, disturbances similar in character can be grouped together and usually they have the same or similar sources of error.

The fault-tracing instructions in this chapter will help you to quickly find and correct the most common faults.

## 6.2 Safety Instructions

Read and follow the safety instructions given in Chapter 1 Introduction when tracing faults. However, local statutory regulations, if stricter, are to take precedence.

## 6.3 Interchangeability

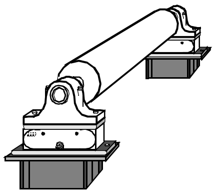
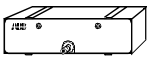
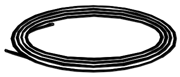
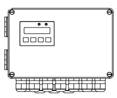
| Unit | Measures |
|---|---|
| Tension Electronics  | The tension electronics PFEA113 is interchangeable with a tension electronics of the same type. A new setup is required. |
| Load cells  | The load cells are directly interchangeable with other load cells of the same type. Zero setting PFEA113 and resetting “Maximum Load A”, “Maximum Load B”, “Maximum Load C” or “Maximum Load D” are required after a load cell has been replaced. |

## 6.4 Necessary Equipment and Documentation

The following items are required to perform fault-tracing and repairs:

- Cable diagrams, see Appendix (B, C, D, E, F or G) for installed load cell type
- Service tools
- Torque wrench
- Multimeter

## 6.5 Fault-tracing Procedure

| Faults in the... | Fault symptoms |
|---|---|
| **Mechanical installation**<br> | Faults in the mechanical installation usually manifest themselves as an unstable zero point or incorrect sensitivity.<br>If a fault is associated with a process parameter, such as the temperature, or can be linked with a particular operation, the fault is likely to emanate from the mechanical part of the installation. |
| **Load cells**<br> | Calibration data for a load cell does not change gradually. A load cell, depending on its size and type, can withstand up to five times[1] the nominal load in the measuring direction. An event in the process line, such as web breakage, may cause an overloading large enough to alter load cell data. Depending on the amount of overload, it may be sufficient to zero set. |
| **Cabling**<br> | Problems such as malfunctions or unstable zero point may arise from faulty cables or wiring.<br>Proximity to noisy cables may cause interference problems.<br>Incorrect installation, such as cable cores connected asymmetrically or screens earthed at both ends instead of only at one end, may show up as an unstable zero point.<br>If the polarity of load cell signals is not correct, the cabling must be checked. |
| **Tension Electronics**<br> | Intermittent loss of a function is usually due to a fault in the tension electronics.<br>Instability problems seldom originate from the tension electronics.<br>Faults in devices connected to the tension electronics may affect its operation. |

(1) Read more about the overload capacity for your load cell type in Appendix B, C, D, E, F or G.

## 6.6 Error and Warning Messages in PFEA113

An **ERROR** is something that causes the electronics to function incorrectly.

A **WARNING** is something that might affect the accuracy of the measurement.

When a warning or an error occurs, a warning or an error message is displayed on the Operator Panel and the “Status” indication turns from green to red.

When is pressed the message disappears from the display.

If the problem that activated the warning or error message has disappeared the “Status” indication turns to green.

If the error or warning remains the “Status” indication is red. Use the to step to the last operator menu, where you can read the error or warning message.

### 6.6.1 Error Messages

The following errors can be detected:

- Flash (memory) error
- EEPROM (memory) error
- Supply error
- Load cell excitation error

See Section 6.8 Warnings and Errors Detected by the Tension Electronics.

### 6.6.2 Warning Messages

The following warnings can be detected:

- Profibus communication problem
- Synchronization problem

See Section 6.8 Warnings and Errors Detected by the Tension Electronics.

## 6.7 Fault Symptoms and Measures

General remark:

If the free (unscreened) cable length exceeds 0.1 m (4 in.) the individual pairs of power and signal conductors must be twisted.

Free length exceeding 0.1 m can cause unstable zero point or incorrect absolute measurement value.

*Table 6-1. Fault Symptoms and Measures*

| Fault symptom | Measures |
|---|---|
| **Noisy signals** | - Check that cable shields are connected to earth according to cable diagram.<br>- Proximity to noisy cables can cause interference problems. |
| **Unstable zero point** | - Check that cable screens are not connected at both ends.<br>- Check that cable between load cell and electronic has diagonal pairs, one pair for signal circuit and one pair for excitation circuit, see Figure 2-2.<br>- If a junction box is installed, check that load cell signal and load cell excitation between junction box and electronics are routed in separate cables.<br>- Check, if two or more IP 20 units are mounted close to each other in the same cabinet, that they are synchronized (cable for synchronizing the units, see cable diagram and Section 2.4.1.3 Synchronization). |
| **Display and LED indictors are not illuminated** | If the Operator panel display is not illuminated and the “Power” and “Status” indications are on and the Operator Panel is “OFF”, check the following:<br>- Check that the cables are correctly connected to the electronics power supply.<br>- Check that the power supply connected to the electronics is correct.<br>- Check that the power switch is “ON” (inside the IP 65-version (NEMA 4) enclosure).<br>- Further tests are described in Section 6.8.1.3 Supply Error. |

*Table 6-1. Fault Symptoms and Measures*

| Fault symptom | Measures |
|---|---|
| **No signal when load is applied** | **1**. Check that cables to the electronics are correctly connected.<br>**2**. Check that the load cells are connected with correct polarity. If not, the load cell signals cancel out each other. This is displayed on the operator panel as described below:<br>**a**. The sum signal (A+B) or (C+D) is low<br>**b**. The difference signal (A-B) or (C-D) is high<br>**c**. The output signal of the individual load cells have opposite signs (polarity) when a force is applied on the middle of the roll.<br>To check load cell signal polarity, see Section 3.9 Checking Load Cell Signal Polarity.<br>For connecting the load cells to give positive signals for increased web tension, see cable diagram for the installed load cell type.<br>**3**. Switch off the tension electronics and measure the cable resistance in the load cell signal circuit between terminals:<br>X3:1 - X3:2,<br>X3:3 - X3:4,<br>X3:5 - X3:6<br>X3:7 - X3:8.<br>**a**. The resistance is > 25 Ω:<br>Check cabling and load cells.<br>**b**. The resistance is < 25 Ω:<br>Check the mechanics. |

## 6.8 Warnings and Errors Detected by the Tension Electronics

### 6.8.1 Errors

#### 6.8.1.1 Flash Memory Error

- Replace PFEA113.

#### 6.8.1.2 EEPROM Memory Error

- Replace PFEA113.

#### 6.8.1.3 Supply Error

**IP 20-version (unsealed):**

When the PFEA113 is connected to the 24 VDC power supply the voltage between terminals X1:1 and X1:2 should be 18 - 36 V.

- If the voltage is lower than 18 V:
  - Check the power supplies rating. Rating should be 18-36 V DC.
  - Check that the power supply has sufficient capacity. See power requirements in Section 2.13.2 Relay Board PXKB 201.
- If the power supply has sufficient capacity, check cabling and cable resistance between power supply and PFEA113.
- If power supply and cabling are correct, the tension electronics is probably defect.

  Replace PFEA113.

**IP 65-version (NEMA 4):**

- Check the mains voltage connected to terminals X9:1 and X9:2.

  Mains voltage must be:

  85 - 264 V AC (100 V -15% to 240 V +10%)

  Frequency range: 45 - 65 Hz

#### 6.8.1.4 Load Cell Excitation Error

- Check that cables are correctly connected to the electronics.
- If not all load cells are connected, make sure that shorting wires are connected, see cable diagram.
  - Switch off the tension electronics and measure the resistance between terminals X2:1 and X2:8.

    If the resistance is > 15 Ω:

    Check that the total cable resistance between electronics and load cells does not exceed 10 Ω. If cable resistance does not exceed 10 Ω, check cabling and load cells.

    If the resistance is < 15 Ω:

    If cabling is correct, the electronics is probably defect.

    Replace PFEA113.

## 6.8.2 Warnings

#### 6.8.2.1 Profibus Communication Problem

Check:

- that the bus is correctly terminated.
- the Profibus address.
- cabling and connectors.

#### 6.8.2.2 Synchronization Problem

Check the cabling and shield.

If the cabling is correct the tension electronics is probably defect.

Replace PFEA113.

### 6.8.3 Changing to Single Side Measurement If One Load Cell Is Faulty

If one load cell is faulty it is possible to change from Standard Roll to Single Side Measurement.

Depending on which load cell that is faulty, do the following:

For load cell connections, please refer to cable diagrams in Appendix B, C, D, E, F or G for the load cell type used in the installation.

**Load cell A or C is faulty:**

Disconnect the faulty load cell from the Tension Electronics.

Connect a shorting wire for the load cell excitation circuit:

- If load cell A is disconnected:
  a. Connect a shorting wire between X2:1 and X2:2.
- If load cell C is disconnected:
  b. Connect a shorting wire between X2:5 and X2:6.

**Load cell B or D is faulty:**

Disconnect the faulty load cell from the Tension Electronics.

Connect a shorting wire for the load cell excitation circuit:

- If load cell B is disconnected:
  – Connect a shorting wire between X2:3 and X2:4
- If load cell D is disconnected:
  – Connect a shorting wire between X2:7 and X2:8

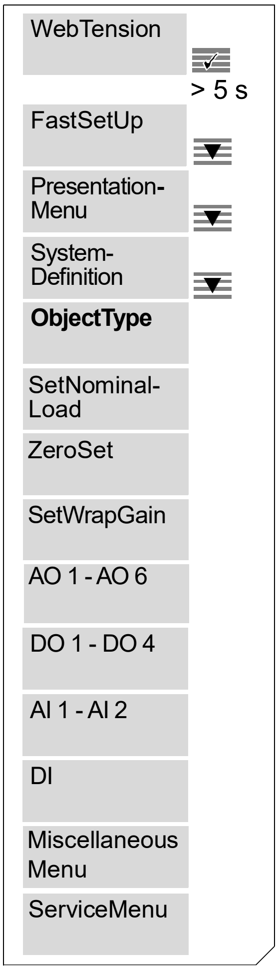
After having changed the load cell connections, one parameter setting in the Tension Electronics must be changed.

- If load cell A or B is disconnected:
  – Change Roll 1 from ***StandardRoll*** to ***SingleSide***.
- If load cell C or D is disconnected:
  – Change Roll 2 from ***StandardRoll*** to ***SingleSide***.

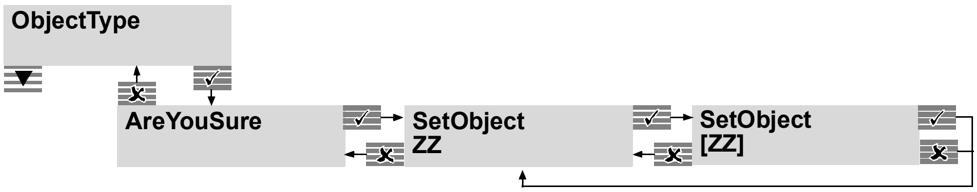
Changing from ***StandardRoll*** to ***SingleSide,*** see Section 6.8.3.1 Menus for Changing from Standard Roll to Single Side Measurement.

### 6.8.3.1 Menus for Changing from Standard Roll to Single Side Measurement

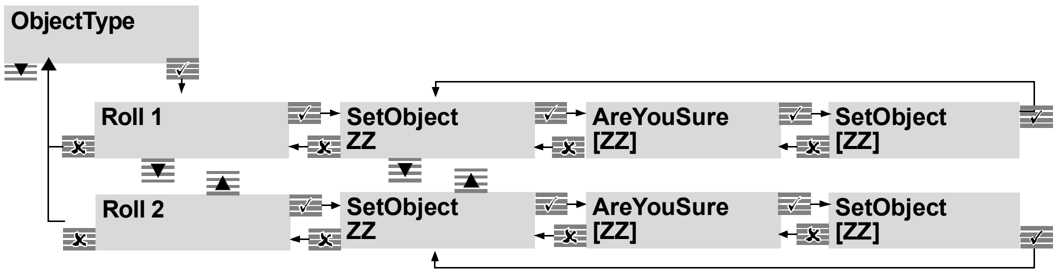
Use these menus to change to Single Side Measurement.




**Setting Object Type for One Roll**

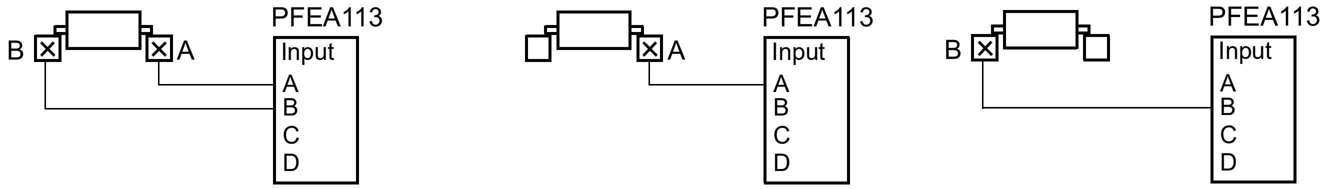



**Setting Object Types for Two Rolls**



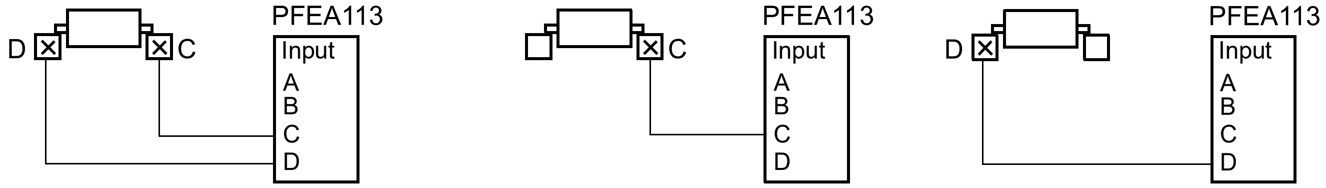
**Roll 1**

Standard roll | Single side A measurement | Single side B measurement




**Roll 2**

Standard roll | Single side C measurement | Single side D measurement



## 6.9 Changing Load Cells

1. Before starting work, read the safety instructions stated in Chapter 1 Introduction.
2. For load cells equipped with an extension cable and connector:
   Disconnect the connection cable from the load cell and protect the connection cable from dirt and damage.

   For load cells equipped with a fixed cable:
   Disconnect the load cell connection in the tension electronics or junction box and protect the loose cable ends from dirt and damage.
3. Clean the old load cell before it is unfastened and removed.
4. Unfasten and remove the old load cell.
5. Unfasten and remove the adapter plates from the old load cell.
6. Clean the support structure, adapter plates and other mounting surfaces.
7. For mounting instructions for the new load cell, see:
   – Appendix B PFCL 301E - Designing the Load Cell Installation
   – Appendix C PFTL 301E - Designing the Load Cell Installation
   – Appendix D PFRL 101 - Designing the Load Cell Installation
   – Appendix E PFTL 101 - Designing the Load Cell Installation
   – Appendix F PFCL 201 - Designing the Load Cell Installation
   – Appendix G PFTL 201 - Designing the Load Cell Installation
8. Set the zero point, see Section 3.12.5 Zero Set.

# Appendix A Technical Data for Tension Electronics PFEA113

## A.1 About this Appendix

This appendix comprises technical data for tension electronics PFEA113.

Data for the load cells are given in:

- Appendix B PFCL 301E - Designing the Load Cell Installation
- Appendix C PFTL 301E - Designing the Load Cell Installation
- Appendix D PFRL 101 - Designing the Load Cell Installation
- Appendix E PFTL 101 - Designing the Load Cell Installation
- Appendix F PFCL 201 - Designing the Load Cell Installation
- Appendix G PFTL 201 - Designing the Load Cell Installation

The definitions used in the load cell appendices are explained in Section A.2, Definitions used in the Web Tension Systems.

## A.2 Definitions used in the Web Tension Systems

*Table A-1. Definitions*

| |
|---|
| **Nominal load,** $F_{nom}$, is the load for which the load cell is dimensioned and calibrated, that is the sum of the stationary load and the maximum measured load in the measuring direction. |
| $\mathbf{F_{ext}}$ = Extended range. Between $\mathbf{F_{nom}}$ and $\mathbf{F_{ext}}$ some decline in measurement accuracy may be experienced. |
| **Sensitivity** is defined as the difference in output signal between nominal load and no load. |
| **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 nominal load. |
| **Temperature dependence** is the drift in %/K related to the sensitivity at 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. |
| **Segmented Roll Scale Factor (SRSF)** is a factor that compensates Wrap Gain when load cells are not installed at each support in segmented roll applications. |

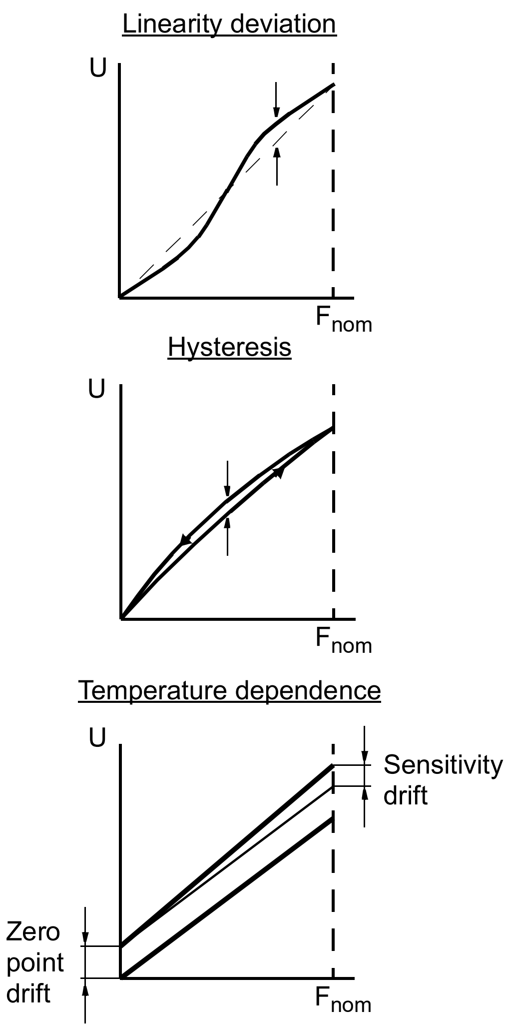
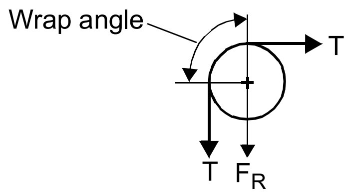


*Table A-1. Definitions*

| Definition | Example |
|---|---|
| **T** = Web tension. | **Example:** |
| **Tare** = Force of tare (weight of roll and bearing arrangement mounted on the load cells) |   |
| $\mathbf{F_R}$ = Measured force (force component of the web tension in the measuring direction of the load cell). | |
| $\mathbf{F_{RT}}$ = Applied force component of tare in the measuring direction of the load cell. | $\mathbf{F_R = T}$ |
| $\mathbf{F_{Rtot}}$ = Total applied force in the measuring direction of the load cell. | Wrap gain = $\frac{T}{F_R}$ |
| **Wrap Gain** = The ratio between web tension, **T**, and measured force, $\mathbf{F_R}$. | Wrap gain = $\frac{T}{T}$ = 1.00<br>Wrap gain = 1.00 |

## A.2.1 Coordinate System

A coordinate system is defined for the load cell. This is used in force calculations to derive force components in the load cell principal directions.

Where direction designations R, V and A are recognized as suffixes for force components, F, this represents the force component in the respective direction. The suffix R may be omitted, when measuring direction is implied by the context.

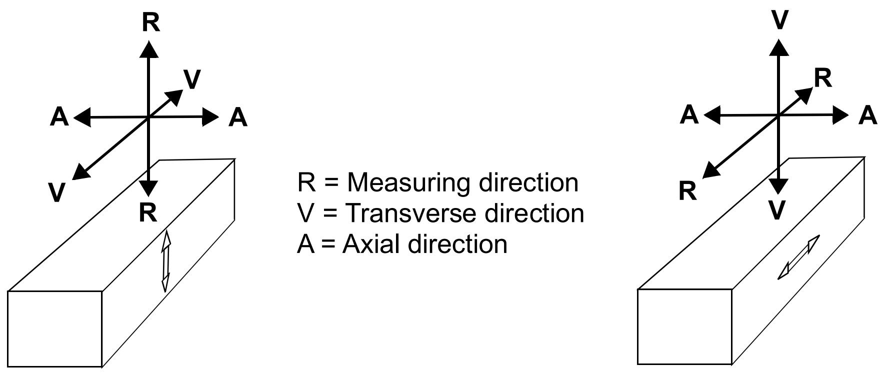



*Figure A-1. Coordinate System Defining Directions used in Force Calculations*

## A.3 Segmented Roll Scale Factor (SRSF)

Segmented Roll Scale Factor (SRSF) is used to compensate the total measured tension and present an estimate of total tension when not all rolls are supported by load cells at both ends in a segmented roll application.

The total force in the load cells measuring direction is $F_{RTension}$ = Tension/Wrapgain. If the number of installed load cells is less than the number of roll supports, the total measured force, $F_{Rmeasured}$ will be less than $F_{RTension}$. To present an estimate of the total web tension, $T_{estimate}$, in those segmented roll applications, a segmented roll scale factor (SRSF) can be set.

$T_{estimate} = F_{Rmeasured} \text{ x } WrapGain \text{ x } SRSF$

**Note:** individual signals (Tension A, Tension B and so on) and difference signals (A-B, A-C, D-AI2 and so on) are not multiplied with SRSF.

The following section describes how to calculate the SRSF.

In the examples are segmented rolls with four rolls used, but with the description below can SRSF easily be calculated in other segmented roll applications.

If a segmented roll have more than one electronic, that is more than four load cells, the SRSF must be calculated separately for each electronic unit.

If N/m, kN/m, kg/m or pli is selected as presentation unit, the individual signals (Tension A, Tension B and so on) and difference signals (A-B, A-C, D-AI2 and so on) are divided with the set web width.

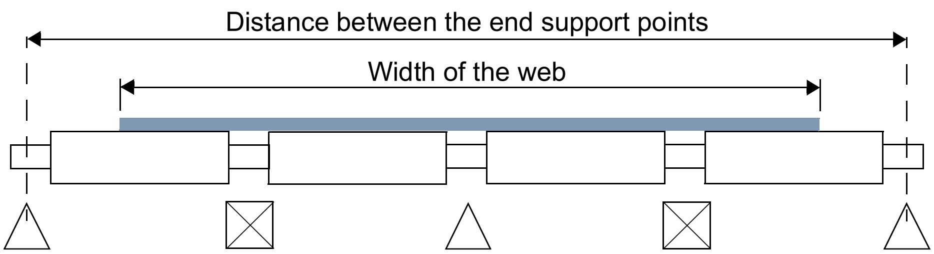



*Figure A-2. Segmented roll*

### A.3.1 Simplified calculation of SRSF

If all rolls have the same length and we neglect that the width of the web is less than the distance between the end support points, the calculation can be done in the following way.

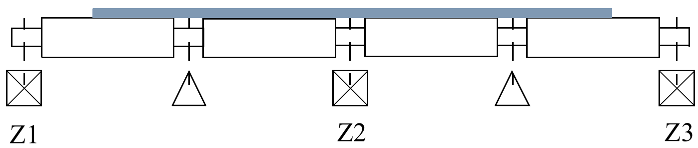



*Figure A-3. Load cells at the end and in the middle of the segmented roll.*

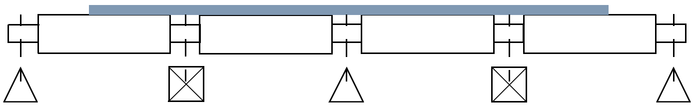



*Figure A-4. Dummy at the end and in the middle of the segmented roll.*

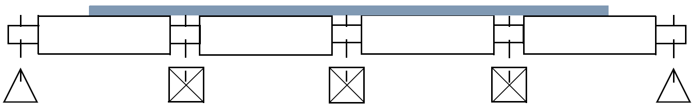



*Figure A-5. Dummies only at the end of the segmented roll.*

Z = Support point supported with load cell.

$n_s$ = number of rolls connected to a electronic unit.

If the load cell is located at the end of the roll:

$$Z = \frac{1}{2 \cdot n_s}$$

(See Z1 and Z3 in Figure A-3)

If the load cell supports two rolls:

$$Z = \frac{1}{n_s}$$

(See Z2 in Figure A-3)

$$\text{SRSF} = \frac{1}{\sum Z}$$

For Figure A-3 is SRSF:

$$\mathrm{SRSF} = \frac{1}{Z_1 + Z_2 + Z_3} = \frac{1}{\frac{1}{2 \cdot n_s} + \frac{1}{n_s} + \frac{1}{2 \cdot n_s}} = \frac{1}{\frac{1}{2 \cdot 4} + \frac{1}{4} + \frac{1}{2 \cdot 4}} = 2$$

For Figure A-4 is SRSF:

$$\mathrm{SRSF} = \frac{1}{Z_1 + Z_2} = \frac{1}{\frac{1}{n_s} + \frac{1}{n_s}} = \frac{1}{\frac{1}{4} + \frac{1}{4}} = 2$$

For Figure A-5 is SRSF

$$\mathrm{SRSF} = \frac{1}{Z_1 + Z_2 + Z_3} = \frac{1}{\frac{1}{n_s} + \frac{1}{n_s} + \frac{1}{n_s}} + \frac{1}{\frac{1}{4} + \frac{1}{4} + \frac{1}{4}} = \frac{4}{3}$$

**For more detailed compensations for actual web width please consult ABB.**

# A.4 Technical Data

*Table A-2. Data for Supply Voltage*

| | Data | Comments |
|---|---|---|
| **Supply voltage** | | |
| IP 20-unit (unsealed) | 24 V DC | 18 - 36 V DC |
| IP 65-unit (NEMA 4) | 24 V DC | 18 - 36 V DC |
| | 85 - 264 V AC | 100 V -10% to 240 V +10% |
| **Mains frequency** | 47 - 63 Hz | 100-240 V AC, 0.2 - 0.1 A |
| **Power consumption** | 15 W (24 V) | Digital outputs not included |
| **Fuse** | | |
| IP 20-unit (unsealed) | Automatic reset | |
| IP 65-unit (NEMA 4) | Slow blow, 2 A, 250 V | |

*Table A-3. Data for Load Cell Excitation*

| | Data | Comments |
|---|---|---|
| **Current** | 0.5 A rms, 330 Hz | Regulated |
| **Max. load** | Four load cells + max. 10 Ω cable resistance (1 μF cable capacitance). | Load cells of type: PFCL 301E, PFTL 301E, PFRL 101, PFTL 101, PFCL 201 and PFTL 201. |

*Table A-4. Data for Load Cell Inputs*

| | Data | Comments |
|---|---|---|
| **Number of inputs** | 4 | |
| **Input impedance** | 10 kΩ | |

*Table A-5. Data for Signal Outputs*

| | Data | | Comments |
|---|---|---|---|
| **Voltage output** | 0 - 10 V | | Range -5 to +11 V |
| Max. load | 5 mA | | |
| Ripple | <10 $mV_{p-p}$ | | Wrap gain = 1 |
| Step response time | 5 ms | | |
| Band width | 132 Hz | | |
| **Current output** | 4 - 20 mA | | Range 0 to 21 mA |
| Max. load | 550 Ω | | |
| Step response time | 5 ms | | |
| Band width | 132 Hz | | |
| **Additional filtering for voltage and current output “FilterSettings”** | Step response time: | Cut-off frequency: | |
| | 15 ms | 35 Hz | |
| | 30 ms | 15 Hz | |
| | 75 ms | 5 Hz | |
| | 250 ms | 1.5 Hz | |
| | 750 ms | 0.5 Hz | |
| | 1500 ms | 0.25 Hz | |
| **Wrap gain adjustment** | 0.5 - 20 | | |

*Table A-6. Data for Analog Inputs*

| | Data | Comments |
|---|---|---|
| **Signal range** | 0 - 10 V | |

*Table A-7. Data for Digital Inputs*

| | Data | Comments |
|---|---|---|
| **Logic levels** | Passive: -36 V to +5 V<br>Active: >16 V (max. + 36 V) | For change of state, the pulse length must be min. 100 ms. |

*Table A-8. Data for Digital Outputs*

| | Data | Comments |
|---|---|---|
| **Rated current (state 1)** | 0.1 A per output | |

*Table A-9. Measurement Ranges for the Tension Electronics*

| Type | Range (1) |
|---|---|
| **Zero Setting Range** | $\pm 2.0 \times F_{nom}$ |
| **Dynamic Measurement Range (including zero set)** | $-2.5 \times F_{nom}$ to $+ 3.5 \times F_{nom}$ |

(1) $F_{nom}$ = Load cell nominal load

*Table A-10. Communication PFEA113*

| | Data | Comments |
|---|---|---|
| **Profibus** | 1 | 12 Mbit |
| Communication protocol | Profibus DP slave | According to EN 50 170 |
| Transfer speed | Max. 12 Mbits / s | |
| Address range | 0 - 125 | |
| RS-232 | | Not used |

*Table A-11. Environmental Data*

| | Data | Comments |
|---|---|---|
| **Temperature dependence** | | |
| Zero point drift | < 50 ppm/K (28 ppm/°F) | |
| Sensitivity drift | < 75 ppm/K (42 ppm/°F) | |
| **Operating temperature**<br>Outside the IP 20-version (unsealed) and IP 65-version (NEMA 4) | +5 to +55 °C (32 - 131 °F) | |
| **Non-operating temperature** | -40 to +70 °C (-40 - 158 °F) | |
| **Degree of protection** | | |
| DIN-rail version | IP 20 (unsealed) | |
| Wall mounting unit | IP 65 (NEMA 4) | According to EN 60 529 |

*Table A-12. Dimensions*

| | Data | Comments |
|---|---|---|
| **Dimensions** | | |
| IP 20-version (unsealed) | 124 x 136 x 110 | Width x Height x Depth |
| IP 65-version (NEMA 4) | 300 x 200 x 159 | Width x Height x Depth |
| **Weight** | | |
| IP 20-version (unsealed) | 0.8 kg | |
| IP 65-version (NEMA 4) | 5.2 kg | |

## A.5 Factory Default Settings

*Table A-13. Factory Default Settings*

| Name | PFEA113 |
|---|---|
| **Display language** | English |
| **Display unit** | N |
| **Load cell combination** | Two rolls |
| **Gain scheduling** | No |
| **Roll 1** | |
| • Object type | Standard roll |
| • Load cell nominal load | 1.0 kN 225 lbs |
| • Wrap gain | 1 |
| **Roll 2** | |
| • Object type | Standard roll |
| • Load cell nominal load | 1.0 kN 225 lbs |
| • Wrap gain | 1 |
| **AO1** | |
| • Function | Current |
| • Connect signals | A+B |
| • Filter settings | 250 ms |
| • High tension | 2000 N |
| • High output | 20.00 mA |
| • Low tension | 0 N |
| • Low output | 4.00 mA |
| • High limit | 21.00 mA |
| • Low limit | 0.00 mA |
| **AO2** | |
| • Function | Current |
| • Connect signals | C+D |
| • Filter settings | 250 ms |
| • High tension | 2000 N |
| • High output | 20.00 mA |
| • Low tension | 0 N |
| • Low output | 4.00 mA |
| • High limit | 21.00 mA |
| • Low limit | 0.00 mA |

*Table A-13. Factory Default Settings*

| **Name** | **PFEA113** |
|---|---|
| **AO3** | |
| Function | Off |
| **AO4** | |
| • Function | Off |
| **AO5** | |
| • Function | Off |
| **AO6** | |
| • Function | Off |
| **DO1** | |
| • Function | Off |
| **DO2** | |
| • Function | Off |
| **DO3** | |
| • Function | Off |
| **DO4** | |
| • Function | Off |
| **AI1** | |
| • High tension | 8000 N |
| • High input | 10.00 V |
| **AI2** | |
| • High tension | 8000 N |
| • High input | 10.00 V |
| **DI1** | |
| • Function | Off |
| **Profibus** | Off |
| • Address | 126 |

# A.6 Optional Units

## A.6.1 Insulation Amplifier PXUB 201

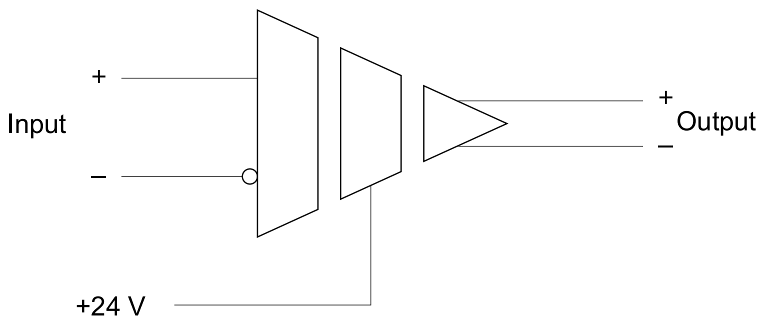



*Figure A-6. Insulation Amplifier PXUB 201*

*Table A-14. Data for Insulation Amplifier PXUB 201*

| Type | Data | |
|---|---|---|
| Power supply | 20 - 253 V AC/DC<br>AC: 48 - 62 Hz, 2 VA<br>DC: 1 W | |
| Current consumption | 10 mA + external load, at 24 V | |
| Signal range | Input | Output |
| | 0 ± 10 V | 0 ± 10 V |
| | 0 - 10 V | 4 - 20 mA |
| | 0 - 5 V | 4 - 20 mA |
| | 0 ± 10 V | 0 ± 20 mA |
| | 0 - 5 V | 0 - 20 mA |
| Input resistance | 1 MΩ at 10 V input<br>500 kΩ at 5 V input | |
| Max. load | 10 mA for voltage output<br>500 Ω for current output | |
| Rise time | 50 μs or 50 ms, selectable | |
| Ripple | 10 $mV_{p-p}$ | |
| Bandwidth (-3 dB) | 10 kHz or 10 Hz | |
| Rated insulation voltage | 600 V, basic insulation | |
| Insulation test voltage | 4 kV | |
| Dimensions (l × w × d) | 99 × 12.5 × 111 mm | |
| Weight | 150 g | |
| Mounting | DIN-rail 35 mm | |

## A.6.2 Relay Board PXKB 201

*Table A-15. Data for Relay Board PXKB 201*

| Type | Data |
|---|---|
| Input voltage | 24 V DC<br>Connected to a digital output on PFEA113 |
| Typical input current | 18 mA |
| Output voltage<br><br>Max connetion voltage<br>Min connection voltage | Should be connected to customers superior system<br>250 V AC/DC<br>12 V AC/DC |
| Max continuous current | 6 A |
| Ambient temperature | -20 to +60 °C |

The relay board PXKB 201 is intended to be installed on a DIN-rail 35 mm.

## A.6.3 Power Supply Unit SD83x

*Table A-16. Mains Supply Voltage*

| | Data | Remarks |
|---|---|---|
| Mains supply voltage | 115 V AC (90 - 132 V),<br>100 V -10% to 120 V + 10%<br><br>230 V AC (180 - 264 V),<br>200 V -10% to 240 V + 10% | Auto-select |

*Table A-17. Power Supply Unit*

| Unit | Dimensions (l x w x d) | Weight |
|---|---|---|
| SD831 | 124 x 35x 102 mm | 0.43 kg |
| SD832 | 124 x 35 x 117 mm | 0.5 kg |
| SD833 | 124 x 60 x 117 mm | 0,7 kg |

The power supply unit is intended to be installed on a DIN- rail 35 mm.

## A.6.4 Junction Box PFXC 141

| Degree of protection | Dimensions (l x w x d) | Weight |
|---|---|---|
| IP 65 (NEMA 4) | 220 x 120 x 80 mm | 2.0 kg |

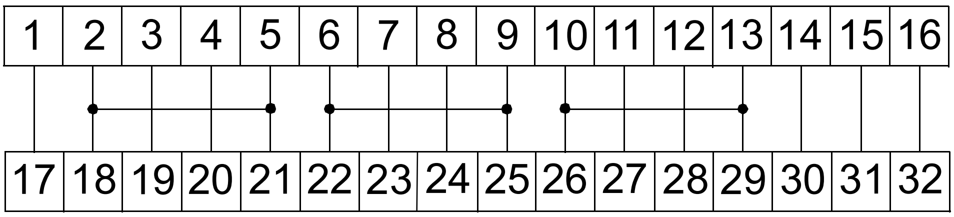
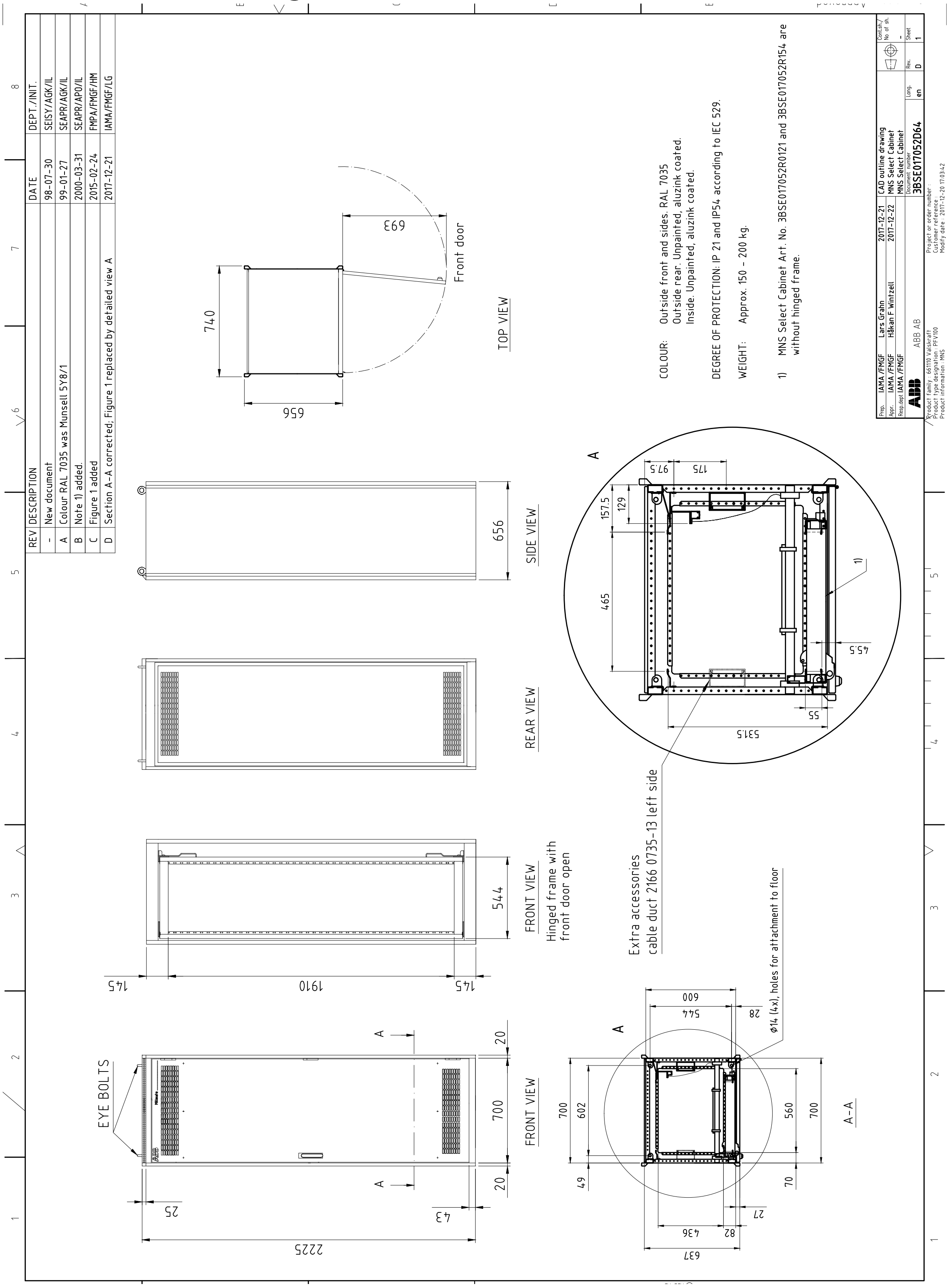


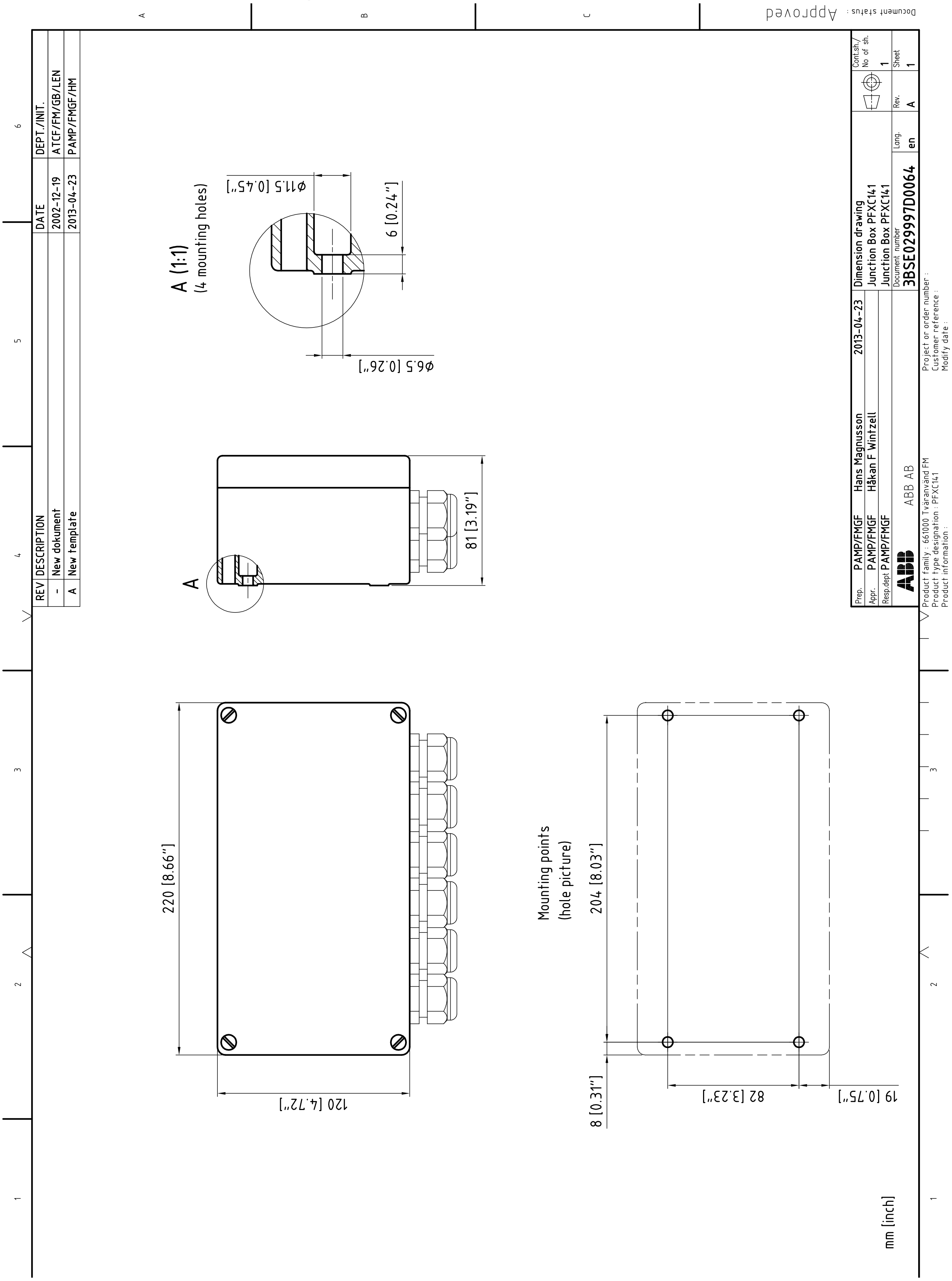

*Figure A-7. Circuit Diagram for Junction Box PFXC 141.*

## A.7 Drawings

### A.7.1 Dimension Drawing 3BSE017052D64, Rev D



## A.7.2 Dimension Drawing 3BSE029997D0064, Rev A



# A.8 Profibus DP - GSD File for PFEA113

```
;===================== GSD file:ABB_0717.GSD =====================
;
; DEVICE NAME:          Tension Electronics PFEA113
; AUTHOR:               M.Sollander
; REVISION DATE:        January 27, 2003
;
;==============================================================

#Profibus_DP

GSD_Revision            = 2

;===================== PRODUCT SPECIFICATION ====================

Vendor_Name             = "ABB Automation Techn. Products"
Model_Name              = "Tension Electronics PFEA113"
Ident_Number            = 0x0717
Revision                = "2.0"
Hardware_Release        = "1.0"
Software_Release        = "1.0"

;===================== OVERALL PROFIBUS SPECIFICATIONS ==========

FMS_supp                = 0
Protocol_Ident          = 0
Station_Type            = 0
Slave_Family            = 0

;===================== HARDWARE CONFIGURATION===================

Implementation_type     = "SPC3"
Redundancy              = 0
```

```
Repeater_Ctrl_Sig          = 0
24V_Pins                   = 0
;===================== PROTOCOL CONFIGURATION ====================

Set_Slave_Add_supp         = 0
Auto_Baud_supp             = 1
Min_Slave_Intervall        = 1
Freeze_Mode_supp           = 1
Sync_Mode_supp             = 1
Fail_Safe                  = 0

;===================== SUPPORTED BAUDRATES =====================

9.6_supp                   = 1
19.2_supp                  = 1
45.45_supp                 = 1
93.75_supp                 = 1
187.5_supp                 = 1
500_supp                   = 1
1.5M_supp                  = 1
3M_supp                    = 1
6M_supp                    = 1
12M_supp                   = 1

MaxTsdr_9.6                = 60
MaxTsdr_19.2               = 60
MaxTsdr_45.45              = 60
MaxTsdr_93.75              = 60
MaxTsdr_187.5              = 60
MaxTsdr_500                = 100
MaxTsdr_1.5M               = 150
MaxTsdr_3M                 = 250
MaxTsdr_6M                 = 450
```

```
MaxTsdr_12M             = 800

;===================== DIAGNOSTIC DEFINITIONS ====================

Max_Diag_Data_Len       = 6

;===================== PARAMETER DEFINITIONS =====================

User_Prm_Data_Len       = 3
User_Prm_Data           = 0, 0, 0

;===================== MODULE DEFINITIONS =======================

Modular_Station         = 0

Module                  = "PFEA113" 0x55,0x11,0x21
EndModule

;===============================================================
```

# Appendix B PFCL 301E - Designing the Load Cell Installation

## B.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Mounting instruction for load cell extension cable
  - Dimension drawing
  - Assembly drawing

## B.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

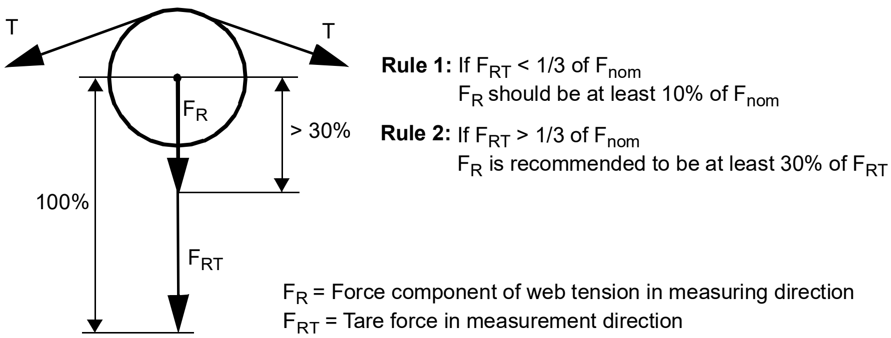
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

## B.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

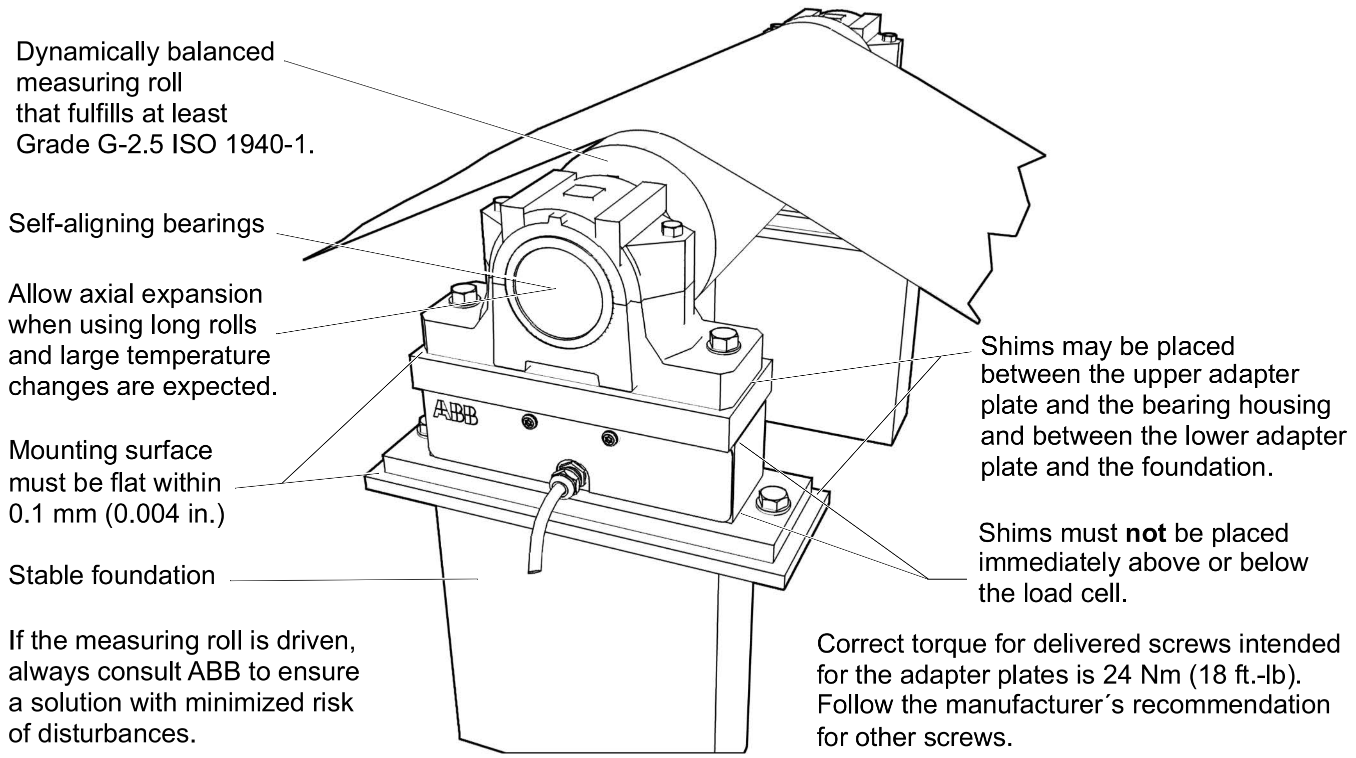
1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orientate load cell so that the guidelines below are met:
   a. Try to achieve a measured value no less than 10% of web tension, in the load cell measurement direction!
   b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
   c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
   d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
   This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
   For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




   e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

## B.4 Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.




**Alignment of the load cells**

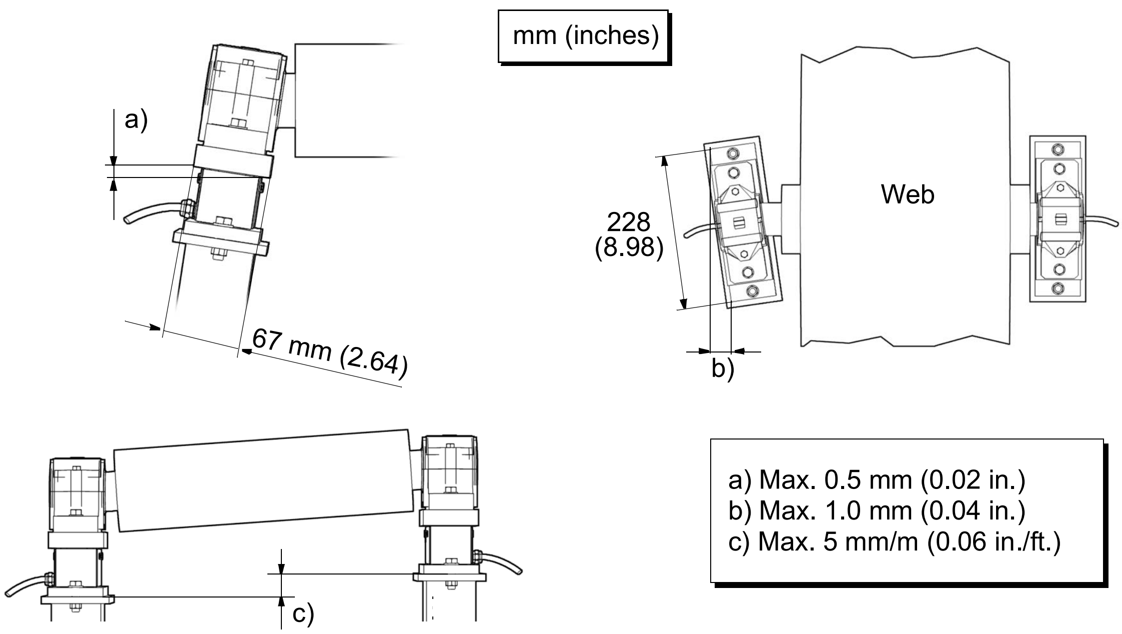
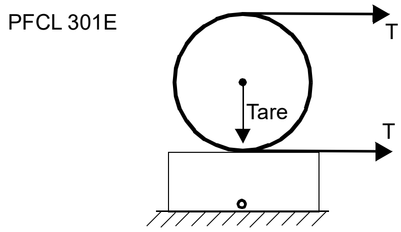



*Figure B-1. Installation Requirements*

# B.5 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

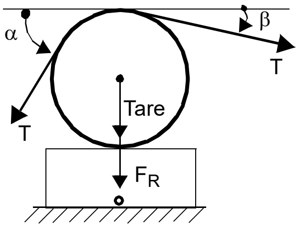
## B.5.1 Horizontal Mounting




No vertical web tension force applied to the load cell.

In most cases, horizontal mounting is the most obvious and simplest solution. The load cell should thus be mounted horizontally when possible.

However, should the machine design require inclined mounting of the load cell or should the web path not give a sufficient vertical force, see figure, the inclined mounting is permitted and the calculations are somewhat more complex, (see Appendix B.5.2).




$F_R = T \times (\sin\alpha + \sin\beta)$

$F_{RT} = \text{Tare}$

$F_{Rtot} = F_R + F_{RT} = T \times (\sin\alpha + \sin\beta) + \text{Tare}$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

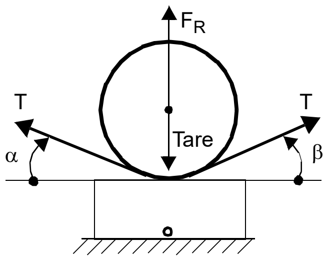
$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\sin\alpha + \sin\beta)}$$

$$\text{Wrap gain} = \frac{1}{\sin\alpha + \sin\beta}$$

The PFCL 301E load cell measures the vertical forces applied to its top surface. The horizontal applied forces are not measured and do not influence the vertical measurement. There are two sources of vertical forces; the forces from the web tension and the tare weight of the roll.

Divide the total vertical force $F_{Rtot}$ by two to get the required capacity of each load cell.

Do not oversize an ABB load cell for overload purposes as the load cell has sufficient overload capacity.




$F_R = T \times (\sin\alpha + \sin\beta)$

$F_{RT} = \text{Tare}$

$F_{Rtot} = F_{RT} - F_R = \text{Tare} - T \times (\sin\alpha + \sin\beta)$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\sin\alpha + \sin\beta)}$$

$$\text{Wrap gain} = \frac{1}{\sin\alpha + \sin\beta}$$

A PFCL 301E load cell can measure tension as well as compression.

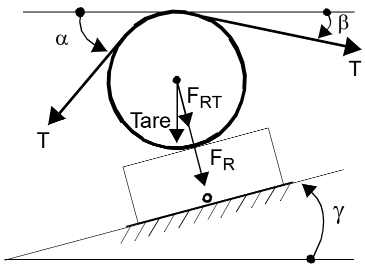
If the T (sin α + sin β) is larger than the tare weight, the load cell will be in tension.

To get the capacity of each load cell:

1. Divide ($F_R$ - Tare) by two
   if $F_R$ is greater than or equal to (Tare × two).
2. Divide Tare by two
   if $F_R$ is smaller than (Tare × two).

## B.5.2 Inclined Mounting

PFCL 301E




$F_R = T \times [\sin(\alpha - \gamma) + \sin(\beta + \gamma)]$

$F_{RT} = \text{Tare} \times \cos\gamma$

$F_{Rtot} = F_R + F_{RT} =$

$T \times [\sin(\alpha - \gamma) + \sin(\beta + \gamma)] + \text{Tare} \times \cos\gamma$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\sin(\alpha - \gamma) + \sin(\beta + \gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\sin(\alpha - \gamma) + \sin(\beta + \gamma)}$$

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or the need to have a proper force component applied to the load cell.

In this case, the incline angle modifies the tare load and the force components as shown.

## B.6 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll. The roll should nevertheless be supported at both ends.

### B.6.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the same calculations given in Section B.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain are valid.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

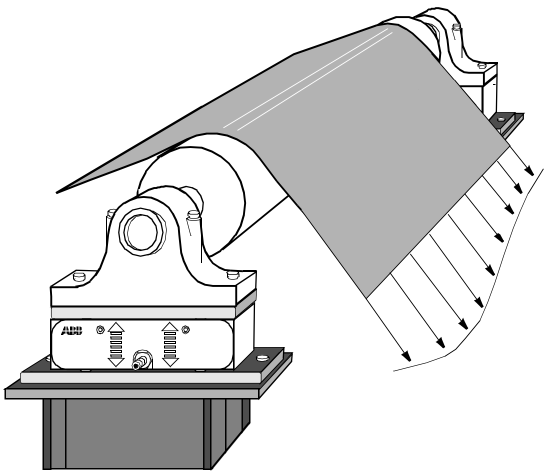
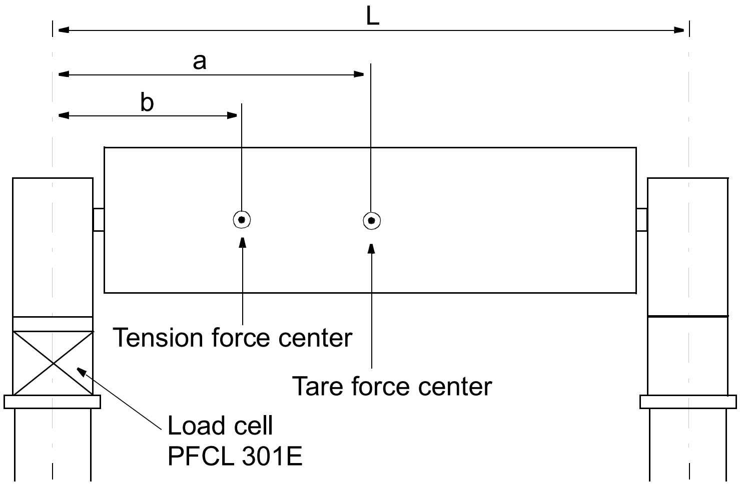


*Figure B-2. Cross-directional stress distribution*

## B.6.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section B.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain
3. Use the following equations:

   $F_R$ for single load cell $= F_R \times \frac{L - b}{L}$

   $F_{RT}$ for single load cell $= F_{RT} \times \frac{L - a}{L}$

   $F_{Rtot}$ for single load cell $=$ $F_R$ for single load cell $+$ $F_{RT}$ for single load cell

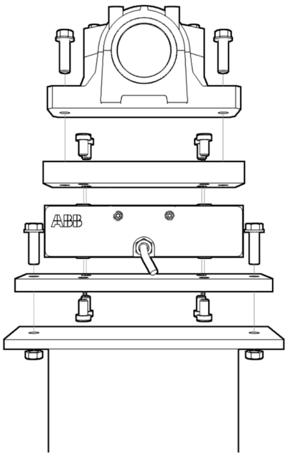
   where:

   L = Distance between load cell centerline and the opposite bearing centerline

   a = Distance between tare force center and load cell centerline

   b = Distance between tension force center and load cell centerline

## B.7 Mounting the Load Cells

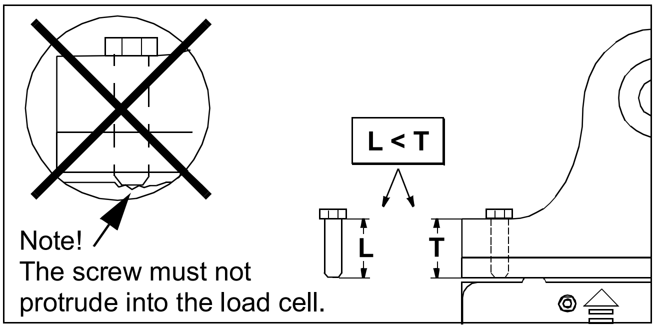



The instructions below apply to a typical mounting arrangement. Variations may be allowed, provided that they comply with the requirements in Appendix B.4.

1. Clean the foundation and other mounting surfaces.
2. Fit the lower adapter plate to the load cell.
   Tighten the screws (included in delivery) with a torque wrench to 24 Nm (18 ft.-lb).
3. Fit the load cell and the lower adapter plate to the foundation,
   but do not fully tighten the screws.
4. Fit the upper adapter plate to the load cell.
   Tighten the screws (included in delivery) with a torque wrench to 24 Nm (18 ft.-lb).
5. Fit the bearing housing and the roll to the upper adapter plate,
   but do not fully tighten the screws.

**CAUTION**

When mounting bearings or other adjacent details to adapter plates, screws must not protrude into the load cell. The load cell can be damaged by an excessive applied force.




6. Adjust the load cells according to the installation requirements.
   Tighten the foundation screws.
7. Adjust the roll according to the installation requirements.
   Tighten the screws in the upper adapter plate.

### B.7.1 Routing the Load Cell Cable

The cable must be supported with clamps and routed to prevent force shunting through the cable.

### B.7.2 Connecting the Load Cell Extension Cable

See Section B.11, Mounting Instruction, Cable Connector, 3BSE019064, Rev. A.

# B.8 Technical Data

| PFCL 301E | | | | Unit |
|---|---|---|---|---|
| **Nominal load** | | | | |
| Nominal load in measuring direction, $F_{nom}$ | 0.2 (45) | 0.5 (112) | 1.0 (225) | kN (lbs) |
| Permitted transverse load within the accuracy, $F_{Vnom}$ For h = 135 mm (5.3 inch) | 0.05 (11) | 0.125 (28) | 0.25 (56) | |
| Permitted axial load within the accuracy, $F_{Anom}$ For h = 135 mm (5.3 inch) | 0.05 (11) | 0.125 (28) | 0.25 (56) | |
| Extended load in measuring direction with accuracy class, compressive force ± 2%, $F_{ext}$ | 0.3 (67) | 0.75 (169) | 1.5 (337) | |
| **Overload capacity** | | | | |
| Max. load in measuring direction without permanent change of data, $F_{max}$ [1)] | 0.6 (135) | 1.5 (337) | 3 (674) | kN (lbs) |
| Max. load in transverse direction without permanent change of data, $F_{Vmax}$ [(1)]. For h = 135 mm (5.3 inch) | 0.3 (67) | 0.75 (169) | 1.5 (337) | |
| **Spring constant** | 9 (52) | 22 (124) | 34 (197) | kN/mm (1000 lbs/inch) |
| **Accuracy** | | | | |
| Accuracy class, compressive force | ± 1.0 | | | % |
| Linearity deviation | < ± 0.5 | | | |
| Repeatability error | < ± 0.1 | | | |
| Hysteresis | < ± 0.3 | | | |
| **Mechanical data** | | | | |
| Weight without adapter plates | approx. 2.5 (approx. 5.5) | | | kg (lbs) |
| Weight including adapter plates | approx. 5.4 (approx. 11.9) | | | |
| Length, width and height are given in Section B.12, Dimension Drawing, 3BSE015955D0094, Rev. D. | | | | |
| **Material** | | | | |
| Load cell | SS 2387 stainless steel, DIN X4CrNiMo 165. Corrosion resistance properties similar to AISI 304. | | | |
| Adapter plates | SS 1312, finished by black chromating. ASTM A 238-79 Grade C. | | | |

(1) $F_{max}$ and $F_{Vmax}$ are allowed at the same time.

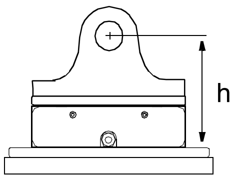



*Figure B-3. Building height*

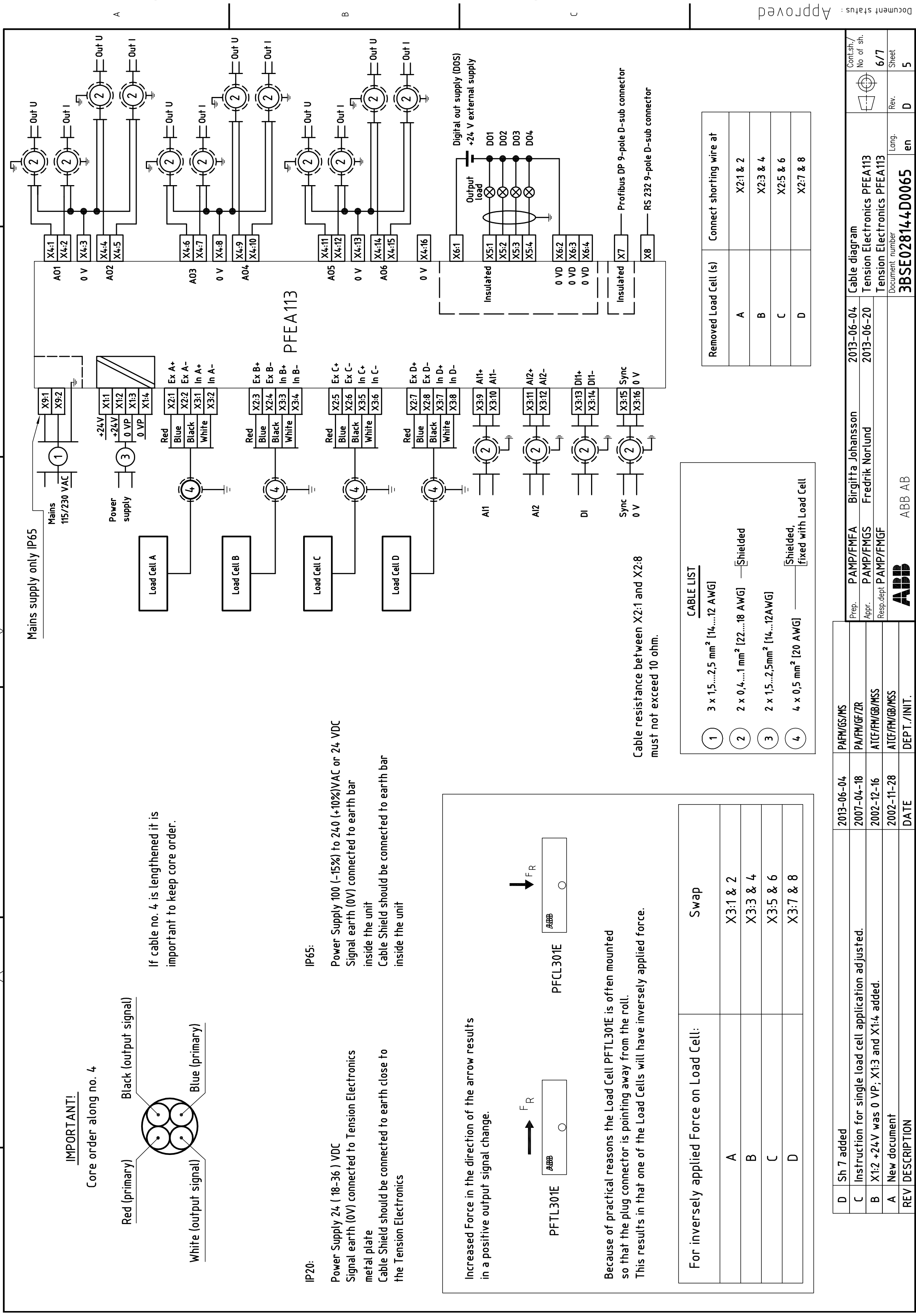
*Table B-1. Environmental data for load cell PFCL 301E*

| PFCL 301E | | Unit |
|---|---|---|
| **Compensated temperature range** | +20 - +60<br>(68 - 140) | °C<br>(°F) |
| Zero point drift | < ± 150<br>(83) | ppm/K<br>(ppm/°F) |
| Sensitivity drift | < ± 250<br>(139) | |
| **Working temperature range** | -10 - +80<br>(14 - 176) | °C<br>(°F) |
| Zero point drift | < ± 250<br>(139) | ppm/K<br>(ppm/°F) |
| Sensitivity drift | < ± 350<br>(194) | |
| **Storage temperature range** | -40 - +90<br>(-40 - 194) | °C<br>(°F) |
| **Degree of protection** | IP 66 acc. to EN 60 529 | |

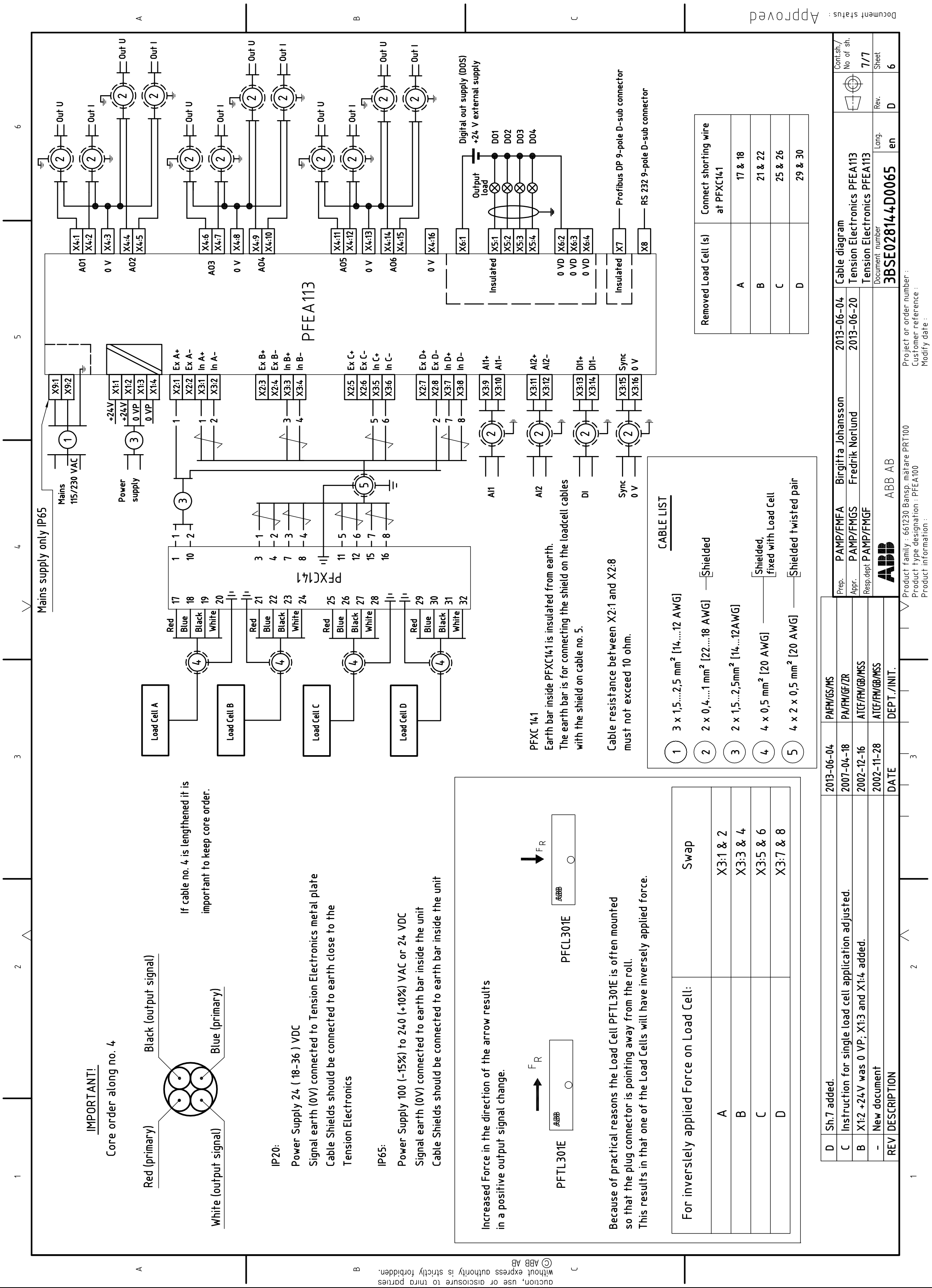
*Table B-2. Mounting screws*

| Type of screws | Strength class | Dimension | Tightening torque |
|---|---|---|---|
| Electro-zincplated steel screws,<br>lubricated with oil or emulsion.<br>Strength class according to ISO 898/1. | 8.8 | M8 | 24 Nm<br>(18 ft-lb) |

## B.9 Cable Diagram 3BSE028144D0065, page 5/7, Rev. D

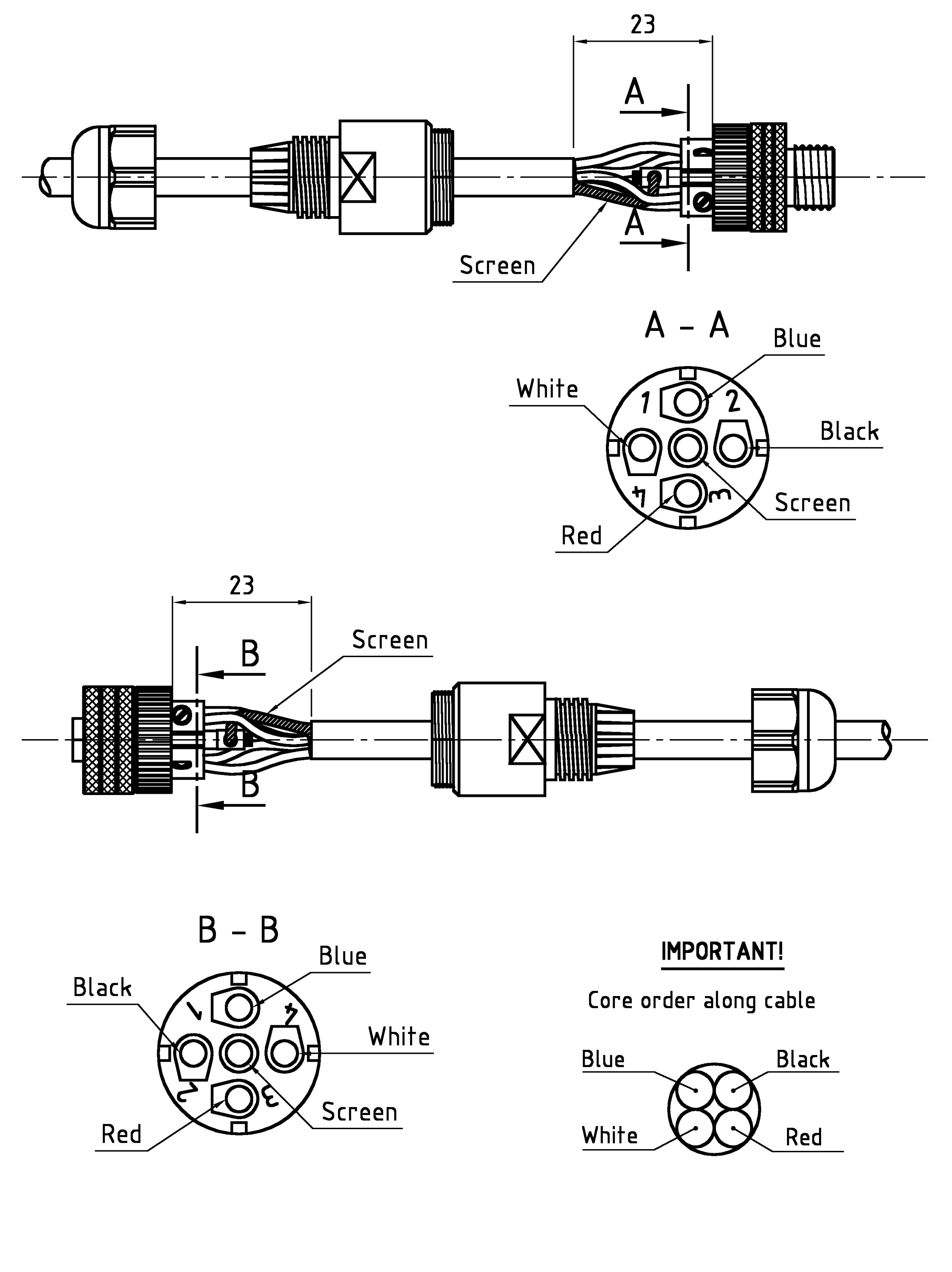


## B.10 Cable Diagram 3BSE028144D0065, page 6/7, Rev. D



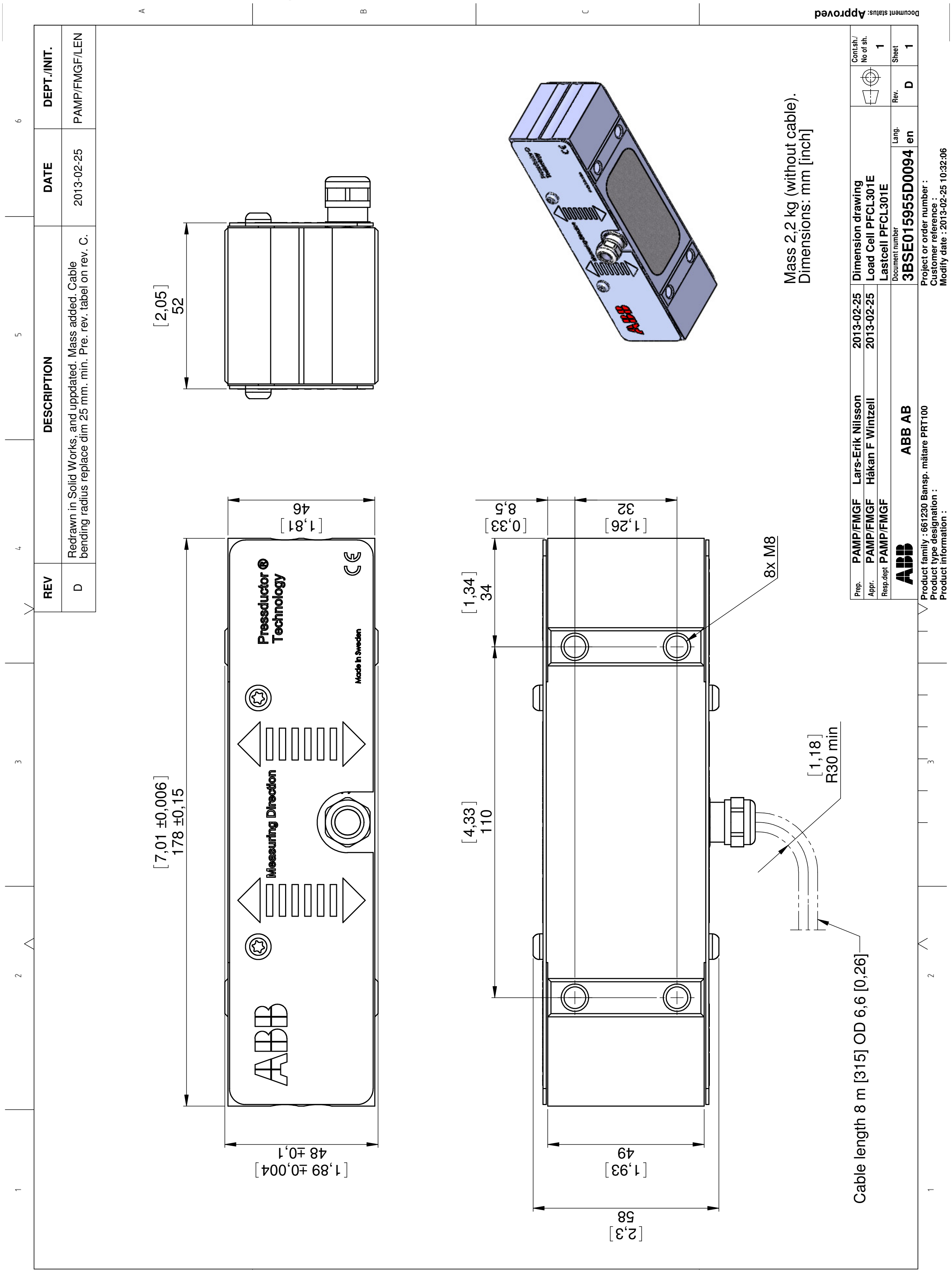
## B.11 Mounting Instruction, Cable Connector, 3BSE019064, Rev. A

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| – | New Document | 1999.07.07 | SEAPR / AGB / JRK |
| A | Core order along cable added. | 00-02-25 | SEAPR / AGB / JK |

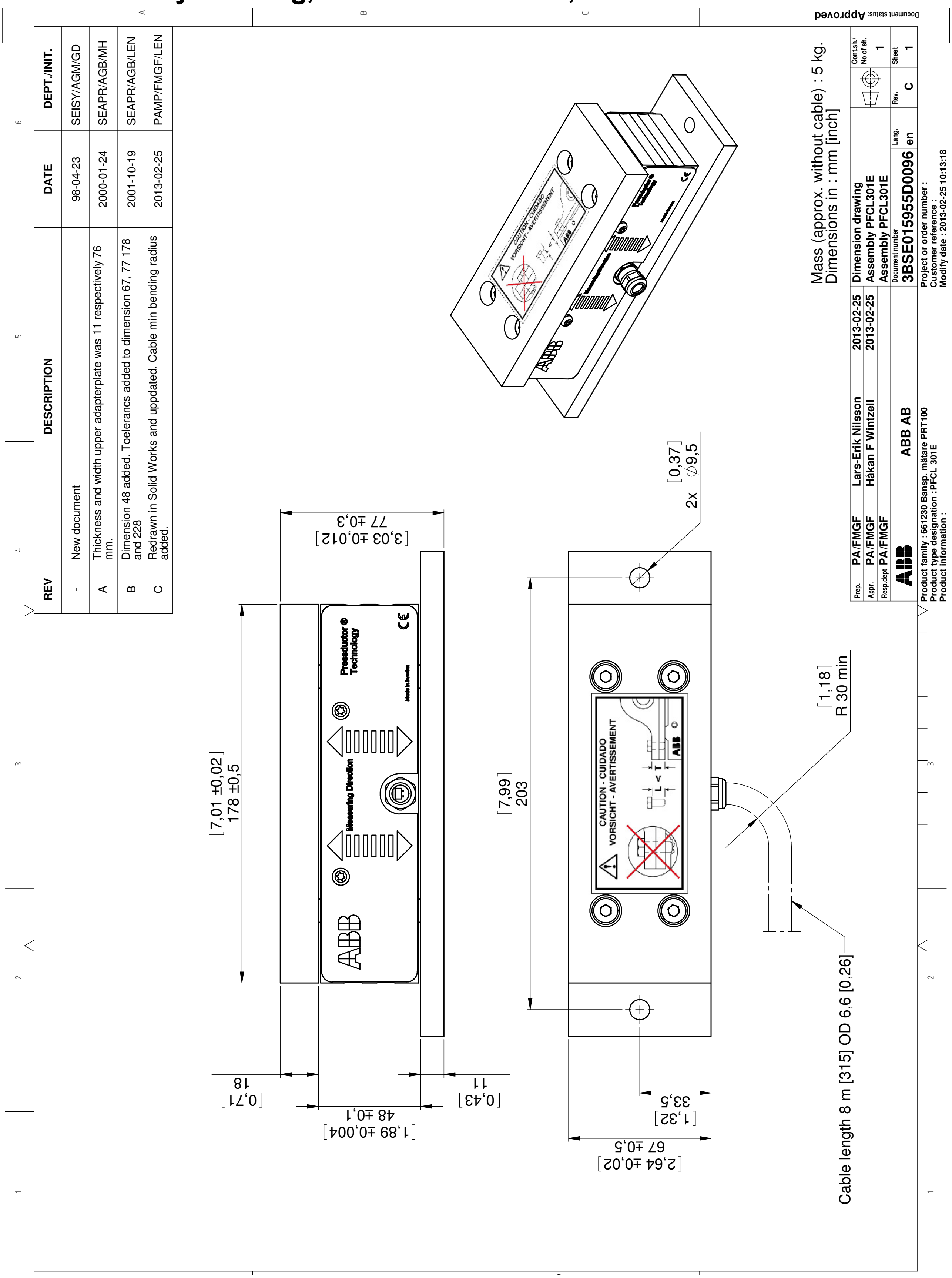



| | | | | | |
|---|---|---|---|---|---|
| Prep. | SEAPR/AGB | Hugosson Mattias | 2000-02-25 | INSTRUCTION | Cont.sh./ No of sh. |
| Appr. | SEAPR/AGB | Carlqvist Ulf | 2000-02-29 | Mounting instr. for cable connector | |
| Resp.dept | SEAPR/AGB | | | Monteringsinstruktion för kontakt | |
| ABB Automation Products AB | | | | Document number: 3BSE019064 / Lang.: en / Rev.: A | Sheet: 1 |

## B.12 Dimension Drawing, 3BSE015955D0094, Rev. D



## B.13 Assembly Drawing, 3BSE015955D0096, Rev. C



# Appendix C PFTL 301E - Designing the Load Cell Installation

## C.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Mounting instruction for load cell extension cable
  - Dimension drawing
  - Assembly drawing

## C.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

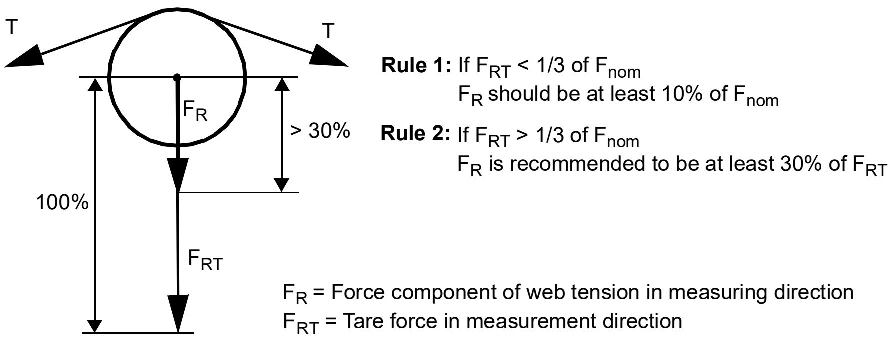
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

# C.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

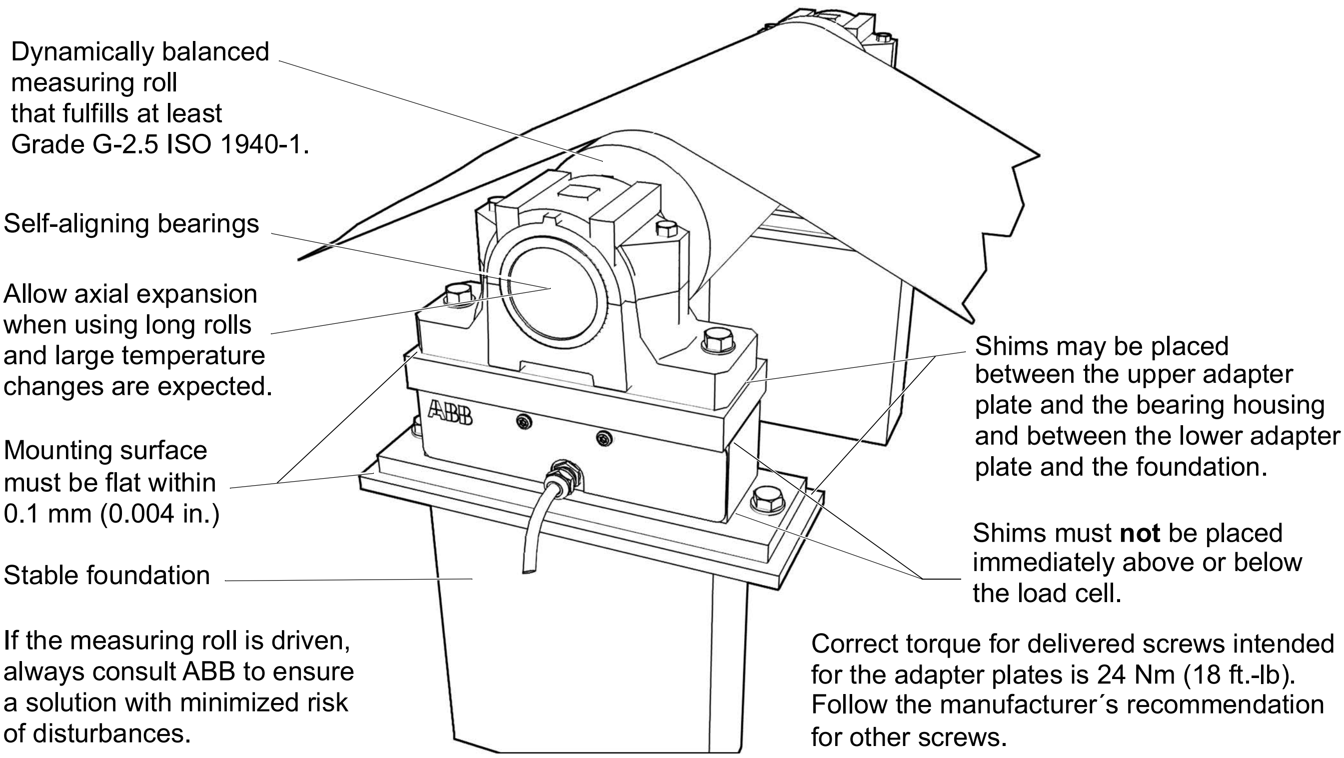
1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orient load cell so that the guidelines below are met:
    a. Try to achieve a measured value no less than 10% of web tension, in the load cell measurement direction!
    b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
    c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
    d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
    This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
    For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




    e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

# C.4 Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.




Alignment of the load cells

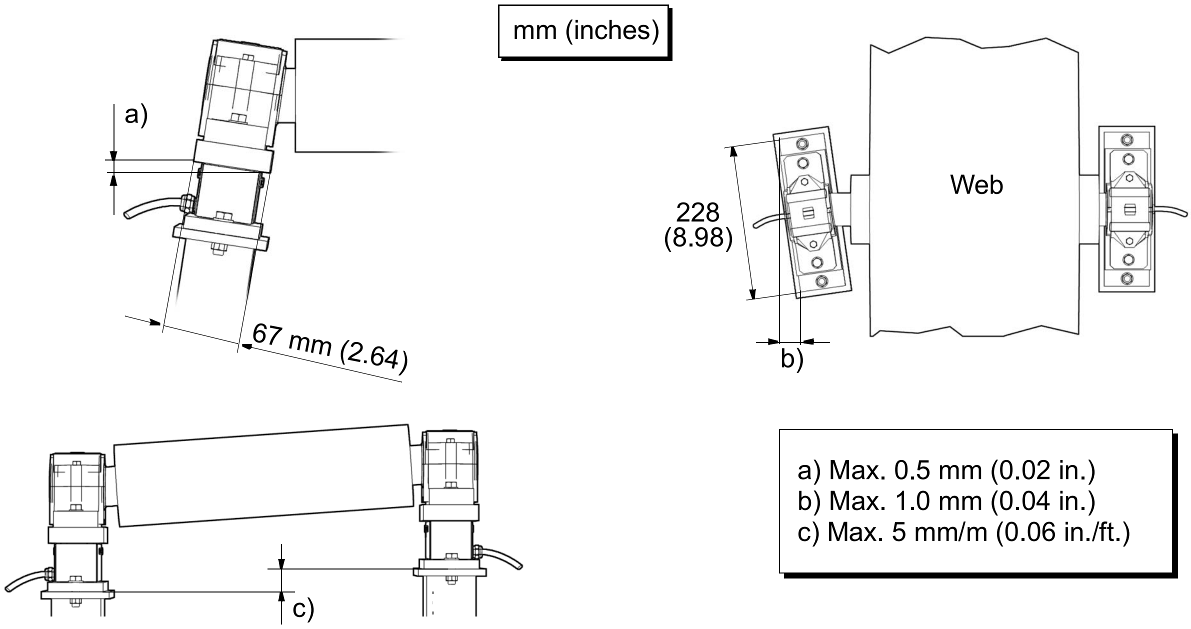
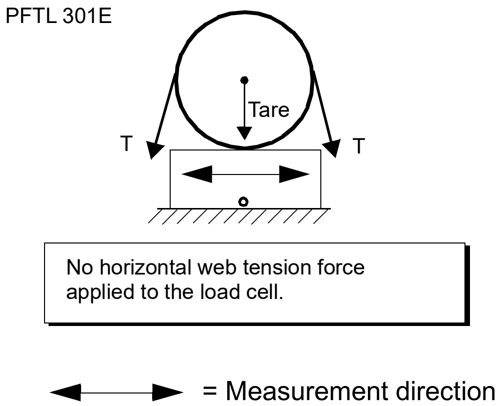



*Figure C-1. Installation Requirements*

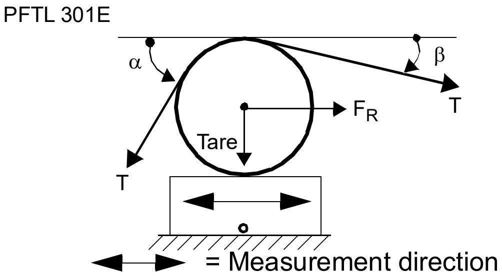
# C.5 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

## C.5.1 Horizontal Mounting




In most cases, horizontal mounting is the most obvious and simplest solution. The load cell should thus be mounted horizontally when possible.

However, should the machine design require inclined mounting of the load cell or should the web path not give a sufficient horizontal force, see figure, the inclined mounting is permitted and the calculations are somewhat more complex, (see Section C.5.2, Inclined Mounting).




$F_R = T \times (\cos\beta - \cos\alpha)$

$F_{RT} = 0$ (Tare force is not measured)

$F_{Rtot} = F_R + F_{RT} = T \times (\cos\beta - \cos\alpha)$

T (Tension) $=$ Wrap gain $\times F_R$

Wrap gain $= \dfrac{T}{F_R} = \dfrac{T}{T(\cos\beta - \cos\alpha)}$

Wrap gain $= \dfrac{1}{\cos\beta - \cos\alpha}$

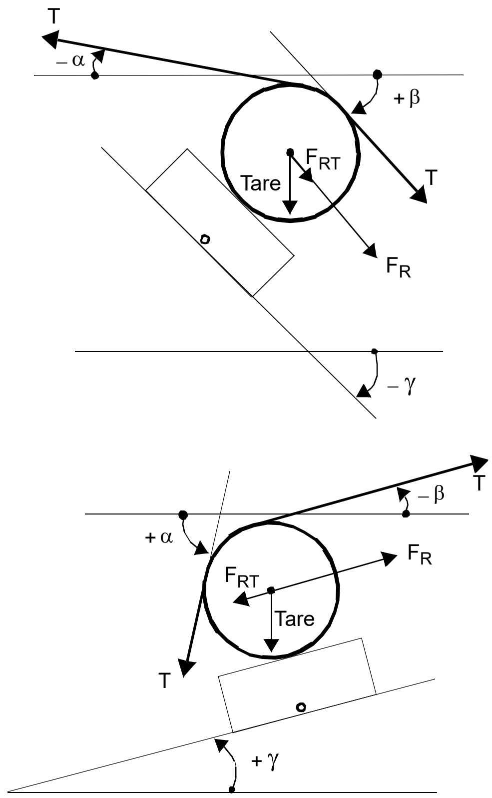
The PFTL 301E load cell measures the horizontal forces applied to its top surface. The load cell can measure in both directions. The vertical applied forces are not measured and do not influence the horizontal measurement. There is one source of horizontal forces; the force from the web tension (the tare weight has no force component in measuring direction). See the force calculations in the figure.

Divide the total horizontal force $F_{Rtot}$ by two to get the required capacity of each load cell.

Do not oversize an ABB load cell for overload purposes as the load cell has sufficient overload capacity.

## C.5.2 Inclined Mounting

PFTL 301E




$F_R = T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)]$

$F_{RT} = -\,\text{Tare} \times \sin\gamma$

$F_{Rtot} = F_R + F_{RT} =$

$T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)] + (-\text{Tare} \times \sin\gamma)$

---

$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\cos(\beta + \gamma) - \cos(\alpha - \gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\cos(\beta + \gamma) - \cos(\alpha - \gamma)}$$

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or the need to have a proper force component applied to the load cell.

Inclined mounting adds a component of tare force in the measuring direction and modifies the force components as shown.

**NOTE**

**When calculating, it is important that the angles are set into the equations with the correct signs in relation to the horizontal plane.**

# C.6 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll. The roll should nevertheless be supported at both ends.

## C.6.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the same calculations given in Section C.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain are valid.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

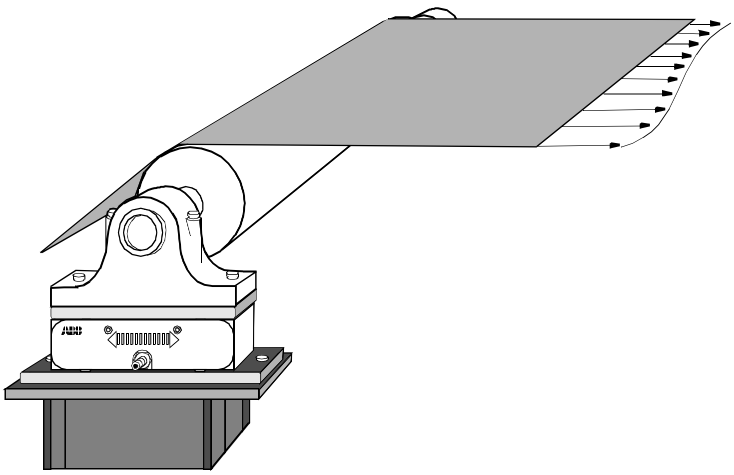
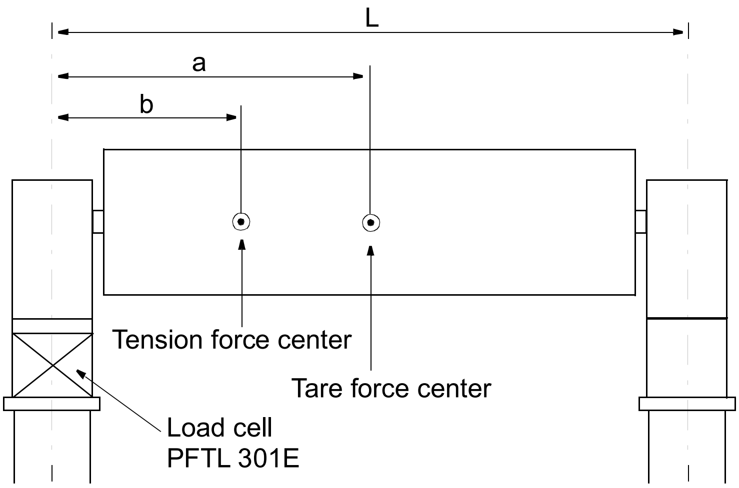


*Figure C-2. Cross-directional stress distribution*

## C.6.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline, see figure.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section C.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain.
3. Use the following equations:

$F_R$ for single load cell $= F_R \times \frac{L-b}{L}$

$F_{RT}$ for single load cell $= F_{RT} \times \frac{L-a}{L}$

$F_{Rtot}$ for single load cell $=$ $F_R$ for single load cell + $F_{RT}$ for single load cell

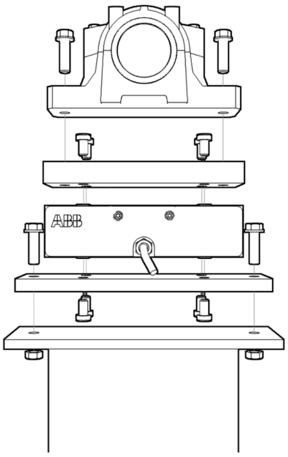
where:

L = Distance between load cell centerline and the opposite bearing centerline

a = Distance between tare force center and load cell centerline

b = Distance between tension force center and load cell centerline

## C.7 Mounting the Load Cells

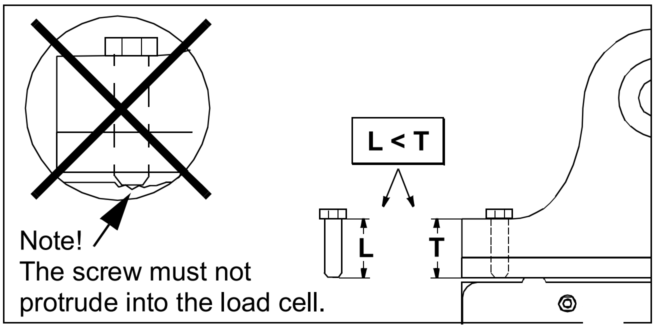


The instructions below apply to a typical mounting arrangement. Variations may be allowed, provided that they comply with the requirements in Section C.4, Installation Requirements.

1. Clean the foundation and other mounting surfaces.
2. Fit the lower adapter plate to the load cell.
   Tighten the screws (included in delivery) with a torque wrench to 24 Nm (18 ft.-lb).
3. Fit the load cell and the lower adapter plate to the foundation,
   but do not fully tighten the screws.
4. Fit the upper adapter plate to the load cell.
   Tighten the screws (included in delivery) with a torque wrench to 24 Nm (18 ft.-lb).
5. Fit the bearing housing and the roll to the upper adapter plate,
   but do not fully tighten the screws.

**CAUTION**

When mounting bearings or other adjacent details to adapter plates, screws must not protrude into the load cell. The load cell can be damaged by an excessive applied force.




6. Adjust the load cells according to the installation requirements.
   Tighten the foundation screws.
7. Adjust the roll according to the installation requirements.
   Tighten the screws in the upper adapter plate.

### C.7.1 Routing the Load Cell Cable

The cable must be supported with clamps and routed to prevent force shunting through the cable.

### C.7.2 Connecting the Load Cell Extension Cable

See Section C.11, Mounting Instruction, Cable Connector, 3BSE019064, Rev. A.

# C.8 Technical Data

| PFTL 301E | | | | | Unit |
|---|---|---|---|---|---|
| **Nominal load** | | | | | |
| Nominal load in measuring direction, $F_{nom}$<br>For h = 135 mm (5.3 inch) | 0.1<br>(22) | 0.2<br>(45) | 0.5<br>(112) | 1.0<br>(225) | kN<br>(lbs) |
| Permitted transverse load within the accuracy, $F_{Vnom}$ | 0.3<br>(67) | 0.6<br>(135) | 1.5<br>(337) | 3.0<br>(675) | |
| Permitted axial load within the accuracy, $F_{Anom}$<br>For h = 135 mm (5.3 inch) | 0.5<br>(112) | 0.5<br>(112) | 1.0<br>(225) | 1.0<br>(225) | |
| Extended load in measuring direction with accuracy class, bidirectional measurement ± 2%, $F_{ext}$ | 0.15<br>(33) | 0.3<br>(67) | 0.75<br>(169) | 1.5<br>(337) | |
| **Overload capacity** | | | | | |
| Max. load in measuring direction without permanent change of data, $F_{max}$ [1]. For h = 135 mm (5.3 inch) | 0.3<br>(67) | 0.6<br>(135) | 1.5<br>(337) | 3.0<br>(674) | kN<br>(lbs) |
| Max. load in transverse direction without permanent change of data, $F_{Vmax}$ [(1)] | 0.5<br>(112) | 1.0<br>(225) | 2.5<br>(562) | 5.0<br>(1125) | |
| Max. load in axial direction without permanent change of data, $F_{Amax}$. For h = 135 mm (5.3 inch) | 0.5<br>(112) | 0.5<br>(112) | 1.0<br>(225) | 1.0<br>(225) | |
| **Spring constant** | 2<br>(11.3) | 4<br>(22.6) | 7<br>(39.7) | 8<br>(44.6) | kN/mm<br>(1000 lbs/inch) |
| **Accuracy** | | | | | |
| Accuracy class | ± 1.0 | | | | % |
| Linearity deviation | < ± 0.5 | | | | |
| Repeatability error | < ± 0.1 | | | | |
| Hysteresis | < ± 0.3 | | | | |
| **Mechanical data** | | | | | |
| Weight without adapter plates | approx. 2.5<br>(approx. 5.5) | | | | kg<br>(lbs) |
| Weight including adapter plates | approx. 5.4<br>(approx. 11.9) | | | | |
| Length, width and height are given in Section C.12, Dimension Drawing, 3BSE019040D0094, Rev. C. | | | | | |
| **Material** | | | | | |
| Load cell | SS 2387 stainless steel, DIN X4CrNiMo 165.<br>Corrosion resistance properties similar to AISI 304. | | | | |
| Adapter plates | SS 1312, finished by black chromating.<br>ASTM A 238-79 Grade C. | | | | |

(1) $F_{max}$ and $F_{Vmax}$ are allowed at the same time.

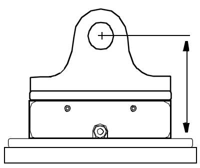



*Figure C-3. Building height*

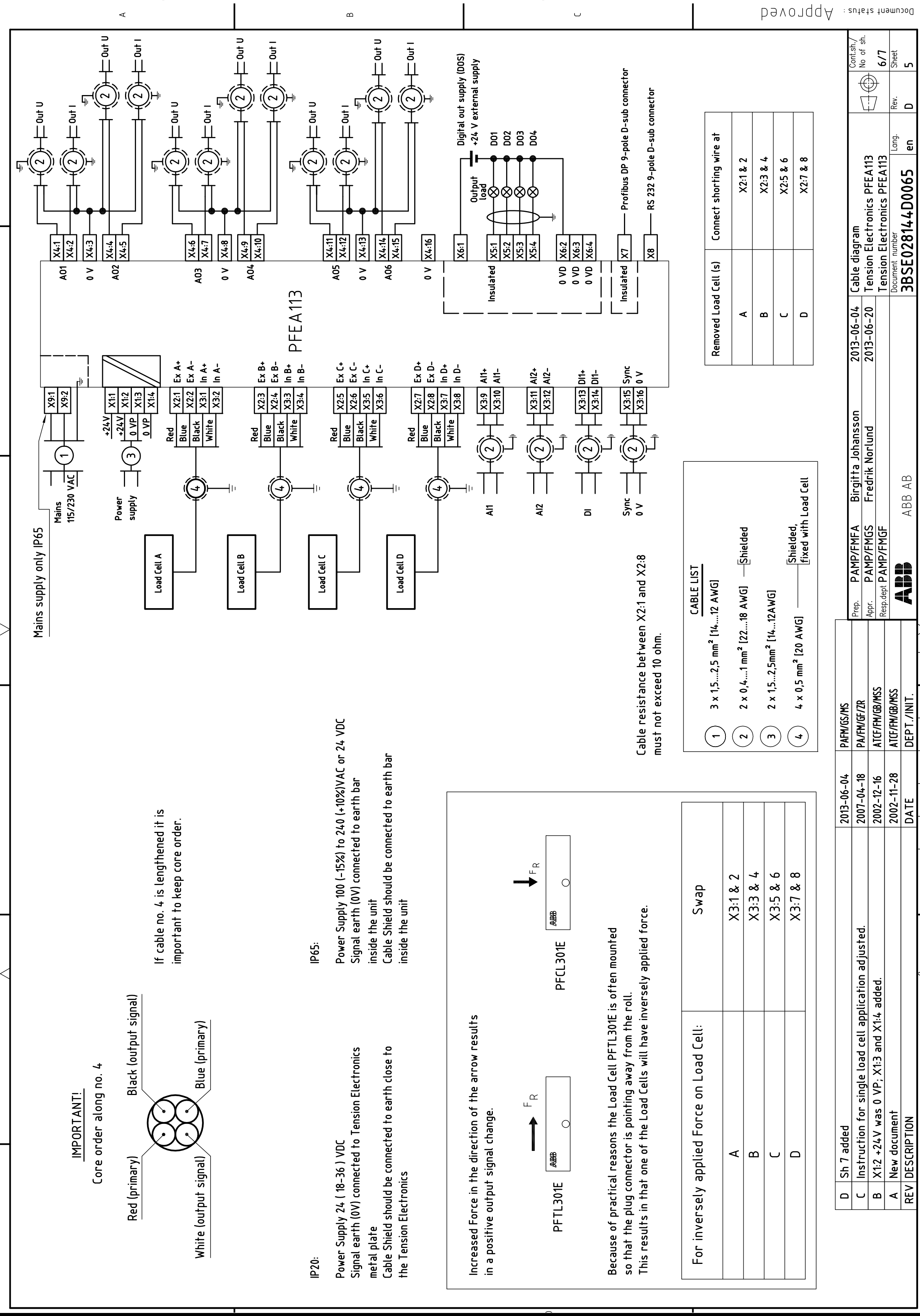
*Table C-1. Environmental data for load cell PFTL 301E*

| **PFTL 301E** | | **Unit** |
|---|---|---|
| **Compensated temperature range** | +20 - +60 (68 - 140) | °C (°F) |
| Zero point drift | < ± 150 (83) | ppm/K (ppm/°F) |
| Sensitivity drift | < ± 250 (139) | |
| **Working temperature range** | -10 - +80 (14 - 176) | °C (°F) |
| Zero point drift | < ± 250 (139) | ppm/K (ppm/°F) |
| Sensitivity drift | < ± 350 (194) | |
| **Storage temperature range** | -40 - +90 (-40 - 194) | °C (°F) |
| **Degree of protection** | IP 66 acc. to EN 60 529 | |

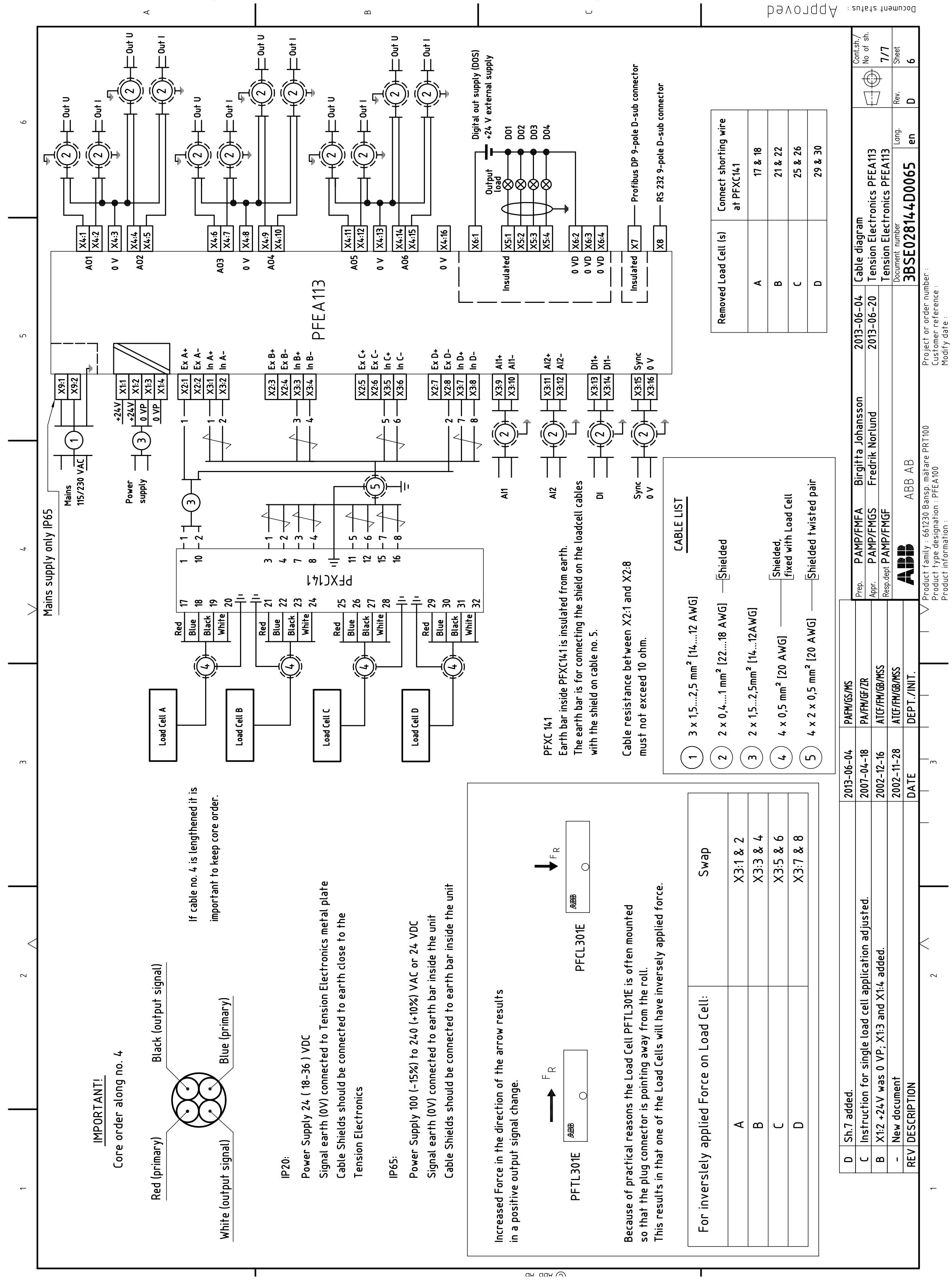
*Table C-2. Mounting screws*

| **Type of screws** | **Strength class** | **Dimension** | **Tightening torque** |
|---|---|---|---|
| Electro-zincplated steel screws, lubricated with oil or emulsion. Strength class according to ISO 898/1. | 8.8 | M8 | 24 Nm (18 ft-lb) |

## C.9 Cable Diagram 3BSE028144D0065, Page 5/7, Rev. D

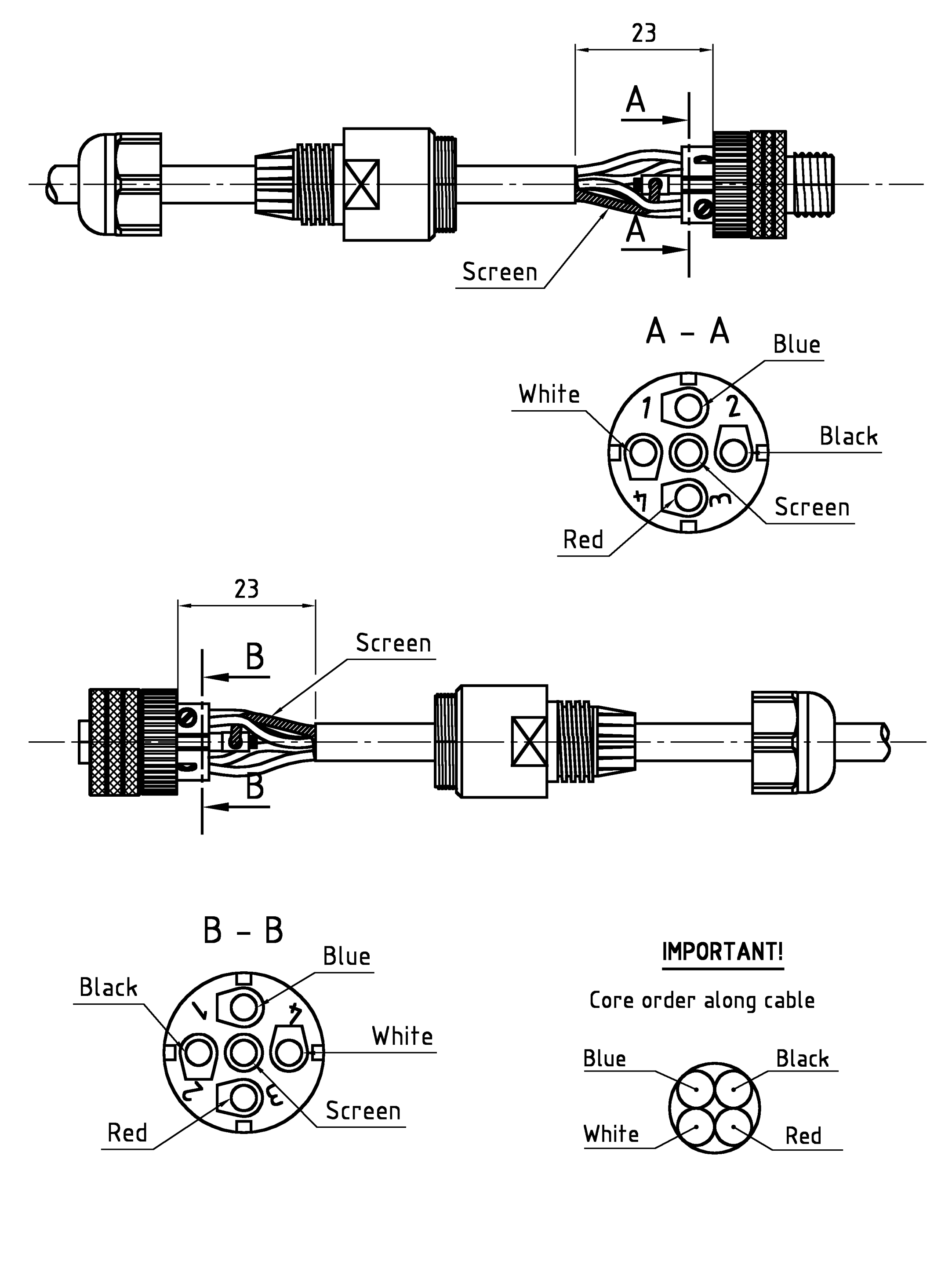


## C.10 Cable Diagram 3BSE028144D0065, Page 6/7, Rev. D



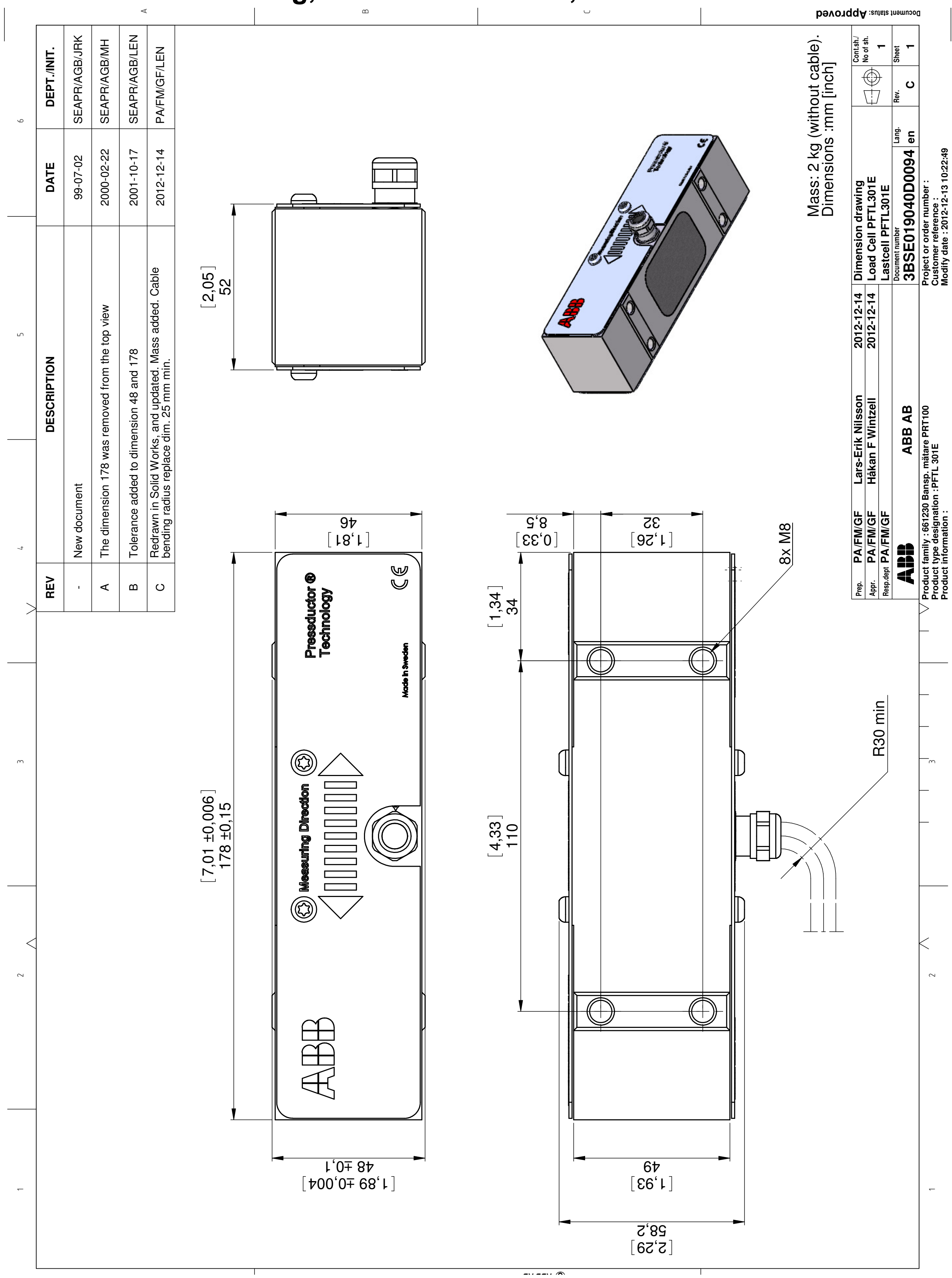
## C.11 Mounting Instruction, Cable Connector, 3BSE019064, Rev. A

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New Document | 1999.07.07 | SEAPR / AGB / JRK |
| A | Core order along cable added. | 00-02-25 | SEAPR / AGB / JK |

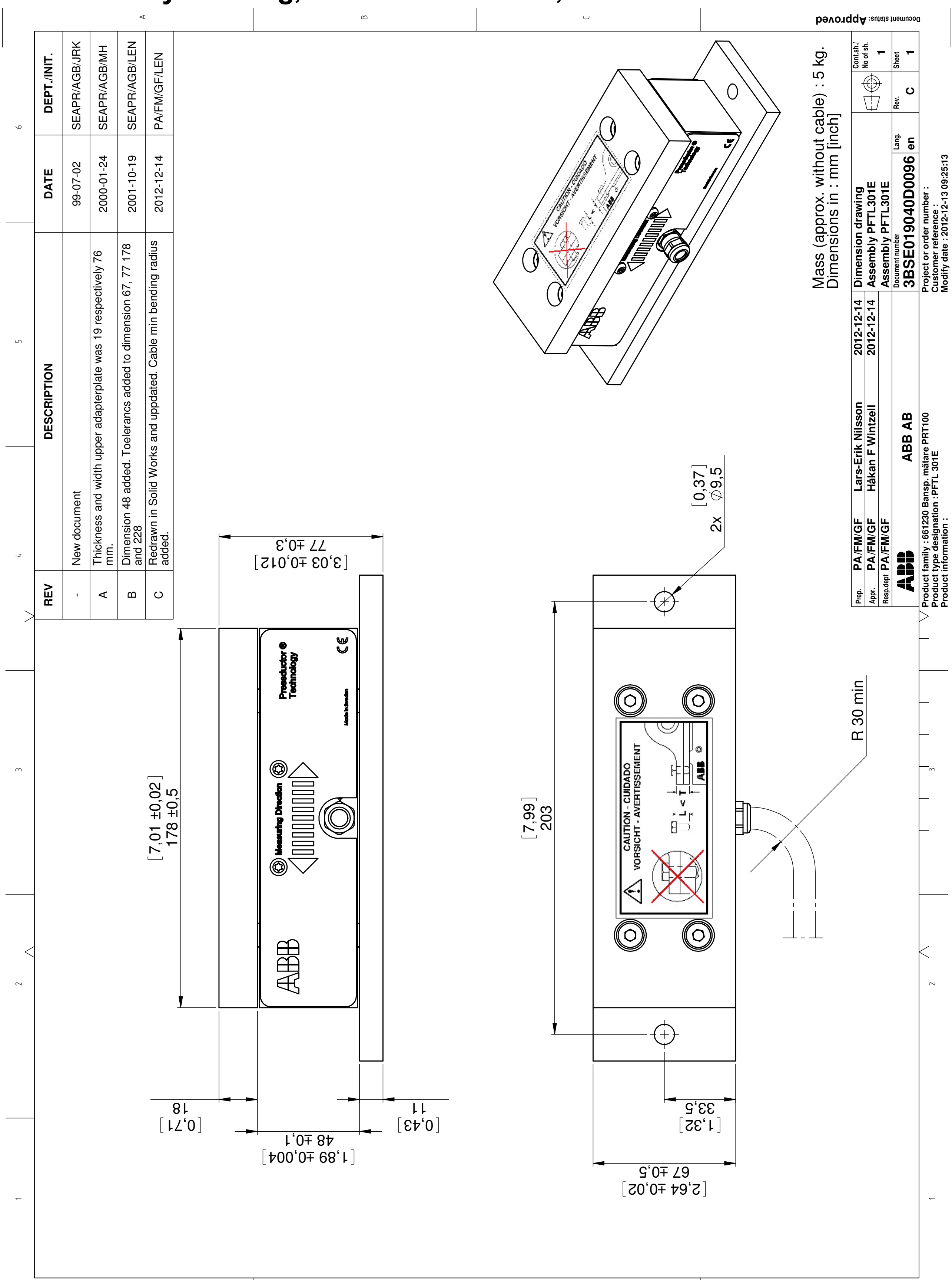



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. SEAPR/AGB | Hugosson Mattias | 2000-02-25 | INSTRUCTION | | | | Cont.sh./ No of sh. |
| Appr. SEAPR/AGB | Carlqvist Ulf | 2000-02-29 | Mounting instr. for cable connector | | | | |
| Resp.dept SEAPR/AGB | | | Monteringsinstruktion för kontakt | | | | |
| ABB Automation Products AB | | | Document number 3BSE019064 | Lang. en | Rev. A | | Sheet 1 |

## C.12 Dimension Drawing, 3BSE019040D0094, Rev. C



## C.13 Assembly Drawing, 3BSE019040D0096, Rev. C



# Appendix D PFRL 101 - Designing the Load Cell Installation

## D.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Dimension drawing(s)

## D.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

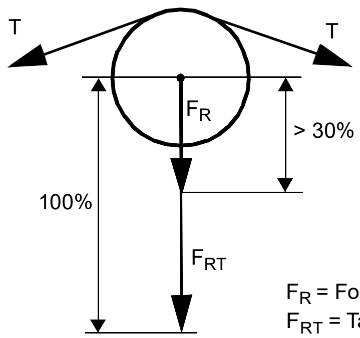
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

## D.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orient load cell so that the guidelines below are met:
   a. Try to achieve a measured value no less than 10% of web tension, in the load cell measurement direction!
   b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
   c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
   d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
   This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
   For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




**Rule 1:** If $F_{RT}$ < 1/3 of $F_{nom}$
$F_R$ should be at least 10% of $F_{nom}$

**Rule 2:** If $F_{RT}$ > 1/3 of $F_{nom}$
$F_R$ is recommended to be at least 30% of $F_{RT}$

$F_R$ = Force component of web tension in measuring direction
$F_{RT}$ = Tare force in measurement direction

   e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

# D.4 Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.

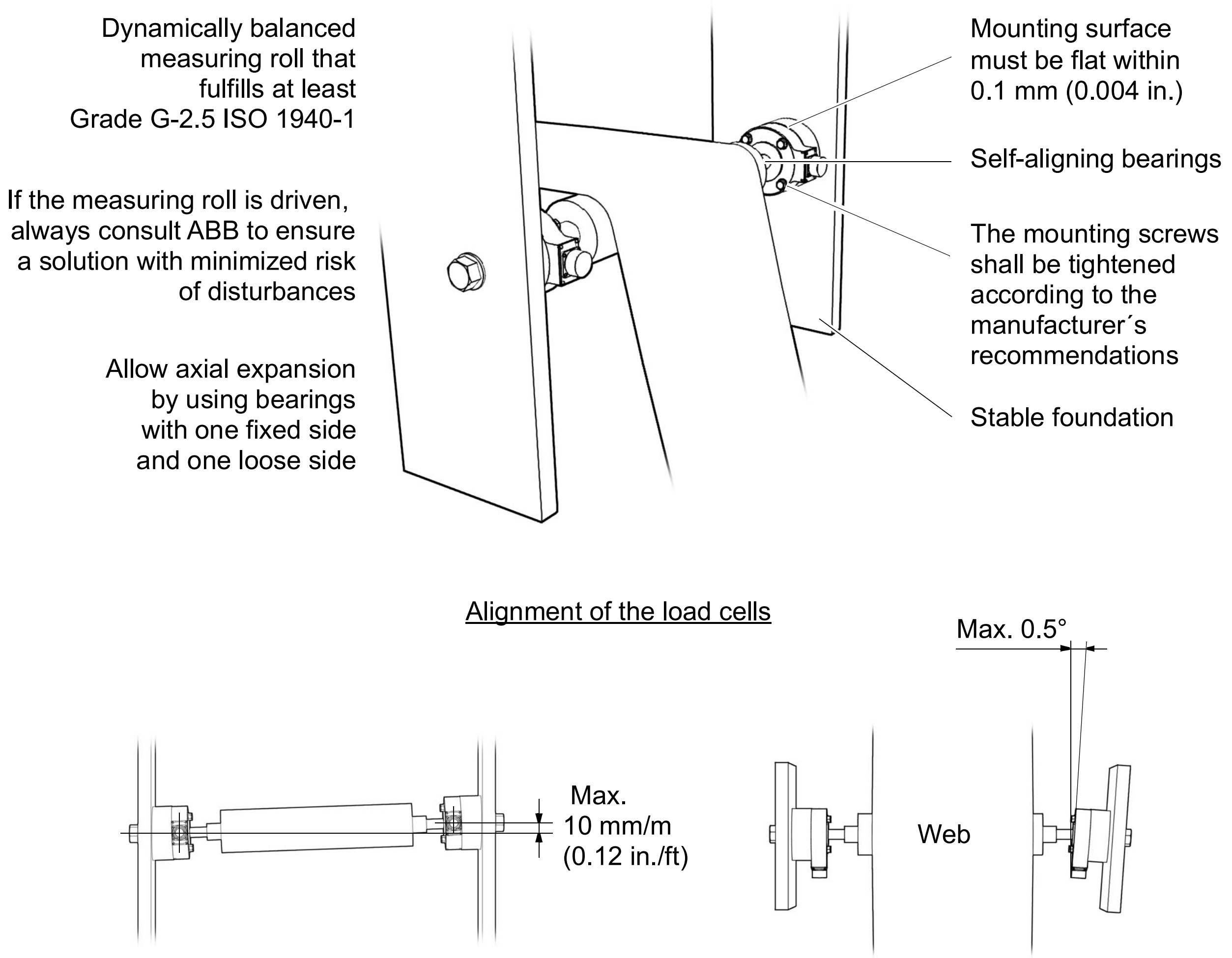
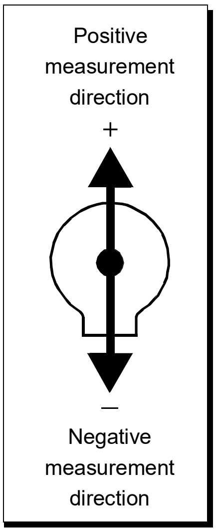
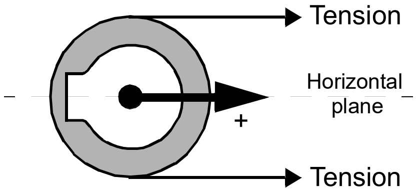
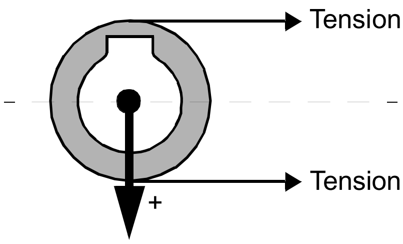
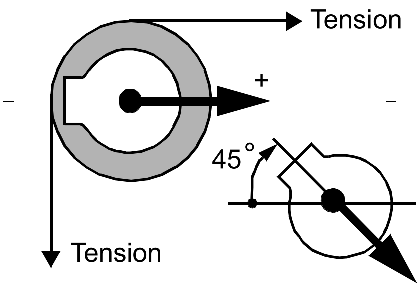



*Figure D-1. Installation requirements*

## D.5 Load Cell Orientation Depending on Measurement Direction

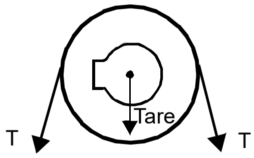



The radial load cell will only measure forces along the axis as shown in the figure to the left. Therefore, the orientation of the measurement direction is important to the amount of signal output. To help understand how the orientation of the measurement direction affects the output see the figures below.

| Orientation of measurement direction | Effects (Two load cells are assumed) |
|---|---|
|  | The load cells measure 2 × Tension, but do not measure the roll weight (Tare). |
|  | The load cells measure no Tension, but do measure the roll weight (Tare). Rotating the load cells counterclockwise will begin to gain in signal from the web tension and will eliminate the output due to roll weight (Tare). Maximum tension signal will occur at 90° of rotation. |
|  | The load cells measure 1 × Tension, but do not measure the roll weight (Tare). Rotate the load cells 45° clockwise and the load cells sense 1.4 × Tension and 70% of the roll weight. |

# D.6 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

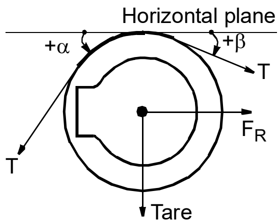
## D.6.1 Horizontal Mounting




No horizontal web tension force applied to the load cell.

The PFRL 101 load cells can be mounted at any incline angle, 0 - 360°. However, it is recommended to minimize the influence of forces other than the tension to be measured. In most cases this means an orientation where the tare force (vertical) is perpendicular to the measured force (horizontal).

However, should the machine design require inclined mounting of the load cell or should the web path not give a sufficient horizontal force, see figure, the inclined mounting is permitted and the calculations are somewhat more complex, (see Section D.6.2, Inclined Mounting).




$F_R = T \times (\cos\beta - \cos\alpha)$

$F_{RT} = 0$ (Tare force is not measured)

$F_{Rtot} = F_R + F_{RT} = T \times (\cos\beta - \cos\alpha)$

$F_{Rtot}$ / load cell = $F_{Rtot} / 2$

$$T \text{ (Tension)} = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\cos\beta - \cos\alpha)}$$

$$\text{Wrap gain} = \frac{1}{\cos\beta - \cos\alpha}$$

The load cell measures the horizontal forces. The load cell can measure in both directions. The vertical applied forces are not measured and do not influence the horizontal measurement. There is one source of horizontal forces, the force from the web tension (the tare weight has no force component in measuring direction). See force calculations in figure.

Divide the total vertical force $F_{Rtot}$ by two to get the required capacity of each load cell.

Do not oversize an ABB load cell for overload purposes as the load cell has sufficient overload capacity.

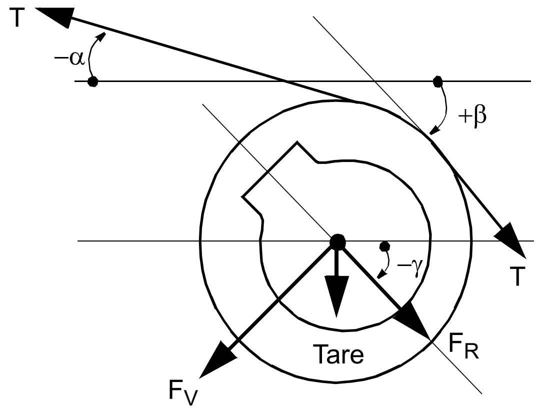
## D.6.2 Inclined Mounting

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or due to the need to have a proper force component applied to the load cell.

Inclined mounting adds a component of tare force and modifies the force components as shown.

**NOTE**

**When calculating it is important that the angles are set into the equations with the correct signs relative to the horizontal plane.**




$F_R = T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)]$

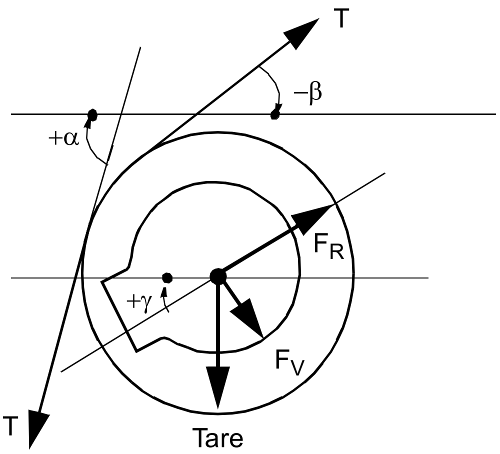
$F_{RT} = -\text{Tare} \times \sin\gamma$

$F_{Rtot} = F_R + F_{RT} =$
$T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)] + (-\text{Tare} \times \sin\gamma)$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\cos(\beta+\gamma) - \cos(\alpha-\gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\cos(\beta+\gamma) - \cos(\alpha-\gamma)}$$



# D.7 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll. The roll should nevertheless be supported at both ends.

## D.7.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the calculations given in Section D.6, Mounting Alternatives, Calculating Force and Calculating Wrap Gain are valid. Note that the output signal is a summation.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

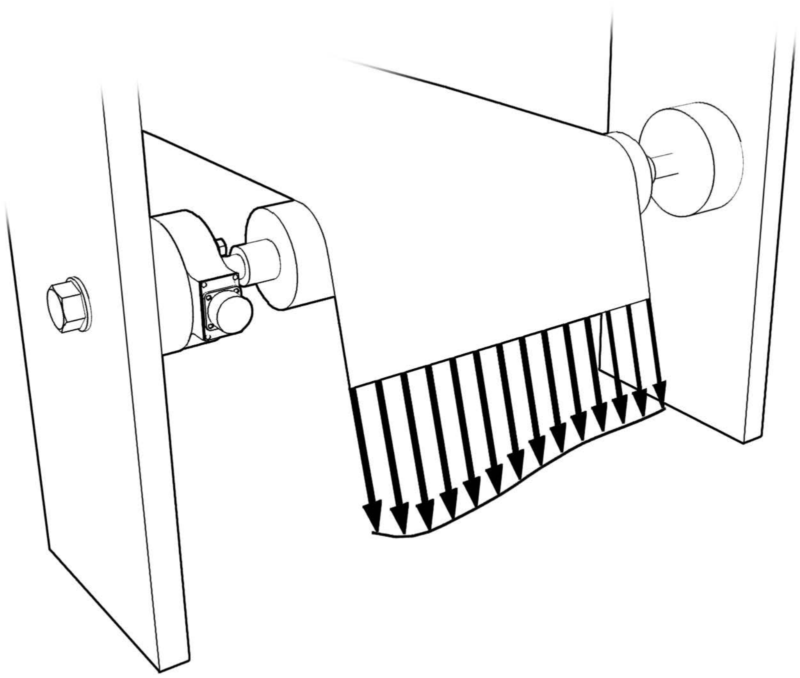
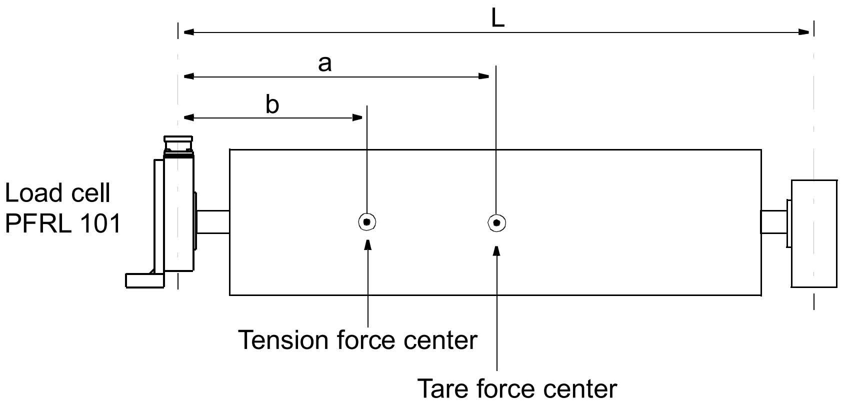


*Figure D-2. Cross-directional stress distribution*

## D.7.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section D.6, Mounting Alternatives, Calculating Force and Calculating Wrap Gain.
3. Use the following equations:

$F_R$ for single load cell $= F_R \times \frac{L-b}{L}$

$F_{RT}$ for single load cell $= F_{RT} \times \frac{L-a}{L}$

$F_{Rtot}$ for single load cell $=$ $F_R$ for single load cell + $F_{RT}$ for single load cell

where:

L = Distance between load cell centerline and the opposite bearing center line

a = Distance between tare force center and load cell centerline

b = Distance between tension force center and load cell centerline

## D.8 Mounting the Load Cells

1. Mount the bearings in the load cells.

**NOTE**

Use tools and materials that will not damage the bearing or the load cell.

**NOTE**

One of the bearings is locked in position with retaining rings while the other bearing is only pressed into the correct position to allow axial expansion.

a. Mount one of the retaining rings into the load cell.

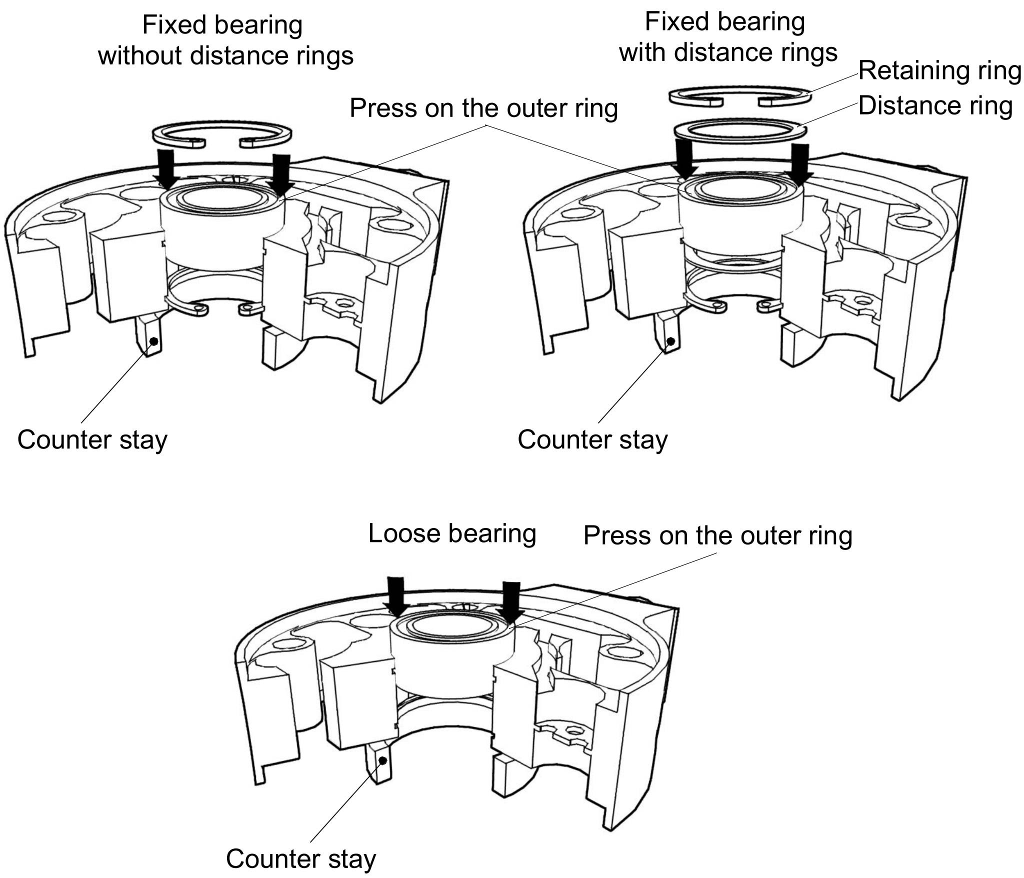
b. Arrange a counterstay as shown in the figure below.

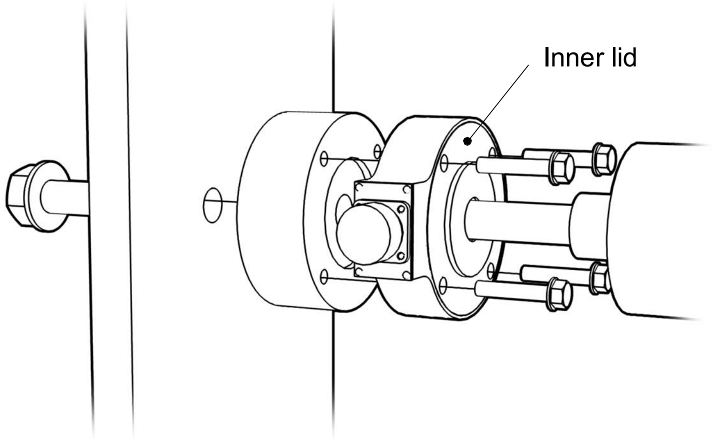
c. Press the bearing to correct position.

**NOTE**

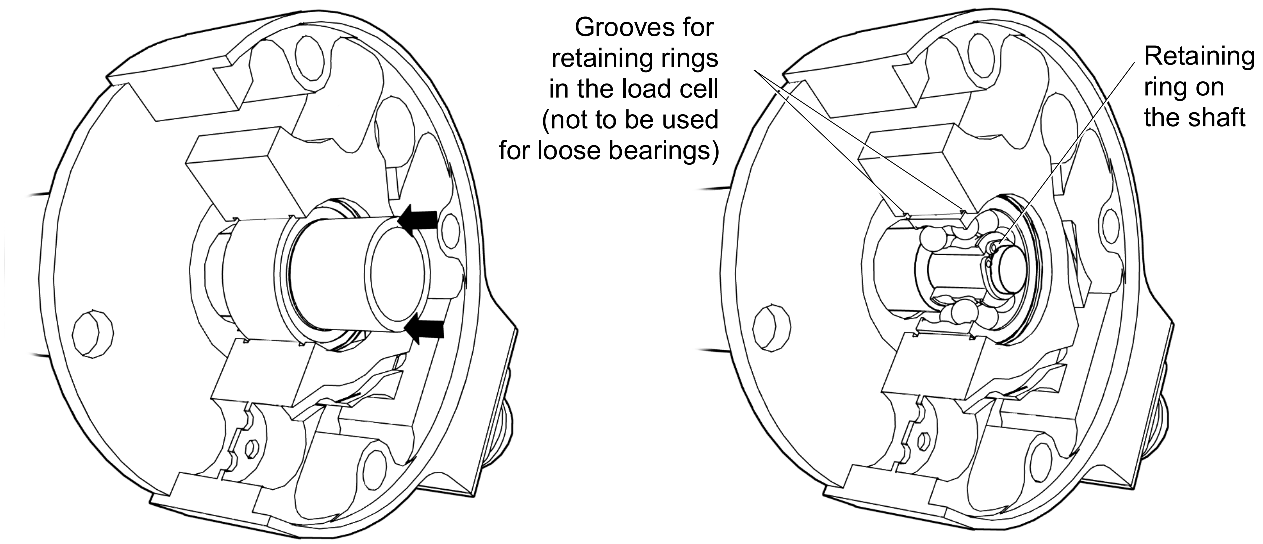
The bearing bed has only a slight interference fit, and, therefore, no heavy forces should be used.

d. Mount the other retaining ring into the load cell.






2. Mount distance spacers and shaft seals, if necessary.
3. Put the inner load cell lids in position, and also four mounting screws in their holes.
4. Press the load cells onto the shaft (press on the inner rings of the bearings only).




5. Mount the retaining rings for the bearings on the shaft.
   Put the outer lids in position.
6. Position the measuring roll complete with the load cells into the correct position on the machine.

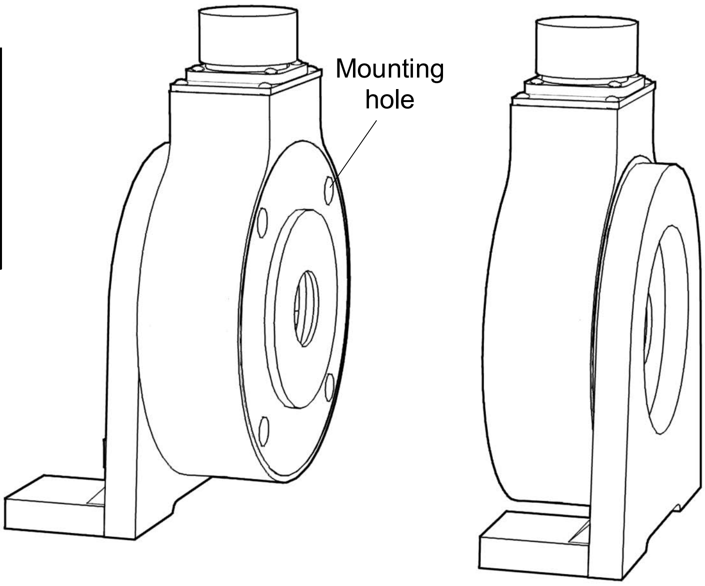
   The load cell with the loose bearing is displaced towards the roll, in order to reduce the total length, so that the measuring roll with the load cells can be fitted in.

   When the roll is in position pull the load cell with the loose bearing back to its proper position.
7. Fix each load cell by using the four mounting screws.
   (Tightening torque according to the manufacturer´s recommendations)
8. Adjust the shaft seals, if necessary.

## D.8.1 Mounting with Brackets

The optional bracket is intended to facilitate mounting on horizontal surfaces.

To achieve the best measuring direction, turn the load cell to a suitable position before drilling the bracket.




Possible ways of mounting using brackets.

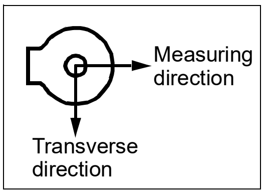
1. Mark the location of the mounting holes.
2. Drill the holes and cut threads, according to Section D.20, Dimension Drawing, 3BSE010457, Rev. B.
3. Install according to the instructions in Section D.8, Mounting the Load Cells.

## D.8.2 Mounting Screws for the Load Cells

The load cell shall be mounted with screws according to Table D-1.

**NOTE**

The screws shall be tightened according to the manufacturer´s recommendations.




Screws with strength class 8.8 are sufficient for normal applications without large transverse forces or overloads.

Screws with strength class 12.9 and a higher tightening torque are recommended in applications where large transverse forces or overloads can occur.

Prior to mounting, check that the mounting surfaces are clean and flat, for example free of burrs and other damage.

*Table D-1. Mounting Screws*

| Load cell PFRL 101 | Screw dimension |
|---|---|
| A | M8 (5/16 UNC) |
| B | M8 (5/16 UNC) |
| C | M10 (3/8 UNC) |
| D | M12 (1/2 UNC) |

## D.8.3 Routing the Load Cell Cable

The cable must be supported with clamps and routed to prevent force shunting through the cable.

# D.9 Technical Data

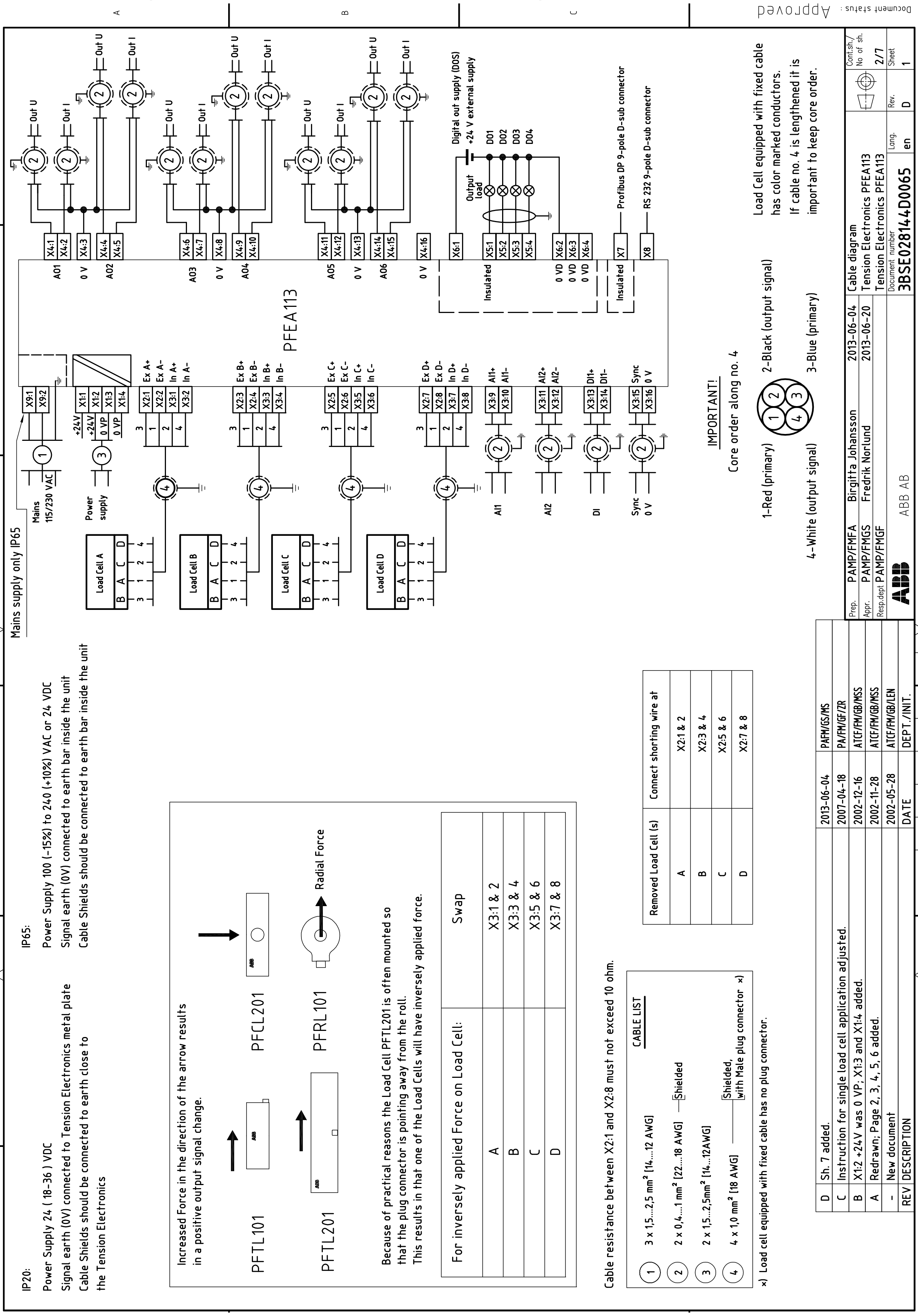
*Table D-2. Technical Data for Different Types of Load Cell PFRL 101*

| PFRL 101 | Type | Data | | | | Unit |
|---|---|---|---|---|---|---|
| **Nominal load** | | | | | | |
| Nominal load, $F_{nom}$ | A | 0.5 (112) | | | | kN (lbs) |
| | B | | 1 (225) | | | |
| | C | 0.5 (112) | 1 (225) | 2 (450) | | |
| | D | | | | 5 (1125) | |
| Accepted transverse load within the accuracy class, $F_{Vnom}$ | A | 2.5 (562) | | | | |
| | B | | 3 (674) | | | |
| | C | 1.25 (281) | 2.5 (562) | 5 (1125) | | |
| | D | | | | 10 (2250) | |
| Accepted axial load within the accuracy class, $F_{Anom}$ | A | 2.5 (562) | | | | |
| | B | | 5 (1125) | | | |
| | C | 2.5 (562) | 5 (1125) | 10 (2250) | | |
| | D | | | | 25 (5625) | |
| **Overload capacity** | | | | | | |
| Maximal load in the direction of measurement without permanent change of data, $F_{max}$ | A | 2.5 (562) | | | | kN (lbs) |
| | B | | 5 (1125) | | | |
| | C | 2.5 (562) | 5 (1125) | 10 (2250) | | |
| | D | | | | 25 (5625) | |
| **Spring constant** | A | 50 (286) | | | | kN/mm (1000 lbs/inch) |
| | B | | 100 (572) | | | |
| | C | 50 (286) | 100 (572) | 200 (1143) | | |
| | D | | | | 500 (2858) | |
| **Mechanical data** | | | | | | |
| Weight | A | 1.5 (3.3) | | | | kg (lbs) |
| | B | | 2.0 (4.4) | | | |
| | C | 5.0 (11) | 5.0 (11) | 5.0 (11) | | |
| | D | | | | 8.5 (18.7) | |

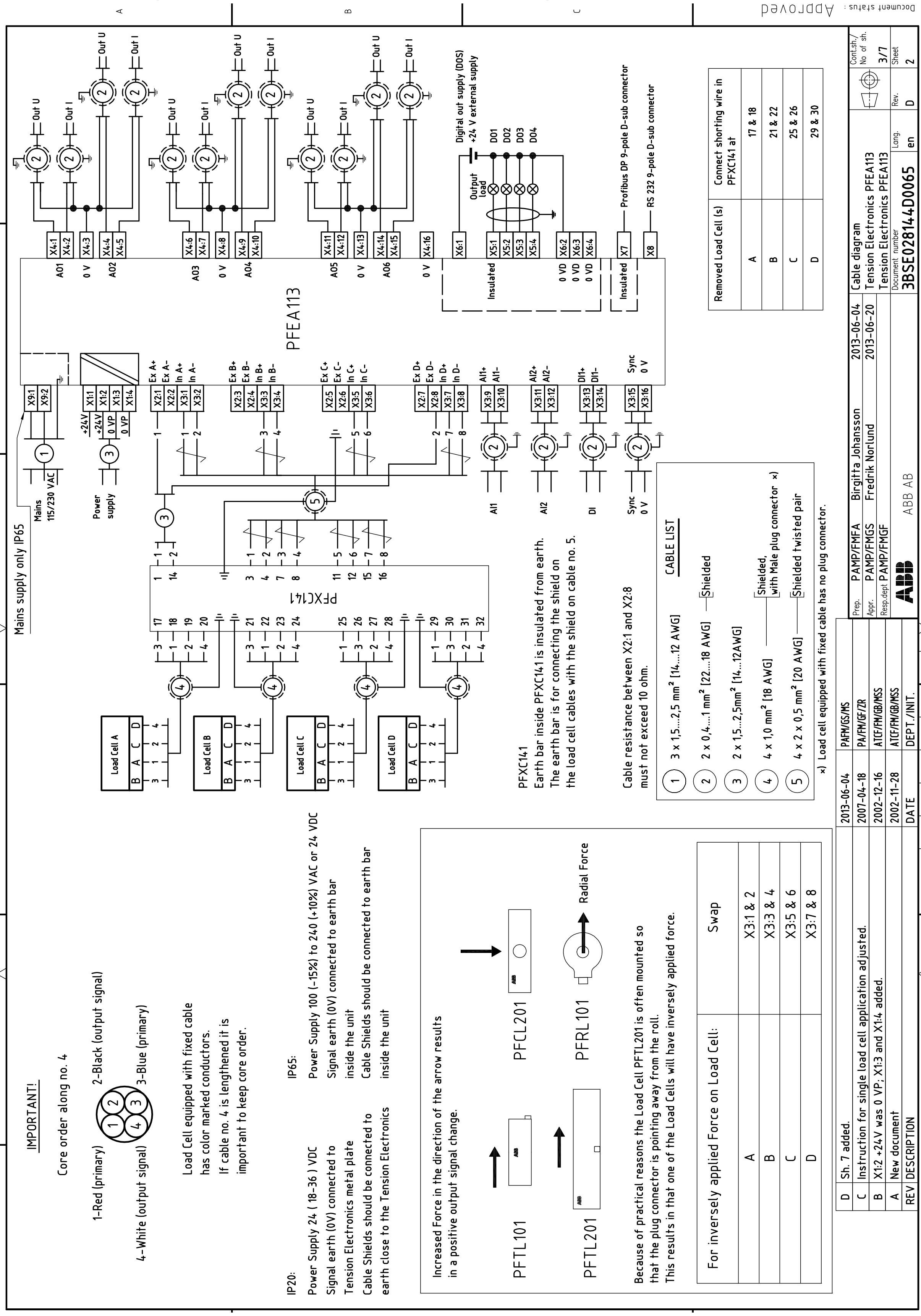
*Table D-2. Technical Data for Different Types of Load Cell PFRL 101*

| PFRL 101 | Type | Data | Unit |
|---|---|---|---|
| **Material** | A B C D | SS 2387 stainless steel, DIN X4CrNiMo 16 5. Corrosion resistance properties similar to AISI 304. | |
| **Accuracy** | | | % |
| Accuracy class | | ± 0.5 | |
| Repeatability error | | < ± 0.1 | |
| **Compensated temperature range** | | +20 - +80 (68 - 176) | °C (°F) |
| Zero point drift | | 150 (83) | ppm/K (ppm/°F) |
| Sensitivity drift | | 150 (83) | |
| **Working temperature range** | | –10 - +80 (14 - 176) | °C (°F) |
| Zero point drift | | 300 (167) | ppm/K (ppm/°F) |
| Sensitivity drift | | 300 (167) | |
| **Storage temperature range** | | –40 - +80 (–40 - 176) | °C (°F) |

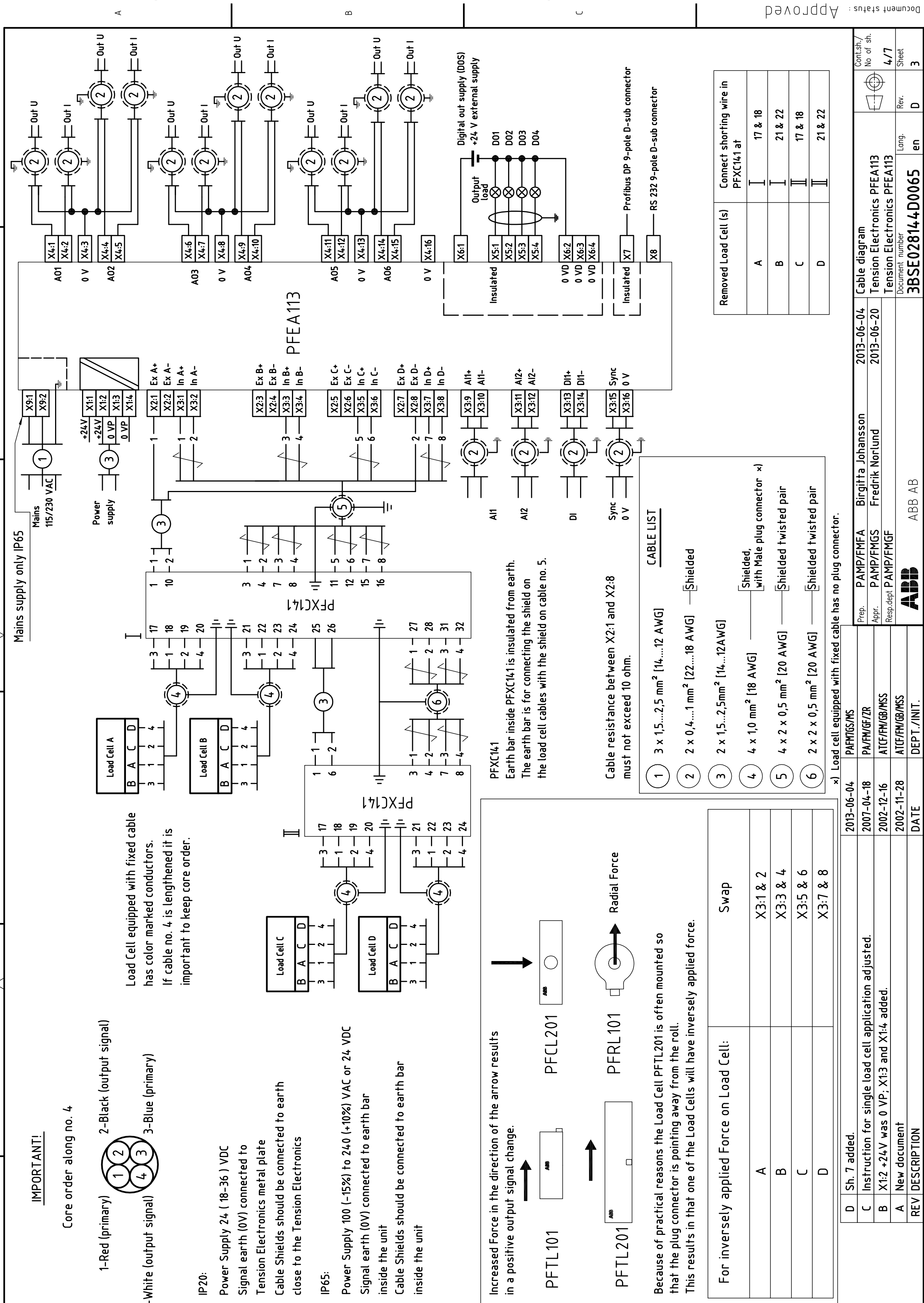
## D.10 Cable Diagram, 3BSE028144D0065, Page 1/7, Rev. D



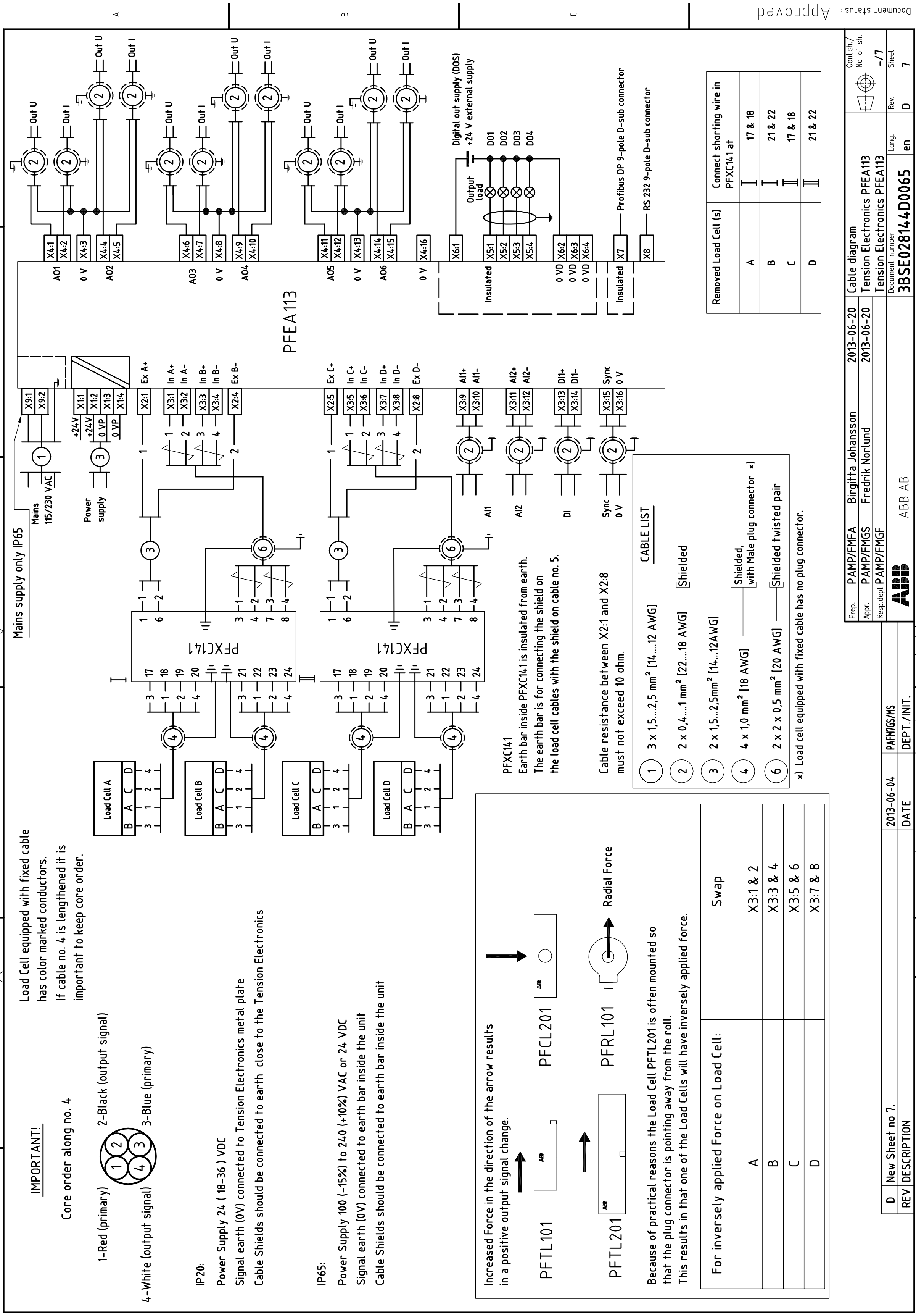
## D.11 Cable Diagram, 3BSE028144D0065, Page 2/7, Rev. D



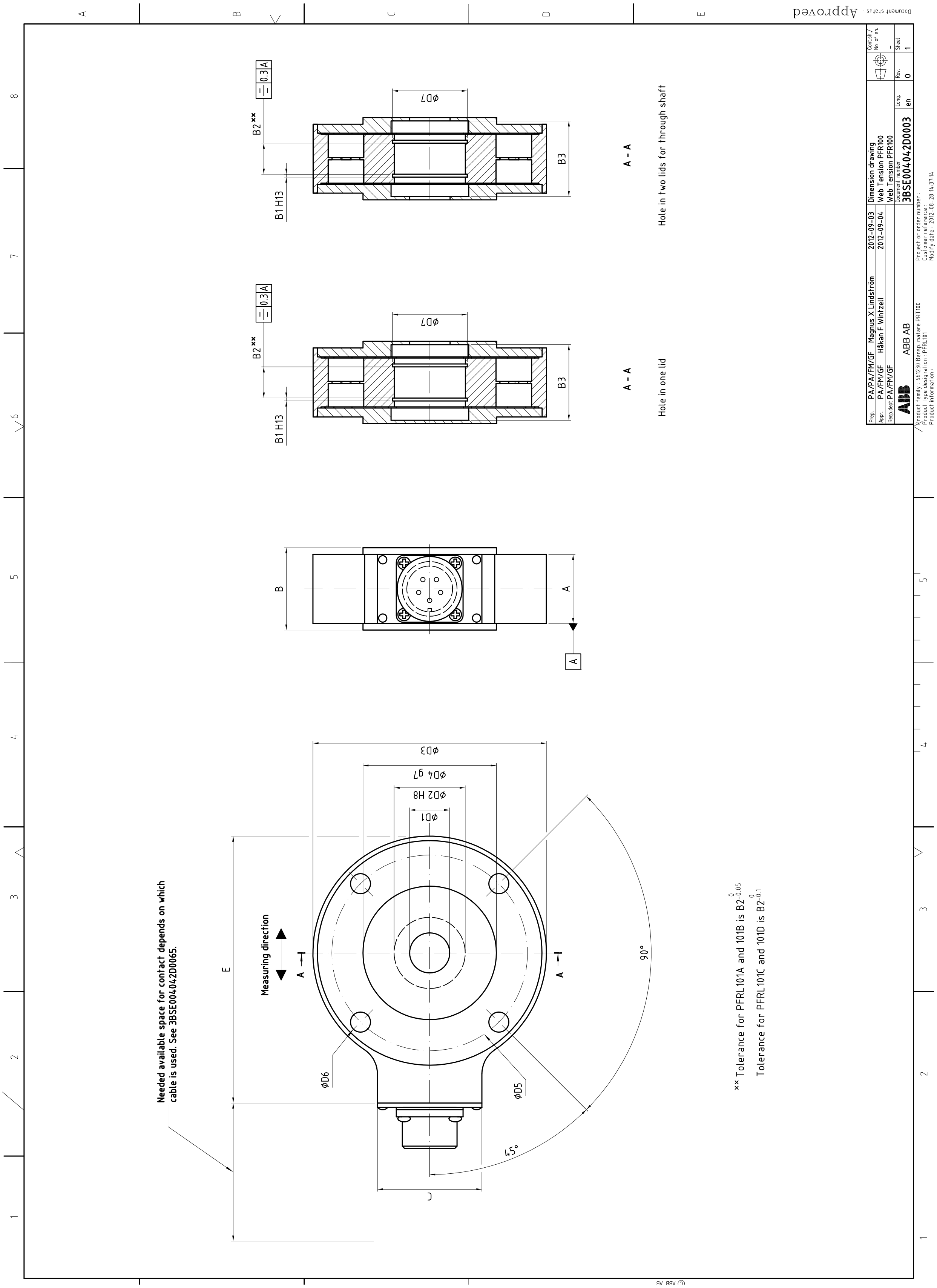
# D.12 Cable Diagram, 3BSE028144D0065, Page 3/7, Rev. D



## D.13 Cable Diagram, 3BSE028144D0065, Page 7/7, Rev. D



# D.14 Dimension Drawing 3BSE004042D0003, page 1/2, rev. O



# D.15 Dimension Drawing, 3BSE004042D0003, page 2/2, rev. O

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New document | 94-05-20 | SEISY/AGK/ML |
| A | Dim. D7, B1 and B2 added | 95-06-20 | SEISY/AGK/TH |
| B | Dim. A, B, for LC 2.0 and 5.0 adjusted | 95-08-18 | SEISY/AGK/TH |
| C | New versions included in table; Format was A3 | 95-09-28 | SEISY/AGK/TH |
| D | New versions incl. 3BSE002963R2 and 3BSE002968R2 | 96-03-06 | SEISY/AGK/TH |
| E | Ø D1 for 3BSE002968R1/R2 was 63 | 96-03-18 | SEISY/AGK/TH |
| F | Bearing recommendation incl. | 96-06-20 | SEISY/AGK/TH |
| G | Sheet 2 added; B3 added; | 96-09-09 | SEISY/AGK/MW |
| G | Versions hole in two lids for through shaft add. | 96-09-09 | SEISY/AGK/MW |
| H | Cyl. roller bearing,Single row ball bearing removed from list | 97-02-24 | SEISY/AGK/JK |
| H | 3BSE002963R0001-R0011,3BSE002968R0001-0011 removed from list | 97-02-24 | SEISY/AGK/JK |
| H | 3BSE002958R (0004w. 0002),(0014 w. 0012),(0005 w. 0003), (0015 w. 0 013) | 97-02-24 | SEISY/AGK/JK |
| H | 3BSE002963R (0502 w. 0501),(0512 w. 0511),(1002 w. 1001),(1012 w. 1011) | 97-02-24 | SEISY/AGK/JK |
| H | 2204 was 1303(d=17) 1204 (d=20), 2205 was 1304(d =20) 1205( d=25) | 97-02-24 | SEISY/AGK/JK |
| H | 22205 was 21304,2208 was 1307, 22208 was 21307. | 97-02-24 | SEISY/AGK/JK |
| H | New version PFRL101D-5.0kN Ø125 , PFRL101D-5,0kN - Ø110 add. | 97-02-24 | SEISY/AGK/JK |
| J | New version 3BSE002950R0004,R0014 | 98-01-22 | SEISY/AGK/JK |
| K | Bearing tolerances changed H8 was G8 | 99-02-10 | SEAPR/AGB/JK |
| L | Hole for Light Roll Pin removed | 99-11-29 | SEAPR/AGB/JRK |
| L | Tolerance for A-dimension removed. | 99-11-29 | SEAPR/AGB/JRK |
| L | A-dimension for PFRL 101A and 101B changed | 99-11-29 | SEAPR/AGB/JRK |
| M | A-dimension for PFRL 101A and 101B changed. Tol. for ØD4 changed. | 00-02-23 | SEAPR/AGB/JRK |
| M | Tolerance for B2-dimension changed. | 00-02-23 | SEAPR/AGB/JRK |
| N | 3BSE002950R0006 and 3BSE002958R0006 included. | 01-11-06 | ATIC/FM/GB/JRK |
| N | "E" shows another dimension. | 01-11-06 | ATIC/FM/GB/JRK |
| O | Art. nr. 3BSE002950R24 and 3BSE002958R24 added in table. | 12-08-28 | PA/FM/GF/ML |
| O | Note ×× added. Doc. title Web Tension PFR100 was PFR100 Tensiometers | 12-08-28 | PA/FM/GF/ML |

| Dimensions | | | | | | | | | | | | | | | | | | Bearing recommendations d = shaft diameter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Article number × | Type designation | Fnom kN | ØD1 | ØD2 | ØD3 | ØD4 | A | B | C | E | ØD5 | ØD6 | ØD7 | B1 | B2 | B3 | | Self aligned ball bearing | Spherial roller bearing |
| 3BSE002950R0001<br>3BSE002950R0011 | PFRL 101A-0,5kN Ø32 B2=14 | 0,5 | 18 | 32 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 33.7H12 | 1.3 | 14 | 34 | | 2201 (d=12) | |
| 3BSE002950R0002<br>3BSE002950R0012 | PFRL 101A-0,5kN Ø35 B2=14 | 0,5 | 23 | 35 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 37 H12 | 1.6 | 14 | 34 | | 2202 (d=15) | |
| 3BSE002950R0003<br>3BSE002950R0013 | PFRL 101A-0,5kN Ø40 B2=16 | 0,5 | 23 | 40 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 42.5H12 | 1.85 | 16 | 34 | | 2203 (d=17) | |
| 3BSE002950R0004<br>3BSE002950R0014 | PFRL 101A-0,5kN Ø35 B2=11 | 0,5 | 23 | 35 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 37 H12 | 1.6 | 11 | 34 | | 1202 (d=15) | |
| 3BSE002950R0024 | PFRL 101A-0,5kN Ø35 B2=11 | 0,5 | ××<br>23/35 | 35 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 37 H12 | 1.6 | 11 | 34 | | 1202 (d=15) | |
| 3BSE002950R0006 | PFRL 101A-0,5kN Ø40<br>for Dead Shaft Application | 0,5 | 23 | 40 | 105 | 60 | 32 | 37 | 47 | 120 | 88 | 9 | 42.5H12 | 1.85 | 16 | 34 | | Bearing (2203) is included in the Dead Shaft Adapter Kit | |
| 3BSE002958R0001<br>3BSE002958R0011 | PFRL 101B-1,0kN Ø40 | 1,0 | 23 | 40 | 125 | 60 | 32 | 37 | 47 | 140 | 106 | 9 | 42.5H12 | 1.85 | 16 | 34 | | 2203 (d=17) | |
| 3BSE002958R0004<br>3BSE002958R0014<br>3BSE002958R0024 | PFRL 101B-1,0kN Ø47 | 1,0 | 30 | 47 | 125 | 60 | 32 | 37 | 47 | 140 | 106 | 9 | 49.5H12 | 1.85 | 18 | 34 | | 2204 (d=20) | |
| 3BSE002958R0005<br>3BSE002958R0015 | PFRL 101B-1,0kN Ø52 | 1,0 | 33 | 52 | 125 | 60 | 32 | 37 | 47 | 140 | 106 | 9 | 55H12 | 2.15 | 18 | 34 | | 2205 (d=25) | 22205 (d=25) |
| 3BSE002958R0006 | PFRL 101B-1,0kN Ø40<br>for Dead Shaft Application | 1,0 | 23 | 40 | 125 | 60 | 32 | 37 | 47 | 140 | 106 | 9 | 42.5H12 | 1.85 | 16 | 34 | | Bearing (2203) is included in the Dead Shaft Adapter Kit | |
| 3BSE002963R0502<br>3BSE002963R0512 | PFRL 101C-0,5kN | 0,5 | 56 | 80 | 175 | 100 | 44 | 50 | 47 | 190 | 152 | 11 | 83.5H12 | 2.65 | 23 | 46 | | | |
| 3BSE002963R1002<br>3BSE002963R1012 | PFRL 101C-1,0kN | 1,0 | 56 | 80 | 175 | 100 | 44 | 50 | 47 | 190 | 152 | 11 | 83.5H12 | 2.65 | 23 | 46 | | 2208 (d=40) | 22208 (d=40) |
| 3BSE002963R0002<br>3BSE002963R0012 | PFRL 101C-2,0kN | 2,0 | 56 | 80 | 175 | 100 | 44 | 50 | 47 | 190 | 152 | 11 | 83.5H12 | 2.65 | 23 | 46 | | | |
| 3BSE002968R0002<br>3BSE002968R0012 | PFRL 101D-5,0kN Ø110 | 5,0 | 77 | 110 | 225 | 130 | 50 | 56 | 47 | 240 | 200 | 14 | 114H13 | 4.15 | 28 | 52 | | 2212 (d=60) | 22212 (d=60) |
| 3BSE002968R0003<br>3BSE002968R0013 | PFRL 101D-5,0kN Ø125 | 5,0 | 77 | 125 | 225 | 130 | 50 | 56 | 47 | 240 | 200 | 14 | 129H13 | 4.15 | 31 | 52 | | 2214 (d=70) | 22214 (d=70) |

× Hole in one lid 3BSE00_ _ _ _R_ _0_

Hole in two lids for through shaft 3BSE00_ _ _ _R_ _1_

×× Hole in two lids with different hole dimensions.

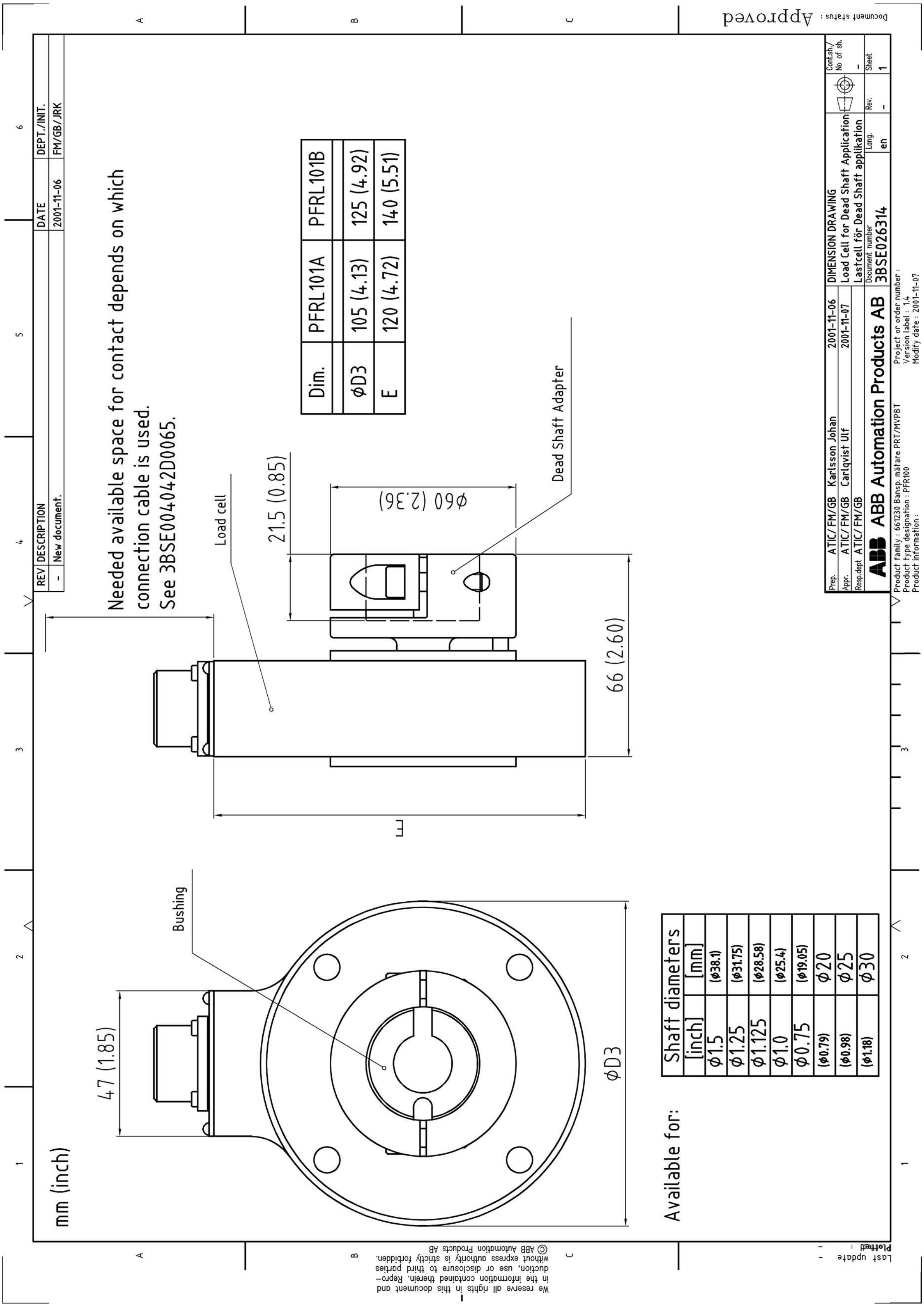
Units: mm

| | | | | | | |
|---|---|---|---|---|---|---|
| Prep. | PA/PA/FM/GF | Magnus X Lindström | 2012-09-03 | Dimension drawing | | Cont.sh./ No of sh |
| Appr. | PA/FM/GF | Håkan F Wintzell | 2012-09-04 | Web Tension PFR100 | | |
| Resp.dept | PA/FM/GF | | | Web Tension PFR100 | | - |
| ABB | ABB AB | | | Document number 3BSE004042D0003 | Lang. en | Rev. 0 / Sheet 2 |

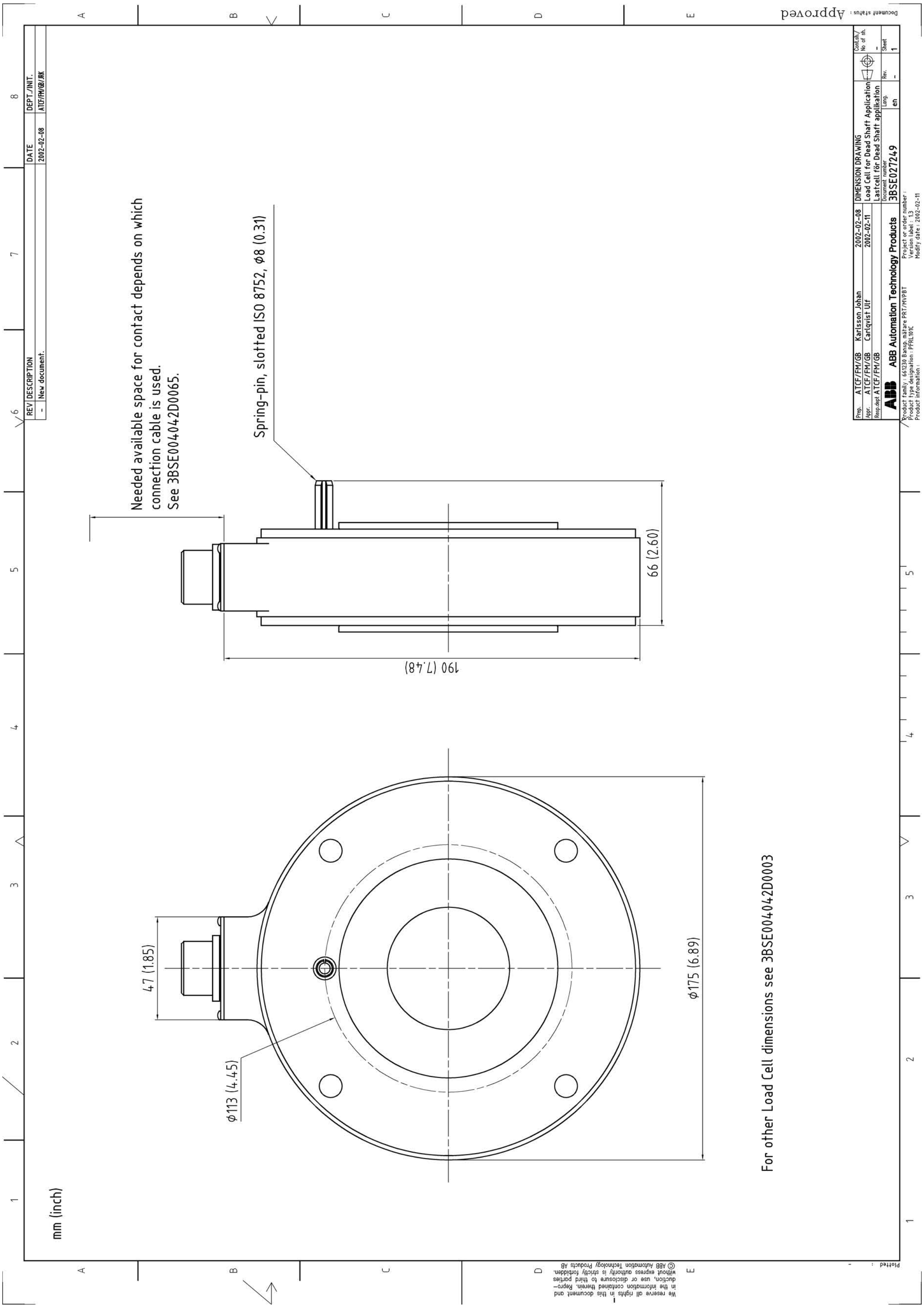
Product family : 661230 Bansp. mätare PRT100
Product type designation : PFRL101
Product information :

Project or order number :
Customer reference :
Modify date : 2012-08-28 14:23:38

## D.16 Dimension Drawing, 3BSE026314, Rev. -



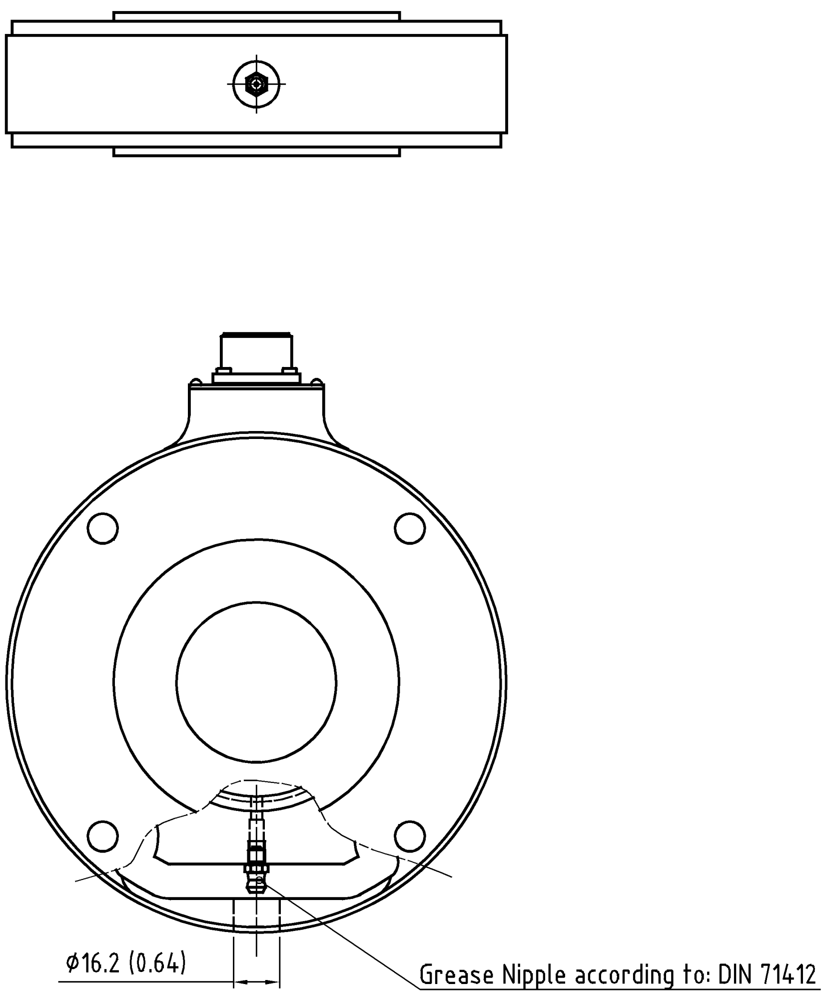
## D.17 Dimension Drawing, 3BSE027249, Rev. -



## D.18 Dimension Drawing, 3BSE004042D0066, Rev. -

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New document. | 2001-12-13 | ATCF/FM/GB/JRK |

mm [inch]




For Load Cell dimensions see: Dimension drawing 3BSE004042D0003



| | | | | | | |
|---|---|---|---|---|---|---|
| Prep. ATCF/FM/GB | Karlsson Johan | 2001-12-13 | DIMENSION DRAWING | | | Cont.sh./ No of sh. |
| Appr. ATCF/FM/GB | Carlqvist Ulf | 2001-12-18 | PRT with Grease Nipple | | | |
| Resp.dept ATCF/FM/GB | | | PRT med smörjnippel | | | - |
| ABB | ABB Automation Technology Products | | Document number 3BSE004042D0066 | Lang. en | Rev. - | Sheet 1 |

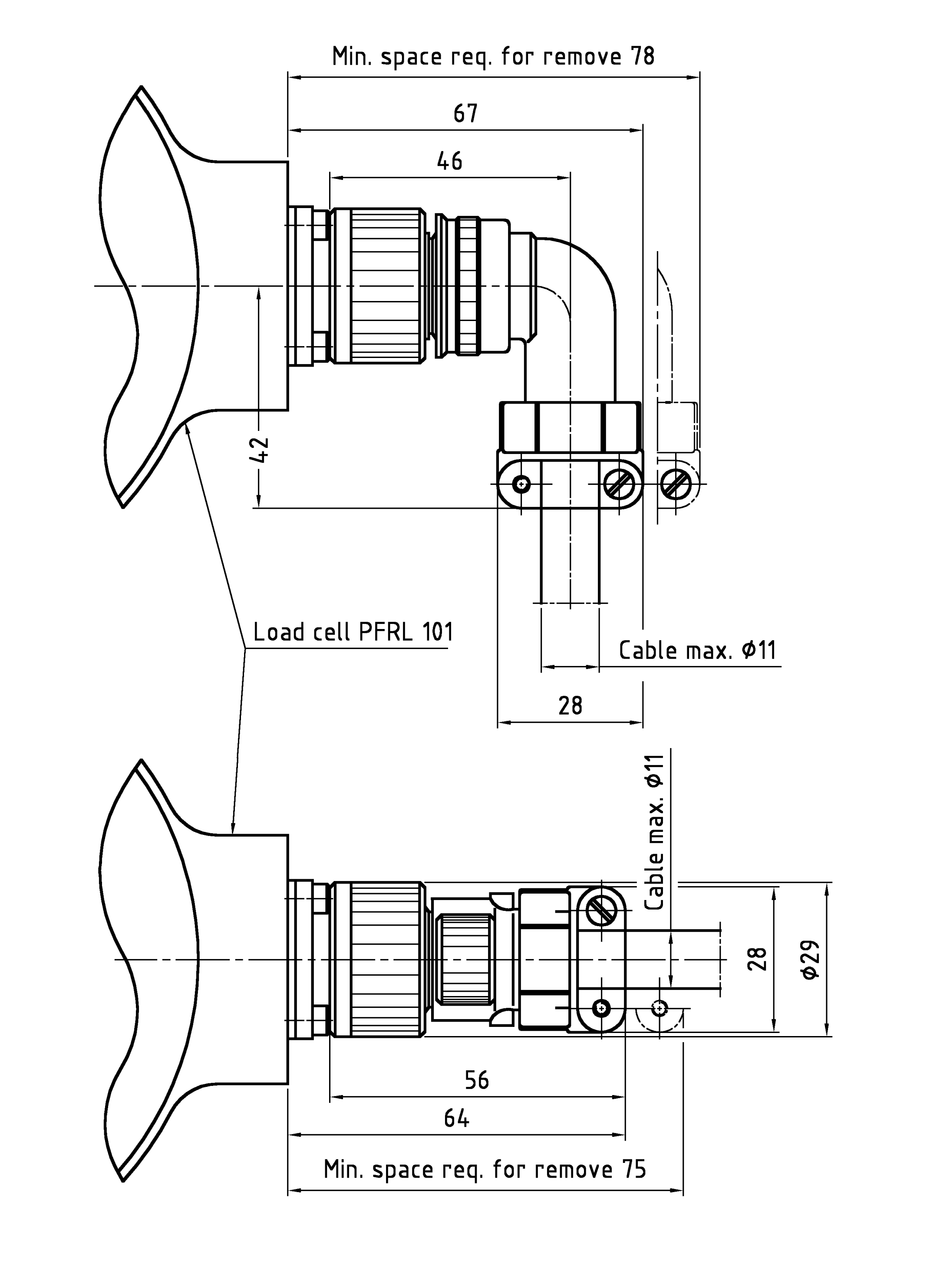
Plotted : -

Document status : Approved

Product family : 661230 Bansp. mätare PRT/MVPBT
Product type designation : PFRL101
Product information :
Project or order number :
Version label : 1.3
Modify date : 2001-12-18

## D.19 Dimension Drawing, 3BSE004042D0065, rev. -

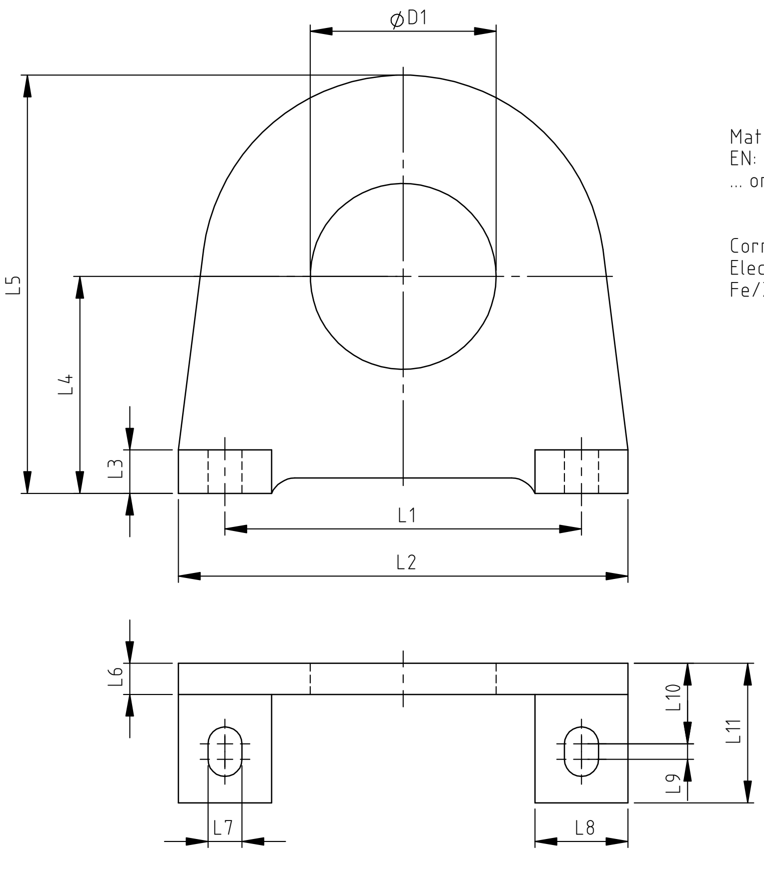
| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | Nytt dokument | 1999-06-16 | SEAPR/AGB/MH |




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | SEAPR/AGB | Wärme Magnus SE | 1999-06-16 | DIMENSION DRAWING<br>Angular and straight plug contact<br>PFRL 101 | | | Cont.sh./<br>No of sh.<br>- |
| Appr. | SEAPR/AGB | Carlqvist Ulf | | | | | |
| Resp.dept | SEAPR/AGB | | | | | | |
| ABB Automation Products AB | | | | Document number<br>3BSE004042D0065 | Lang.<br>en | Rev.<br>- | Sheet<br>1 |

# D.20 Dimension Drawing, 3BSE010457, Rev. B

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New drawing | 96-06-28 | SEISY/AGK/TH |
| A | New material, corrosion protection and template. Updated dimensions. | 2002-06-13 | ATCF/FM/GB/JRK |
| B | CAD-format changed to SolidWorks. Material number of DIN NF BS and SS deleted. | 2014-02-04 | PAMP/FMGF/HG |




Material: B
EN: S355MC, S355 J2G3
... or equivalent steel.

Corrosion protection:
Electro-zinkplated
Fe/Zn 12C4

| Art. no. | Load cell type | ØD1 H8 | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | L9 | L10 | L11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3BSE003694R0001 | PFRL101A PFRL101B | 60 | 115±0,2 | 145 | 12,5 | 70±0,1 | 135 | 10±0,2 | 11 | 30 | 5 | 28 | 45 |
| 3BSE003695R0001 | PFRL101C | 100 | 195±0,2 | 240 | 22 | 100±0,1 | 190 | 18,5±0,2 | 14 | 45 | 10 | 40,5 | 65 |
| 3BSE003696R0001 | PFRL101D | 130 | 240±0,2 | 285 | 30 | 120±0,1 | 235 | 23,5±0,2 | 17,5 | 45 | 10 | 45,5 | 70 |



| | | | | | | |
|---|---|---|---|---|---|---|
| Prep. | PAMP/FMGF | Hongmei Gao | 2014-02-04 | Dimension drawing | | Cont.sh./ No of sh. |
| Appr. | PAMP/FMGF | Håkan F Wintzell | 2014-02-07 | Bracket for PFRL101 | | |
| Resp.dept | PAMP/FMGF | | | Vinkelkonsol för PFRL101 | | 1 |
| ABB | | ABB AB | | Document number 3BSE010457 | Lang. en | Rev. B / Sheet 1 |

Document status: Approved

# Appendix E PFTL 101 - Designing the Load Cell Installation

## E.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Dimension drawing(s)

## E.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

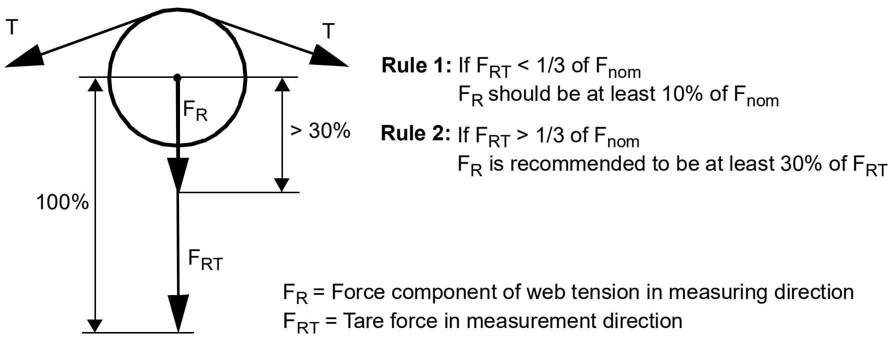
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

# E.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orient load cell so that the guidelines below are met:
   a. Try to achieve as large portion as possible no less than 10% of web tension, in the load cell measurement direction!
   b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
   c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
   d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
   This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
   For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




   e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

## E.4 Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.

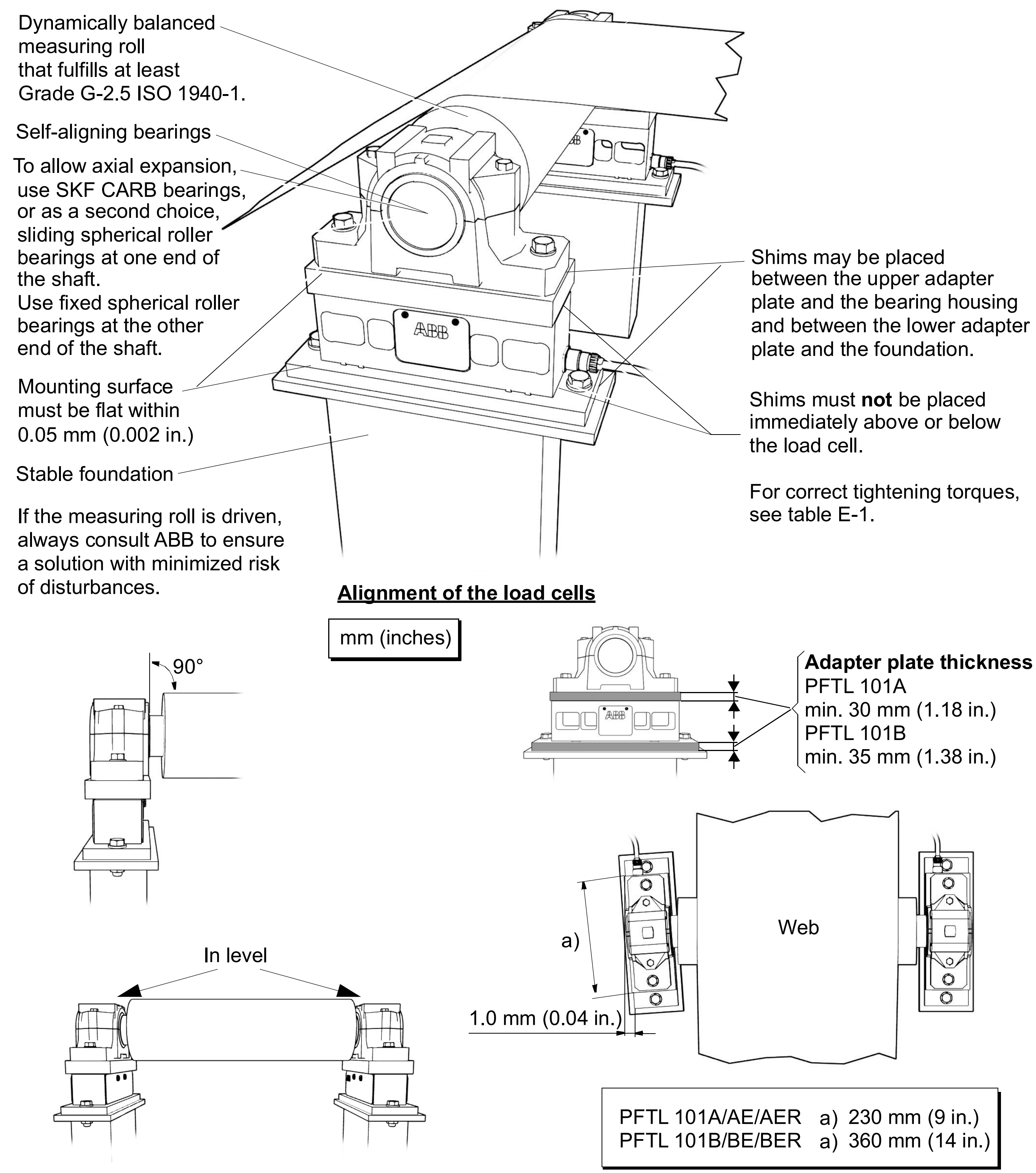
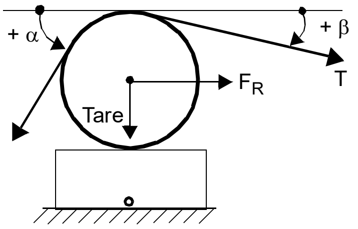



*Figure E-1. Installation Requirements*

# E.5 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

## E.5.1 Horizontal Mounting




$F_R = T \times (\cos\beta - \cos\alpha)$

$F_{RT} = 0$ (Tare force is not measured)

$F_{Rtot} = F_R + F_{RT} = T \times (\cos\beta - \cos\alpha)$

---

T (Tension) $=$ Wrap gain $\times F_R$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\cos\beta - \cos\alpha)}$$

$$\text{Wrap gain} = \frac{1}{\cos\beta - \cos\alpha}$$

In most cases, horizontal mounting is the most obvious and simplest solution. The load cell should thus be mounted horizontally when possible.

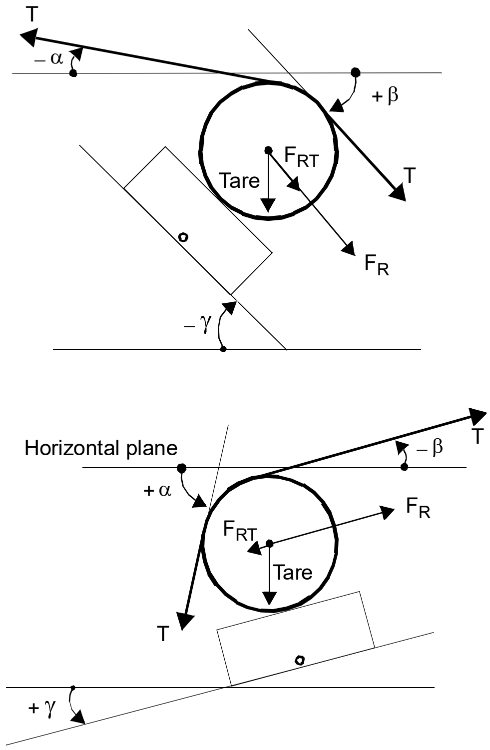
# E.5.2 Inclined Mounting

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or the need to have a sufficient force component applied to the load cell.

Inclined mounting adds a component of tare force in the measuring direction and modifies the force components as shown.

**NOTE**

**When calculating, it is important that the angles are set into the equations with the correct signs in relation to the horizontal plane.**




$F_R = T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)]$

$F_{RT} = -\,\text{Tare} \times \sin\gamma$

$F_{Rtot} = F_R + F_{RT} =$

$T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)] + (-\text{Tare} \times \sin\gamma)$

---

$\text{T (Tension)} = \text{Wrap gain} \times F_R$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\cos(\beta + \gamma) - \cos(\alpha - \gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\cos(\beta + \gamma) - \cos(\alpha - \gamma)}$$

## E.6 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll. The roll should nevertheless be supported at both ends.

### E.6.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the same calculations given in Section E.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain are valid.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

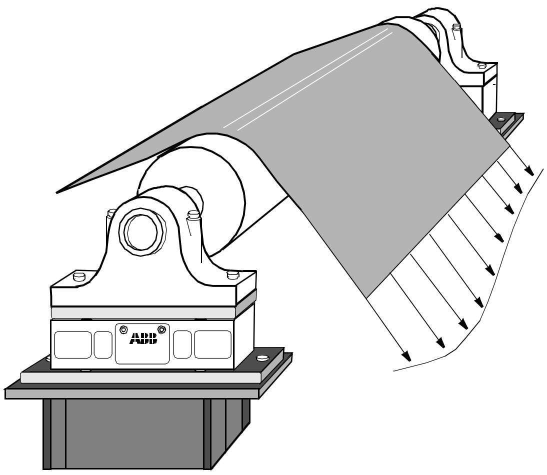
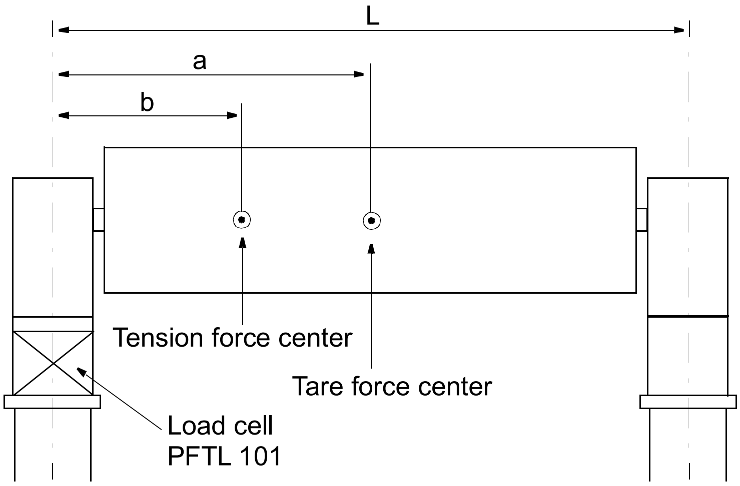


*Figure E-2. Cross-directional stress distribution*

## E.6.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline, see figure.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section E.5, Mounting Alternatives, Calculating Force and Calculating Wrap Gain.
3. Use the following equations:

$$F_R \text{ for single load cell} = F_R \times \frac{L-b}{L}$$

$$F_{RT} \text{ for single load cell} = F_{RT} \times \frac{L-a}{L}$$

$$F_{Rtot} \text{ for single load cell} = F_R \text{ for single load cell} + F_{RT} \text{ for single load cell}$$

where:

| | | |
|---|---|---|
| L | = | Distance between load cell centerline and the opposite bearing centerline |
| a | = | Distance between tare force center and load cell centerline |
| b | = | Distance between tension force center and load cell centerline |

# E.7 Mounting the Load Cells

The instructions below apply to a typical mounting arrangement. Variations are allowed, provided that the requirements of Section E.4, Installation Requirements are complied with.

If it is necessary to use tubular dowel pins to secure the position of the load cell, see instructions in Figure E-3.

1. Clean the foundation and other mounting surfaces.
2. Fit the lower adapter plate to the load cell.
   Tighten the screws to the torque stated in Table E-1.
3. Fit the load cell and the lower adapter plate to the foundation, but do not fully tighten the screws.
4. Fit the upper adapter plate to the load cell.
   Tighten the screws to the torque stated in Table E-1.
5. Fit the bearing housing and the roll to the upper adapter plate, but do not fully tighten the screws.

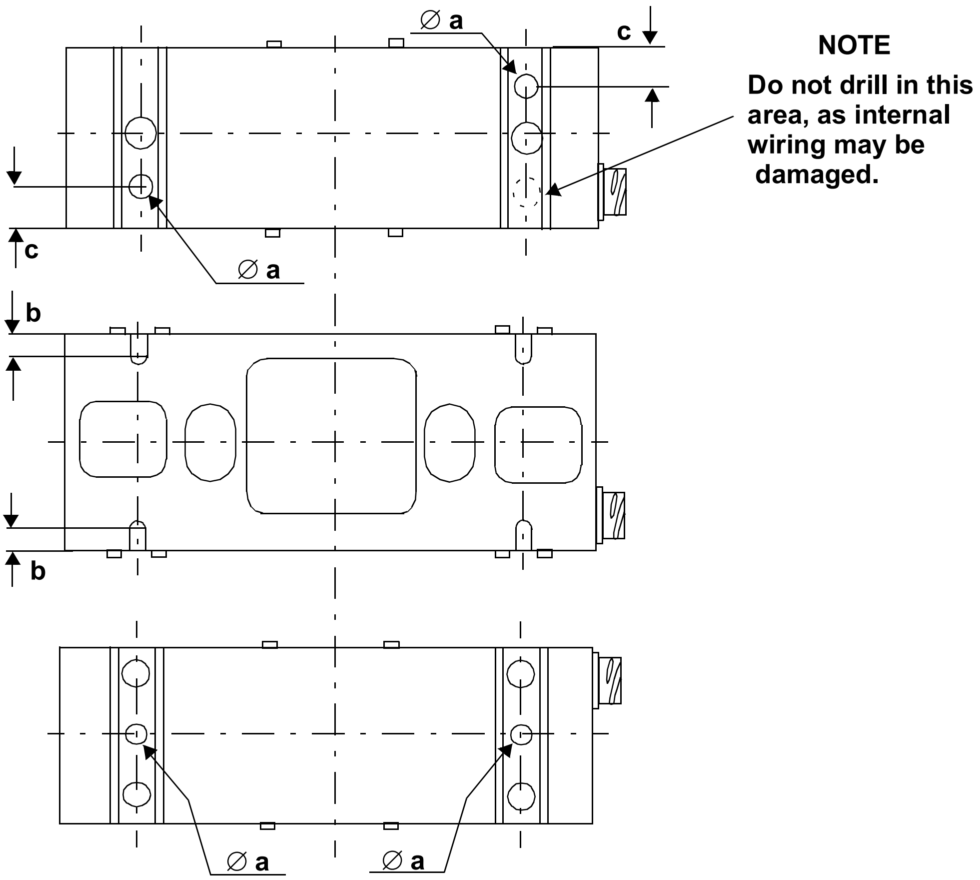
**CAUTION**

During this operation it is possible to over load the load cells if the operation is done not careful enough, especially if the roll is heavy. The most critical load cells are naturally the PFTL 101A-0.5 kN and PFTL 101B-2 kN. Applications with inclined mounting are most critical.

6. Adjust the load cells so that they are in parallel with each other and in line with the axial direction of the roll. Tighten the foundation screws, see Table E-1.
7. Adjust the roll so that it is at right angles to the longitudinal direction of the load cells. Tighten the screws in the upper adapter plate, see Table E-1.

*Table E-1. Tightening Torques for Load Cell PFTL 101*

| Alternative | Type of screws | Strength class | Type of lubrication | Dimension | Tightening torque [Nm] ± 5% |
|---|---|---|---|---|---|
| **1** (Recommended) | Alloyed steel screws Strength class according to ISO 898/1 | 12.9 | Oil | M12 | 136 Nm |
| | | | | M16 | 333 Nm |
| | | | | M20 | 649 Nm |
| **2** (Recommended) | Alloyed steel screws Strength class according to ISO 898/1 | 12.9 | $MoS_2$ | M12 | 117 Nm |
| | | | | M16 | 286 Nm |
| | | | | M20 | 558 Nm |
| **3** | Stainless steel (A2-80) or acid resistant steel (A4-80), Strength class according to ISO 3506 | A2-80 or A4-80 | Wax | M12 | 76 Nm |
| | | | | M16 | 187 Nm |
| | | | | M20 | 364 Nm |
| **4** | Stainless steel (A2-80) or acid resistant steel (A4-80), Strength class according to ISO 3506 | A2-80 or A4-80 | Oil or emulsion | M12 | 65 Nm |
| | | | | M16 | 161 Nm |
| | | | | M20 | 313 Nm |




| Load cell PFTL 101 | ∅ a | b | c | Tubular dowel pin |
|---|---|---|---|---|
| A/AE/AER | 8 | 15 | 15 | ∅ 8.4 |
| B/BE/BER | 12 | 15 | 20 | ∅ 12.5 |

*Figure E-3. Drilling Dowel Pin Holes*

## E.7.1 Routing the Load Cell Cable

The cable must be supported with clamps and routed to prevent force shunting through the cable.

## E.8 Technical Data

*Table E-2. Technical Data for Different Types of Load Cell PFTL 101*

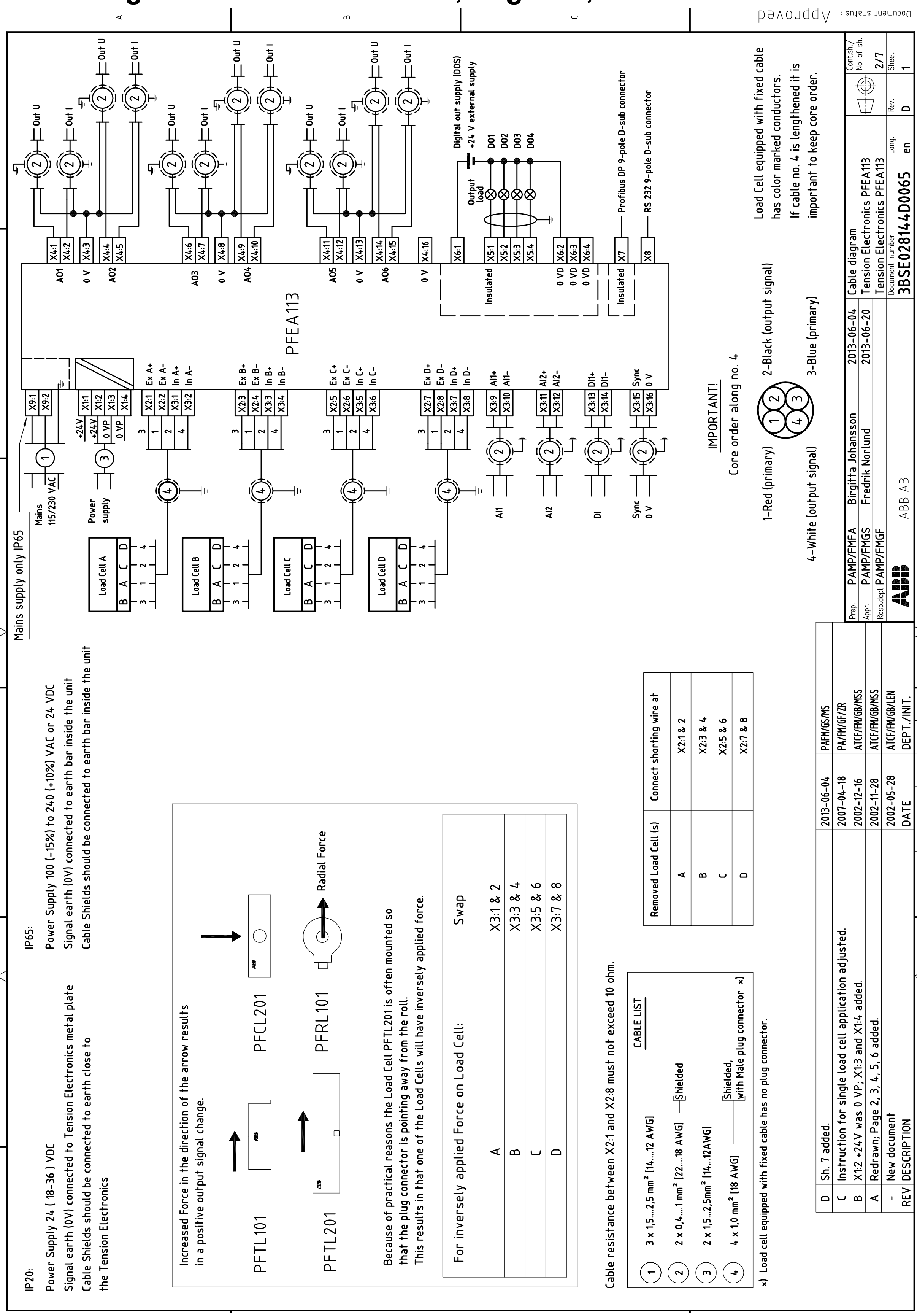
| PFTL 101 | Type | Data | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|
| **Nominal load** | | | | | | | | |
| Nominal load in measuring direction, $F_{nom}$ | A/AE/AER | 0.5 (112) | 1.0 (225) | 2.0 (450) | | | | kN (lbs) |
| | B/BE/BER | | | 2.0 (450) | 5.0 (1120) | 10.0 (2250) | 20.0 (4500) | |
| Permitted transverse load within the accuracy, $F_{Vnom}$ | A/AE/AER | 5 (1120) | 10 (2250) | 10 (2250) | | | | |
| | B/BE/BER | | | 30 (6740) | 30 (6740) | 30 (6740) | 40 (9000) | |
| Permitted axial load within the accuracy, $F_{Anom}$ | A/AE/AER | 2 (450) | 5 (1120) | 5 (1120) | | | | |
| | B/BE/BER | | | 5 (1120) | 10 (2250) | 10 (2250) | 10 (2250) | |
| **Overload capacity** | | | | | | | | |
| Max. load in measuring direction without permanent change of data, $F_{max}$ | A/AE/AER | 2.5 (562) | 5 (1120) | 10 (2250) | | | | |
| | B/BE/BER | | | 10 (2250) | 25 (5620) | 50 (11200) | 80 (18000) | |
| **Spring constant** | A/AE/AER | 32 (183) | 65 (372) | 130 (744) | | | | kN/mm (1000 lbs/in.) |
| | B/BE/BER | | | 130 (744) | 325 (1860) | 650 (3718) | 1300 (7440) | |
| **Mechanical data** | | | | | | | | |
| Length | A/AE/AER | 230 (9) | 230 (9) | 230 (9) | | | | mm (inch) |
| | B/BE/BER | | | 360 (14) | 360 (14) | 360 (14) | 360 (14) | |
| Width | A/AE/AER | 84 (3.3) | 84 (3.3) | 84 (3.3) | | | | |
| | B/BE/BER | | | 104 (4) | 104 (4) | 104 (4) | 104 (4) | |
| Height | A/AE/AER | 125 (5) | 125 (5) | 125 (5) | | | | |
| | B/BE/BER | | | 125 (5) | 125 (5) | 125 (5) | 125 (5) | |

*Table E-2. Technical Data for Different Types of Load Cell PFTL 101*

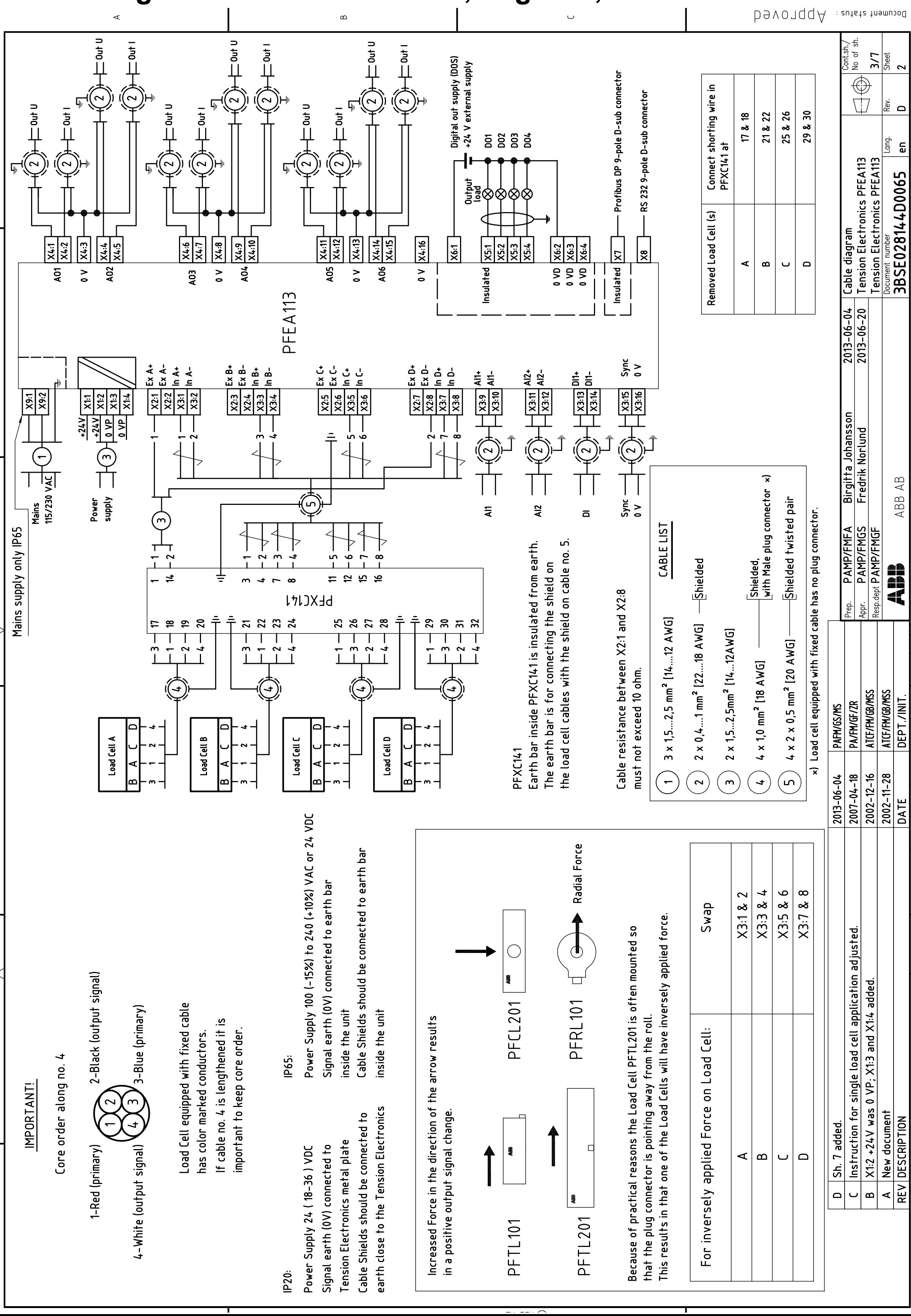
<table>
<tr><th>PFTL 101</th><th>Type</th><th colspan="6">Data</th><th>Unit</th></tr>
<tr><td rowspan="2">Weight</td><td>A/AE/AER</td><td>9<br>(20)</td><td>9<br>(20)</td><td>10<br>(22)</td><td></td><td></td><td></td><td rowspan="2">kg<br>(lbs)</td></tr>
<tr><td>B/BE/BER</td><td></td><td></td><td>20<br>(44)</td><td>21<br>(46)</td><td>21<br>(46)</td><td>23<br>(51)</td></tr>
<tr><td rowspan="2">Material</td><td>A/AE/B/BE</td><td colspan="7">Stainless steel:<br>SS 2383<br>DIN 17440 X12CrMoS17<br>Werkstoffnr 1.4104<br>AISI 430F</td></tr>
<tr><td>AER/BER</td><td colspan="7">Acid resistant steel:<br>SS 2348<br>DIN 17440 X2CrNiMo17 13 2<br>Werkstoffnr 1.4404<br>AISI 316L</td></tr>
<tr><td>Accuracy</td><td rowspan="12">A/AE/AER<br>B/BE/BER</td><td colspan="6"></td><td></td></tr>
<tr><td>Accuracy class</td><td colspan="6">± 0.5</td><td rowspan="4">%</td></tr>
<tr><td>Linearity deviation</td><td colspan="6">± 0.3</td></tr>
<tr><td>Repeatability error</td><td colspan="6">< ± 0.05</td></tr>
<tr><td>Hysteresis</td><td colspan="6"><0.2</td></tr>
<tr><td>Compensated temperature range</td><td colspan="6">+20 - +80 (68 - 176)</td><td>°C (°F)</td></tr>
<tr><td>Zero point drift</td><td colspan="6">30 / 80[1] (17 / 44[1])</td><td rowspan="2">ppm/K<br>(ppm/F)</td></tr>
<tr><td>Sensitivity drift</td><td colspan="6">150 (83)</td></tr>
<tr><td>Working temperature range</td><td colspan="6">–10 - +105 (14 - 221)</td><td>°C (°F)</td></tr>
<tr><td>Zero point drift</td><td colspan="6">50 / 100[1] / (28 / 56[1])</td><td rowspan="2">ppm/K<br>(ppm/F)</td></tr>
<tr><td>Sensitivity drift</td><td colspan="6">250 (139)</td></tr>
<tr><td>Storage temperature range</td><td colspan="6">–40 - +105 (–40 - +105)</td><td>°C (°F)</td></tr>
<tr><td>Degree of protection</td><td>A/B<br>AE/BE<br>AER/BER</td><td colspan="2">IP 65<br>IP 66<br>IP 66/67</td><td colspan="5">According. to EN 60 529</td></tr>
</table>

(1) PFTL 101AER -0.5 kN/ -1.0 kN

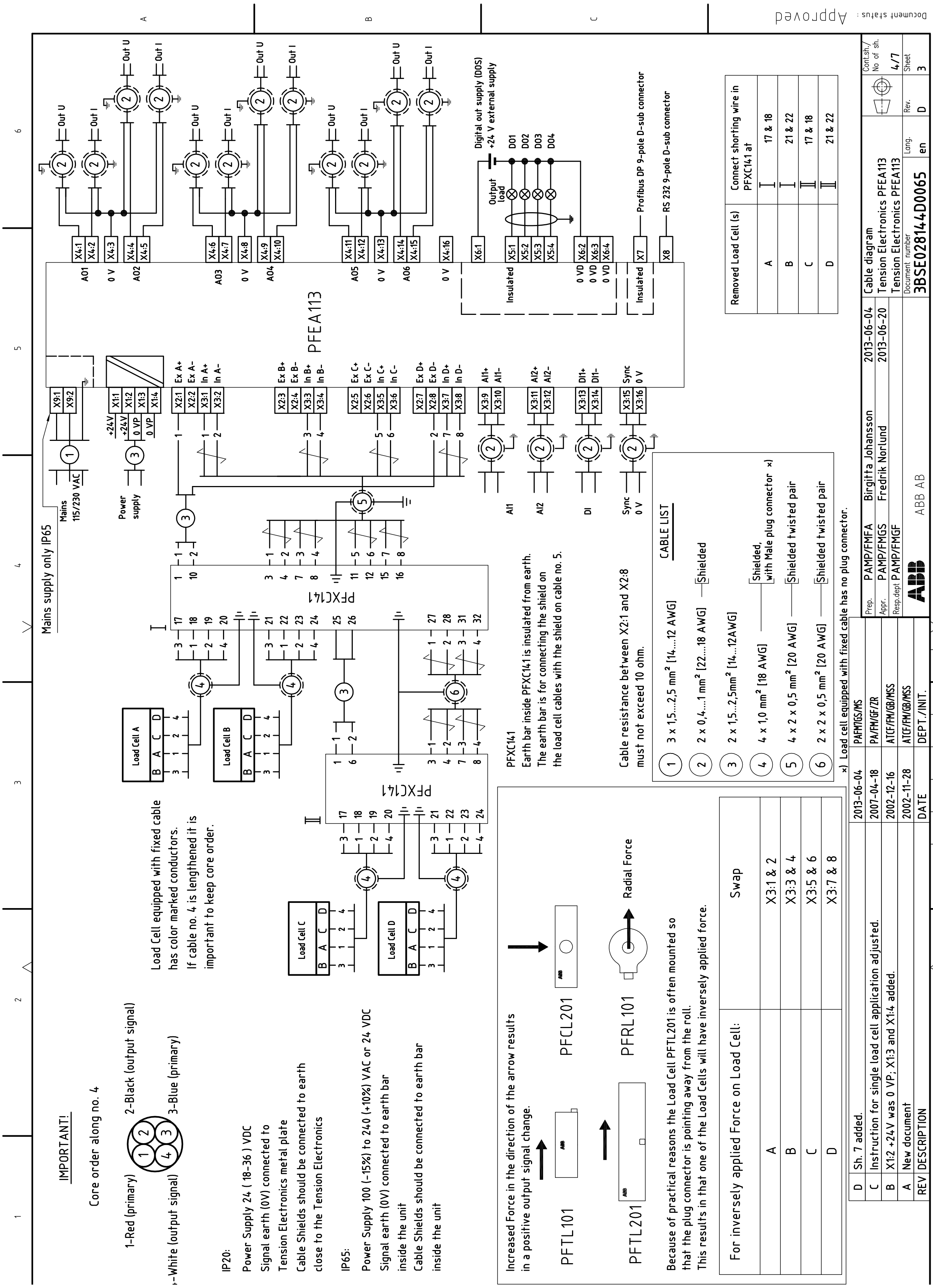
# E.9 Cable Diagram 3BSE028144D0065, Page 1/7, Rev. D



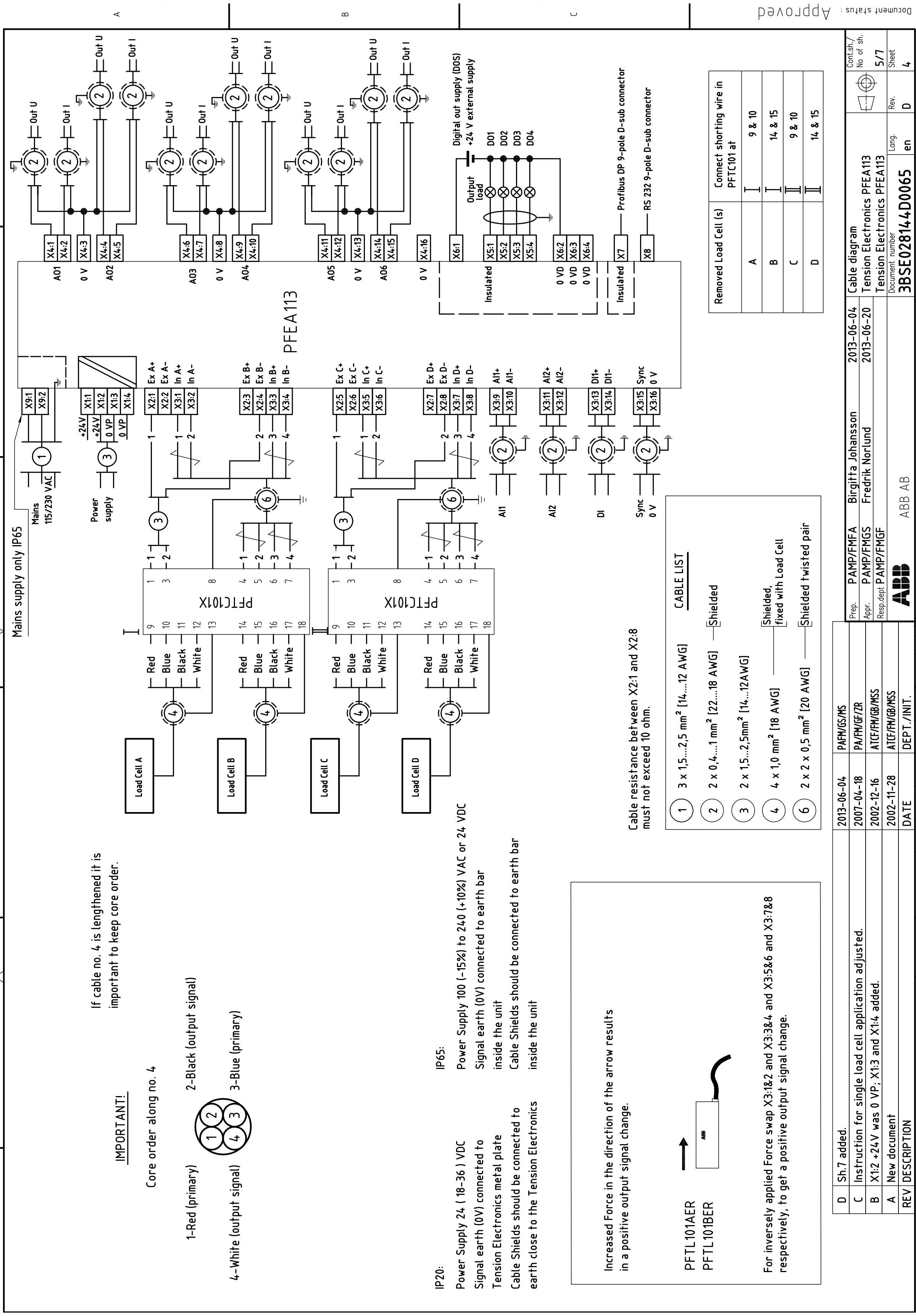
## E.10 Cable Diagram 3BSE028144D0065, Page 2/7, Rev. D



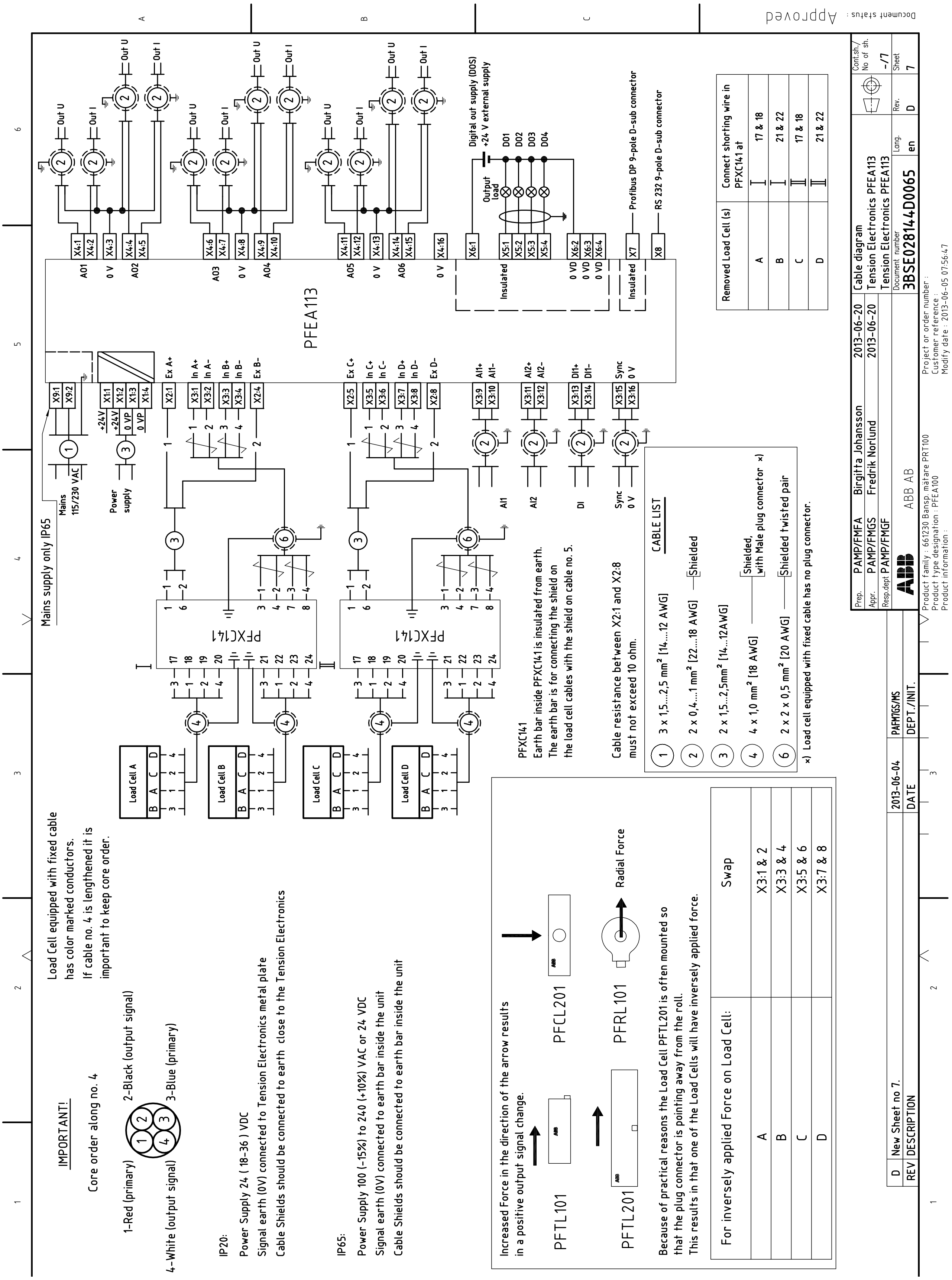
## E.11 Cable Diagram 3BSE028144D0065, Page 3/7, Rev. D



## E.12 Cable Diagram 3BSE028144D0065, Page 4/7, Rev. D

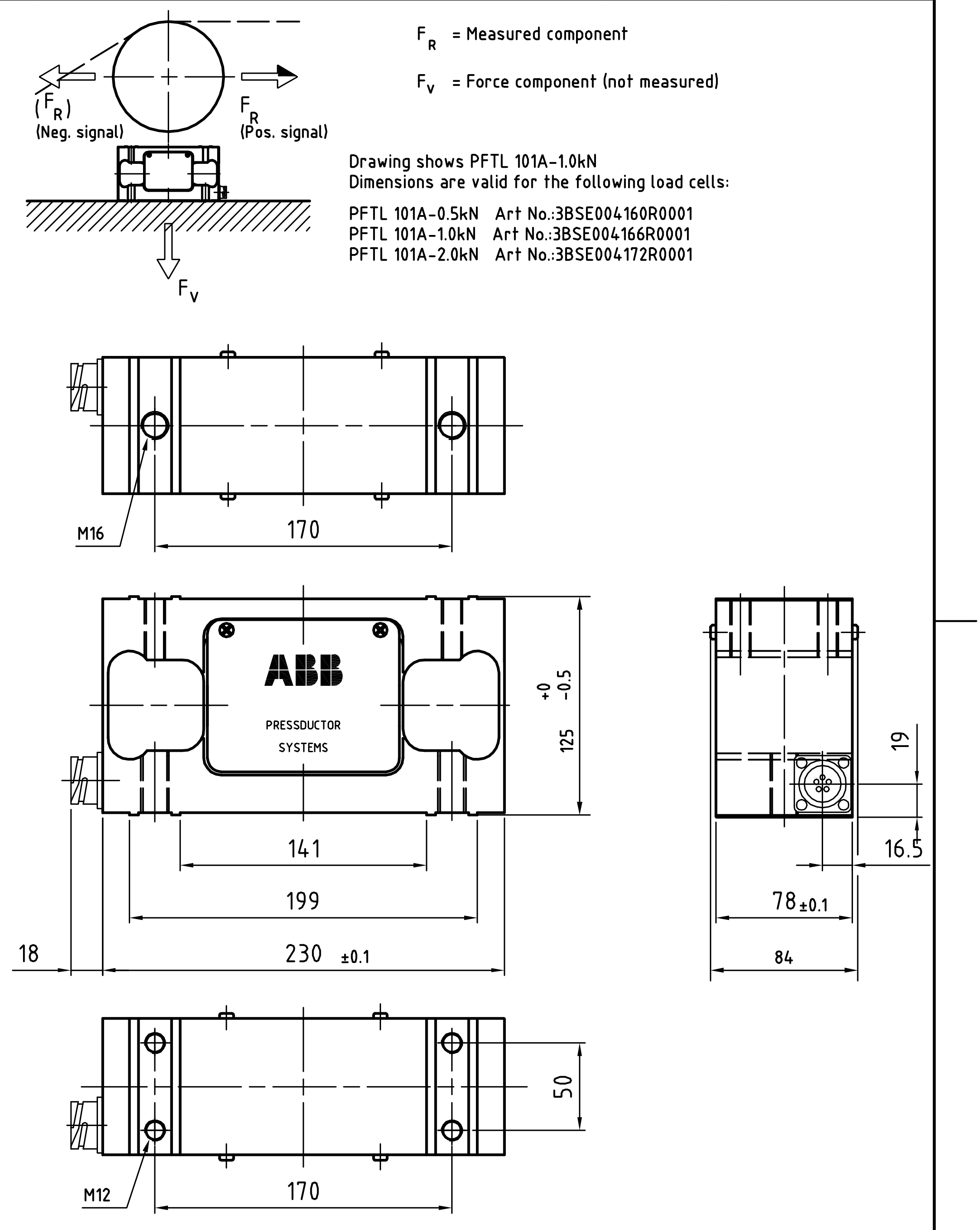


# E.13 Cable Diagram 3BSE028144D0065, Page 7/7, Rev. D



# E.14 Dimension Drawing, 3BSE004171, Rev. B

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New document | 93-07-07 | SEAUT/AGK/RoK |
| A | Tolerance and text add. | 94-10-18 | SEISY/AGK/ÅP |
| B | Connector moved. Text (Neg. signal) and (Pos. signal) added. | 2002-01-08 | ATCF/FM/GB/LEN |

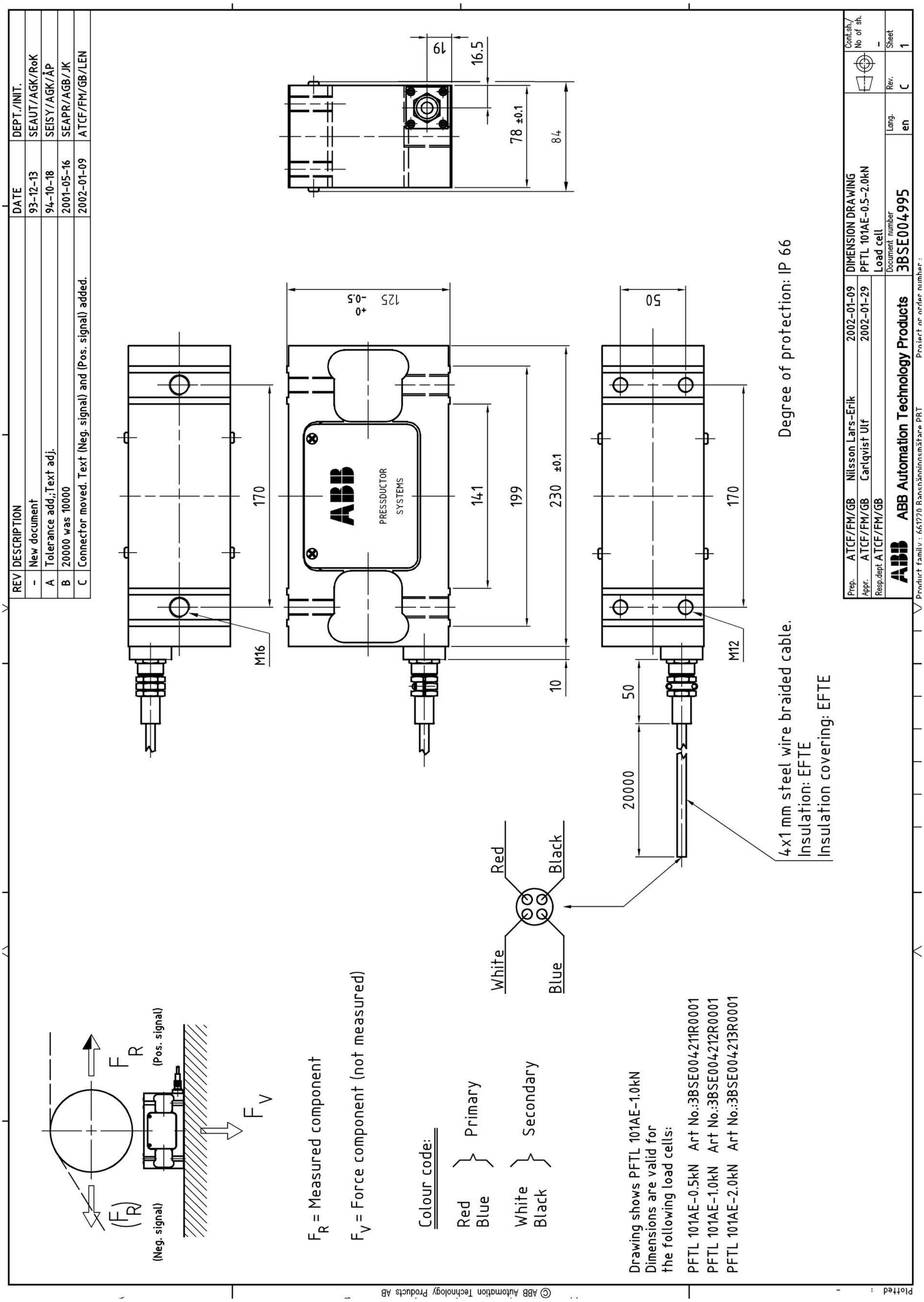



| | | | | |
|---|---|---|---|---|
| Prep. | ATCF/FM/GB | Nilsson Lars-Erik | 2002-01-08 | DIMENSION DRAWING |
| Appr. | ATCF/FM/GB | Carlqvist Ulf | 2002-01-29 | PFTL 101A-0.5-2.0kN |
| Resp.dept | ATCF/FM/GB | | | Load cell |

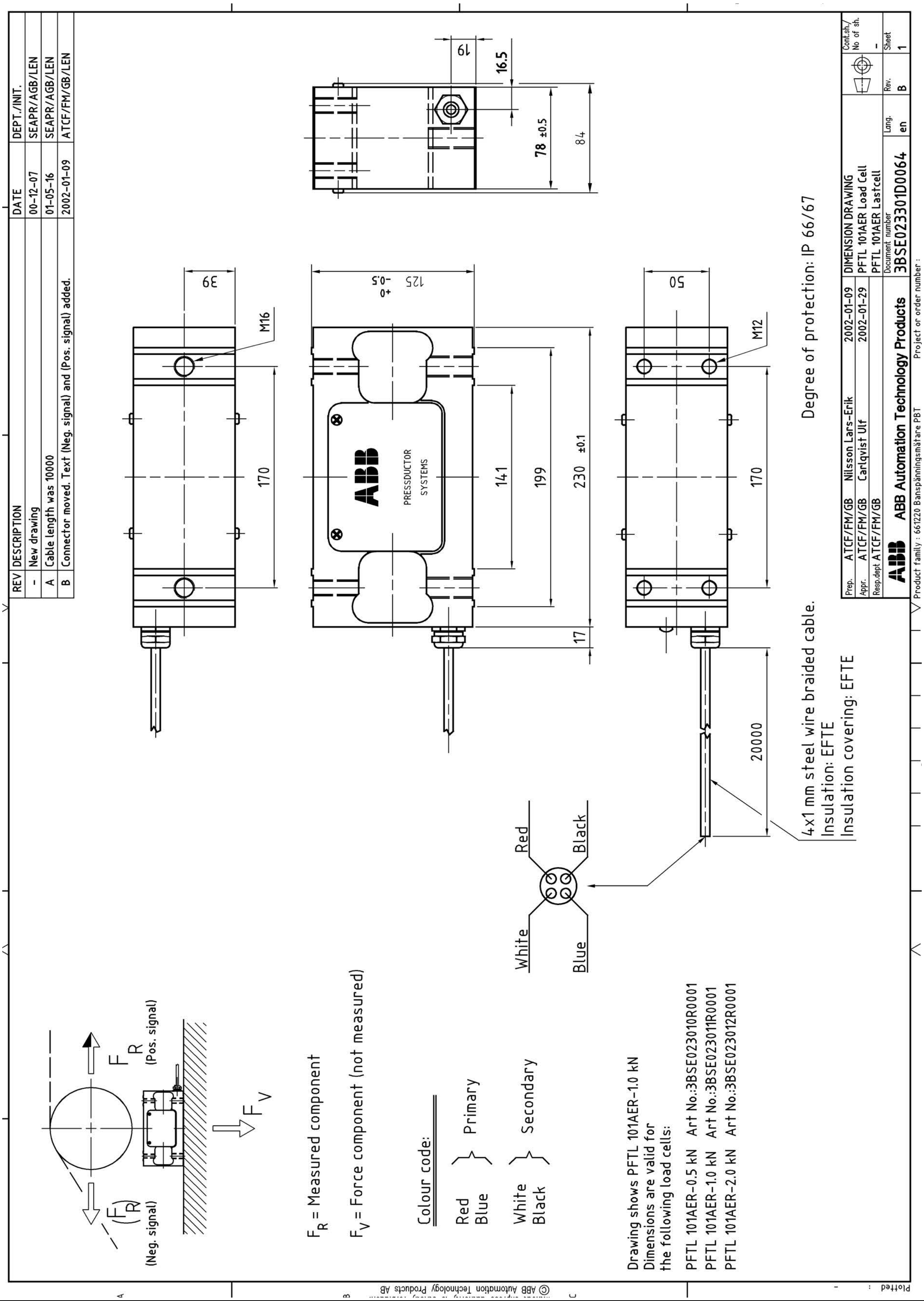
| | Document number | Lang. | Rev. | Sheet | Cont.sh./ No of sh. |
|---|---|---|---|---|---|
| ABB Automation Technology Products | 3BSE004171 | en | B | 1 | - |

Plotted

## E.15 Dimension Drawing, 3BSE004995, Rev. C

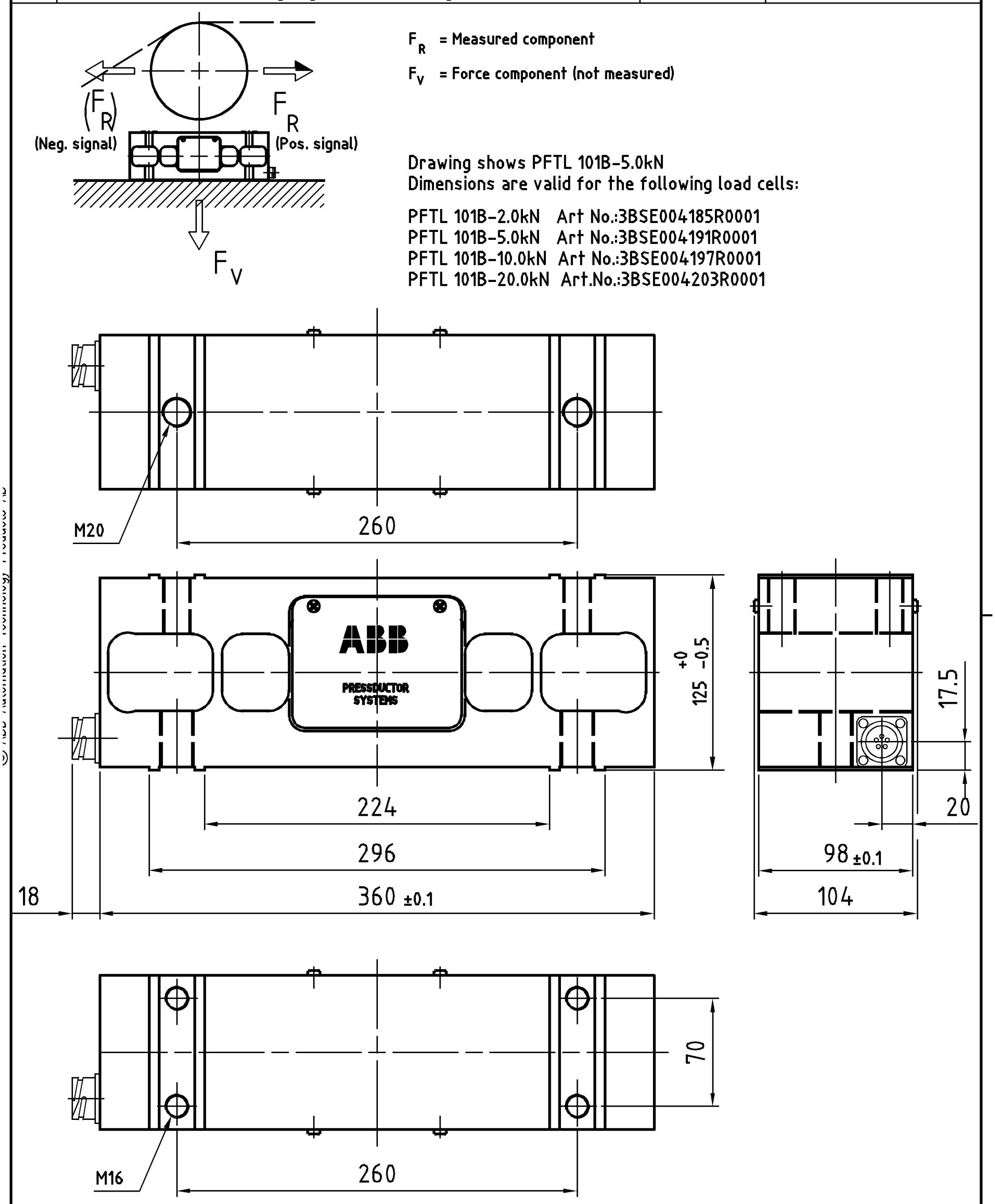


# E.16 Dimension Drawing, 3BSE023301D0064, Rev. B



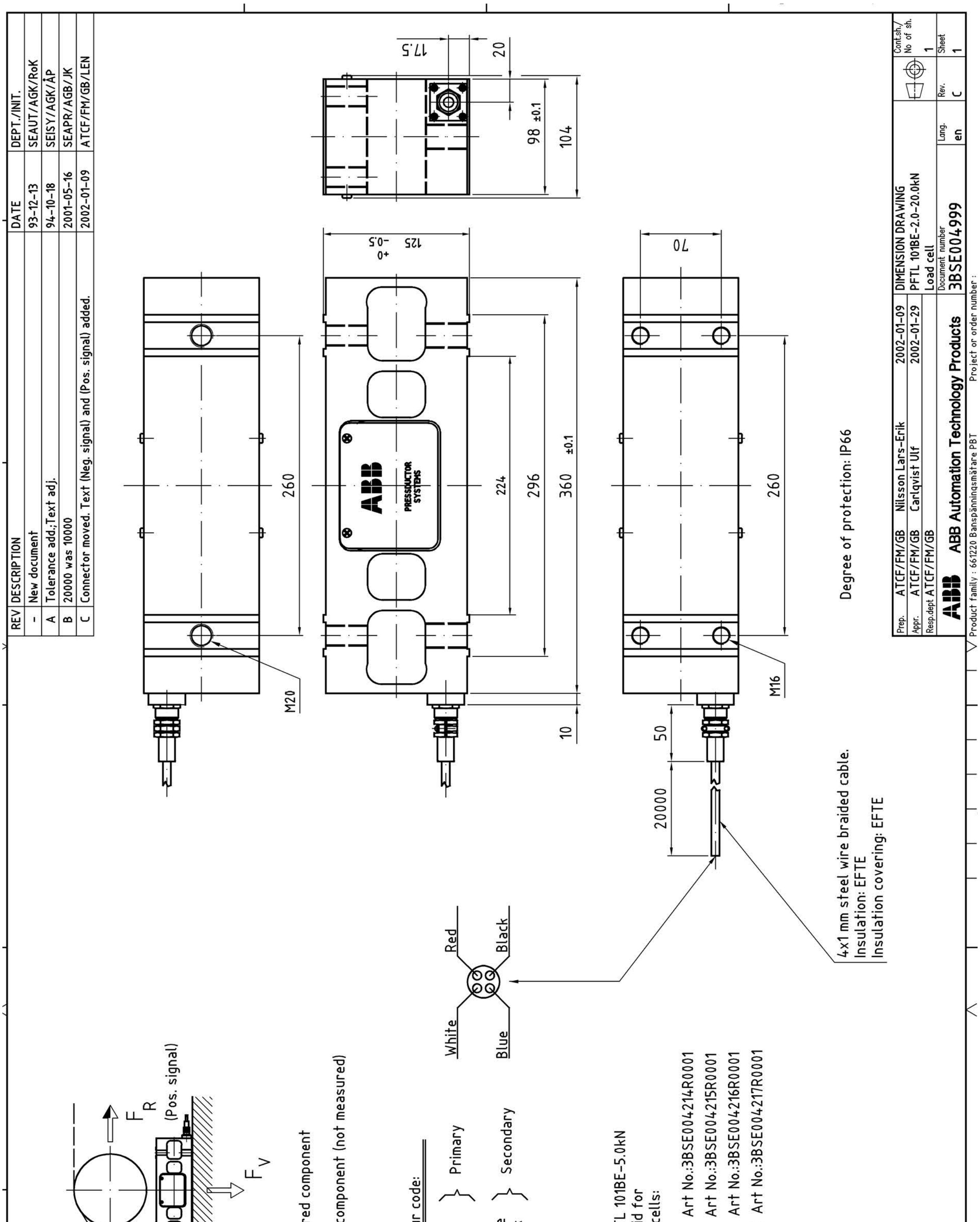
## E.17 Dimension Drawing, 3BSE004196, Rev. C

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New document | 93-07-11 | SEAUT/AGK/RoK |
| A | Tolerance and text add. | 94-10-18 | SEISY/AGK/ÅP |
| B | Art.No. 3BSE004197R0001 var 3BSE004177R0001 | 95-08-04 | SEISY/AGK/ÅP |
| C | Connector moved. Text (Neg. signal) and (Pos. signal) added. | 2002-01-08 | ATCF/FM/GB/LEN |

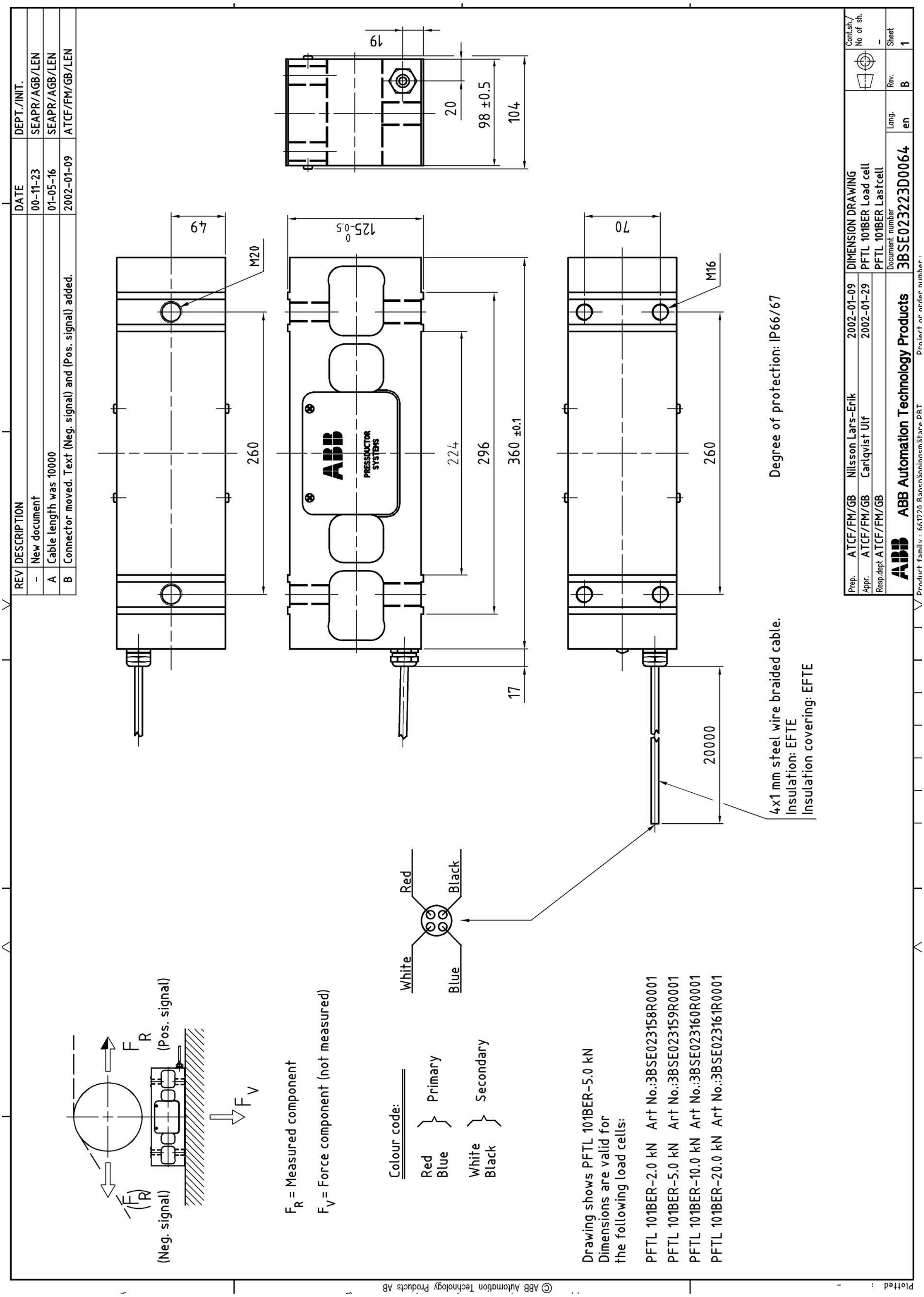



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | ATCF/FM/GB | Nilsson Lars-Erik | 2002-01-09 | DIMENSION DRAWING | | | Cont.sh./ No of sh. |
| Appr. | ATCF/FM/GB | Carlqvist Ulf | 2002-01-29 | PFTL 101B-2.0-20.0kN | | | |
| Resp.dept | ATCF/FM/GB | | | Load cell | | | - |
| ABB | ABB Automation Technology Products | | | Document number 3BSE004196 | Lang. en | Rev. C | Sheet 1 |

## E.18 Dimension Drawing, 3BSE004999, Rev. C



## E.19 Dimension Drawing, 3BSE023223D0064, Rev. B



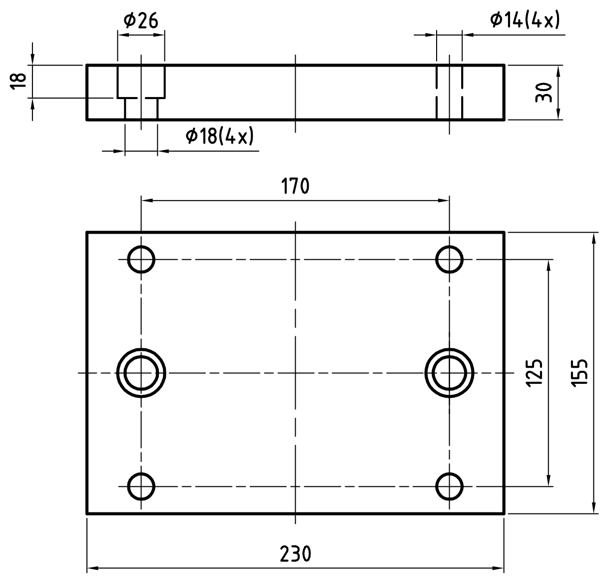
## E.20 Dimension Drawing, 3BSE012173, Rev. F

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New drawing | 97-02-28 | SEISY/AGK/ÅP |
| A | Yield strenght was 250 N/mm² | 97-06-11 | SEISY/AGK/ÅP |
| B | Title block updated | 00-10-10 | SEAPR/AGB/JK |
| C | PFTL 101AER added to Material table | 01-02-21 | SEAPR/AGB/LEN |
| D | Redrawn , Material table moved to 3BSE030638D3101 | 2009-04-23 | PA/FM/GF/JK |
| E | Table Technical materials added. | 2012-12-07 | PA/FM/GF/ML |
| E | Doc. title Lower adpt. plate for PFTL101A/AE was | 2012-12-07 | PA/FM/GF/ML |
| E | Lower adapter plate for PFTL 101 A. | 2012-12-07 | PA/FM/GF/ML |
| F | Technical materials table adjusted. Doc. title adjusted. | 2013-06-10 | PAMP/FMGF/ML |

Technical materials

| Loadcell | Material description | Material specification | Material designation |
|---|---|---|---|
| PFTL101A/AE | Steel, through hardened | Hardness 300-400HB, Yield stress>500MPa(N/mm²), CTE 11- 13 μm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | 34CrNiMo6+QT900, Toolox 33, Toolox 44, W.nr. 1.6582 +QT900, ASTM 4340 or equivalent |
| | Martensitic Stainless Steel | Hardness 300-400HB, Yield stress>400MPa(N/mm²), CTE 10 - 13 μm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X12CrMoS13+AT, X20Cr13 +AT, W.nr.1.4005 +AT, W.nr 1.4021 +AT, ASTM 416, 420 or equivalent |
| PFTL101AER | Austenitic Stainless Steel. | Hardness 150-350HB, Yield stress>220MPa(N/mm²), CTE 16- 18 μm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X2CrNiMo17-12-2 +AT X5CrNi18-10+AT, W.nr.1.4301+AT, W.nr.1.4404 +AT ASTM 313, 314 or equivalent. |






Manufacturing drawing : 3BSE030638D3101

Mass(weight) : App 8 kg

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | PA/FMGF | Magnus X Lindström | 2013-06-10 | Dimension drawing | | | Cont.sh./ No of sh. |
| Appr. | PA/FMGF | Håkan F Wintzell | 2013-06-14 | Lower adpt. plate PFTL101A/AE/AER | | | - |
| Resp.dept | PA/FMGF | | | Und. adpt. platta PFTL101A/AE/AER | | | |
| ABB | ABB AB | | | Document number 3BSE012173 | Lang. en | Rev. F | Sheet 1 |

Product family : 661220 Bansp. mätare PFT100 Project or order number :

Document status : Approved

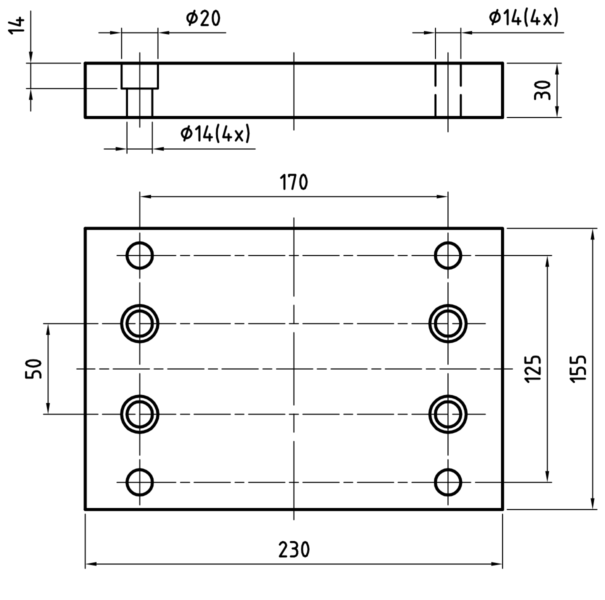
## E.21 Dimension Drawing, 3BSE012172, Rev. F

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New drawing | 97-02-28 | SEISY/AGK/ÅP |
| A | Yield strength was 250 N/mm | 97-06-11 | SEISY/AGK/ÅP |
| B | Title block updated | 00-10-10 | SEAPR/AGB/JK |
| C | PFTL 101AER added to Material table | 01-02-21 | SEAPR/AGB/LEN |
| D | Redrawn , Material table moved to 3BSE030638D3100 | 2009-04-22 | PA/FM/GF/JK |
| E | Table Technical materials added. | 2012-12-07 | PA/FM/GF/ML |
| E | Doc. title Top adpt. plate for PFTL101A/AE was | 2012-12-07 | PA/FM/GF/ML |
| E | Top adapter plate for PFTL 101 A. | 2012-12-07 | PA/FM/GF/ML |
| F | Technical materials table adjusted. Doc. title adjusted. | 2013-06-10 | PAMP/FMGF/ML |

Technical materials

| Loadcell | Material description | Material specification | Material designation |
|---|---|---|---|
| PFTL101A/AE | Steel, through hardened | Hardness 300-400HB, Yield stress>500MPa(N/mm²), CTE 11- 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | 34CrNiMo6+QT900, Toolox 33, Toolox 44, W.nr. 1.6582 +QT900, ASTM 4340 or equivalent |
| | Martensitic Stainless Steel | Hardness 300-400HB, Yield stress>400MPa(N/mm²), CTE 10 - 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X12CrMoS13+AT, X20Cr13 +AT, W.nr.1.4005 +AT, W.nr 1.4021 +AT, ASTM 416, 420 or equivalent |
| PFTL101AER | Austenitic Stainless Steel. | Hardness 150-350HB, Yield stress>220MPa(N/mm²), CTE 16- 18 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X2CrNiMo17-12-2 +AT X5CrNi18-10+AT, W.nr.1.4301+AT, W.nr.1.4404 +AT ASTM 313, 314 or equivalent. |






Manufacturing drawing: 3BSE030638D3100

Mass(weight) : App 8 kg

| | | | | | | |
|---|---|---|---|---|---|---|
| Prep. | PA/FMGF | Magnus X Lindström | 2013-06-13 | Dimension drawing<br>Top adpt. plate PFTL101A/AE/AER<br>Övr. adpt. platta PFTL101A/AE/AER | | Cont.sh./ No of sh.<br>- |
| Appr. | PA/FMGF | Håkan F Wintzell | 2013-06-14 | | | |
| Resp.dept | PA/FMGF | | | | | |
| ABB | ABB AB | | | Document number<br>3BSE012172 | Lang.<br>en | Rev.<br>F |
| | | | | | | Sheet<br>1 |

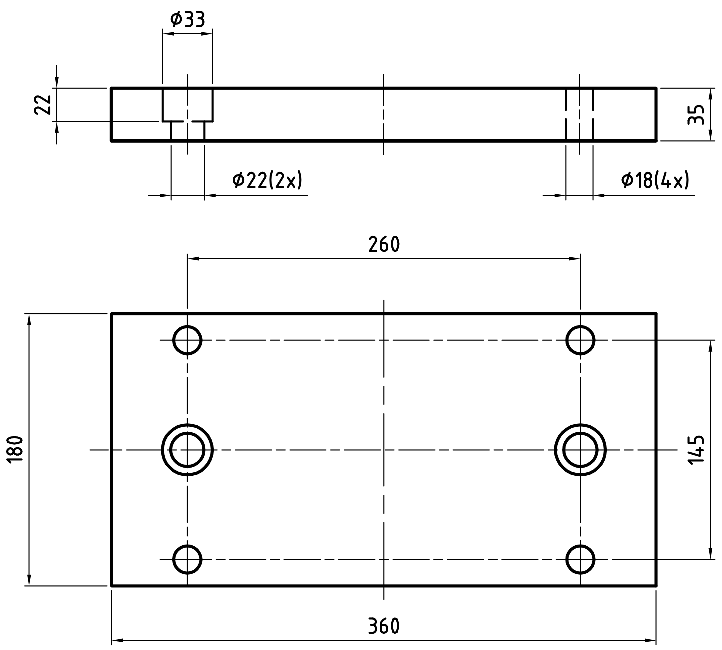
Document status: Approved

## E.22 Dimension Drawing, 3BSE012171, Rev. F

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New drawing | 97-02-28 | SEISY/AGK/ÅP |
| A | Yield strength was 250N/mm² | 97-06-11 | SEISY/AGK/ÅP |
| B | Title block updated | 00-10-10 | SEAPR/AGB/JK |
| C | PFTL 101BER added to Material table | 01-02-21 | SEAPR/AGB/LEN |
| D | Changed to all english version . Redrawn | 2009-04-22 | PA/FM/GF/JK |
| E | Table Technical materials added. | 2012-12-07 | PA/FM/GF/ML |
| E | Doc. title Lower adpt. plate for PFTL101B/BE was | 2012-12-07 | PA/FM/GF/ML |
| E | Lower adapter plate for PFTL 101 B. | 2012-12-07 | PA/FM/GF/ML |
| F | Technical materials table adjusted. Doc title adjusted. | 2013-06-10 | PAMP/FMGF/ML |

Technical materials

| Loadcell | Material description | Material specification | Material designation |
|---|---|---|---|
| PFTL101B/BE | Steel, through hardened | Hardness 300-400HB, Yield stress>500MPa(N/mm²), CTE 11- 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | 34CrNiMo6+QT900, Toolox 33, Toolox 44, W.nr. 1.6582 +QT900, ASTM 4340 or equivalent |
| | Martensitic Stainless Steel | Hardness 300-400HB, Yield stress>400MPa(N/mm²), CTE 10 - 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X12CrMoS13+AT, X20Cr13 +AT, W.nr.1.4005 +AT, W.nr 1.4021 +AT, ASTM 416, 420 or equivalent |
| PFTL101BER | Austenitic Stainless Steel. | Hardness 150-350HB, Yield stress>220MPa(N/mm²), CTE 16- 18 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X2CrNiMo17-12-2 +AT X5CrNi18-10+AT, W.nr.1.4301+AT, W.nr.1.4404 +AT ASTM 313, 314 or equivalent. |






Manufacturing drawing : 3BSE030638D3201

Weight: 18 kg

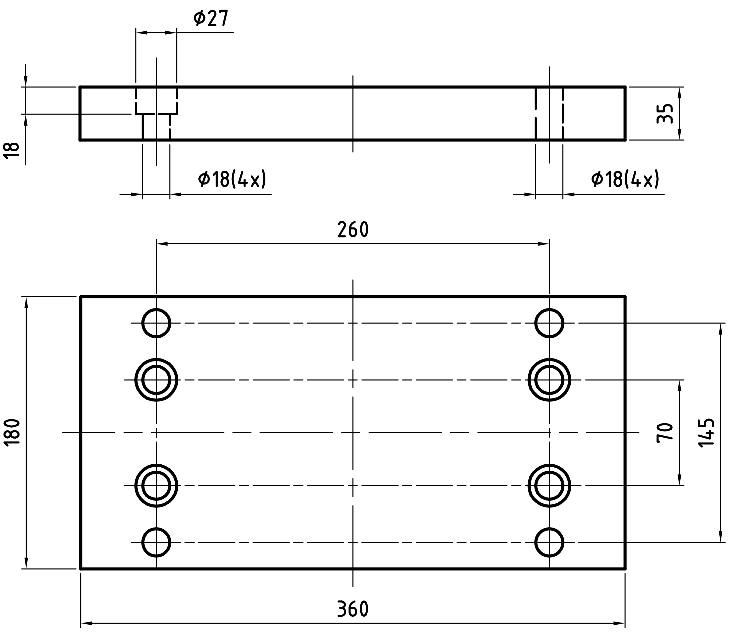
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | PA/FMGF | Magnus X Lindström | 2013-06-10 | Dimension drawing | | | Cont.sh./ No of sh. |
| Appr. | PA/FMGF | Håkan F Wintzell | 2013-06-14 | Low. adpt. plate PFTL101B/BE/BER | | | |
| Resp.dept | PA/FMGF | | | Und. adpt. platta PFTL101B/BE/BER | | | - |
| ABB | ABB AB | | | Document number 3BSE012171 | Lang. en | Rev. F | Sheet 1 |

Document status : Approved

## E.23 Dimension Drawing, 3BSE012170, Rev. F

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| - | New drawing | 97-02-28 | SEISY/AGK/ÅP |
| A | Yield strength was 250 N/mm$^2$ | 97-06-11 | SEISY/AGK/ÅP |
| B | Title block updated | 00-10-10 | SEAPR/AGB/JK |
| C | PFTL 101BER added to Material table | 01-02-21 | SEAPR/AGB/LEN |
| D | Changed to all english version ; redrawn. | 2009-04-23 | PA/FM/GF/JK |
| E | Table Technical materials added. | 2012-12-07 | PA/FM/GF/ML |
| E | Doc. title Top adpt. plate for PFTL101B/BE was | 2012-12-07 | PA/FM/GF/ML |
| E | Top adapter plate for PFTL 101 B. | 2012-12-07 | PA/FM/GF/ML |
| F | Technical materials table adjusted. Doc. title adjusted. | 2013-06-10 | PAMP/FMGF/ML |

| Technical materials | | | |
|---|---|---|---|
| Loadcell | Material description | Material specification | Material designation |
| PFTL101B/BE | Steel, through hardened | Hardness 300-400HB, Yield stress>500MPa(N/mm$^2$), CTE 11- 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | 34CrNiMo6+QT900, Toolox 33, Toolox 44, W.nr. 1.6582 +QT900, ASTM 4340 or equivalent |
| | Martensitic Stainless Steel | Hardness 300-400HB, Yield stress>400MPa(N/mm$^2$), CTE 10 - 13 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X12CrMoS13+AT, X20Cr13 +AT, W.nr.1.4005 +AT, W.nr 1.4021 +AT, ASTM 416, 420 or equivalent |
| PFTL101BER | Austenitic Stainless Steel. | Hardness 150-350HB, Yield stress>220MPa(N/mm$^2$), CTE 16- 18 µm/m/°C. Remanent magnetism of the finished detail must be less than 2 Gauss(0-0,2mT) | X2CrNiMo17-12-2 +AT X5CrNi18-10+AT, W.nr.1.4301+AT, W.nr.1.4404 +AT ASTM 313, 314 or equivalent. |




Manufacturing drawing : 3BSE030638D3200

Weight: App.17.5 kg

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | PA/FMGF | Magnus X Lindström | 2013-06-10 | Dimension drawing | | | Cont.sh./ No of sh. |
| Appr. | PA/FMGF | Håkan F Wintzell | 2013-06-14 | Top adpt. plate PFTL101B/BE/BER | | | |
| Resp.dept | PA/FMGF | | | Övre adpt platta PFTL101B/BE/BER | | | - |
| ABB | ABB AB | | | Document number 3BSE012170 | Lang. en | Rev. F | Sheet 1 |

Document status : Approved

# Appendix F PFCL 201 - Designing the Load Cell Installation

## F.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Dimension drawing(s)

## F.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

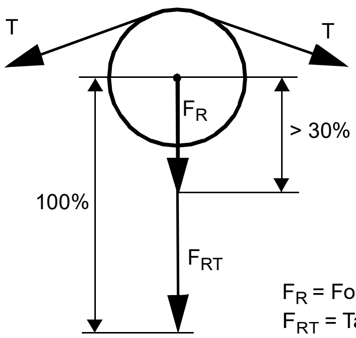
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

# F.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orient load cell so that the guidelines below are met:
   a. Try to achieve a measured value no less than 10% of web tension, in the load cell measurement direction!
   b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
   c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
   d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
   This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
   For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




**Rule 1:** If $F_{RT}$ < 1/3 of $F_{nom}$
$F_R$ should be at least 10% of $F_{nom}$

**Rule 2:** If $F_{RT}$ > 1/3 of $F_{nom}$
$F_R$ is recommended to be at least 30% of $F_{RT}$

$F_R$ = Force component of web tension in measuring direction
$F_{RT}$ = Tare force in measurement direction

   e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

# F.4 Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.

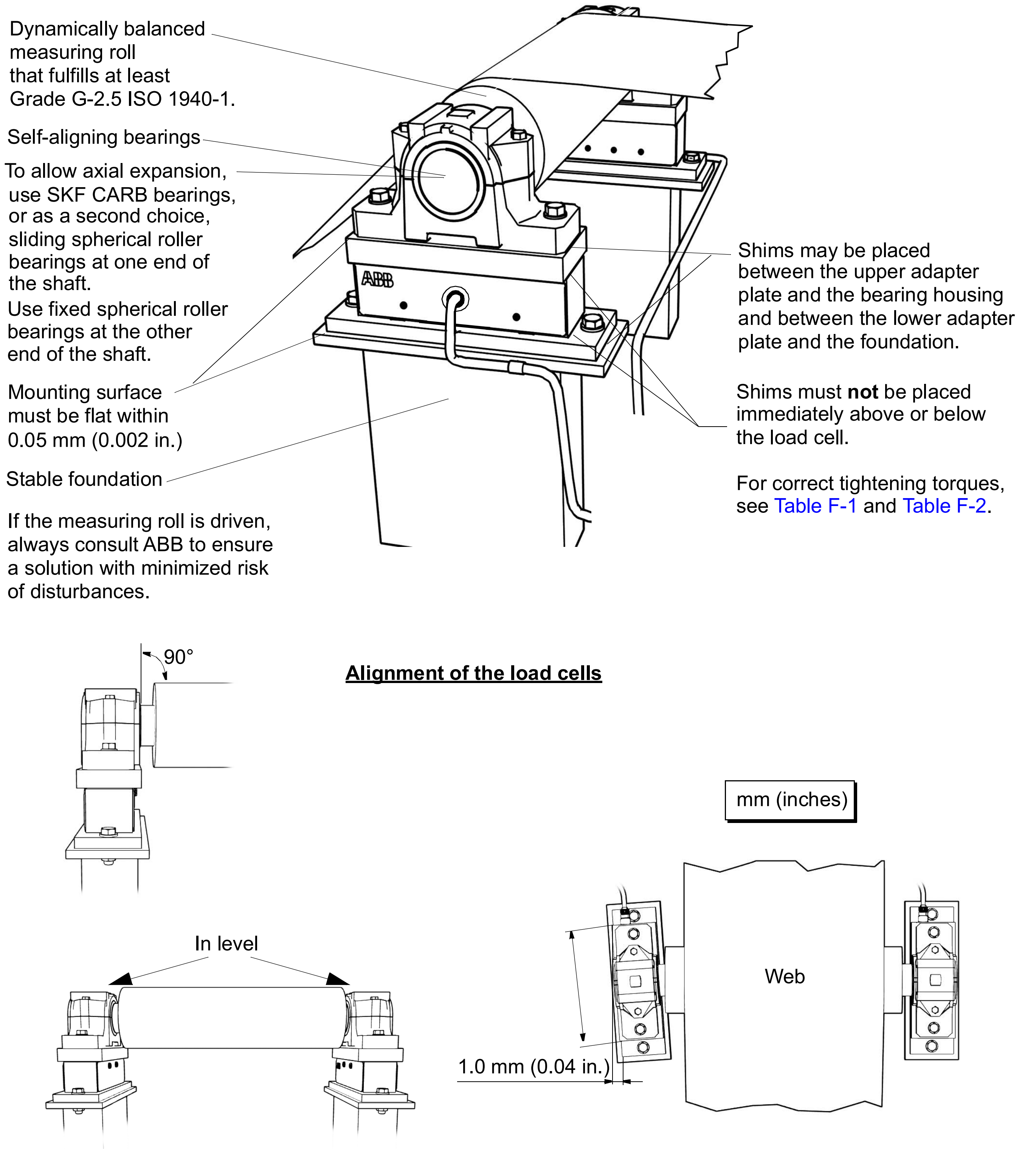
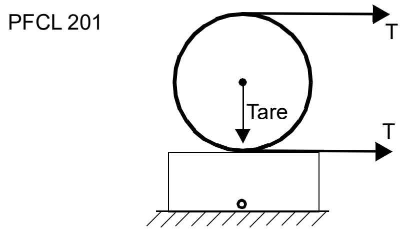



*Figure F-1. Installation requirements*

# F.5 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

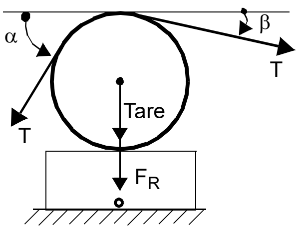
## F.5.1 Horizontal Mounting




No vertical web tension force applied to the load cell.

In most cases, horizontal mounting is the most obvious and simplest solution. The load cell should thus be mounted horizontally when possible.

However, should the machine design require inclined mounting of the load cell or should the web path not give a sufficient vertical force, see figure, the inclined mounting is permitted and the calculations are somewhat more complex, (see Section F.5.2).




$F_R = T \times (\sin\alpha + \sin\beta)$

$F_{RT} = \text{Tare}$

$F_{Rtot} = F_R + F_{RT} = T \times (\sin\alpha + \sin\beta) + \text{Tare}$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

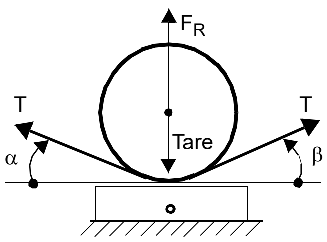
$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\sin\alpha + \sin\beta)}$$

$$\text{Wrap gain} = \frac{1}{\sin\alpha + \sin\beta}$$

The load cell measures the vertical forces applied to its top surface. The horizontal applied forces are not measured and do not influence the vertical measurement. There are two sources of vertical forces; the forces from the web tension and the tare weight of the roll.

Divide the total vertical force $F_{Rtot}$ by two to get the required capacity of each load cell.

Do not oversize an ABB load cell for overload purposes as the load cell has sufficient overload capacity.




$F_R = T \times (\sin\alpha + \sin\beta)$

$F_{RT} = \text{Tare}$

$F_{Rtot} = F_{RT} - F_R = \text{Tare} - T \times (\sin\alpha + \sin\beta)$

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\sin\alpha + \sin\beta)}$$

$$\text{Wrap gain} = \frac{1}{\sin\alpha + \sin\beta}$$

The load cell can measure tension as well as compression.

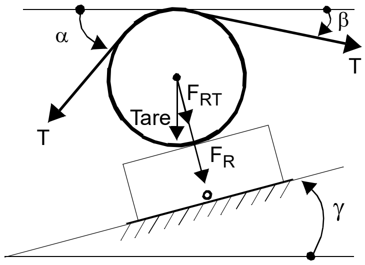
If the T (sin α + sin β) is larger than the tare weight, the load cell will be in tension.

To get the capacity of each load cell:

1. Divide ($F_R$ - Tare) by two
   if $F_R$ is greater than or equal to (Tare × two).
2. Divide Tare by two
   if $F_R$ is smaller than (Tare × two).

## F.5.2 Inclined Mounting

PFCL 201




$F_R = T \times [\sin(\alpha - \gamma) + \sin(\beta + \gamma)]$

$F_{RT} = \text{Tare} \times \cos\gamma$

$F_{Rtot} = F_R + F_{RT} =$

$T \times [\sin(\alpha - \gamma) + \sin(\beta + \gamma)] + \text{Tare} \times \cos\gamma$

---

$$T \text{ (Tension)} = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\sin(\alpha - \gamma) + \sin(\beta + \gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\sin(\alpha - \gamma) + \sin(\beta + \gamma)}$$

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or the need to have a proper force component applied to the load cell.

In this case, the incline angle modifies the tare load and the force components as shown.

## F.6 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll.

### F.6.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the same calculations given in Section F.5 are valid.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

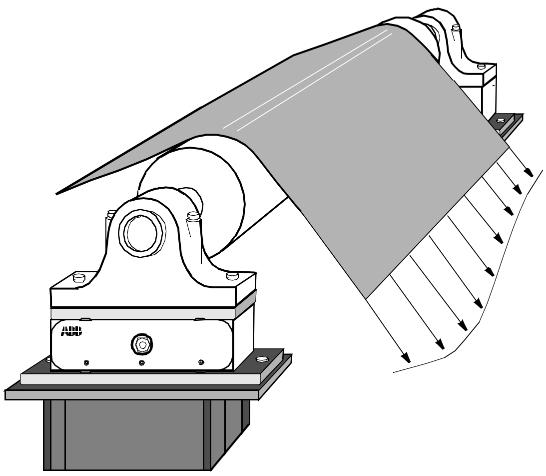
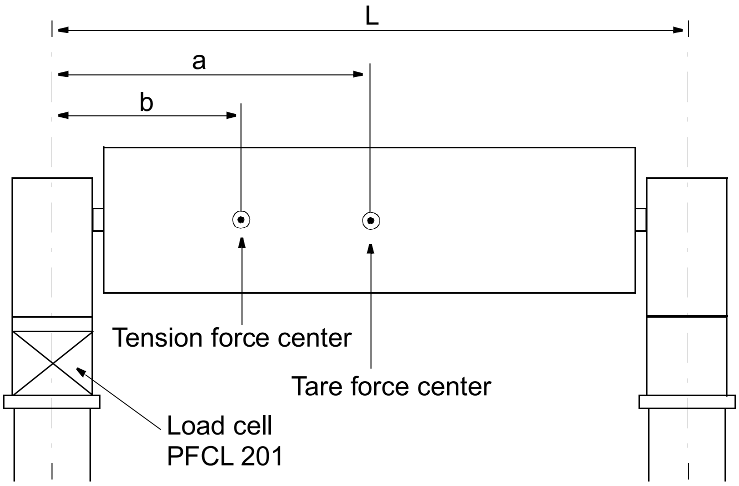


*Figure F-2. Cross-directional stress distribution*

## F.6.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section F.5
3. Use the following equations:

$F_R$ for single load cell $= F_R \times \frac{L-b}{L}$

$F_{RT}$ for single load cell $= F_{RT} \times \frac{L-a}{L}$

$F_{Rtot}$ for single load cell $=$ $F_R$ for single load cell + $F_{RT}$ for single load cell

where:

L = Distance between load cell centerline and the opposite bearing centerline

a = Distance between tare force center and load cell centerline

b = Distance between tension force center and load cell centerline

# F.7 Mounting the Load Cells

## F.7.1 Preparations

Prepare the installation in good time by checking that the necessary documents and material are available, as follows:

- Installation drawings and this manual.
- Standard tools, torque wrench and instruments.
- Rust protection, if additional protection is to be given to machined surfaces.
  Choose TECTYL 511 (Valvoline) or FERRYL (104), for example.
- Locking fluid (medium strength) to lock fixing screws.
- Screws as listed in Table F-1 and Table F-2 to secure the load cell, and other screws for bearing housings etc.
- Load cells, adapter plates, bearing housings, etc.

## F.7.2 Mounting

The instructions below apply to a typical mounting arrangement. Variations may be allowed, provided that the requirements of Section F.4 are complied with.

1. Clean the foundation and other mounting surfaces.
2. Fit the lower adapter plate to the load cell. Tighten the screws to the torque stated in Table F-1 or Table F-2 and lock them with locking fluid.
3. Fit the load cell and the lower adapter plate to the foundation, but do not fully tighten the screws.
4. Fit the upper adapter plate to the load cell, tighten to the torque stated in Table F-1 or Table F-2, and apply locking fluid.
5. Fit the bearing housing and the roll to the upper adapter plate, but do not fully tighten the screws.
6. Adjust the load cells so that they are in parallel with each other and in line with the axial direction of the roll. Tighten the foundation screws.
7. Adjust the roll so that it is at right angles to the longitudinal direction of the load cells. Tighten the screws in the upper adapter plate.
8. Apply rust protection to any machined surfaces that are not rust proof.

*Table F-1. $MoS_2$ lubricated, galvanized Screws According to ISO 898/1*

| Strength class | Dimension | Tightening torque |
|---|---|---|
| 8.8 (1) (12.9) | M16 | 170 (286) Nm |

*Table F-2. Waxed Screws of Stainless Steel According to ISO 3506*

| Strength class | Dimension | Tightening torque |
|---|---|---|
| A2-80 (1) | M16 | 187 Nm |

(1) Strength class 12.9 is recommended for 50 kN load cells, when large overloads are expected, especially if the fixing screws are subjected to tension.

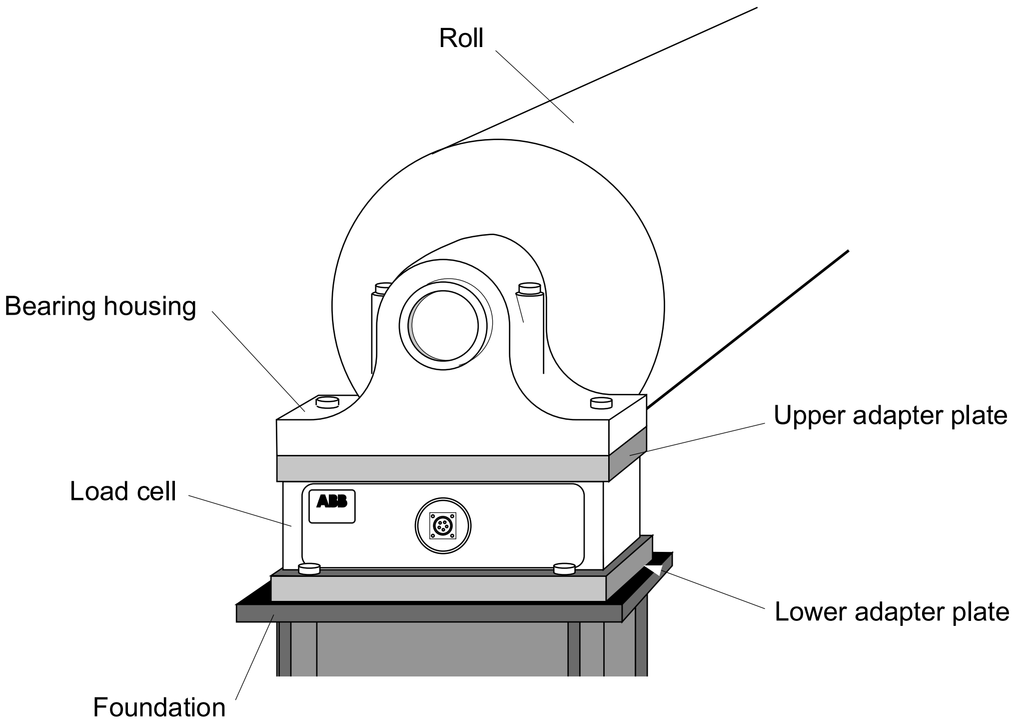



*Figure F-3. Typical Installation*

## F.7.3 Cabling for Load Cell PFCL 201CE

Cable with protective hose shall be mounted so that the movement of the intermediate part of the load cell is not prevented. Figure F-4 shows how the cable and protective hose shall be mounted for load cell PFCL 201CE. If the intermediate part of the load cell is prevented in its movement, it will shunt force and the measured force will differ from the actual.

The direction of the cable and protecting hose can be changed by unscrewing the connection box and turning it 90- 180°. Make sure that the cable between the connection box and the load cell does not get jammed or damaged when the connection box is remounted.

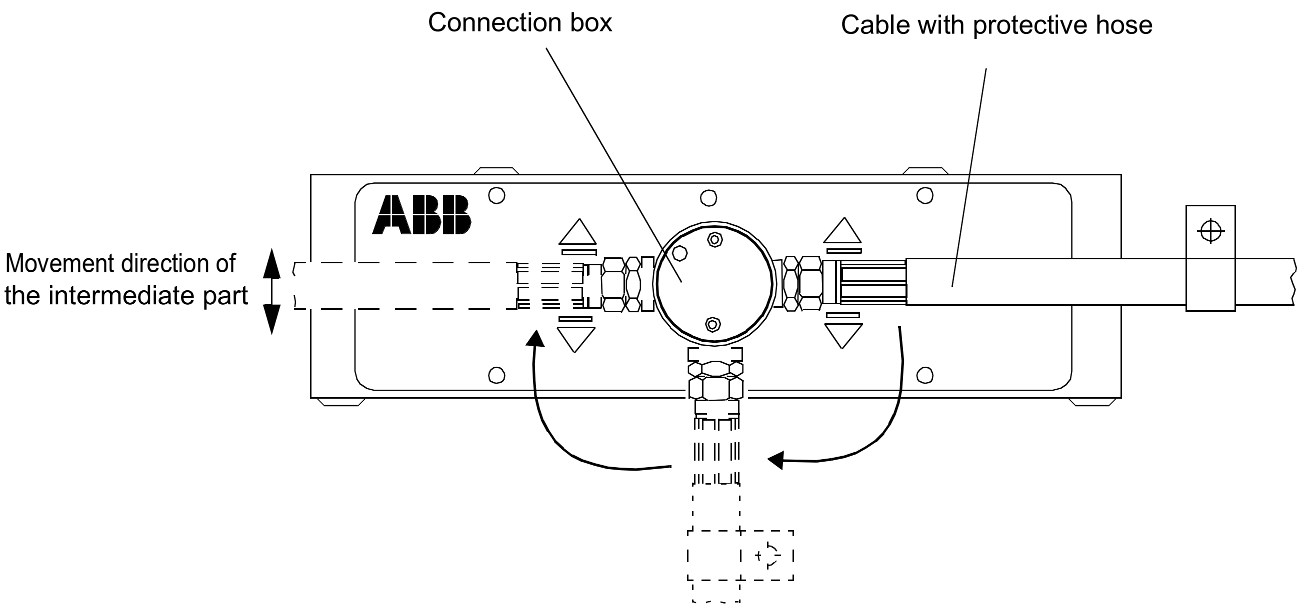



*Figure F-4. Allowed Laying of Cable with Protective Hose for PFCL 201CE*

**NOTE!**

The cable with the protective hose must not be mounted so that it bends close to the connection box, see Figure F-5, or is vertically directed.

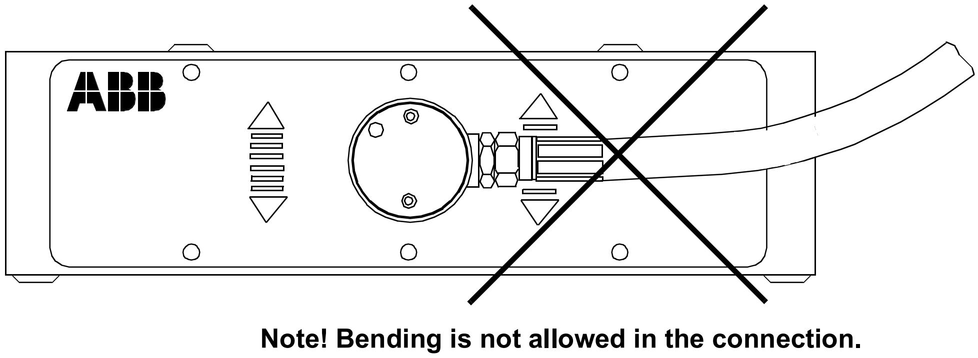



*Figure F-5. Not Allowed Laying of Cable with Protective Hose for PFCL 201CE*

## F.8 Technical Data Load Cell PFCL 201

*Table F-3. Technical Data*

| | Type | PFCL 201 | | | | Unit |
|---|---|---|---|---|---|---|
| **Nominal loads** [1)] | | | | | | |
| Nominal load in measuring direction, $F_{nom}$ | C/CD/CE | 5<br>(1120) | 10<br>(2250) | 20<br>(4500) | 50<br>(11200) | kN<br>(lbs) |
| Permitted transverse force within the accuracy, $F_{Vnom}$ (for h = 300 mm) | C/CD/CE | 2.5<br>(562) | 5<br>(1120) | 10<br>(2250) | 25<br>(5620) | kN<br>(lbs) |
| Permitted axial load within the accuracy, $F_{Anom}$ (for h = 300 mm) | C/CD/CE | 1.25<br>(281) | 2.5<br>(562) | 5<br>(1120) | 12.5<br>(2810) | kN<br>(lbs) |
| Extended load in measuring direction with accuracy class ±1%, $F_{ext}$ | C/CD/CE | 7.5<br>(1690) | 15<br>(3370) | 30<br>(6740) | 75<br>(16900) | kN<br>(lbs) |
| **Max permitted load** | | | | | | |
| In the direction of measurement without permanent change of data, $F_{max}$ [2)] | C/CD/CE | 50<br>(11200) | 100<br>(22500) | 200<br>(45000) | 500 [3)]<br>(112000) | (kN)<br>(lbs) |
| In the transverse direction without permanent change of data, $F_{Vmax}$ [2)] (for h = 300 mm) | C/CD/CE | 12.5<br>(2810) | 25<br>(5620) | 50<br>(11200) | 125<br>(28100) | (kN)<br>(lbs) |
| **Spring constant** | C/CD/CE | 250<br>(1430) | 500<br>(2850) | 1000<br>(5710) | 2500<br>(14300) | kN/mm<br>(1000 lbs/inch) |
| **Mechanical data** | | | | | | |
| Length | C/CD/CE | 450<br>(17.7) | | | | mm<br>(inch) |
| Width | C | 110<br>(4.3) | | | | mm<br>(inch) |
| | CD | 138<br>(5.4) | | | | mm<br>(inch) |
| | CE | 156<br>(6.1) | | | | mm<br>(inch) |
| Height | C/CD/CE | 125<br>(4.9) | | | | mm<br>(inch) |
| Weight | C/CD/CE | 37<br>(82) | | | | kg<br>(lbs) |
| **Material** | C/CD/CE | Stainless steel SIS 2387 DIN X4CrNiMo 165 | | | | |

*Table F-3. Technical Data*

| | Type | PFCL 201 | Unit |
|---|---|---|---|
| **Accuracy** | | | |
| Accuracy class | C/CD/CE | ± 0.5 | % |
| Linearity deviation | | < ± 0.3 | |
| Repeatability error | | < ± 0.05 | |
| Hysteresis | | < 0.2 | |
| **Compensated temperature range** | | +20 - +80<br>(+68 - +176) | °C<br>(°F) |
| Zero point drift | | 50<br>(28) | ppm/K<br>(ppm/°F) |
| Sensitivity drift | | 100<br>(56) | |
| **Working temperature range** | | –10 - +90<br>(+14 - +194) | °C<br>(°F) |
| Zero point drift | | 100<br>(56) | ppm/K<br>(ppm/°F) |
| Sensitivity drift | | 200<br>(111) | |
| **Storage temperature range** | | –40 - +90<br>(–40 - +194) | °C<br>(°F) |

1) Definitions of direction designations "$_V$"and "$_A$" in $F_V$ and $F_A$ are given in Section A.2.1.

2) $F_{max}$ and $F_{Vmax}$ are allowed at the same time.

3) Max. permitted load for the load cell is 10 × $F_{nom}$. The overload capacity for the total installation may be limited by the screws.

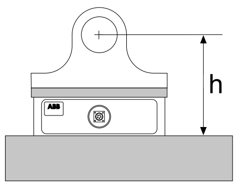
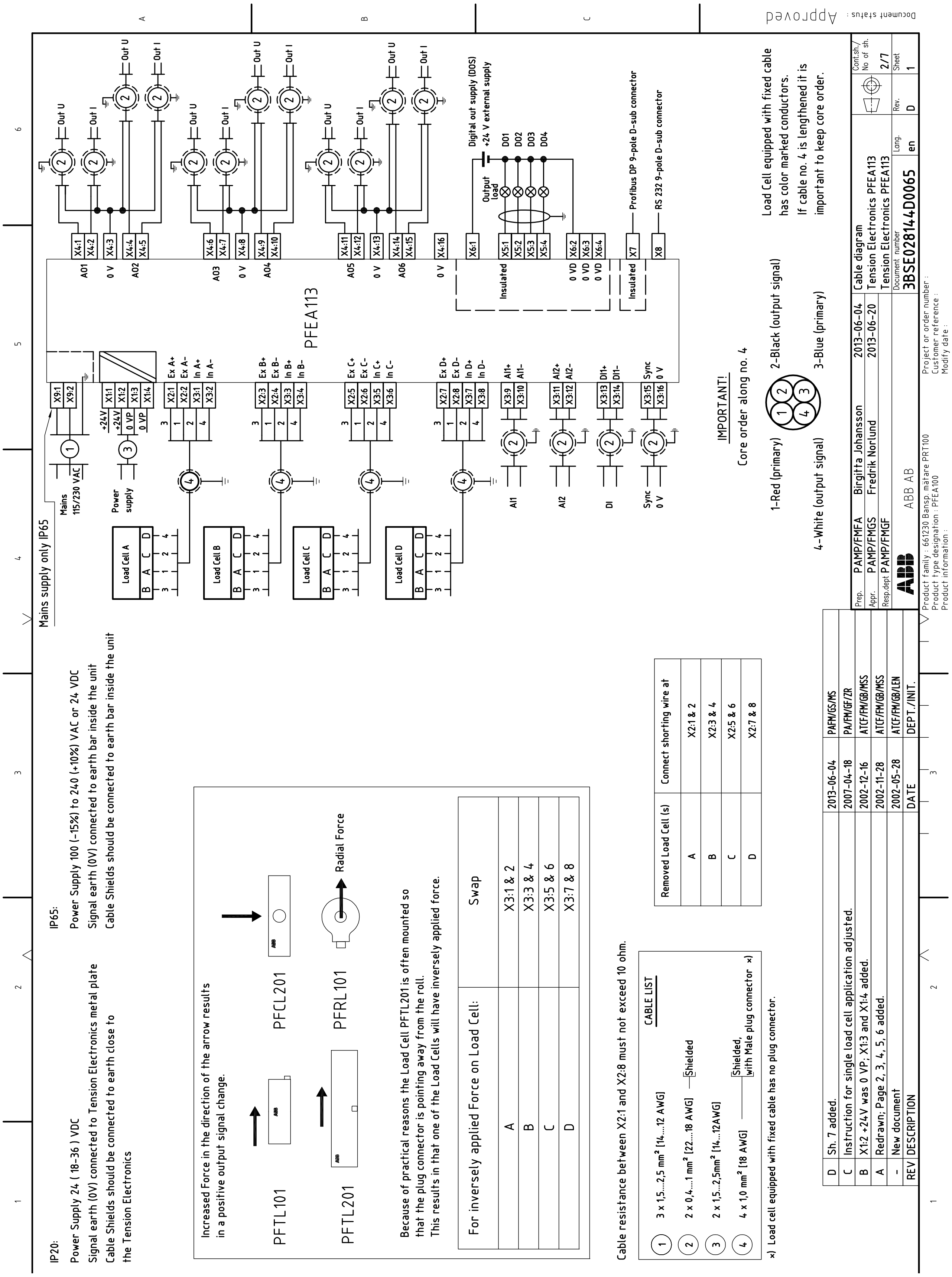
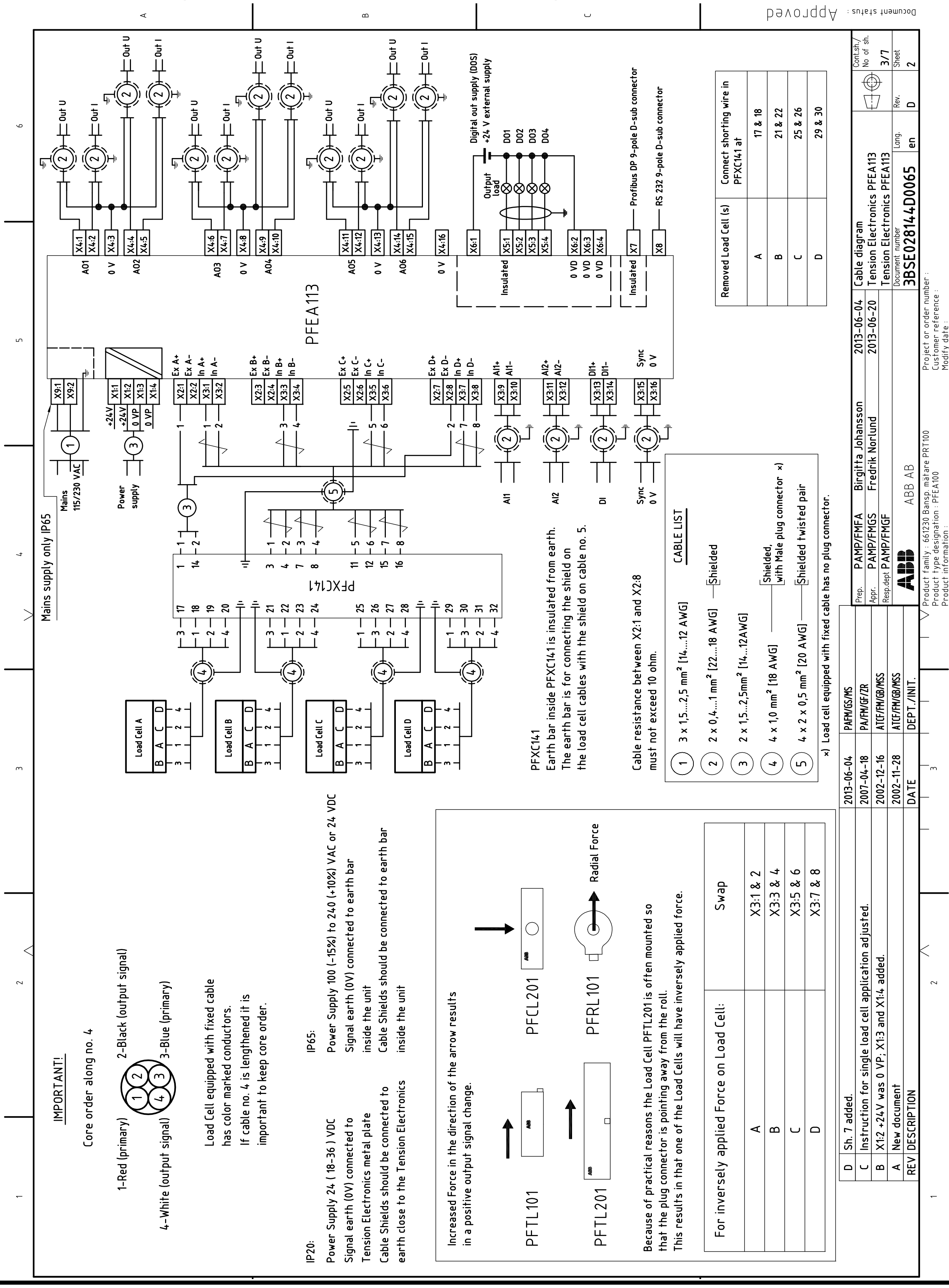



*Figure F-6. Building Height*

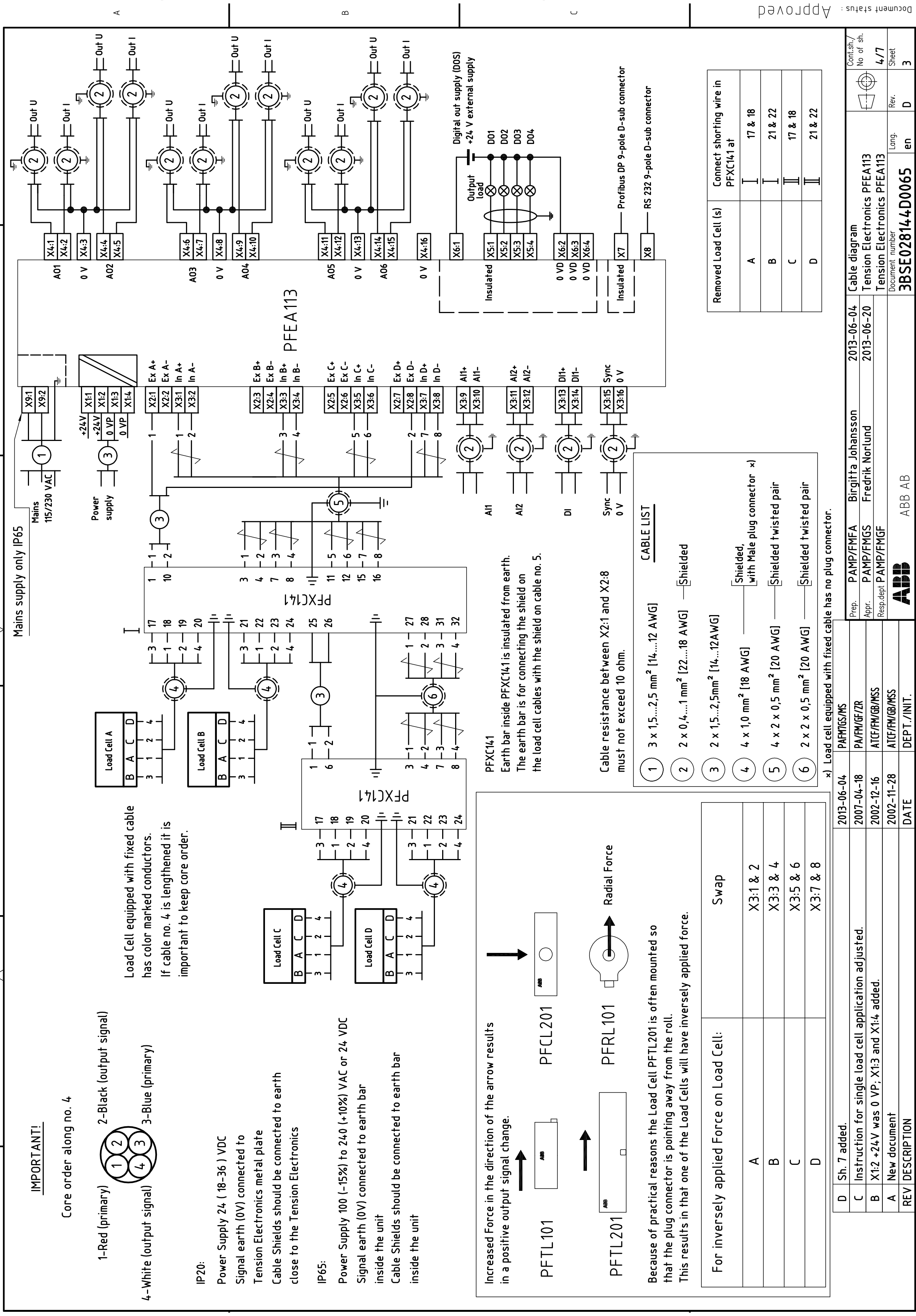
## F.9 Cable Diagram 3BSE028144D0065, Page 1/7, Rev. D



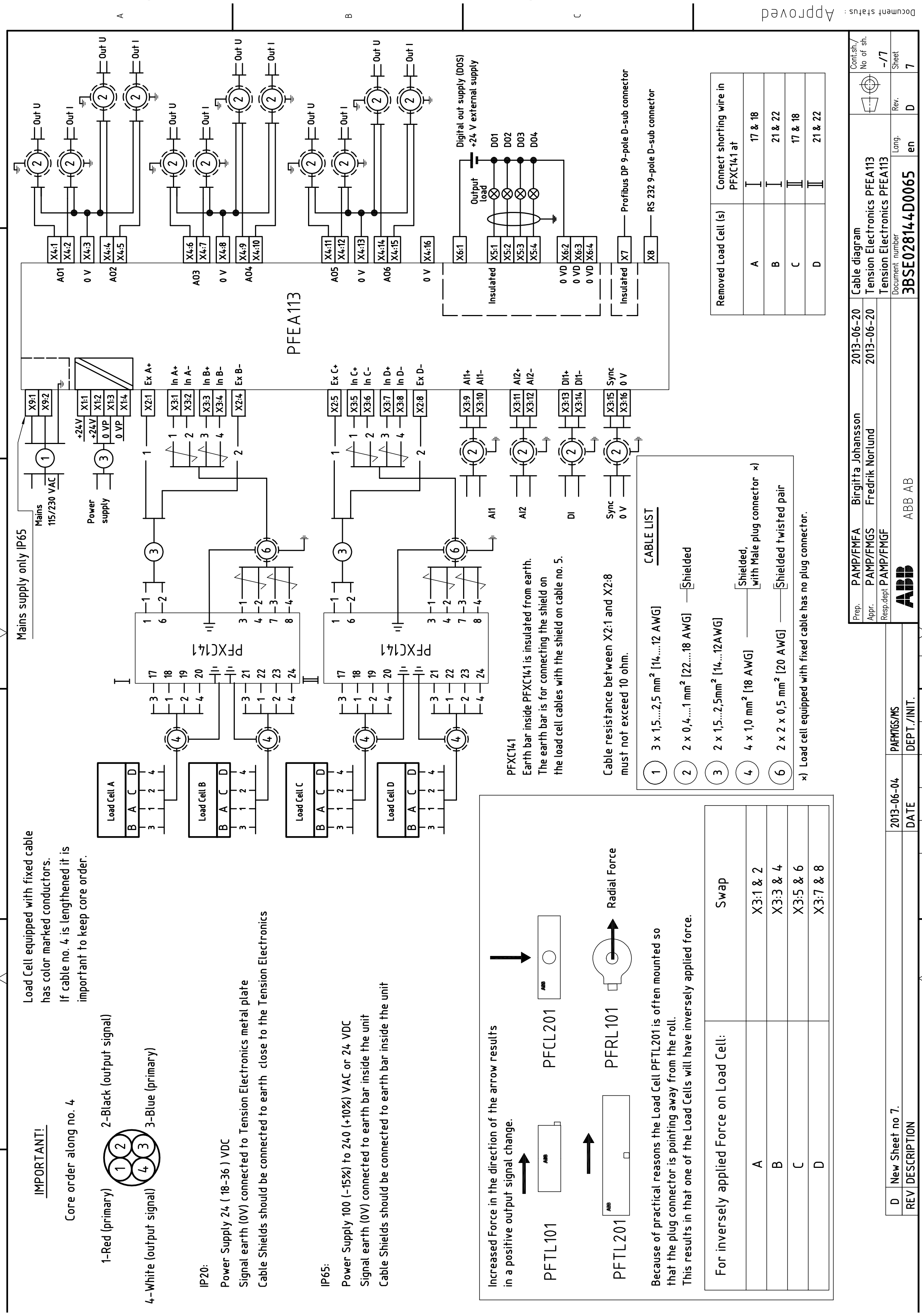
## F.10 Cable Diagram 3BSE028144D0065, Page 2/7, Rev. D



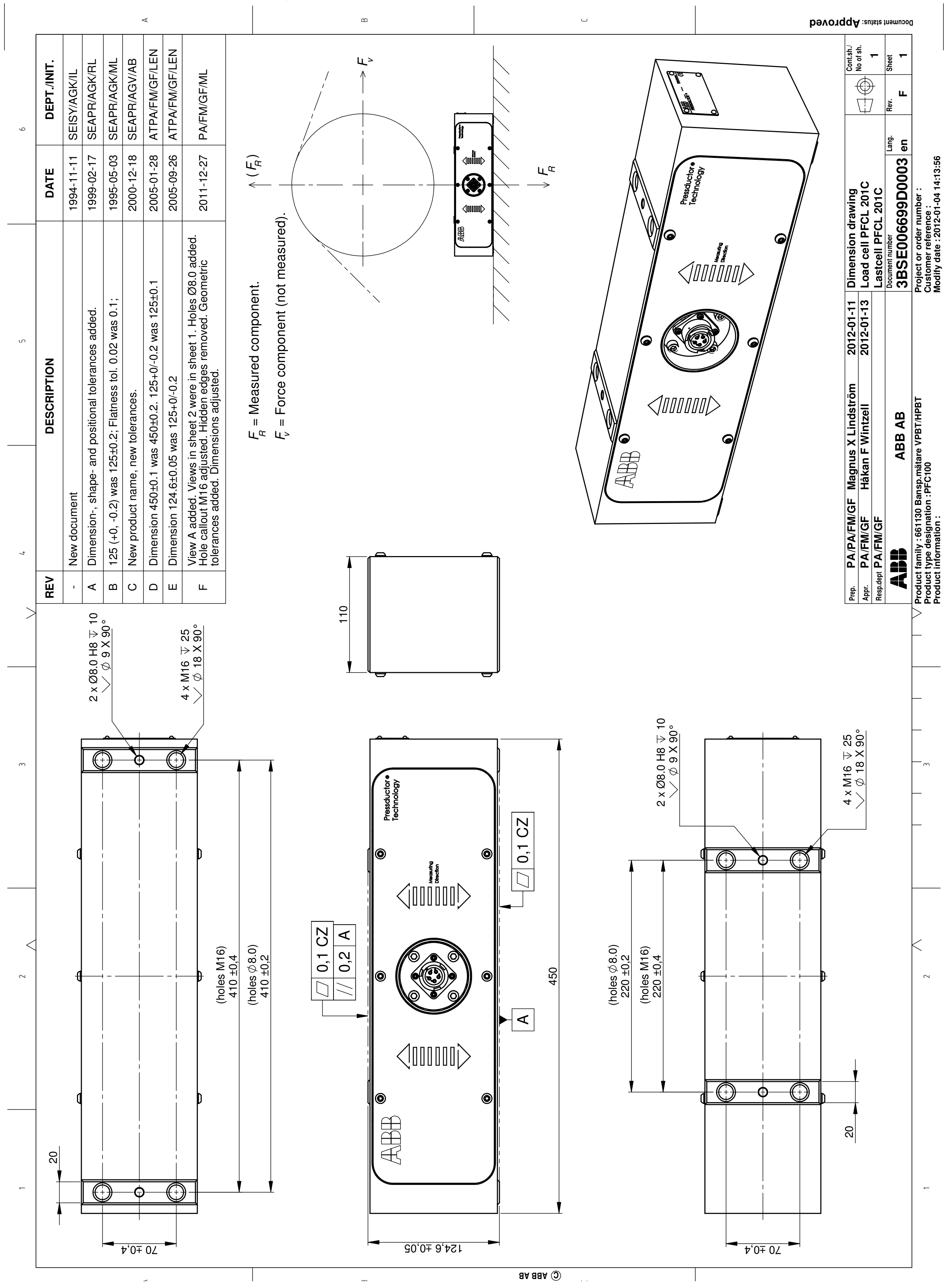
## F.11 Cable Diagram 3BSE028144D0065, Page 3/7, Rev. D



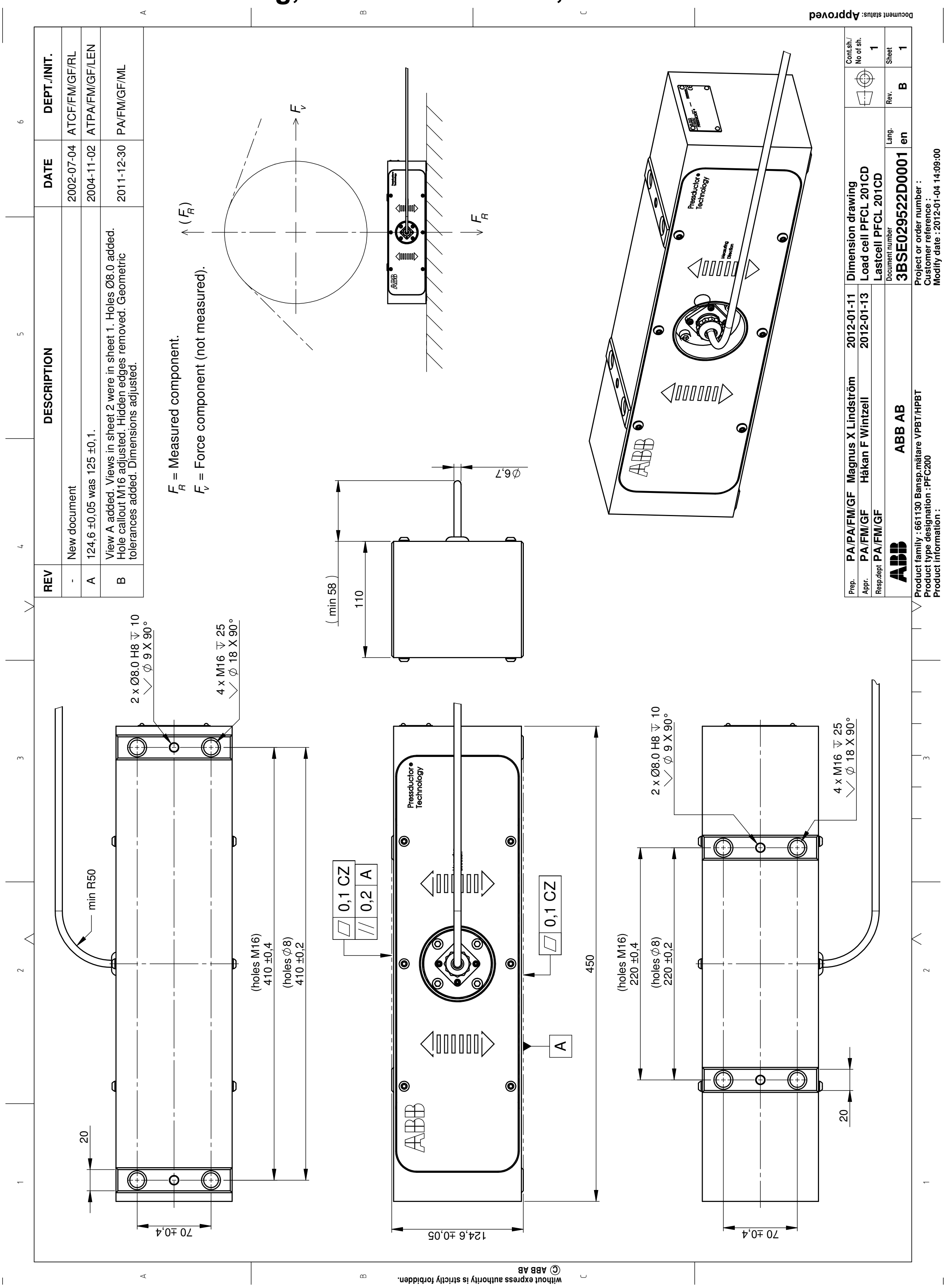
## F.12 Cable Diagram 3BSE028144D0065, Page 7/7, Rev. D



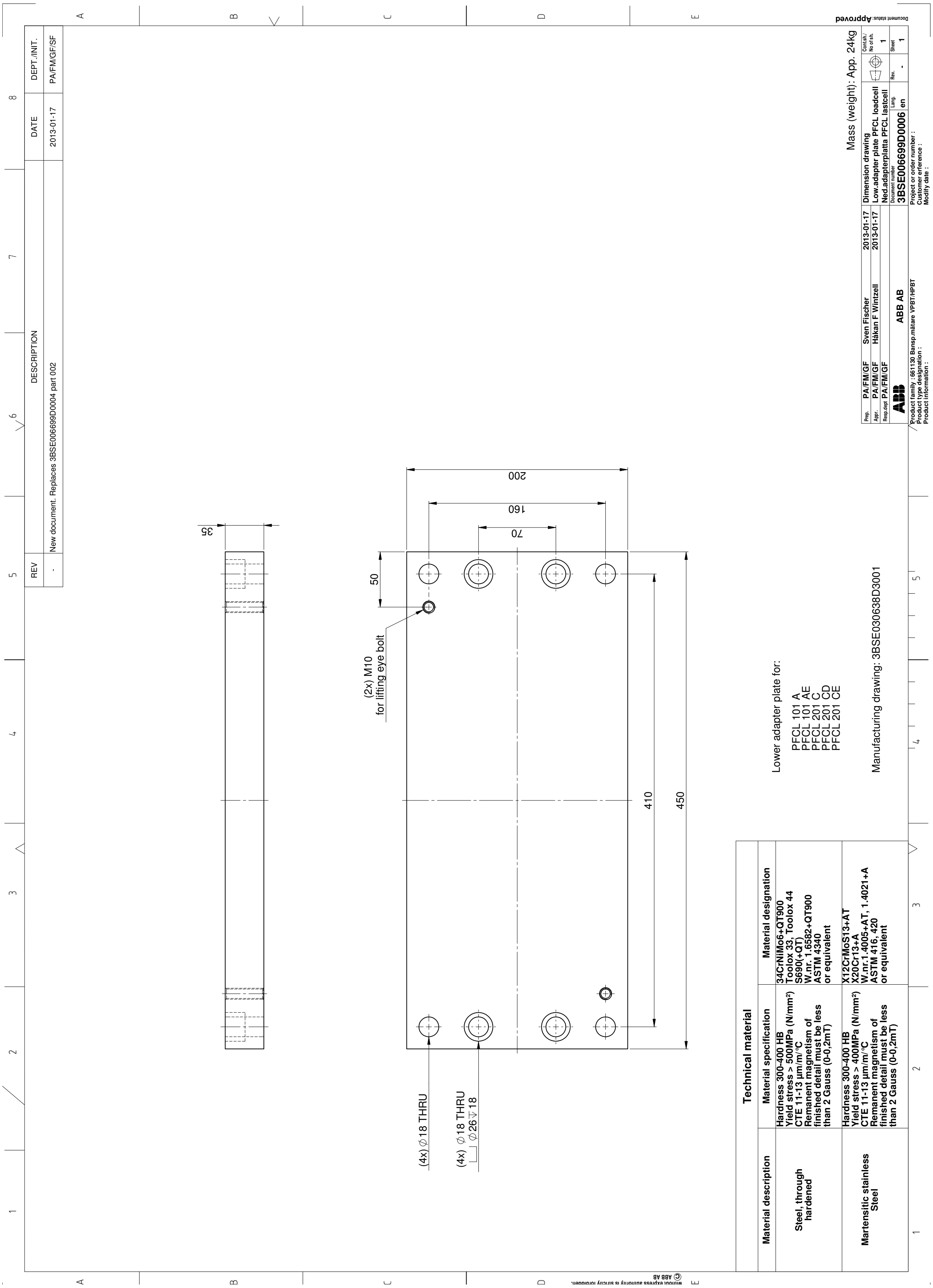
## F.13 Dimension Drawing, 3BSE006699D0003, Rev. F



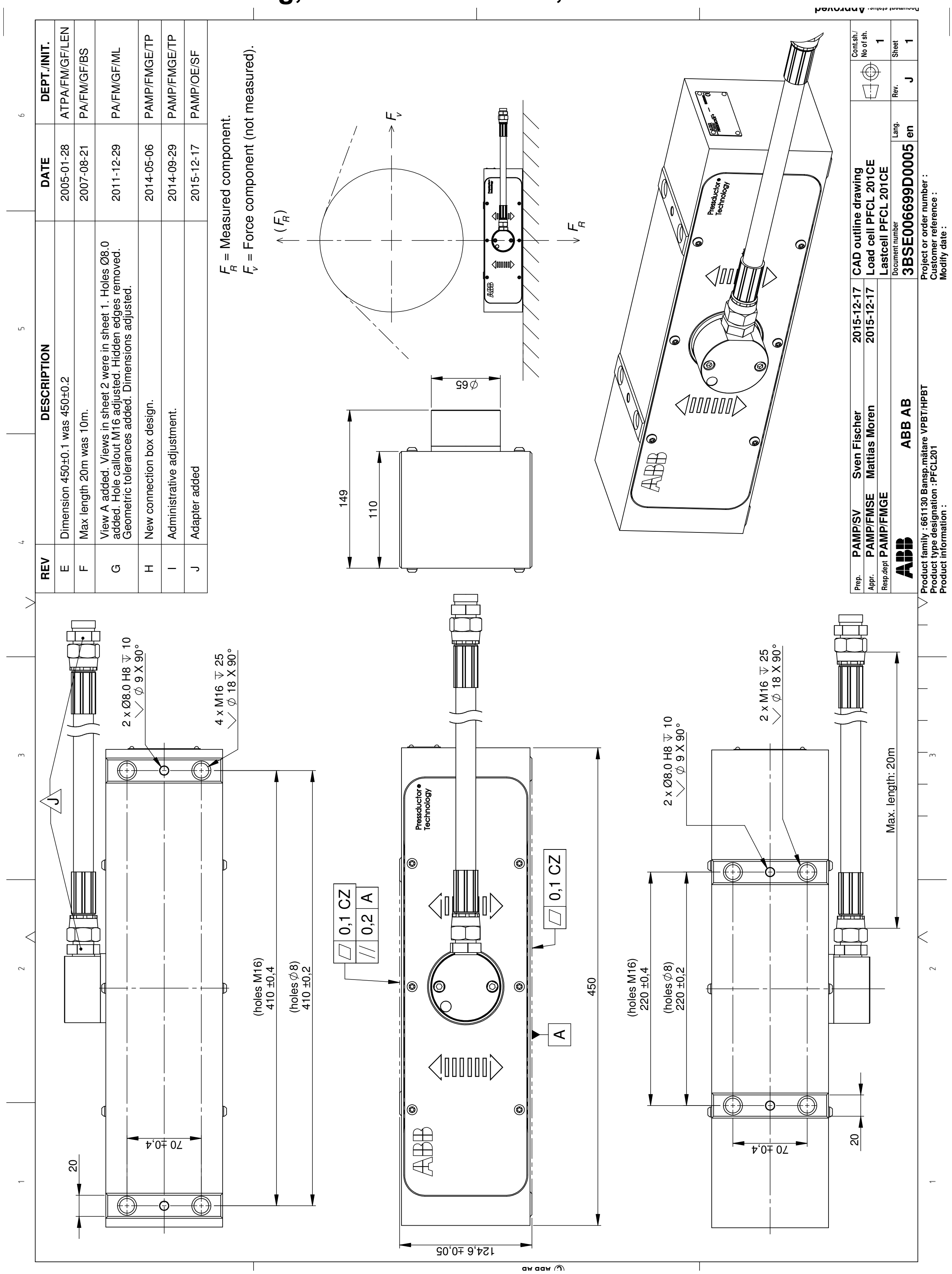
## F.14 Dimension Drawing, 3BSE029522D0001, Rev. B



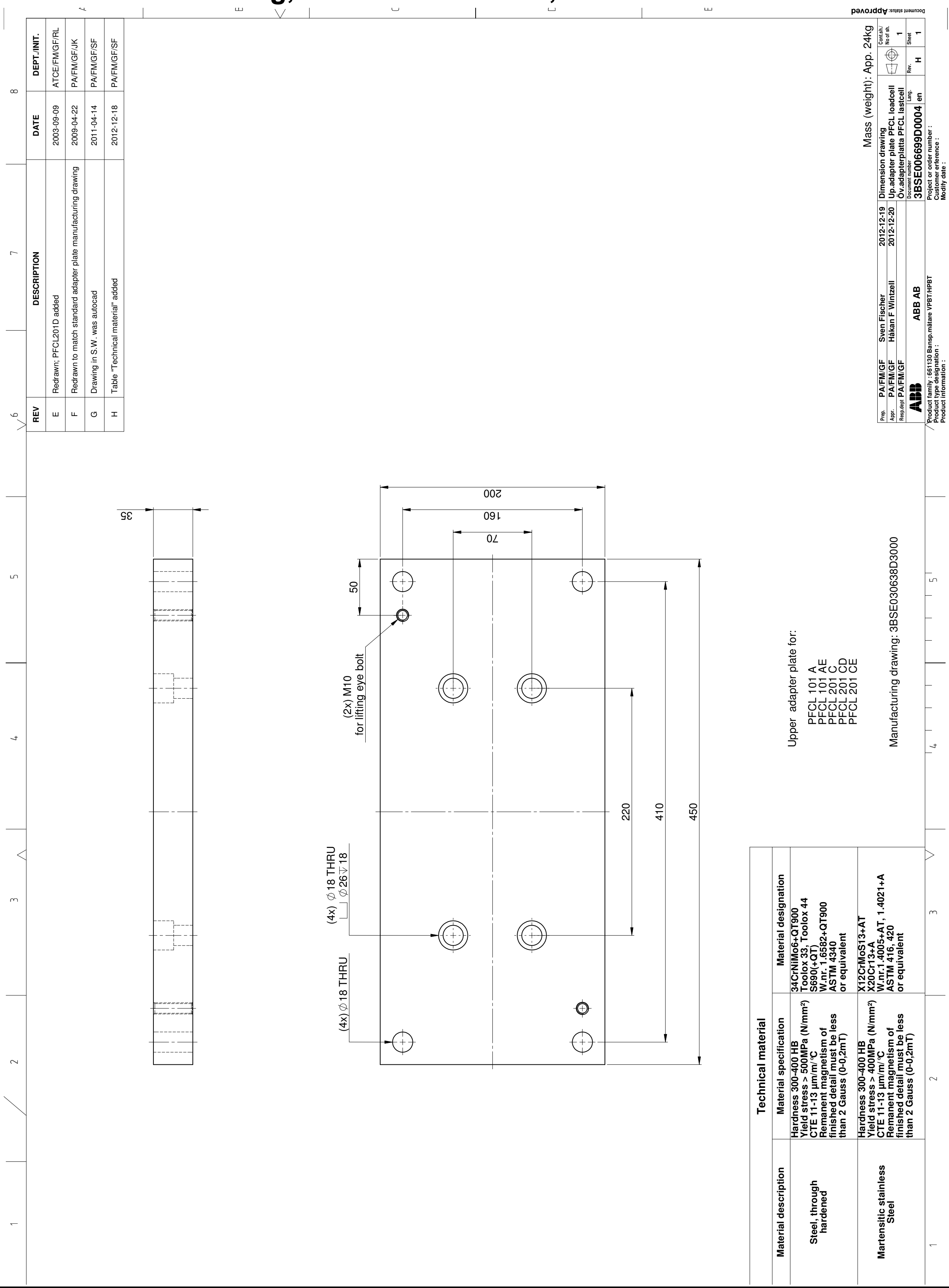
## F.15 Dimension Drawing, 3BSE006699D0006, Rev. -



# F.16 Dimension Drawing, 3BSE006699D0005, Rev. J



## F.17 Dimension Drawing, 3BSE006699D0004, Rev. H



# Appendix G PFTL 201 - Designing the Load Cell Installation

## G.1 About This Appendix

This appendix describes the procedure for designing the load cell installation.

The following sections are included:

- Basic application considerations
- Designing the load cell installation (step-by-step guide)
- Installation requirements
- Force and wrap gain calculation
  - Horizontal mounting
  - Inclined mounting
  - Single side measurement
- Mounting the load cells
- Technical data
- Drawings
  - Cable diagram(s)
  - Dimension drawing(s)

## G.2 Basic Application Considerations

Each application has its own individual demands that have to be considered; though a few basic considerations tend to repeat themselves.

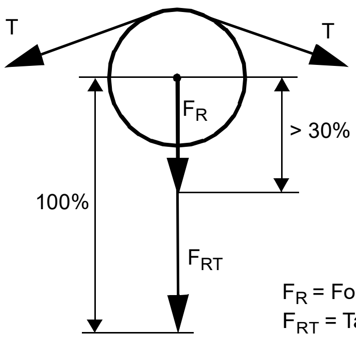
- What type of process is involved (papermaking, converting, etc.)?
  Is the environment demanding (temperature, chemicals, etc.)?
- What is the tension measurement purpose; indication or closed loop control?
  Are there any specific accuracy demands involved?
- What is the machine design like? Is there the possibility to modify the design, in order to fit the most suitable load cell, or is the machine design fixed?
- What are the forces acting on the roll like (size and direction)?
  Can they be altered by redesign?

If these questions are dealt with thoroughly, the installation is very likely to be successful. However, the extent to which measurement accuracy is needed, defines the requirements when designing a load cell installation.

## G.3 Step-by-Step Guide for Designing the Load Cell Installation

The procedure below defines the main considerations involved in designing a load cell installation.

1. Check load cell data so that environmental demands are met.
2. Calculate forces; vertical, horizontal and axial (cross directional).
3. Size and orient load cell so that the guidelines below are met:
   a. Try to achieve a measured value no less than 10% of web tension, in the load cell measurement direction!
   b. Select load cell size so that it is loaded as close as possible to its nominal load! Do not dimension Force component of Tension in measuring direction, $F_R$, for less than 10% of the load cell nominal load!
   c. If the span between maximum and minimum tension in the process is large, select load cell so that the maximum tension will be in the load cell extended range (when applicable)!
   d. The measured force component of web tension is recommended to be at least 30% of tare force component (roll weight) acting in load cell measurement direction. The reason for this recommendation is load cell signal stability, especially when the system operates in a large temperature span.
   This means that if $F_{RT}$ < 1/3 of $F_{nom}$, $F_R$ should be at least 10% of $F_{nom}$.
   For larger $F_{RT}$, lowest $F_R$ is recommended to be at least 30% of $F_{RT}$.




**Rule 1:** If $F_{RT}$ < 1/3 of $F_{nom}$
$F_R$ should be at least 10% of $F_{nom}$
**Rule 2:** If $F_{RT}$ > 1/3 of $F_{nom}$
$F_R$ is recommended to be at least 30% of $F_{RT}$

$F_R$ = Force component of web tension in measuring direction
$F_{RT}$ = Tare force in measurement direction

   e. Check load cell data so that limits for building height, transverse and axial forces are not exceeded.
4. Design base frame and/or adapter plates.

## G.4  Installation Requirements

To achieve the specified accuracy, the best possible reliability and long-term stability, install the load cells in accordance with the requirements below.

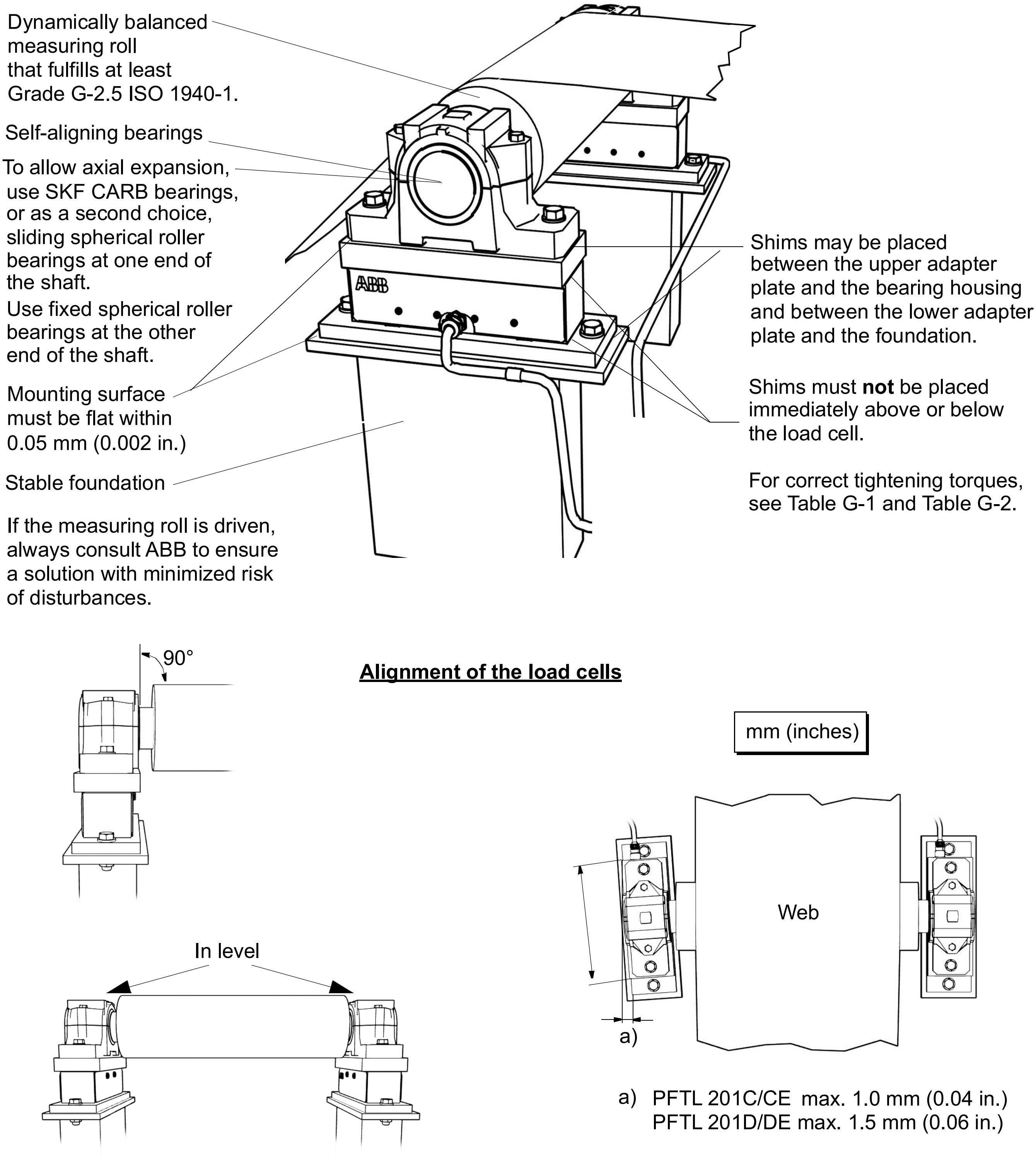
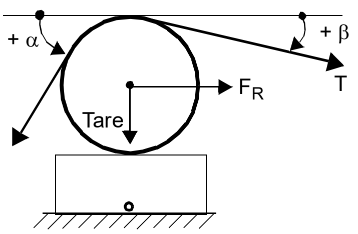



*Figure G-1. Installation requirements*

# G.5 Mounting Alternatives, Calculating Force and Calculating Wrap Gain

## G.5.1 Horizontal Mounting




$F_R = T \times (\cos\beta - \cos\alpha)$

$F_{RT} = 0$ (Tare force is not measured)

$F_{Rtot} = F_R + F_{RT} = T \times (\cos\beta - \cos\alpha)$

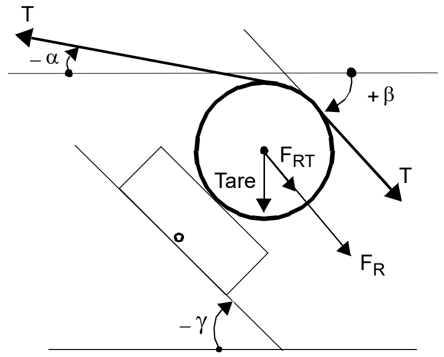
T (Tension) $=$ Wrap gain $\times F_R$

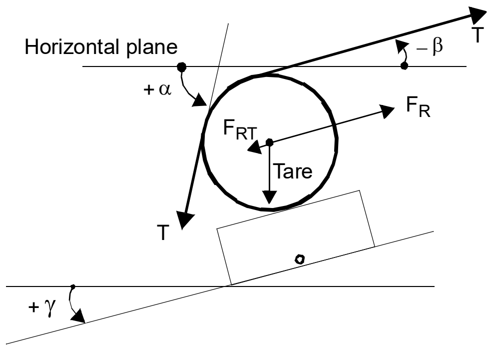
$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T(\cos\beta - \cos\alpha)}$$

$$\text{Wrap gain} = \frac{1}{\cos\beta - \cos\alpha}$$

In most cases, horizontal mounting is the most obvious and simplest solution. The load cell should thus be mounted horizontally when possible.

## G.5.2 Inclined Mounting




$F_R = T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)]$

$F_{RT} = -\text{Tare} \times \sin\gamma$

$F_{Rtot} = F_R + F_{RT} =$

$T \times [\cos(\beta + \gamma) - \cos(\alpha - \gamma)] + (-\text{Tare} \times \sin\gamma)$

---

$$T\ (\text{Tension}) = \text{Wrap gain} \times F_R$$

$$\text{Wrap gain} = \frac{T}{F_R} = \frac{T}{T[\cos(\beta + \gamma) - \cos(\alpha - \gamma)]}$$

$$\text{Wrap gain} = \frac{1}{\cos(\beta + \gamma) - \cos(\alpha - \gamma)}$$

Sometimes it is necessary to mount the load cell on an incline due to mechanical design constraints of the machine or the need to have a sufficient force component applied to the load cell.

Inclined mounting adds a component of tare force in the measuring direction and modifies the force components as shown.

**NOTE**

**When calculating, it is important that the angles are set into the equations with the correct signs in relation to the horizontal plane.**

## G.6 Force Calculation for Measurement with a Single Load Cell

In some cases, it is sufficient to measure the tension with only a single load cell mounted at one end of the roll.

### G.6.1 The Most Common and Simple Solution

The most obvious and simple solution is horizontal mounting with the web evenly distributed and centered on the roll.

As long as the roll is supported at both ends, the same calculations given in Section G.5 are valid.

**NOTE**

The accuracy of a single load cell measurement is highly dependent on how well the center of force can be determined. Since the cross-directional stress distribution generally is somewhat uneven, this is not easily done. The load cell will, however, produce a stable and repeatable measurement.

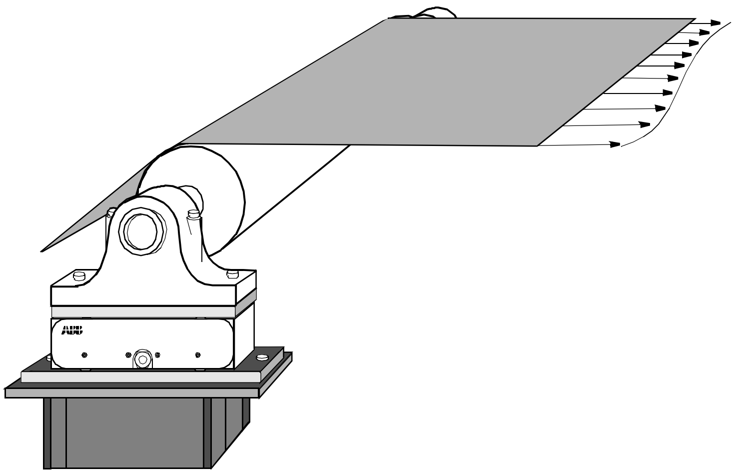
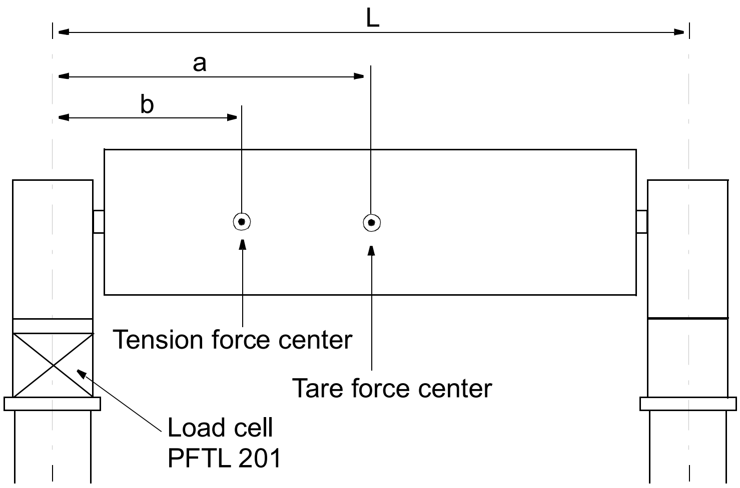


*Figure G-2. Cross-directional stress distribution*

# G.6.2 Force Calculation when the Web is not Centered on the Roll

Use the calculations below for horizontal and inclined mounting when the web is not centered on the roll.

The applied force at the load cell will be proportional to the distance between the tension force center and the load cell centerline, see figure.




Calculation procedure:

1. Horizontal or inclined mounting?
2. Calculate $F_R$ and $F_{RT}$, see Section G.5.
3. Use the following equations:

$F_R$ for single load cell $= F_R \times \frac{L-b}{L}$

$F_{RT}$ for single load cell $= F_{RT} \times \frac{L-a}{L}$

$F_{Rtot}$ for single load cell $=$ $F_R$ for single load cell + $F_{RT}$ for single load cell

where:

L = Distance between load cell centerline and the opposite bearing centerline

a = Distance between tare force center and load cell centerline

b = Distance between tension force center and load cell centerline

# G.7 Mounting the Load Cells

## G.7.1 Preparations

Prepare the installation in good time by checking that the necessary documents and material are available, as follows:

- Installation drawings and this manual.
- Standard tools, torque wrench and instruments.
- Rust protection, if additional protection is to be given to machined surfaces. Choose TECTYL 511 (Valvoline) or FERRYL (104), for example.
- Screws as listed in Table G-1 or Table G-2 to secure the load cell, and other screws for bearing housings etc.
- Load cells, adapter plates, bearing housings, etc.

## G.7.2 Adapter plates

The adapter plates shall normally be provided with stop blocks in order to prevent movement, if the load cells are overloaded. The screw joints may not alone fix the load cells in a proper way at overload. See drawing in Section G.17 and Section G.18.

## G.7.3 Mounting

The instructions below apply to a typical mounting arrangement. Variations are allowed, provided that the requirements of Section G.4 are complied with.

1. Clean the foundation and other mounting surfaces.
2. Fit the lower adapter plate to the load cell. Tighten the screws to the torque stated in Table G-1 or Table G-2 and lock them with locking fluid.
3. Fit the load cell and the lower adapter plate to the foundation, but do not fully tighten the screws.
4. Fit the upper adapter plate to the load cell, tighten to the torque stated in Table G-1 or Table G-2, and apply locking fluid.
5. Fit the bearing housing and the roll to the upper adapter plate, but do not fully tighten the screws.
6. Adjust the load cells so that they are in parallel with each other and in line with the axial direction of the roll. Tighten the foundation screws.
7. Adjust the roll so that it is at right angles to the longitudinal direction of the load cells. Tighten the screws in the upper adapter plate.
8. Apply rust protection to any machined surfaces not rust proof.

*Table G-1. $MoS_2$ lubricated , galvanized screws according to ISO 898/1*

| Strength class | Dimension | Tightening torque |
|---|---|---|
| 8.8 * (12.9) | M24 | 572 (963) Nm |
| 8.8 * (12.9) | M36 | 1960 (3310) Nm |

*Table G-2. Waxed screws of stainless steel according to ISO 3506*

| Strength class | Dimension | Tightening torque |
|---|---|---|
| A2-80 * | M24 | 629 Nm |
| A2-80 * | M36 | 2160 Nm |

* Strength class 12.9 must be used for load cells PFTL 201C-50 kN and PFTL 201D-100 kN.

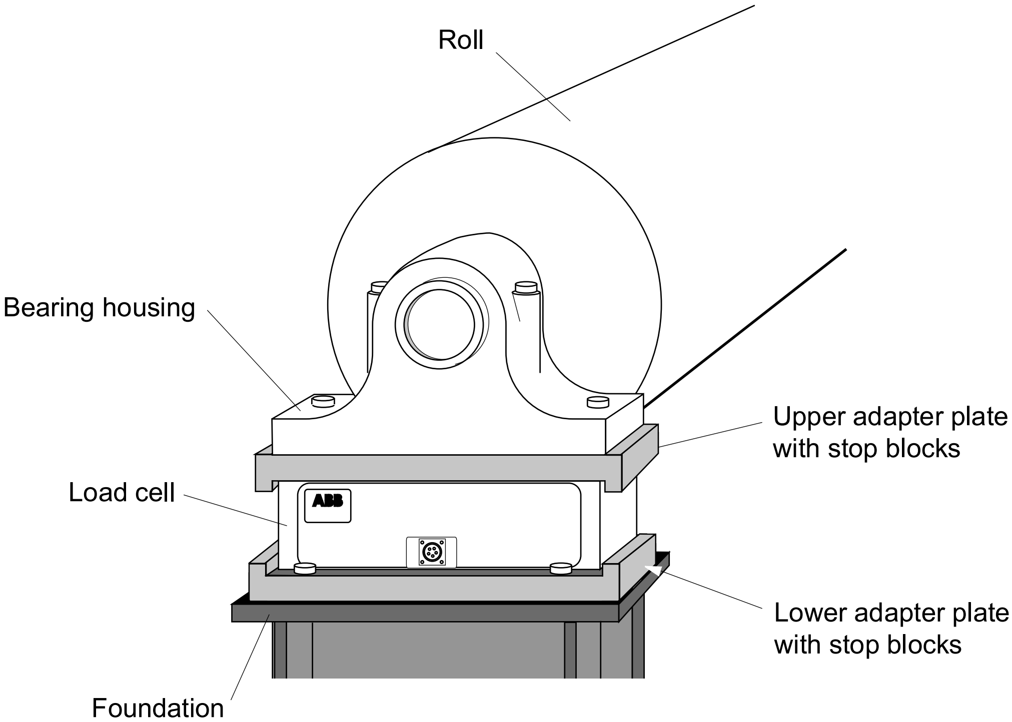



*Figure G-3. Typical installation*

## G.7.4 Cabling

Figure G-4 shows how the cable and protective hose shall be mounted for load cells PFTL 201CE and PFTL 201DE. The direction of the cable and protecting hose can be changed.

**NOTE**

The cable with protective hose shall not be rotated more than 180° from its initial mounting direction, otherwise the cable can be damaged.

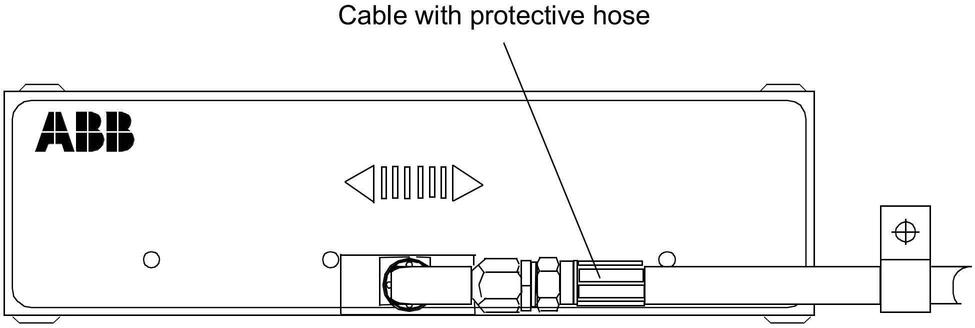



*Figure G-4. Allowed laying of cable with protective hose for PFTL 201CE and PFTL 201DE*

## G.8 Technical data load cell PFTL 201

*Table G-3. Technical data for different types of load cell PFTL 201*

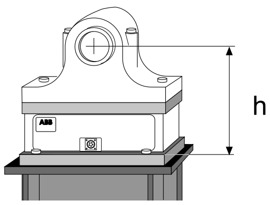
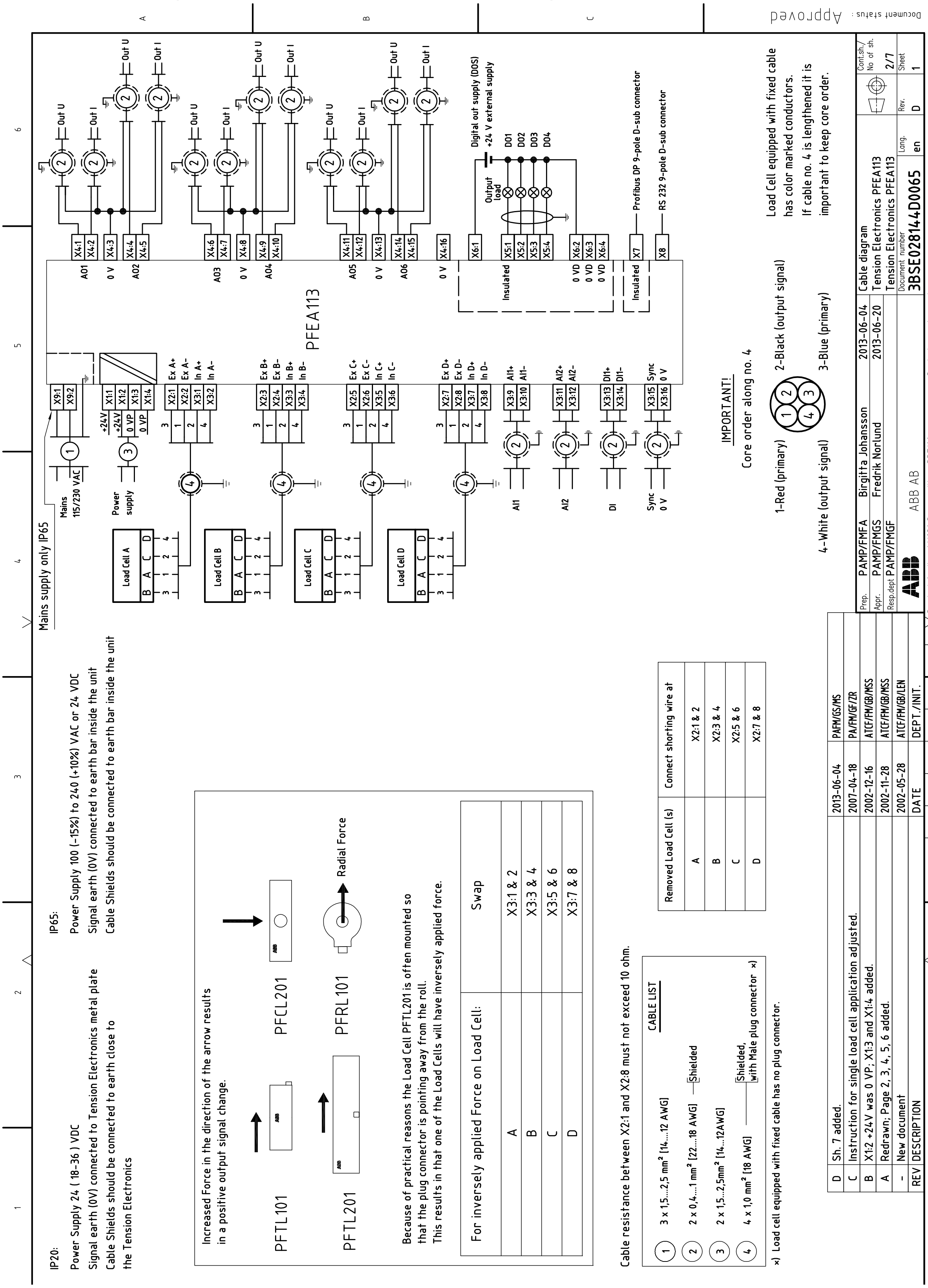
| | **PFTL 201, type** | **Data** | | | | **Unit** |
|---|---|---|---|---|---|---|
| **Nominal load** | | | | | | |
| Nominal load in measuring direction, $F_{nom}$ | C/CE | 10 (2250) | 20 (4500) | 50 (11200) | | kN (lbs) |
| | D/DE | | | 50 (11200) | 100 (22500) | |
| Permitted transverse load within the accuracy, $F_{Vnom}$ | C/CE | 100 (22500) | 200 (45000) | 250 (56200) | | kN (lbs) |
| | D/DE | | | 500 (112000) | 500 (112000) | |
| Permitted axial load within the accuracy, $F_{Anom}$ (h=300 mm)   | C/CE | 20 (4500) | 20 (4500) | 50 (11250) | | kN (lbs) |
| | D/DE | | | 100 (22500) | 100 (22500) | |
| Extended load in measuring direction with accuracy class ±1%, $F_{ext}$ | C/CE | 15 (3370) | 30 (6740) | 75 (16900) | | kN (lbs) |
| | D/DE | | | 75 (16900) | 150 (33700) | |
| **Overload capacity** | | | | | | |
| Maximal load in measuring direction without permanent change of data, $F_{max}$ | C/CE | 100 (11200) | 200 (22500) | 500 (56200) | | kN (lbs) |
| | D/DE | | | 500 (56200) | 1000 (112000) | |
| **Spring constant** | C/CE | 1000 (5710) | 1000 (5710) | 1000 (5710) | | kN/mm (1000 lbs/inch) |
| | D/DE | | | 2000 (11400) | 2000 (11400) | |

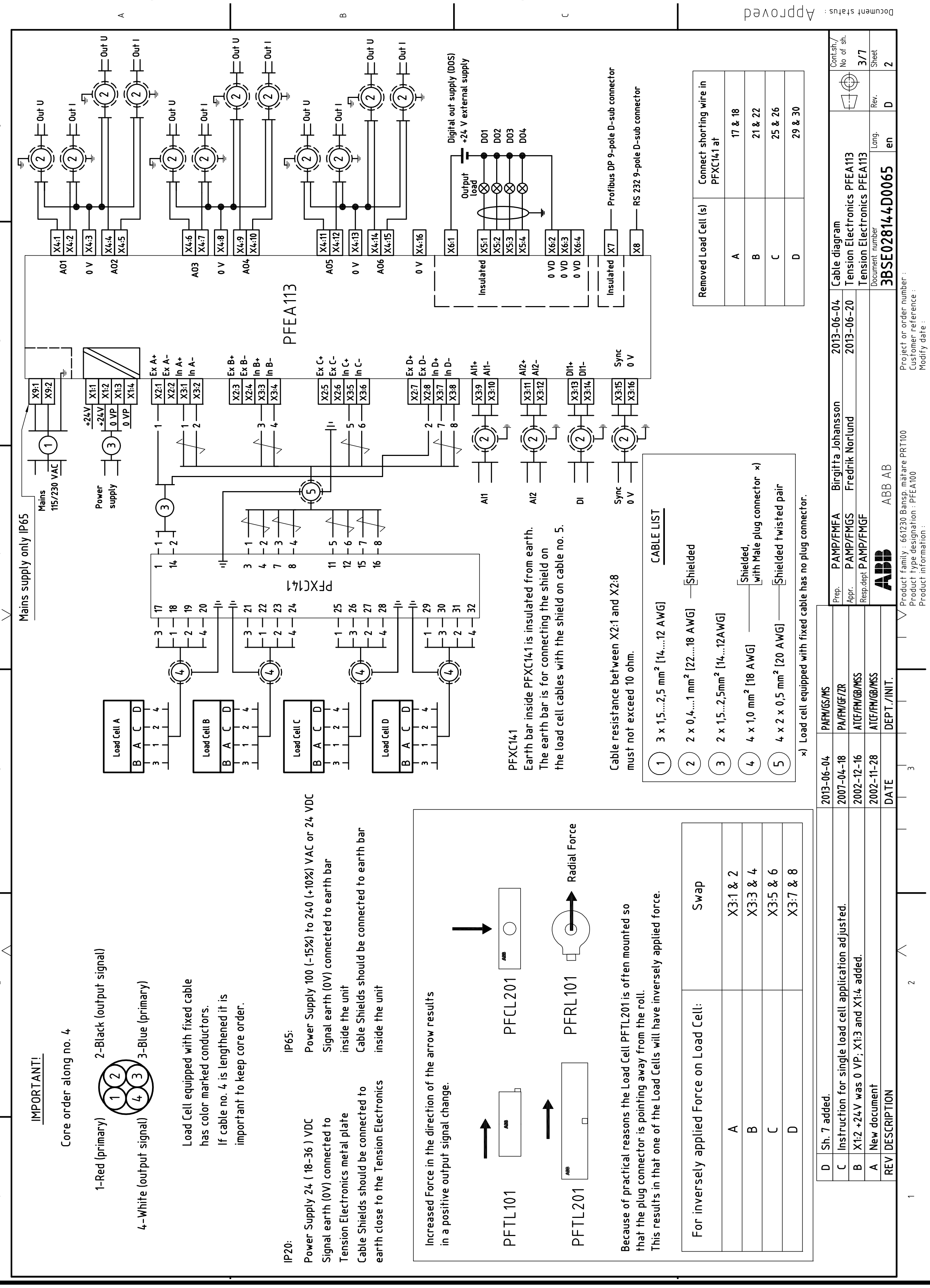
*Table G-3. Technical data for different types of load cell PFTL 201*

| | PFTL 201, type | Data | | | | Unit |
|---|---|---|---|---|---|---|
| **Mechanical data** | | | | | | |
| Length | C/CE | 450 (17.7) | 450 (17.7) | 450 (17.7) | | mm (inch) |
| | D/DE | | | 650 (25.6) | 650 (25.6) | |
| Width | C | 110 (4.3) | 110 (4.3) | 110 (4.3) | | mm (inch) |
| | D | | | 150 (5.9) | 150 (5.9) | |
| | CE | 180 (7.1) | 180 (7.1) | 180 (7.1) | | |
| | DE | | | 220 (8.7) | 220 (8.7) | |
| Height | C/CE | 125 (4.9) | 125 (4.9) | 125 (4.9) | | mm (inch) |
| | D/DE | | | 150 (5.9) | 150 (5.9) | |
| Weight | C/CE | 35 (77) | 35 (77) | 35 (77) | | kg (lbs) |
| | D/DE | | | 80 (176) | 80 (176) | |
| **Material** | C/D/CE/DE | Stainless steel SIS 2387 DIN X4CrNiMo165 | | | | |
| **Accuracy** | | | | | | |
| Accuracy class | C/D/CE/DE | ± 0.5 | | | | % |
| Linearity deviation | | ± 0.3 | | | | |
| Repeatability error | | < ± 0.05 | | | | |
| Hysteresis | | <0.2 | | | | |
| **Compensated temperature range** | | +20 - +80 (+68 - +176) | | | | °C (°F ) |
| Zero point drift | | 50 (28) | | | | ppm/K (ppm/°F) |
| Sensitivity drift | | 100 (56) | | | | |
| **Working temperature range** | | -10 - +90 (+14 - +194) | | | | °C (°F ) |
| Zero point drift | | 100 (56) | | | | ppm/K (ppm/°F) |
| Sensitivity drift | | 200 (111) | | | | |
| **Storage temperature range** | | -40 - +90 (-40 - +194) | | | | °C (°F ) |

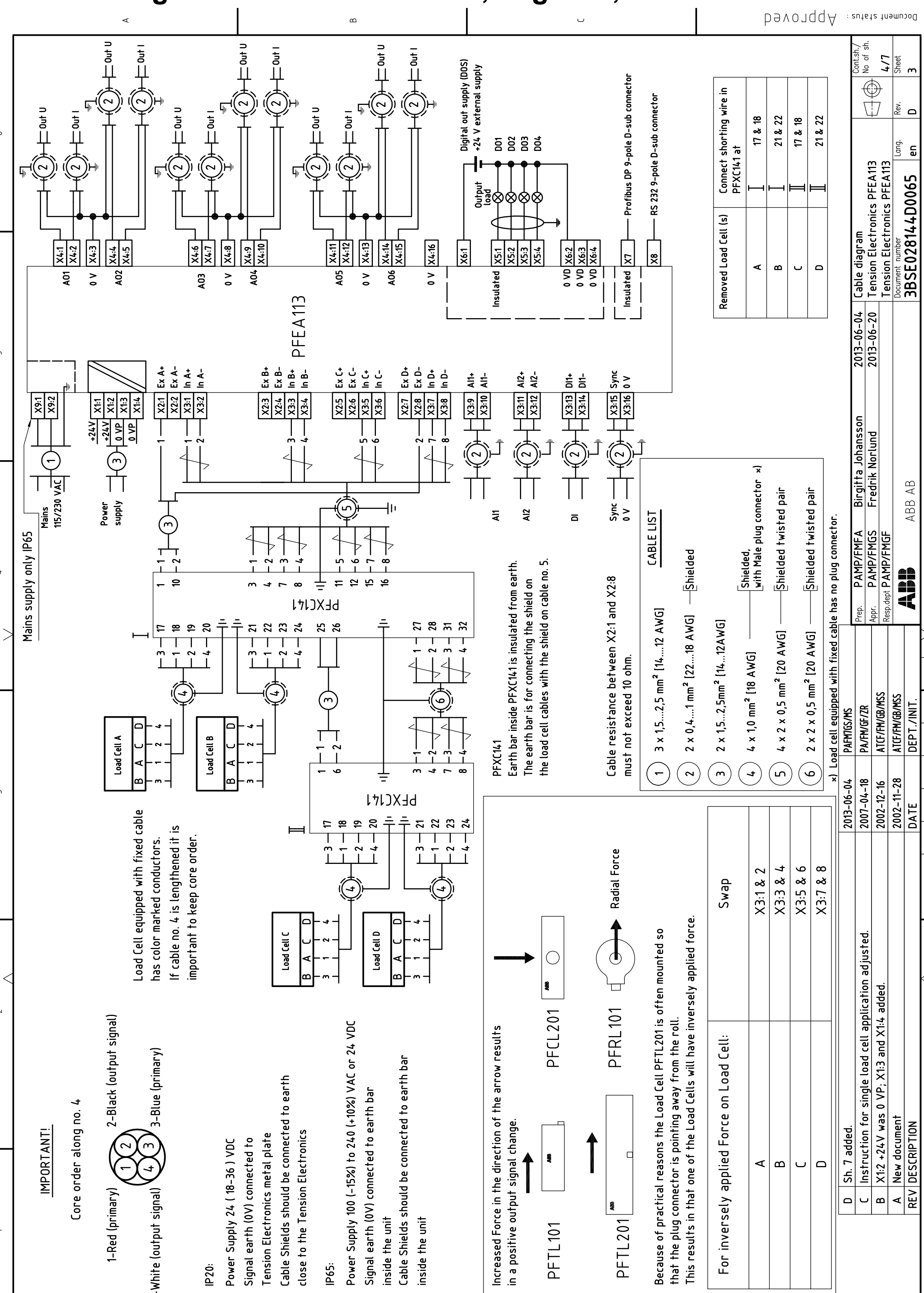
## G.9 Cable Diagram 3BSE028144D0065, Page 1/7, Rev. D



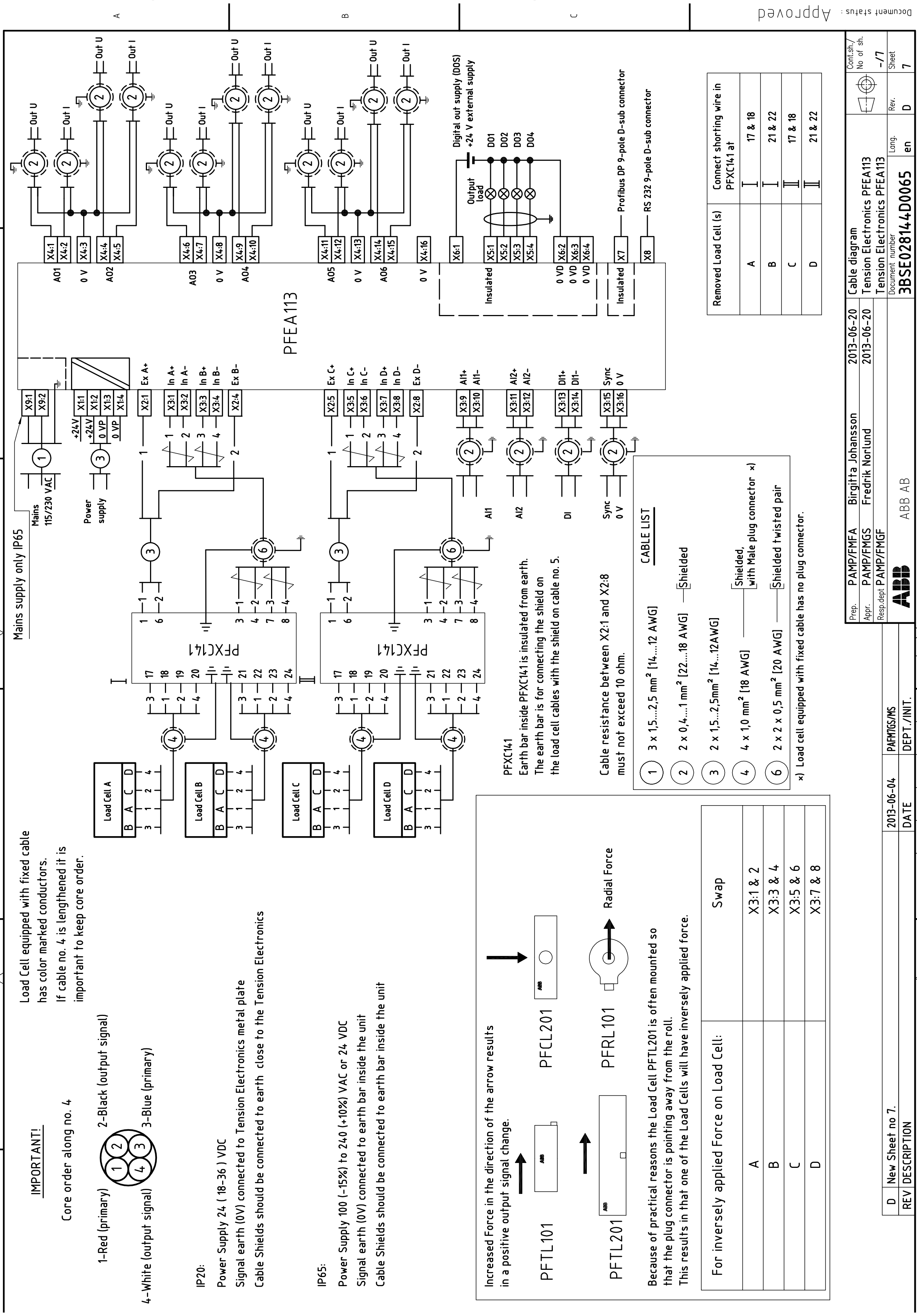
## G.10 Cable Diagram 3BSE028144D0065, Page 2/7, Rev. D



## G.11 Cable Diagram 3BSE028144D0065, Page 3/7, Rev. D

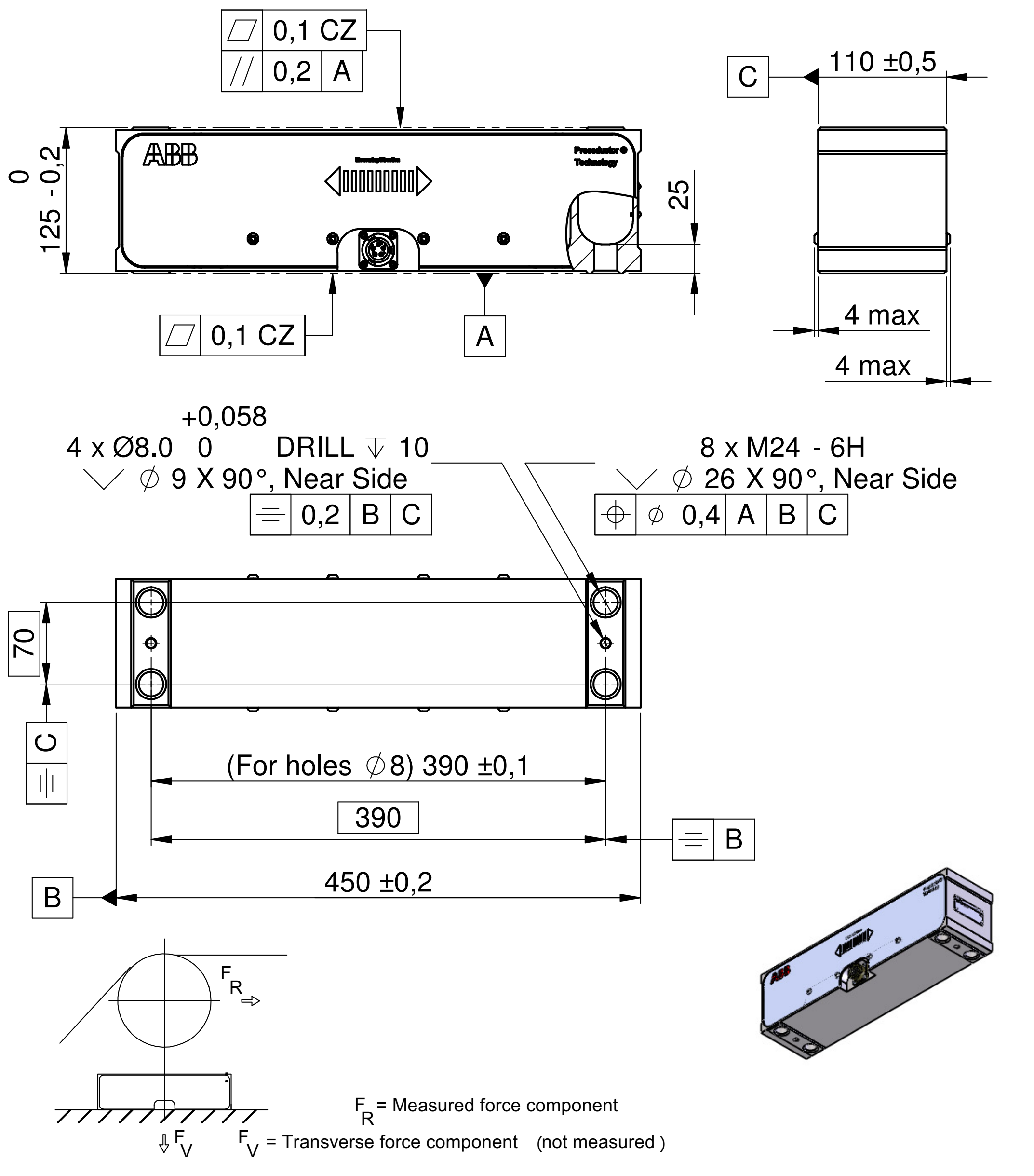


## G.12 Cable Diagram 3BSE028144D0065, Page 7/7, Rev. D



## G.13 Dimension Drawing, 3BSE008723, Rev. D

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| D | Redrawn and uppdated in Solid Works. Previous revision table removed, exist on revision C. | 2011-12-14 | PA/FM/GF/LEN |




General tolerances according to SS-ISO2768-m



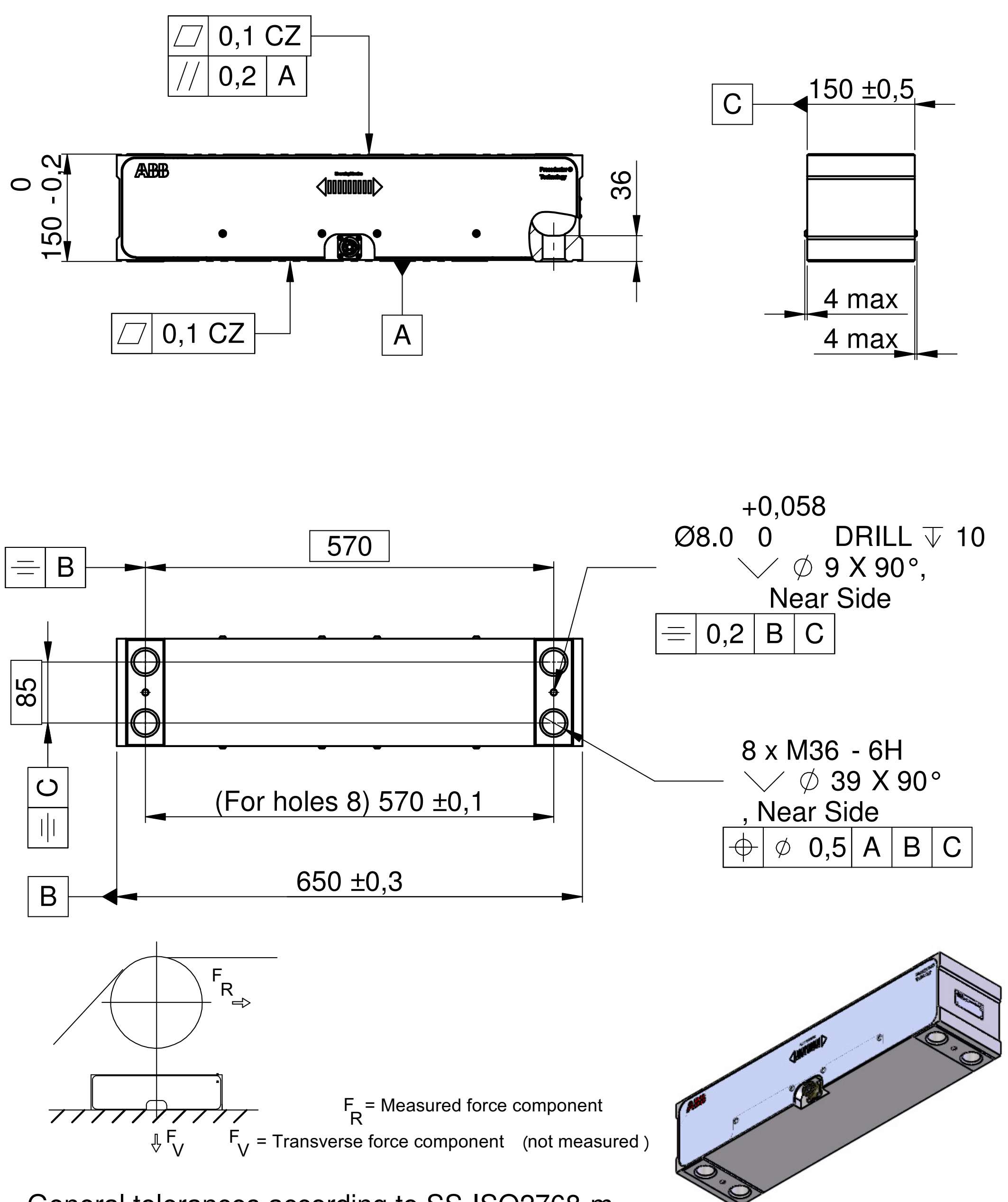
| | | | | | | |
|---|---|---|---|---|---|---|
| Prep. | PA/FM/GF | Lars-Erik Nilsson | 2011-12-14 | Dimension drawing | | Cont.sh./No of sh. 1 |
| Appr. | PA/FM/GF | Håkan F Wintzell | 2012-02-15 | Load Cell PFTL201-C | | |
| Resp.dept | PA/FM/GF | | | Lastcell PFTL201-C | | |
| ABB | ABB AB | | | Document number 3BSE008723 | Lang. en | Rev. D / Sheet 1 |

Product family :661130 Ransn mätare VPBT/HPBT
Project or order number :

Document status: Approved

## G.14 Dimension Drawing, 3BSE008904, Rev. D

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| D | Redrawn and uppdated in Solid Works. Previous revision table removed, exist on revision C. | 2011-12-14 | PA/FM/GF/LEN |



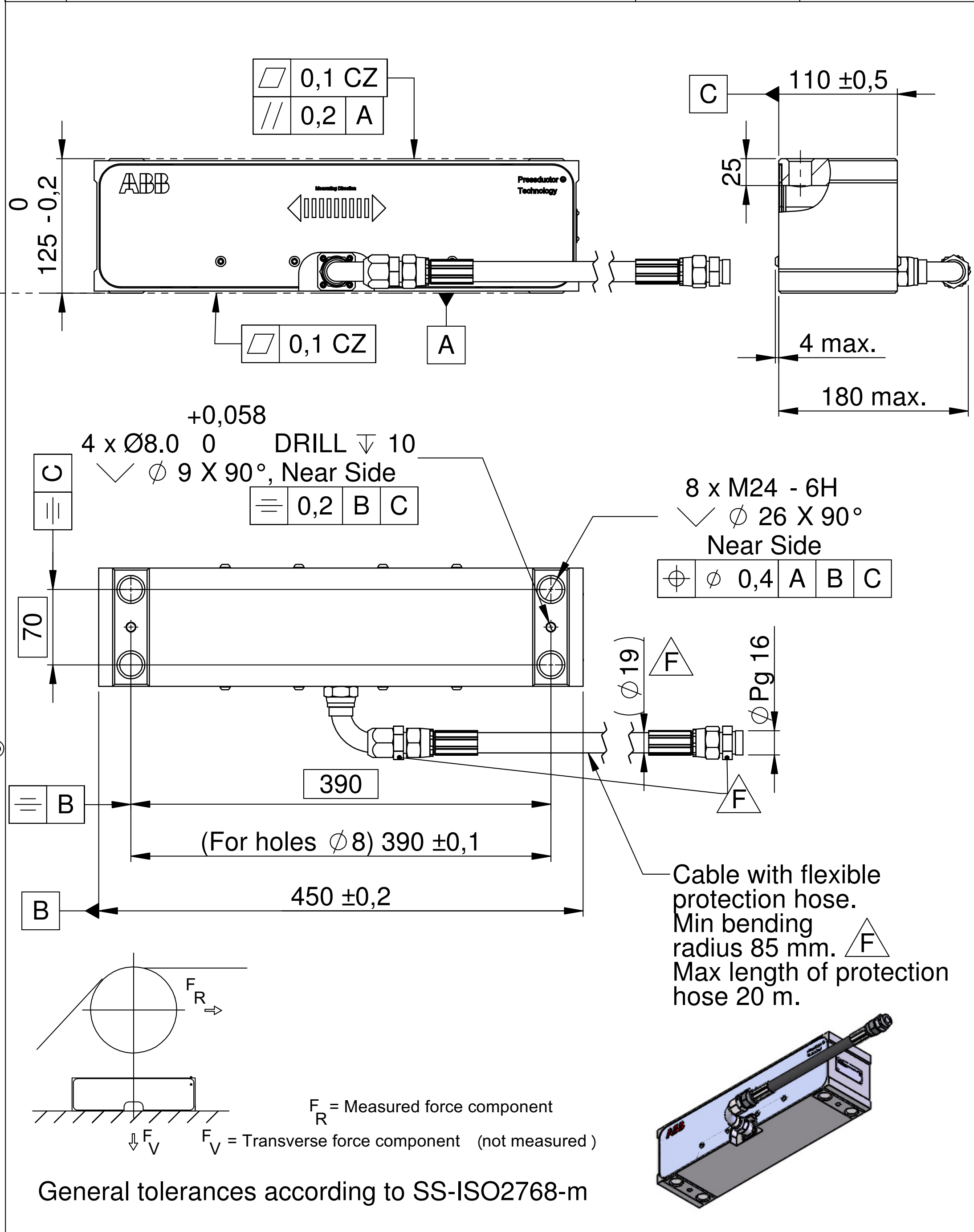

General tolerances according to SS-ISO2768-m

| | | | | | |
|---|---|---|---|---|---|
| Prep. PA/FM/GF | Lars-Erik Nilsson | 2011-12-14 | Dimension drawing | | Cont.sh./ No of sh. |
| Appr. PA/FM/GF | Håkan F Wintzell | 2012-02-15 | Load Cell PFTL201-D | | |
| Resp.dept PA/FM/GF | | | Lastcell PFTL201-D | | 1 |
| ABB | ABB AB | | Document number 3BSE008904 | Lang. en | Rev. D / Sheet 1 |

Document status: **Approved**

## G.15 Dimension Drawing, 3BSE008724, Rev. F

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| E | Redrawn and uppdated in Solid Works. Previous revision table removed, exist on revision D. | 2012-01-25 | PA/FM/GF/LEN |
| F | Adapter for hose added. Ø19 was 25 and radius 85 was 150 | 2017-01-09 | IAMA/OE/SF |






| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. IAMA /OE | Sven Fischer | 2017-01-12 | CAD outline drawing Load cell PFTL 201CE Lastcell PFTL 201CE | | | Cont.sh./ No of sh. 1 | |
| Appr. IAMA /OE | Jan-Olov Skogqvist | 2017-01-16 | | | | | |
| Resp.dept IAMA /FMOE | | | | | | | |
| ABB | ABB AB | | Document number 3BSE008724 | Lang. en | Rev. F | Sheet 1 | |

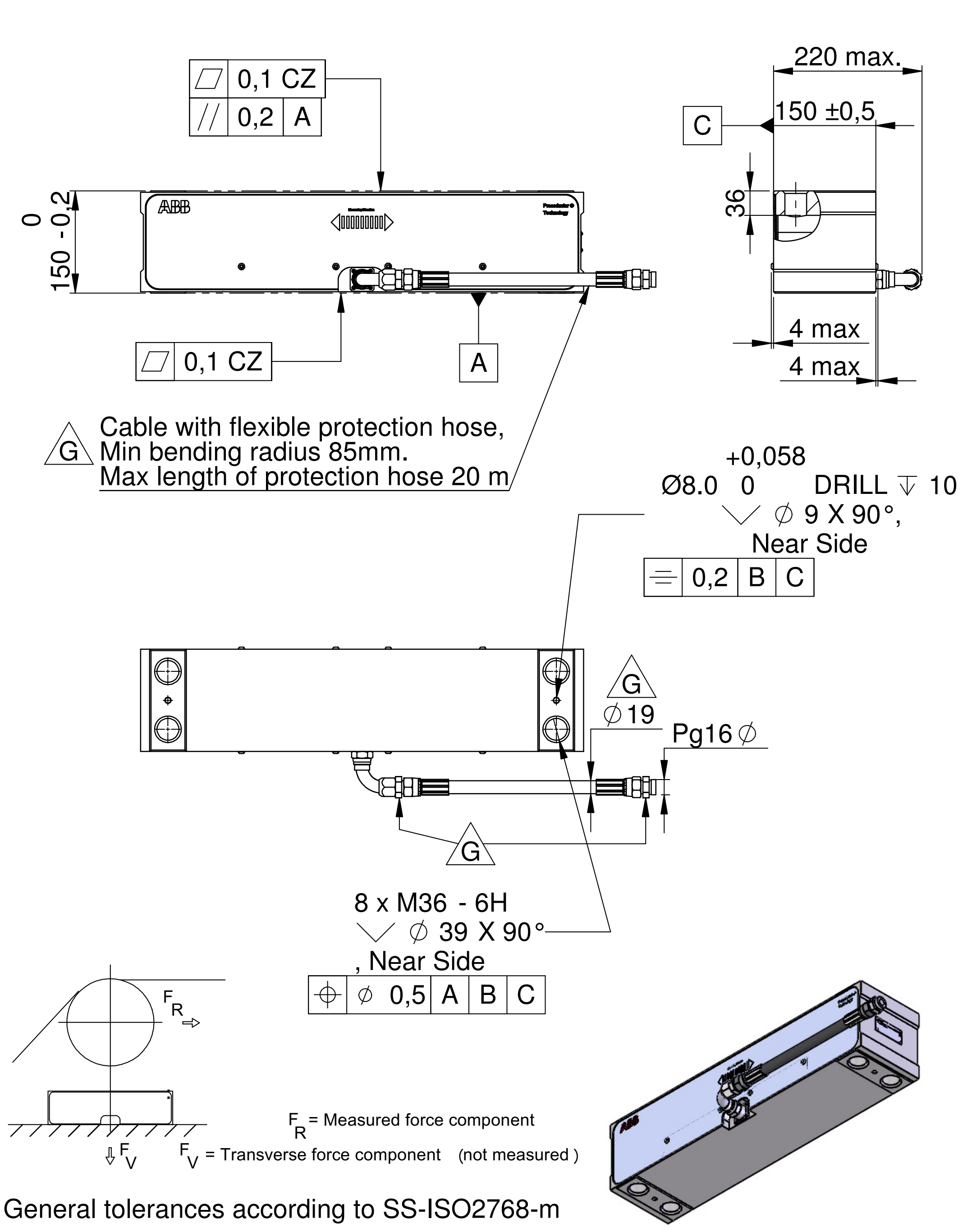
Product family : 661130 Bansp.mätare VPBT/HPBT

Project or order number :

Document status: Approved

## G.16 Dimension Drawing, 3BSE008905, Rev. G

| REV | DESCRIPTION | DATE | DEPT./INIT. |
|---|---|---|---|
| F | Redrawn and uppdated in Solid Works. Previous revision table removed, exist on revision E. | 2012-01-24 | PA/FM/GF/LEN |
| G | Adapter for hose added. Ø19 was Ø25 and radius 85 was 150 | 2017-01-12 | IAMA/OE/SF |




General tolerances according to SS-ISO2768-m

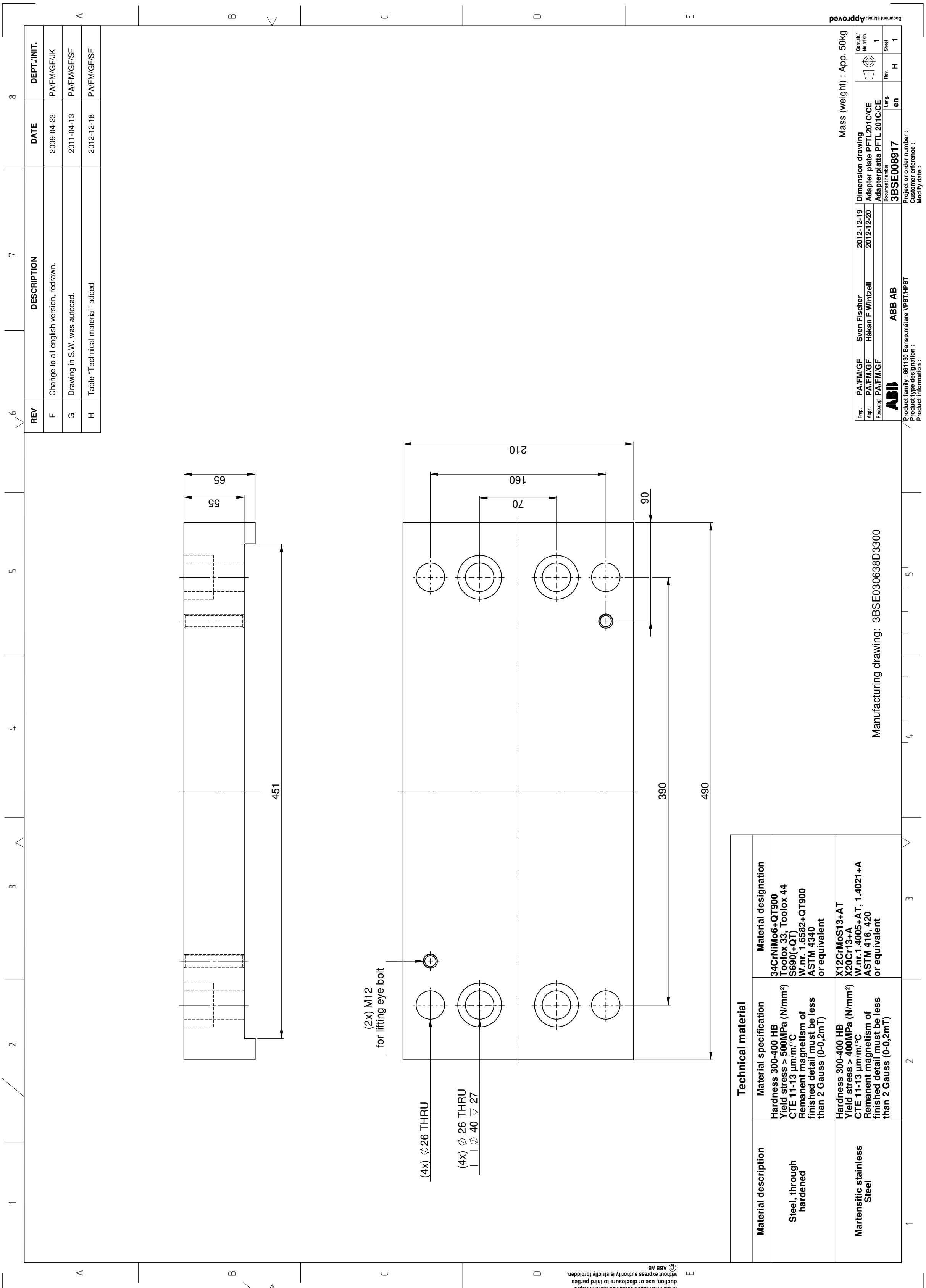


| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Prep. | IAMA /OE | Sven Fischer | 2017-01-12 | CAD outline drawing | | Cont.sh./ No of sh. | |
| Appr. | IAMA /OE | Jan-Olov Skogqvist | 2017-01-16 | Load Cell PFTL201-DE | | 1 | |
| Resp.dept | IAMA /FMOE | | | Lastcell PFTL201-DE | | | |
| ABB | ABB AB | | | Document number: 3BSE008905 | Lang.: en | Rev.: G | Sheet: 1 |

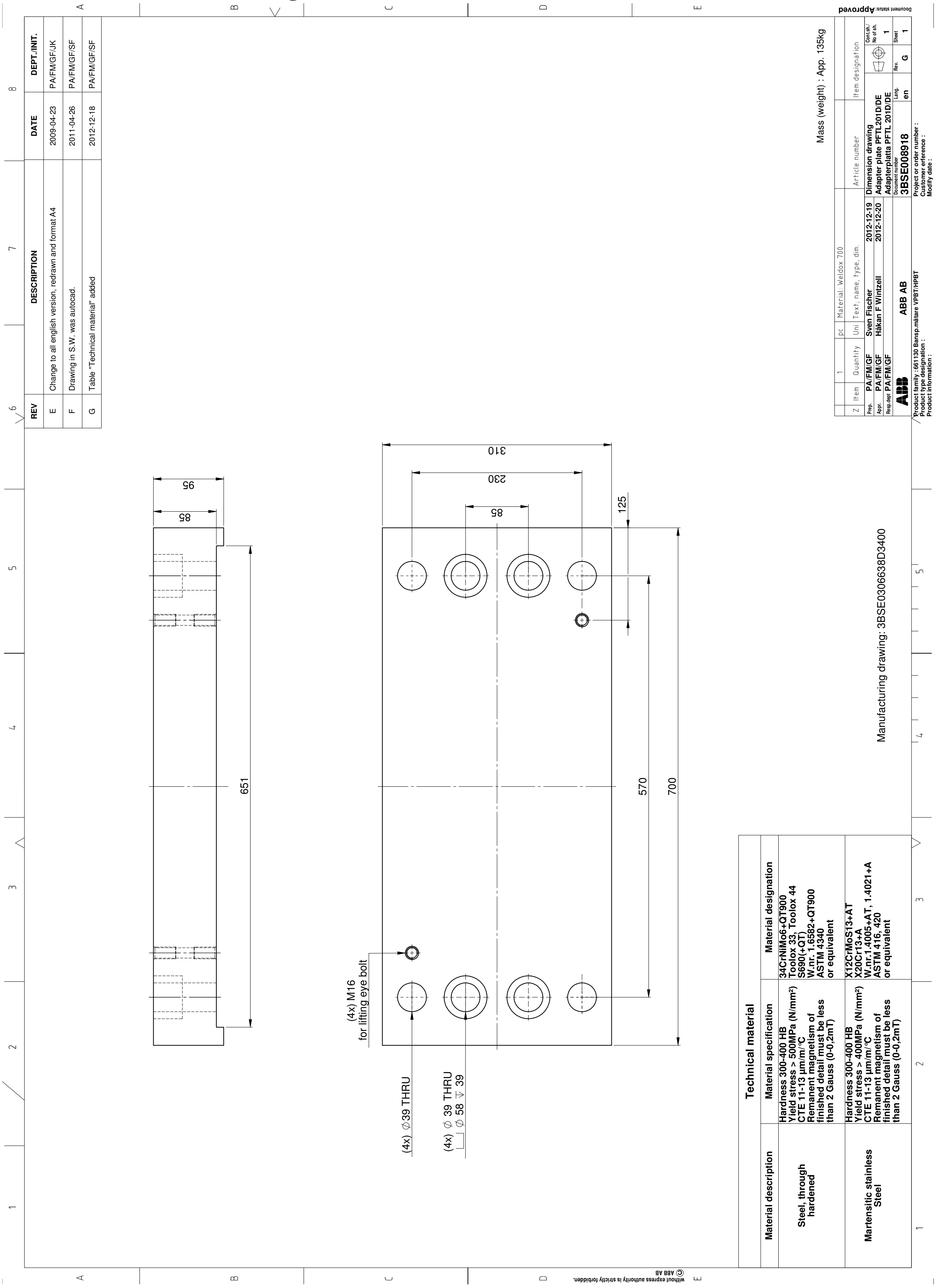
Product family : 661130 Bansp.mätare VPBT/HPBT
Project or order number :

Document status: Approved

## G.17  Dimension Drawing, 3BSE008917, Rev. H



## G.18 Dimension Drawing, 3BSE008918, Rev. G



# Appendix H Actual Data and Settings at Commissioning

## H.1 Document the Commissioning in this Form

Fill in actual data and settings to document the commissioning.

| | | | | | |
|---|---|---|---|---|---|
| **Display language** | | | | | |
| **Display unit** | | | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| **Web width** | | | | | m, inch |
| **System Definition** | **ONE ROLL** | | | | |
| | Gain scheduling | Yes | No | | |
| | Object type | Standard roll | | | |
| | | Single side | | | |
| | Load cell nominal load | | | | kN, lbs |
| | Wrap gain 1 | | | | |
| | Wrap gain 2 | | | | |
| | **TWO ROLLS** | | | | |
| | Gain scheduling | Yes | No | | |
| | Roll 1 | Object type | Standard roll | | |
| | | | Single side | | |
| | | Load cell nominal load | | | kN, lbs |
| | | Wrap gain 1 | | | |
| | | Wrap gain 2 | | | |
| | Roll 2 | Object type | Standard roll | | |
| | | | Single side | | |
| | | Load cell nominal load | | | kN, lbs |
| | | Wrap gain 1 | | | |
| | **SEGMENTED ROLL** | | | | |
| | Gain scheduling | Yes | No | | |
| | Segmented Roll Scale Factor (SRSF) | | | | |
| | Object type | One input | | | |
| | | Two inputs | | | |
| | | Three input | | | |
| | | Four inputs | | | |
| | Load cell nominal load | | | | kN, lbs |
| | Wrap gain 1 | | | | |
| | Wrap gain 2 | | | | |

If HangWeight has been used at commissioning, go to menu “EnterWrapGain”, read the Wrap gain value calculated by the electronics and fill in this Wrap gain value in the table.

| | | | |
|---|---|---|---|
| **Analog Output 1** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |
| **Analog Output 2** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |
| **Analog Output 3** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |

| | | | |
|---|---|---|---|
| **Analog Output 4** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |
| **Analog Output 5** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |

| | | | |
|---|---|---|---|
| **Analog Output 6** | Off | | |
| | Voltage | | |
| | Current | | |
| | Profibus only | | |
| | Connect signals | | |
| | Filter settings | | ms |
| | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Output | | V, mA |
| | Low Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Output | | V, mA |
| | High Limit | | V, mA |
| | Low Limit | | V, mA |

| | | | | |
|---|---|---|---|---|
| **Digital Out 1** | Define Function | Off | | |
| | | High Active | | |
| | | Low Active | | |
| | | High and Low Active | | |
| | | Status | | |
| | Connect Signals | AO1 | | |
| | | AO2 | | |
| | | AO3 | | |
| | | AO4 | | |
| | | AO5 | | |
| | | AO6 | | |
| | High Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Hysteresis | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |

| | | | | |
|---|---|---|---|---|
| **Digital Out 2** | Define Function | Off | | |
| | | High Active | | |
| | | Low Active | | |
| | | High and Low Active | | |
| | | Status | | |
| | Connect Signals | AO1 | | |
| | | AO2 | | |
| | | AO3 | | |
| | | AO4 | | |
| | | AO5 | | |
| | | AO6 | | |
| | High Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Hysteresis | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| **Digital Out 3** | Define Function | Off | | |
| | | High Active | | |
| | | Low Active | | |
| | | High and Low Active | | |
| | | Status | | |
| | Connect Signals | AO1 | | |
| | | AO2 | | |
| | | AO3 | | |
| | | AO4 | | |
| | | AO5 | | |
| | | AO6 | | |
| | High Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Hysteresis | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |

| | | | | |
|---|---|---|---|---|
| **Digital Out 4** | Define Function | Off | | |
| | | High Active | | |
| | | Low Active | | |
| | | High and Low Active | | |
| | | Status | | |
| | Connect Signals | AO1 | | |
| | | AO2 | | |
| | | AO3 | | |
| | | AO4 | | |
| | | AO5 | | |
| | | AO6 | | |
| | High Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Low Level | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Hysteresis | | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |

| | | | |
|---|---|---|---|
| **Analog Input 1** | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Input | | V |
| **Analog Input 2** | High Tension | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | High Input | | V |

| | | |
|---|---|---|
| **Digital Input** | Off | |
| | Zero set | |
| | Gain scheduling | |

| | | | |
|---|---|---|---|
| **Profibus** On | | Off | |
| - Address | | | |

| | | | |
|---|---|---|---|
| **Measuring Range** | Roll 1 | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Roll 2 | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |
| | Segmented Roll | | N, kN, kg, lbs, N/m, kN/m, kg/m, pli |

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