

669

T-SENSE®

and PEM4 stand alone

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1. PREFACE

1.1 GENERAL

The PEM4 touch screen is a microprocessor based instrument, which is able to fulfil standard torque, shaft speed and power calculations within narrow limits. Thrust and thrust/power calculations can be performed when thrust measurements are available.

The T-Sense® torque sensor is the measuring instrument providing torque, speed and power as input for the PEM4 touch screen. The TT-Sense® additionally provides thrust measurements as input. This completely unique and compact total solution can be used for simple to complicated configurations.



Never use the equipment outside its specifications or beyond common engineering practice nor use the equipment for other applications or make connections to other equipment than explicitly described in the order acknowledgement and/or technical manuals of VAF Instruments.



To ensure safe and correct installation and operation, read this manual completely before installing the equipment and starting operations.

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Their addresses can be found on www.vaf.nl

1.2 SYMBOLS

The following symbols are used to call attention to specific types of information.



A warning to use caution! In some instances, personal injury or damage to the torque sensor or control system may result if these instructions are not followed properly.



An explanation or information of interest.

1.3 COPYRIGHT

This Technical Manual is copyrighted with all rights reserved.

While every precaution has been taken in the preparation of this manual, no responsibility for errors or omissions is assumed. Neither is any liability assumed for damages resulting from the use of the information contained herein. Specifications can be changed without notice.

2. SYSTEM DESCRIPTION

2.1 PEM4 TOUCH SCREEN

The PEM4 touch screen is able to calculate several output data.

Functions, which can be performed with this PEM4 touch screen are:

- Measurement and display of torque, shaft speed, power and thrust (optional).
- Calculation of average shaft power, shaft speed and torque during the last 1, 4 and 24 hours.
- Calculation of total energy and total revolutions including reset.
- Calculation of average thrust/quotient when thrust measurement (optional) is provided.
- Displaying of parameters.

The PEM4 touch screen can be installed in a control cabinet or control panel.

2.2 SYSTEM SECURITY

Besides checking the status of the torque measurement system the PEM4 system also checks itself continuously for program and configuration data integrity, normal program flow and power supply conditions. Alarm messages will be logged in a dedicated alarm screen.

3. TECHNICAL SPECIFICATIONS

3.1 PEM4.7 TOUCH SCREEN

Supply voltage	115-230 VAC to power supply unit
Dimensions	235 x 150 x 44 (w x h x d)
Cut out	217,6 x 128,6 mm (w x h)
Cut out depth	38 mm
Front panel thickness	6 mm
Connections	RJ45 Ethernet connection on the back-bottom side of the panel
Temperature range	-20°C up to +60°C
Display	Color TFT LCD, PCAP Touch screen 7,0" (1024 x 600 dots) with adjustable LED backlight
Net weight	1,3 kg



3.2 PEM4.8 TOUCH SCREEN

Supply voltage	115-230 VAC to power supply unit
Dimensions	218,16 x 162,67 x 46,5 mm (w x h x d)
Cut out	167 x 116 mm (w x h)
Cut out depth	32 mm
Front panel thickness	17 mm
Connections	RJ45 Ethernet connection on the back-bottom side of the panel
Temperature range	-10°C up to +50°C (Operating Temperature)
Display	Color TFT LCD, Touch screen 8" (1024 x 600 dots) with adjustable backlight
Weight	940 g



3.3 PEM4.10 TOUCH SCREEN

Supply voltage	115-230 VAC to power supply unit
Dimensions	260 x 178 x 44 mm (w x h x d)
Cut out	246,5 x 164,5 mm (w x h)
Cut out depth	46 mm
Front panel thickness	3,20 mm
Connections	RJ45 Ethernet connection on the back-bottom side of the panel
Temperature range	0°C up to +50°C (Operating Temperature)
Display	Color TFT LCD, Touch screen 10.1" (1280 x 800 dots) with night view
Weight	2 kg



4. SAFETY INSTRUCTIONS

There are no special safety instructions for the equipment.

5. UNPACKING

Let the equipment acclimatize inside the closed box for at least one hour at the location where the system will be installed.

When the equipment is taken out of the box, please leave the special protection supplied with the equipment as long as possible in place to avoid any damage.

The special protection should be stored for the unlikely event the equipment has to be sent for repair.

Dispose of the packing material should be done according to the laws of the country where the equipment is installed, or according to the rules that are applicable on the vessel.

- Be careful when unpacking the electronic equipment. The content is fragile.
- Do not press on the PEM4 touch screen.

6. INSTALLATION AND FIRST USE

The PEM4 touch screen will be delivered with the software and correct data settings installed. First connect the Ethernet cables to the control box and the touch screen.

The wires for power supply should be connected at last.

Check if the inputs show any errors. If that is the case the connection(s) or connected equipment should be checked and corrected.

6.1 TO RECORD NAMEPLATE DATA

This information is required when contacting the supplier for any reason.

Date of delivery:	xx xx xxxx
Serial number:	xxxx
Stator version:	xxxx
Interface version:	xxxx
Hull number:	xxxx
Type:	PEM4 touch screen

Above information can be found at the PEM4 info screen.

6.2 INSTALLATION DIAGRAM

The PEM4 touch screen can be connected to the stator control box as shown in the following figures. The maximum number of touch screens, which can be connected by Ethernet connection is two.

6.2.1 PEM4.7 - Installation diagram

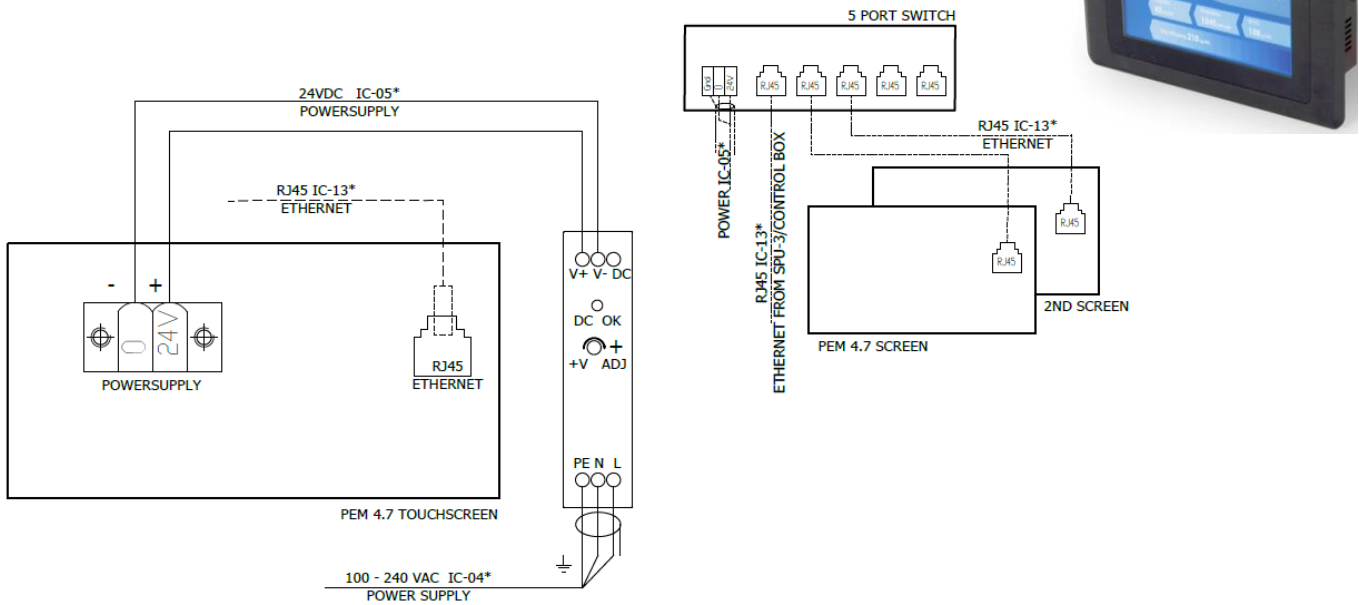


Figure 1 – Example of T-Sense® torque sensor connected to one and two PEM4.7 touch screens

6.2.2 PEM4.8 - Installation diagram

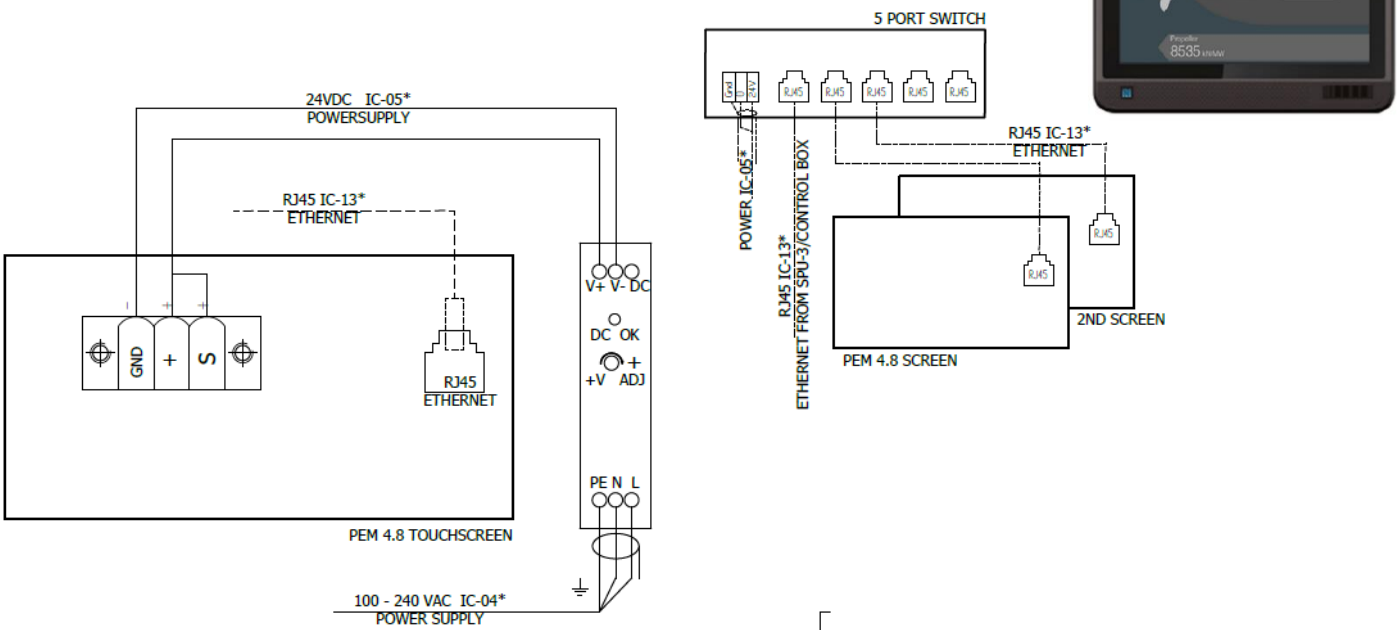


Figure 2 – Example of T-Sense® torque sensor connected to one and two PEM4.8 touch screens

6.2.3 PEM4.10 - Installation diagram

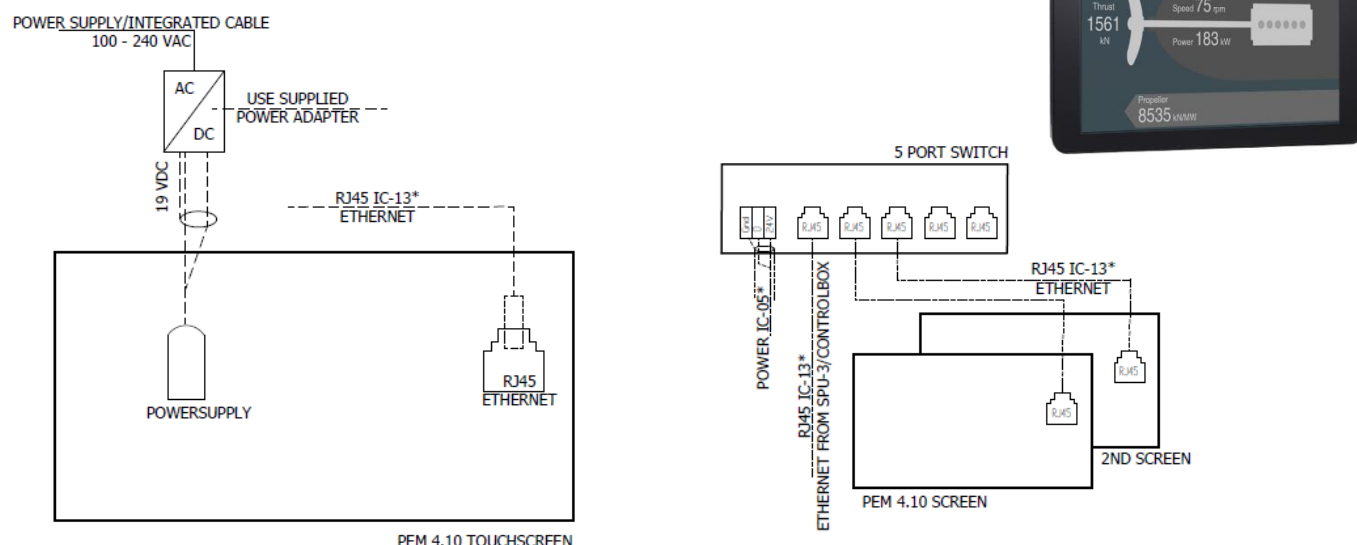


Figure 3 – Example of T-Sense® torque sensor connected to one and two PEM4.10 touch screens



Remark:

When a TT-Sense® Thrust & Torque sensor is installed it can be connected in the same way as above mentioned T-Sense® equipment.

6.3 INSTALLATION OF THE PEM4 TOUCH SCREEN

1. Install the PEM4 touch screen in a control cabinet or control panel in the ECR or on the bridge, where it will be free as possible from moisture, large fluctuations of temperature and particularly of vibration shock. Also influences such as large magnetic fields caused by transformers, relays or electromagnets must be avoided.
2. All cable connections should be made using cables as specified in section 6.4.
3. Connect the RJ45 Ethernet from the stator control box and power supply to the backside bottom of the PEM4 touch screen.
4. Check for correct power supply and integrity of external wiring connections. Turn on power and observe several readings, like torque, shaft speed, power etc.



Important notes

- Never connect cable shields at both ends to ground, but at one end only, to avoid earth loops.
 - To avoid interference on the signal cables, such cables must be installed as far as possible from electric power cables used for power supply and stator.
 - Ensure that the ambient temperature at the PEM4 never exceeds 50°C.
5. Only applicable if an additional (second) touch screen is connected to the T-Sense® system.
Additional touch screens are connected to the system as described in Figure 1, 2 and 3.

6.4 CABLE SPECIFICATIONS

Specification for the input, output and power supply cables connected to the PEM4 touch screen.

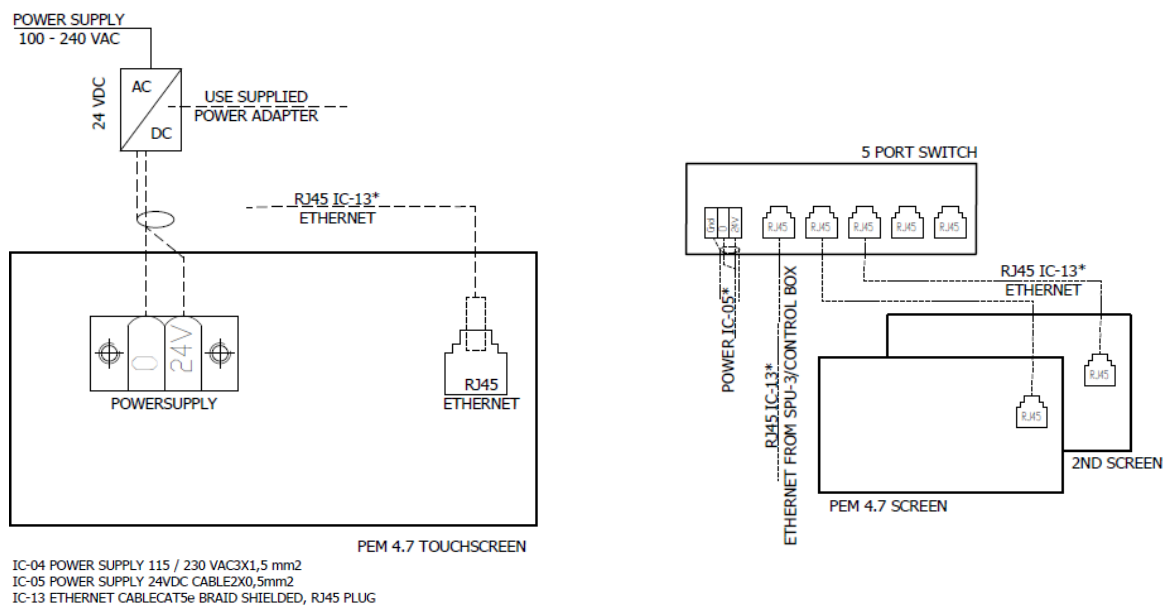


Figure 4 – Specification of input and output cables at the stator control box and PEM4 touch screens

Cable specification:

- IC-04 Power supply (115 / 230 VAC) cable, 3 x 1,5 mm², flex strands
- IC-05 Power supply (24 VDC) cable, 1x2x0,5 mm², flex strands
- IC-13 Ethernet CableCAT5e Braid Shielded, RJ45 PLUG



Remark:

When a TT-Sense® Thrust & Torque sensor is installed it can be connected in the same way as above mentioned T-Sense® equipment.

6.5 IP SETTINGS PEM4 DISPLAYS

The PEM4 is shipped fully preprogrammed. In some cases, the network settings require changes. In that situation the IP settings for the PEM4 and the control box can be changed. This paragraph describes how to change the IP-settings for each individual PEM4 touch screen. It is very important to follow these instructions.



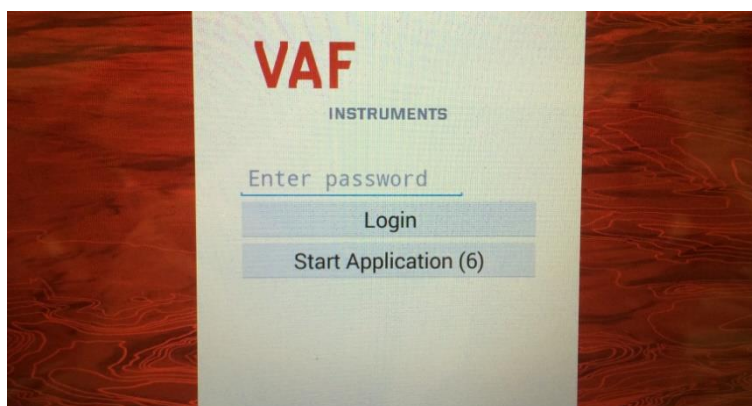
Changing settings incorrectly can cause the system to stop functioning.

The instructions below are describing the default IP settings.

6.5.1 IP settings of the PEM4.7 display

In order to have no malfunction of the system the IP settings of the PEM4 display have to be set up correctly. The next steps will explain how to adjust the IP settings of the system.

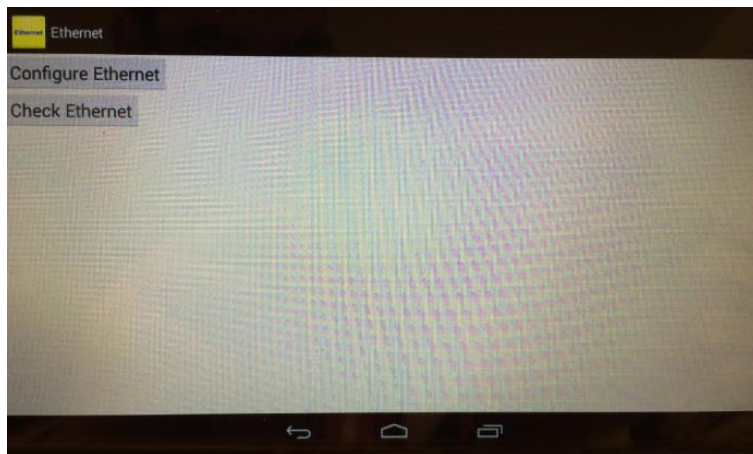
Switch off the power supply of the PEM4 display. Wait for 1 minute and then repower the PEM4.



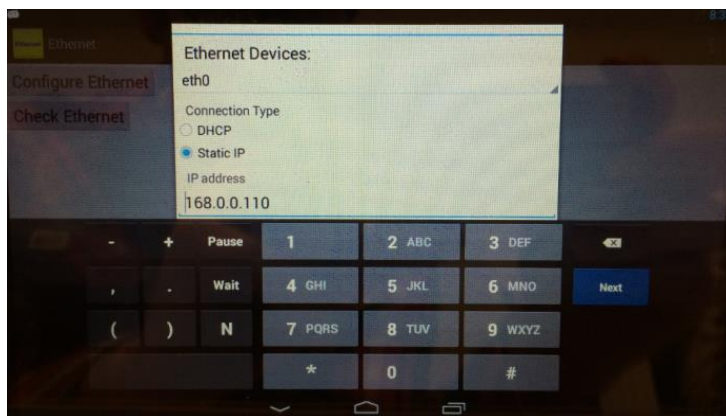
Enter password “5678” and press login. The screen below will appear.



Change the Address to `http://168.0.0.140` (this is the default IP address of the stator control box) and press “Save setting”. Then Press “Ethernet settings”. The screen below will appear.



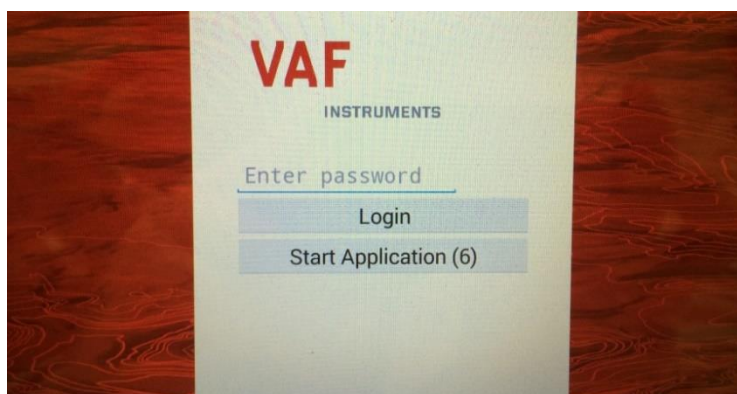
Press “Ethernet settings”. The next screen will appear.



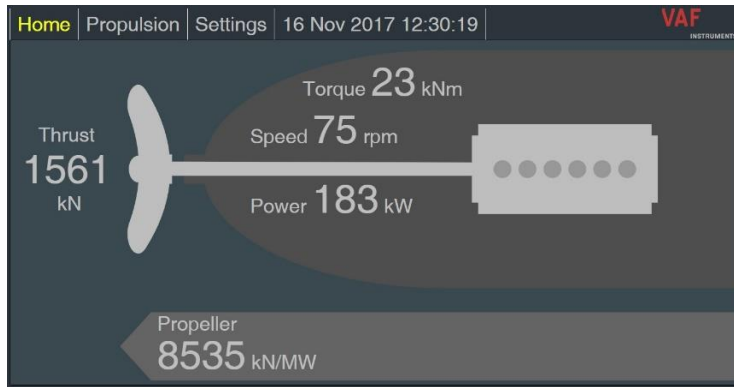
Ensure the IP address is 168.0.0.110 for the first PEM4 display. In case a second PEM4 display is installed the second screen should have IP address 168.0.0.111. If this is correct press “Next”. Set the DNS address to 255.255.255.0 and press “Done”. The screen below will appear.



Press “Confirm” to save settings. Next, switch of the power supply of the PEM4, wait for 1 minute and repower the PEM4 display. The screen below will appear.



Press “Start Application” or wait until the timer has gone to zero, the application will start at the home screen, see screen below.



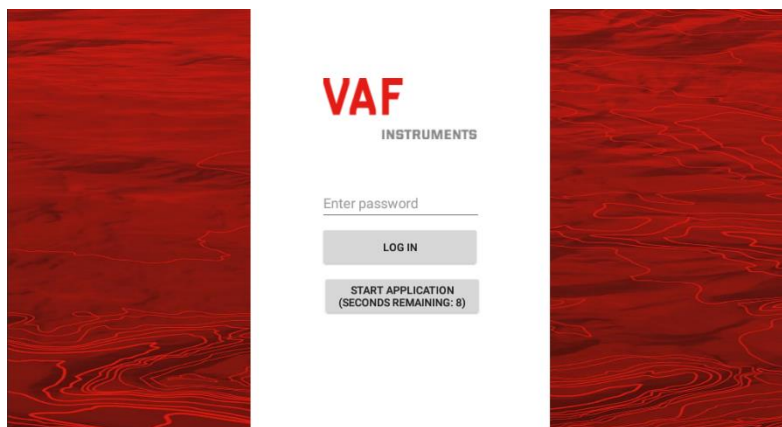
6.5.2 IP settings of the PEM4.8 display

In order to have no malfunction of the system the IP settings of the PEM4 display have to be set up correctly. The next steps will explain how to adjust the IP settings of the system.

Switch off the power supply of the PEM4 display. Wait for 1 minute and then repower the PEM4.



You will see the login screen, as shown below. **Immediately press the “Enter password” field!**



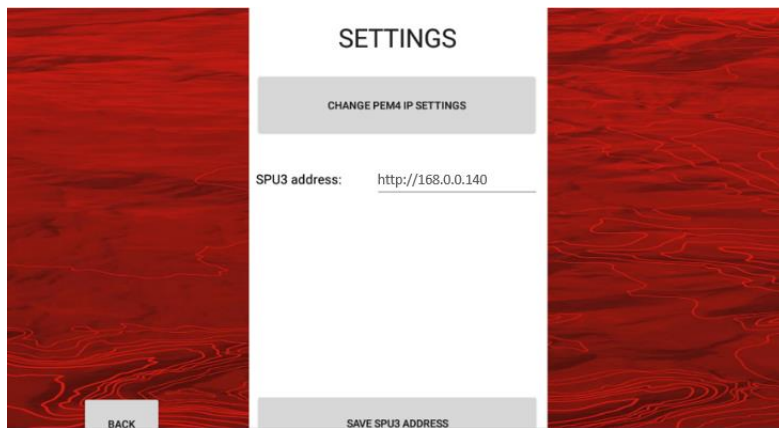
Pressing the “Enter password” field stops the “Start application” countdown.

If you are not able to press the “Enter password” field in time, please restart the PEM4 by pressing and holding the power button, then selecting “Restart”.

The password is **5678**.

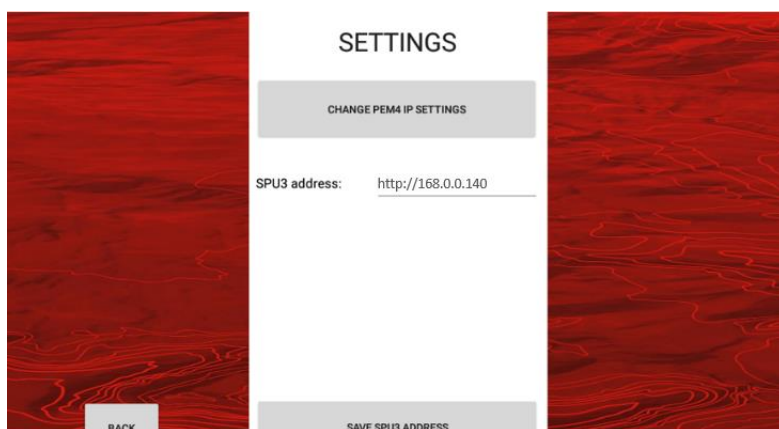
Enter the password, then press “log in” to go to the settings screen.

As soon as you log in, you will see the settings screen below:

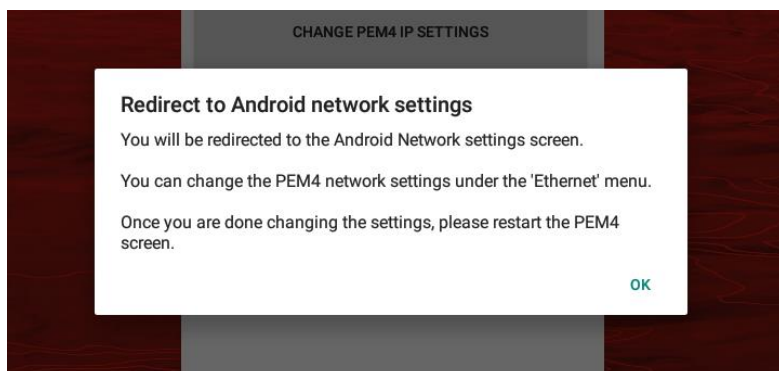


Change the Address to **http://168.0.0.140** (this is the default IP address of the stator control box). Then press the 'Save SPU3 address' button.

In the same screen as before, press the button labelled "Change PEM4 IP settings".

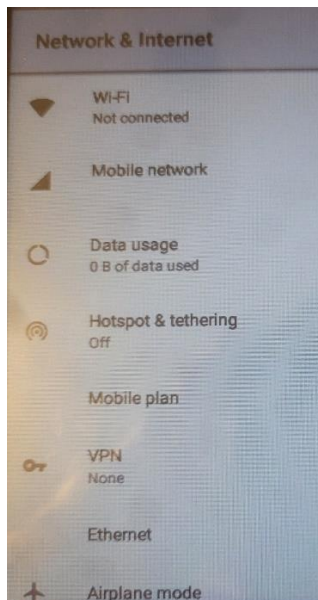


You will see the following pop-up:



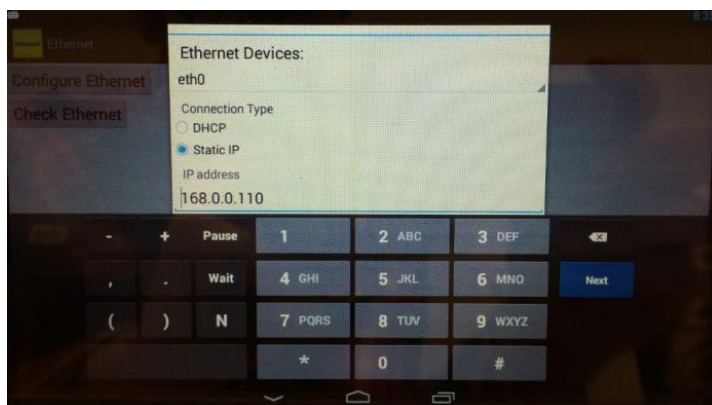
Press "OK".

You are now in the Android network settings menu.



Press the “Ethernet” button. The next screen will appear.

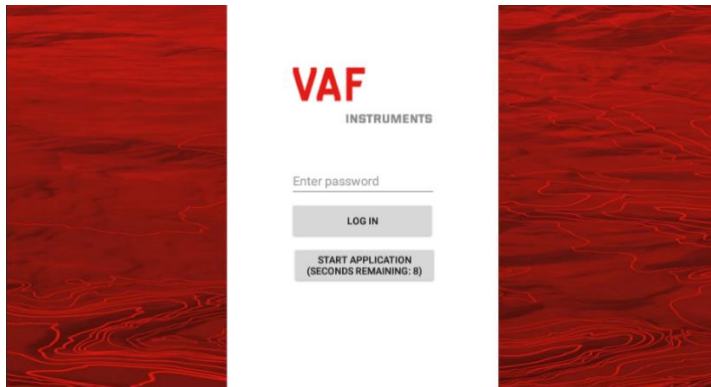
Ensure the IP address is 168.0.0.110 for the first PEM4 display. In case a second PEM4 display is installed the second screen should have IP address 168.0.0.111. If this is correct press “Next”. Set the DNS address to 255.255.255.0 and press “Done”. The screen below will appear.



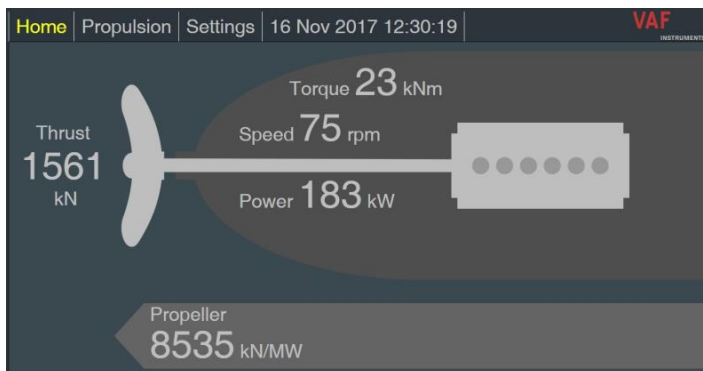
Ensure the IP address is 168.0.0.110 for the first PEM4 display. In case a second PEM4 display is installed the second screen should have IP address 168.0.0.111. If this is correct press “Next”. Set the DNS address to 255.255.255.0 and press “Done”. The screen below will appear.



Press “Confirm” to save settings. Next, switch of the power supply of the PEM4 , wait for 1 minute and repower the PEM4 display. The screen below will appear.



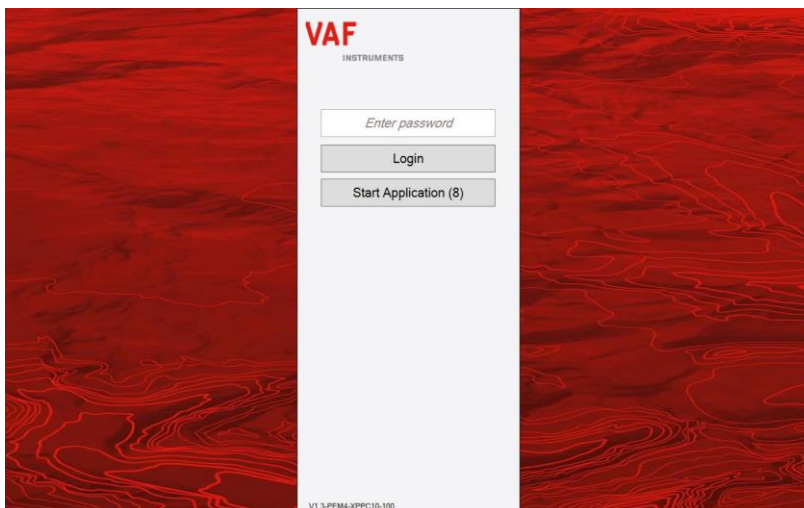
Press “Start Application” or wait until the timer has gone to zero, the application will start at the home screen, see screen below.



6.5.3 IP settings of the PEM4.10 display

Plugin 19V DC adaptor. Windows will startup and login automatically. About 15 seconds after Windows login PEM4 app will startup automatically.

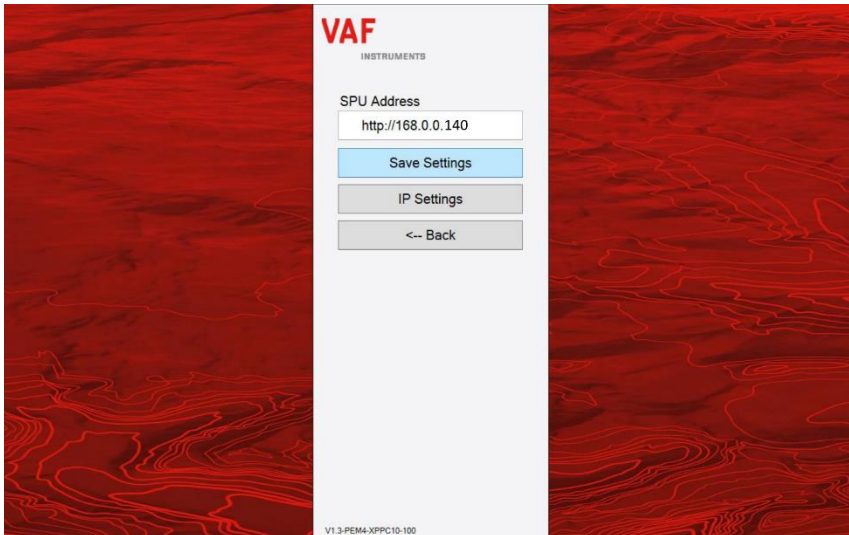
Enter password “5678” (without quote) for logging in PEM4 settings screen or PEM4 app will start automatically after countdown (10 sec.)



Checking PEM4 screen IP address

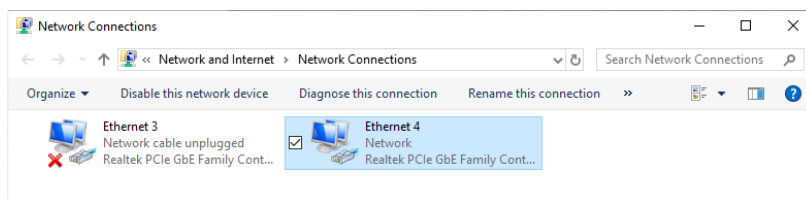
Once PEM4 settings screen is logged in, PEM4 address can be filled in. The address is <http://168.0.0.140>

- Press “Save settings” when done.
- Press “IP Settings” if PEM4 screen IP address needs to be changed.
- Press “← Back” to going back to login screen.

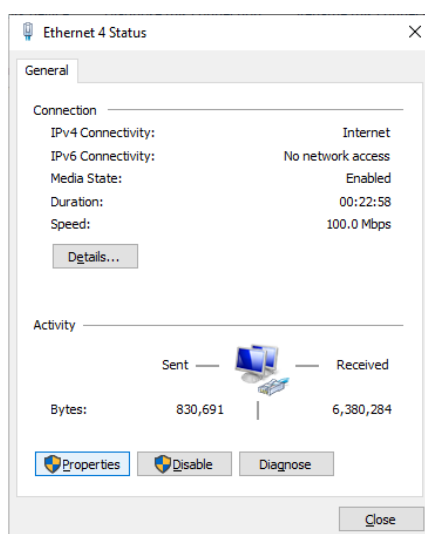


Checking PEM4 screen IP address

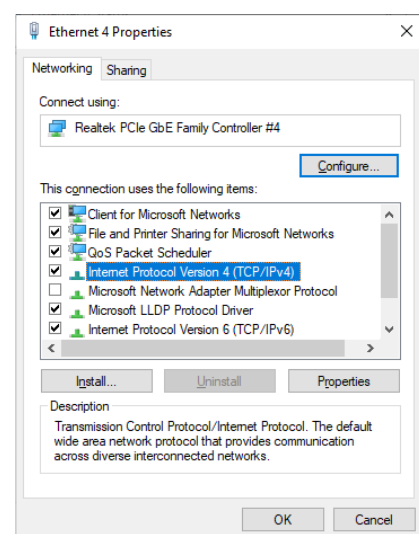
Press “IP Settings” on PEM4 settings screen, “Network Connections” window will show up.



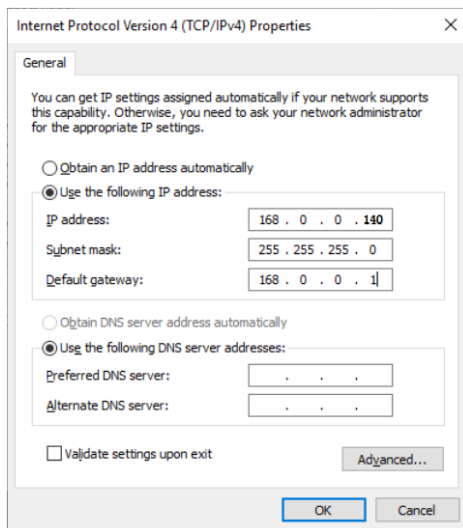
Double click the connected ethernet connection, “Ethernet ... Status” window will show up.



Press “Properties”. Ethernet ... Properties window will show up.



Select “Internet Protocol Version 4 (TCP/IPv4)” and press “Properties”, IP settings windows will show up.



LAN1 is configured as static by default:

- Ip: 168.0.0.140
- Subnet mask: 255.255.255.0
- Gateway: 168.0.0.1

Press OK when done and close all ethernet setting windows.

Press “← Back” to going back to login screen.

Press “Start Application” to start PEM4

If everything is configured correctly, PEM4 screen shows up.



7. OPERATING PRINCIPLES

7.1 GENERAL

A zero setting procedure is always necessary in order to obtain a correct measurement and reading. For more detailed information see paragraph 6.4 in TIB 661 of the T-Sense® torque sensor.

The PEM4 touch screen is easy to operate and provides the operator with a standard selection of torque, shaft speed and power data.

A number of conditional messages will inform you about error/fault conditions if applicable.

Setups determining functionality are only possible via the **access code 1234**.

All setups and computations are stored in a battery backup RAM. The PEM4 system is self-checking as for correct functioning of its memories, program run and existence of supply voltage.

7.2 DISPLAYED PARAMETER AND ENGINEERING UNITS

The following parameters are available at the PEM4 touch screen:

- Torque (kNm)
- Shaft speed (rpm)
- Shaft power (kW)
- Total energy (kWh, MWh, GWh)
- Time-base (hours, minutes, seconds)

When a TT-Sense® Thrust & Torque measurement system is applied the PEM4 touch screen will display below parameters in addition:

- Propeller thrust (kN)
- Thrust power quotient (kN/MW)

7.3 EXPLANATION OF THE PARAMETERS

7.3.1 Torque

The torque signal, measured in the rotor part, is sent wireless via the stator antenna to the electronics in the control box. In this control box the signal is converted to an Ethernet, which signal is connected to the PEM4 touch screen. Zero torque adjustment will be done during commissioning of the T-Sense® rotor and control box.

7.3.2 Shaft speed

The shaft speed is measured via a gravity sensor in the T-Sense® rotor part. This rotor part is connected wireless to the stator electronics in the control box. The stator electronics are connected to the PEM4 touch screen via Ethernet.

7.3.3 Power

The power is calculated by multiplying the above measured shaft speed and torque. The output values are submitted to the PEM4 touch screen via the same Ethernet connection.

7.3.4 Thrust (option)

In case a TT-Sense® is installed, which additionally measures the axial displacement due to propeller thrust, the thrust values are converted to an Ethernet signal in the same way as the torque and shaft speed outputs.

7.4 OPERATING INSTRUCTIONS PEM4 TOUCHSCREEN

7.4.1 Operating menus

The PEM4 touch screen includes with the following operating menus:

7.4.1.1 *The user mode*

For daily use: In this mode all relevant system menus are displayed. Different pages could be selected by tapping the page at the top of the screen.

7.4.1.2 *The settings mode (settings menu) for users*

Only displayed after choosing the “Settings Menu” page and entering your **password (1234)**.

7.5 HOW TO OPERATE THE TOUCH SCREEN

The PEM4 touch screen screens are designed in such a way that they are easy to operate and self explaining. By pressing at the touch screen buttons/text fields/characters/pages are selected.

Browsing through the menus by tapping on the different pages at the top of the touch screen will help you to find the information you are looking for.

In the “Settings Menu” you will be able to change specific values via a numeric keypad. This keypad will be displayed after pressing the values in the grey sections at the touch screen.

In the following sections several examples of PEM4 screens are shown and a description of the main PEM4 functions is added.

7.5.1 Home screen

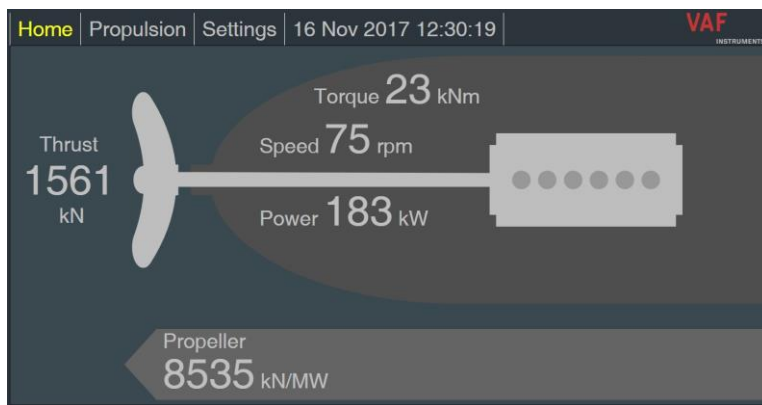


Figure 5 – Home screen

This is the “Home” submitting information about the actual torque, propeller speed and power at the propeller. Note that thrust and thrust power quotient (propeller) are only visible if a TT-Sense® is installed.

7.5.2 Propulsion screen



Home	Propulsion	Settings	16 Nov 2017 12:30:42	VAF INSTRUMENTS
Average	1 hr	4 hrs	24 hrs	
Power (kW)	182.871	182.907	183.484	
Speed (rpm)	75.000	75.000	75.000	
Torque (kNm)	23.284	23.288	23.362	
Thrust (kNm)	1560.908	1561.974	1562.275	
Total energy	93532	kWh	Reset	
Total revolutions	2253438		Reset	

Figure 6 – Propulsion screen

This page is showing the average propulsion data over the last 1, 4 and 24 hours. When the propeller shaft is rotating the PEM4 is continuously recalculating these average values. In case the propeller shaft is not rotating the average values stay as they are.

“Total Energy” consumed by the propeller and the “Total Revolutions” made by the shaft are available at the lower part of the screen.

The “Total Energy” value jumps from kW to MW to GW (min. 0,000 kW and max. 9999 GW).

The “Total Revolutions” value jumps from E3 to E6 to E9 (respectively 1000, 1×10^6 and 1×10^9 revolutions).

These total values can be set to zero anytime by pushing the “Reset” buttons.



After resetting “Total Energy” and “Total Revolutions” the previous displayed values are lost.

7.5.3 Settings menu

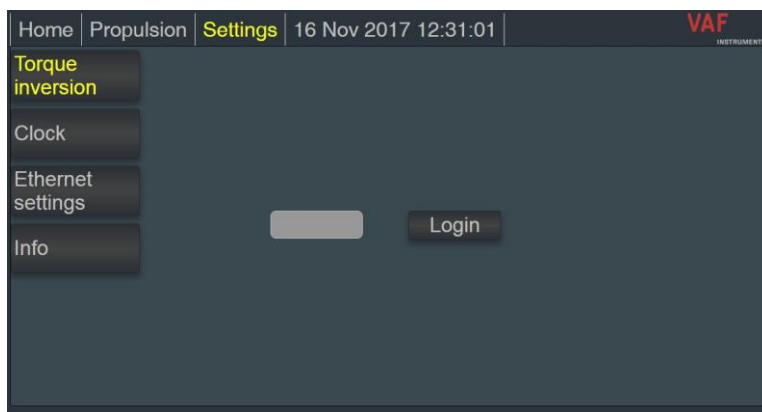


Figure 7 – Settings menu

This “Settings Menu” is accessible by entering the 4-digit **password 1234** in the login screen. This screen is your entrance to adjustment of settings.

7.5.3.1 Settings menu, torque inversion



Figure 8 – Settings menu, torque inversion

When the touch screen is showing a negative torque value, when sailing ahead, you are able to convert this negative value to positive by pushing the “Standard” button once. “Standard” will now change to “Inverse”. Pushing “Inverse” will change the button back to “standard” again.

7.5.3.2 Settings menu, clock

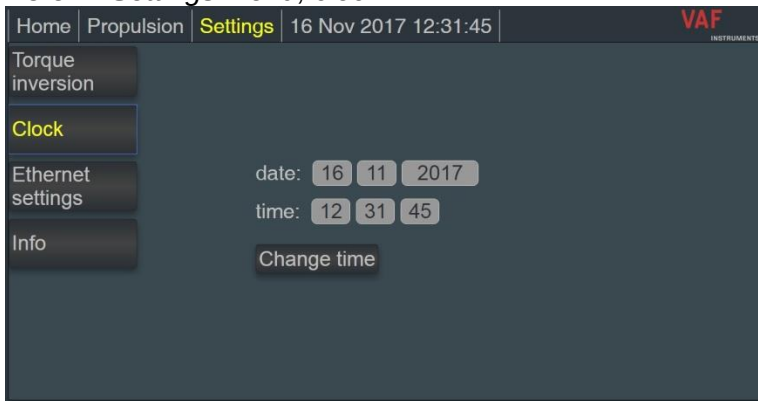


Figure 9 – Settings menu, clock

7.5.3.3 Settings menu, Ethernet settings



Figure 10 – Settings menu, Ethernet settings

In this menu it is possible to change the Ethernet settings of the stator control box. Via “Get settings” the current settings are shown.



Remark:

Please double check changes before pressing changing settings. Incorrect settings might cause malfunctioning of the complete system.

7.5.3.4 Settings menu, info

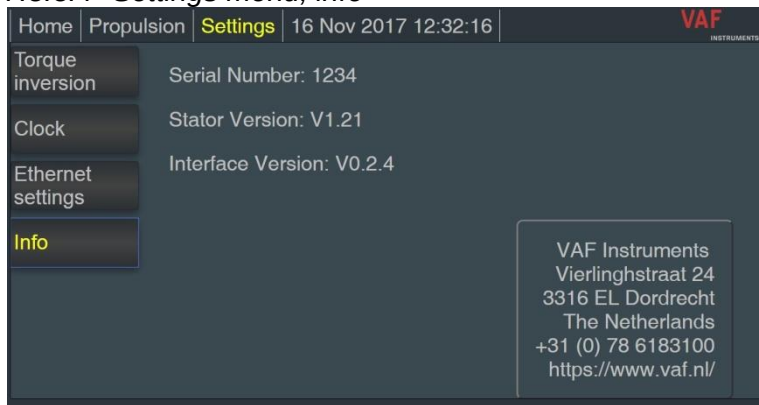


Figure 11 – Settings menu, info

This screen is displaying all essential data in case you to have to contact VAF Instruments regarding your T-Sense® torque measuring system.

7.5.4 Alarm screen

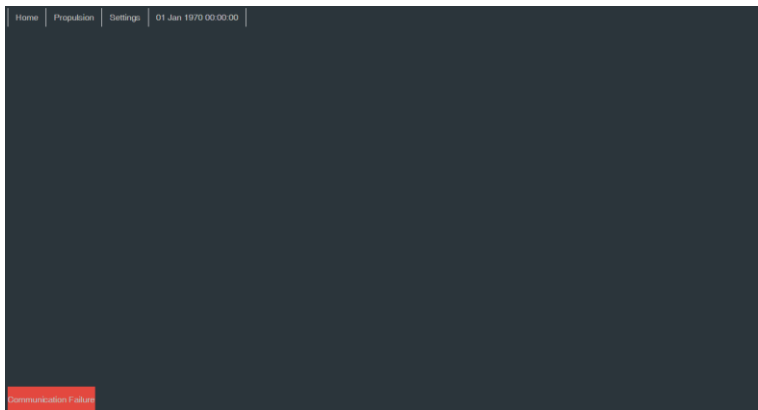


Figure 12 – Alarm Screen

In case the PEM4 touch screen detects that output data is missing the system will showing the alarm message “Communication Fail”.

7.6 METHOD OF CALCULATIONS

Shaft power is calculated from the measured torque and the revolutions of the shaft.

- **Shaft power**

$$P = \frac{M \cdot n}{9.945}$$

P	= Shaft power	[kW]
M	= Torque	[kNm]
n	= rotations per minute	[rpm]

Total energy is calculated from the integrating shaft power over time

- **Total energy**

$$E = \sum \Delta P \cdot \Delta t$$

E	= Total energy	[kWh]
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The thrust quotient indicates the amount of thrust generated per MW propulsion power. The thrust quotient is an indicator of propeller efficiency. Be aware that propeller thrust and ship speed influence each other.

- **Thrust quotient**

$$\text{Thrust quotient} = \frac{T}{P/1000}$$

T	= Thrust	[kN]
P	= Shaft power	[kW]

8. MAINTENANCE

No special maintenance is needed for the PEM4 touch screen.
The touch screen can be cleaned with a dry and clean cloth.
Do not use any cleaning product or chemical on the screen.

9. REPAIR

Nothing on the PEM4 touch screen can be repaired on site.

10. TAKE OUT OF SERVICE

Switch off the power supply.

11. REMOVAL AND STORAGE OF EQUIPMENT

Switch off the power supply.

Make sure that all wires that are connected to the PEM4 are labelled correctly so that re-installation of the PEM4 can be done without any errors. Disconnect all the input and output wires.

Store the PEM4 in a box in a cool and dry place, so that the PEM4 cannot be damaged.

12. MALFUNCTION AND SEND FOR REPAIR

If the PEM4 stops working completely contact VAF Instruments for instructions.

VAF Instruments is working with a RMA (return material authorisation), in the event the PEM4 has to be sent back for repair, you can contact VAF Instruments, by email: service@vaf.nl for further instructions.

13. ENVIRONMENT

The PEM4 touch screen has no negative influence on the environment during normal operation.

14. DISPOSAL

The PEM4 touch screen is made out of metal and electronics. It should be disposed according to local laws of the country.

15. TROUBLE SHOOTING

15.1 PEM4 MALFUNCTION

If the PEM4 does malfunction, power the PEM4 down, check all wiring and power the PEM4 back up again. This will restart the program.

15.2 NO TORQUE SIGNAL

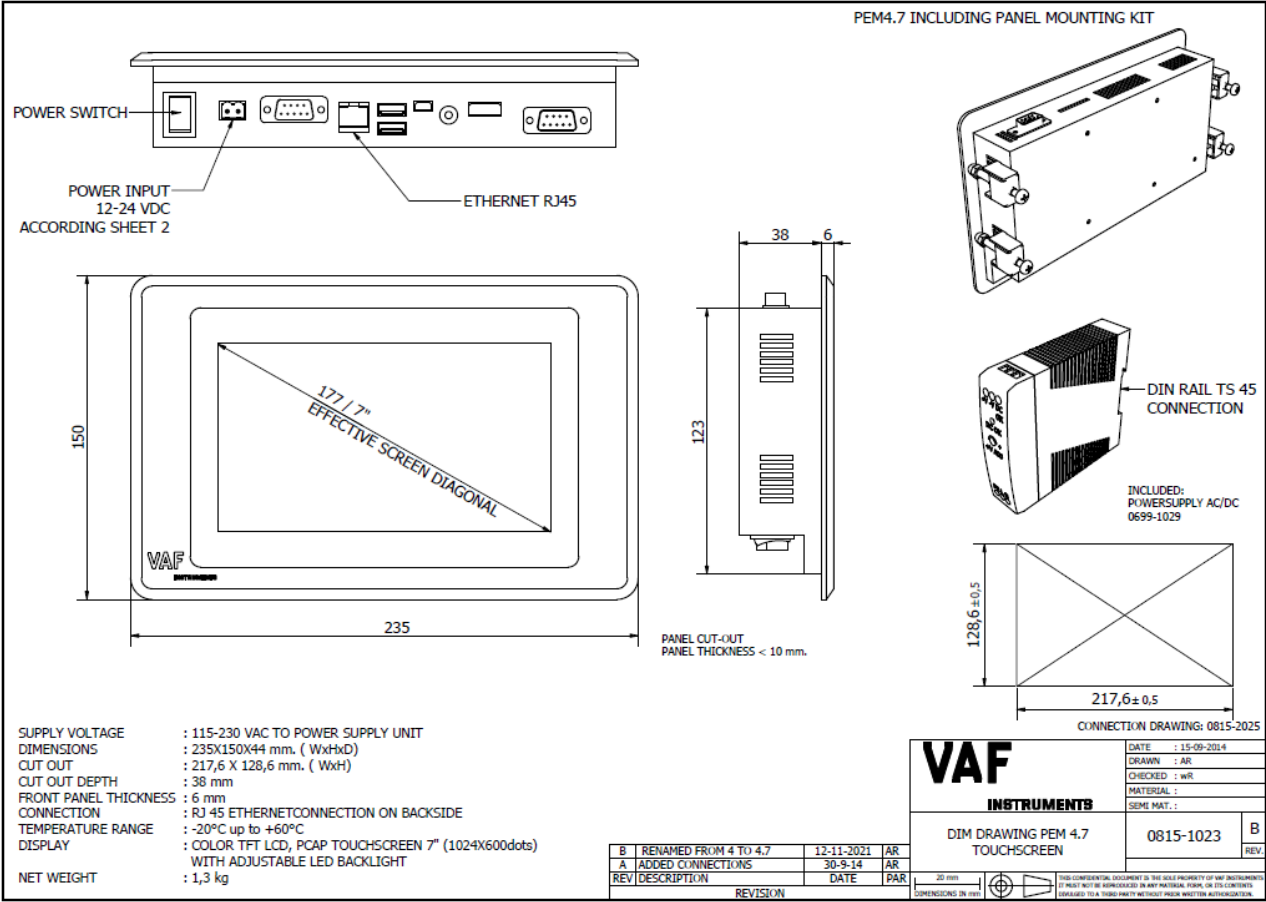
The connection between the PEM4 and the stator control box is broken.

- Check wires for damage.
- Check the connections in the stator control box or at the PEM4 touch screen.

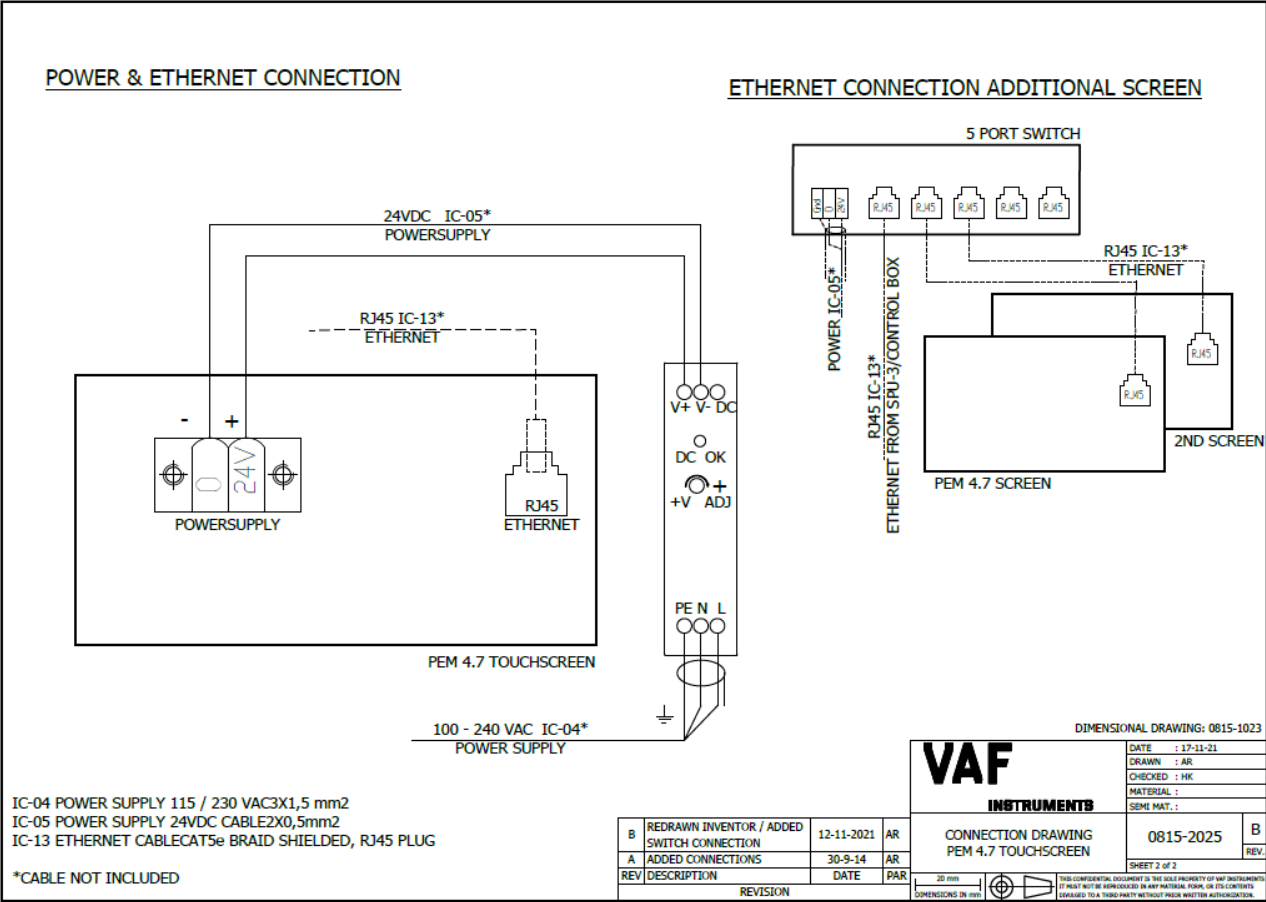
16. CERTIFICATES

For a torque measuring system no classification certificates are required.

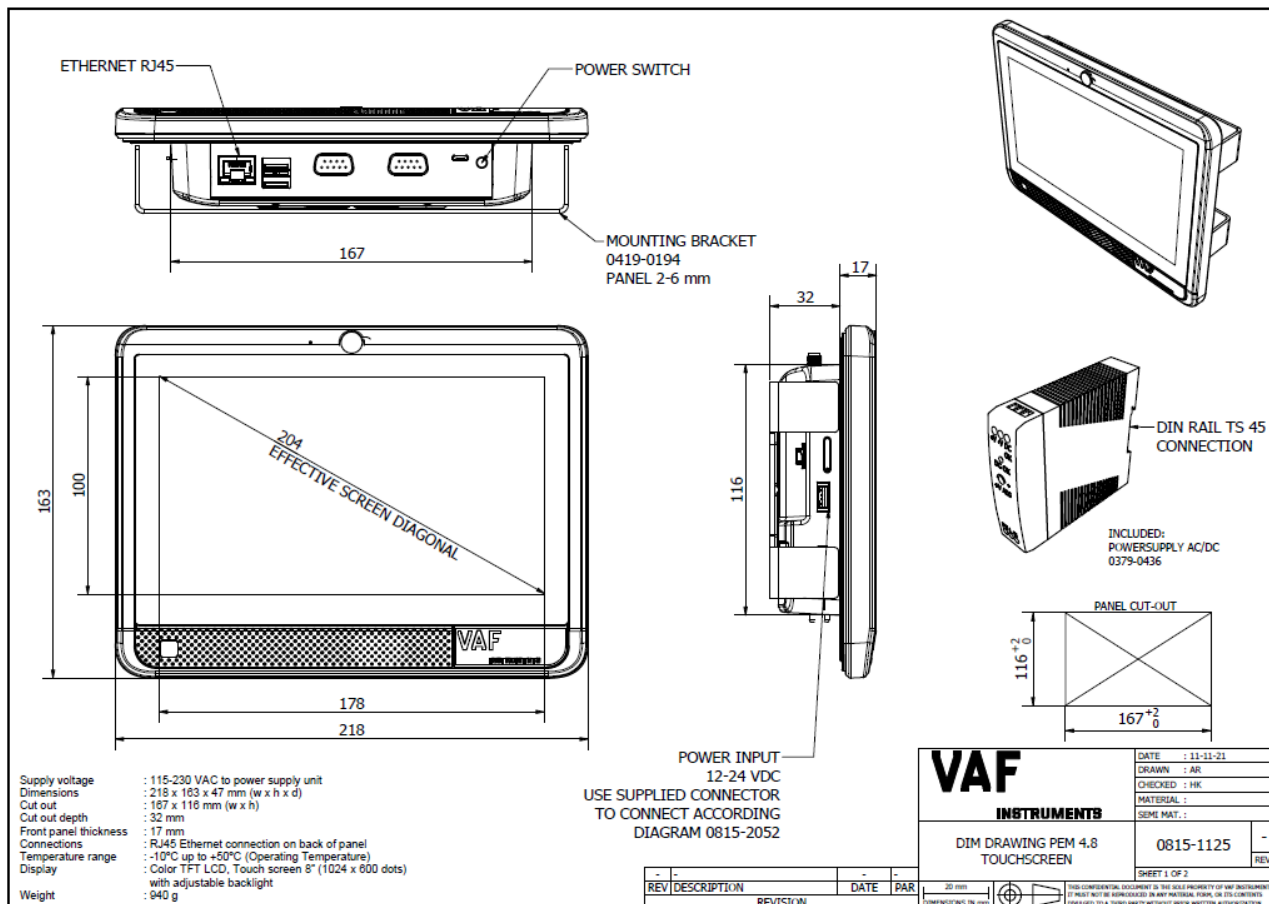
17. DRAWINGS



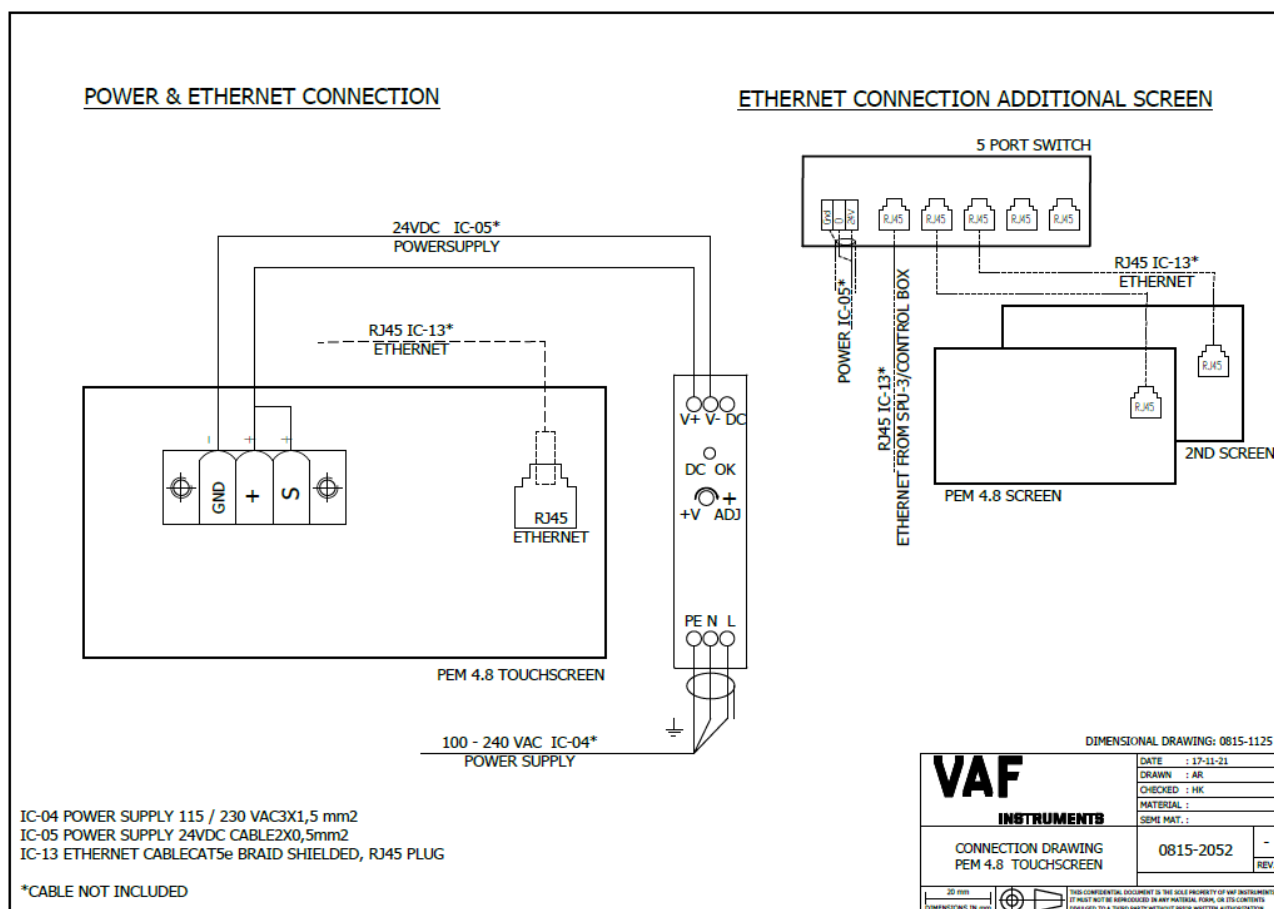
Drawing 0815-1023 Dimensional Drawing PEM4.7 Touch Screen



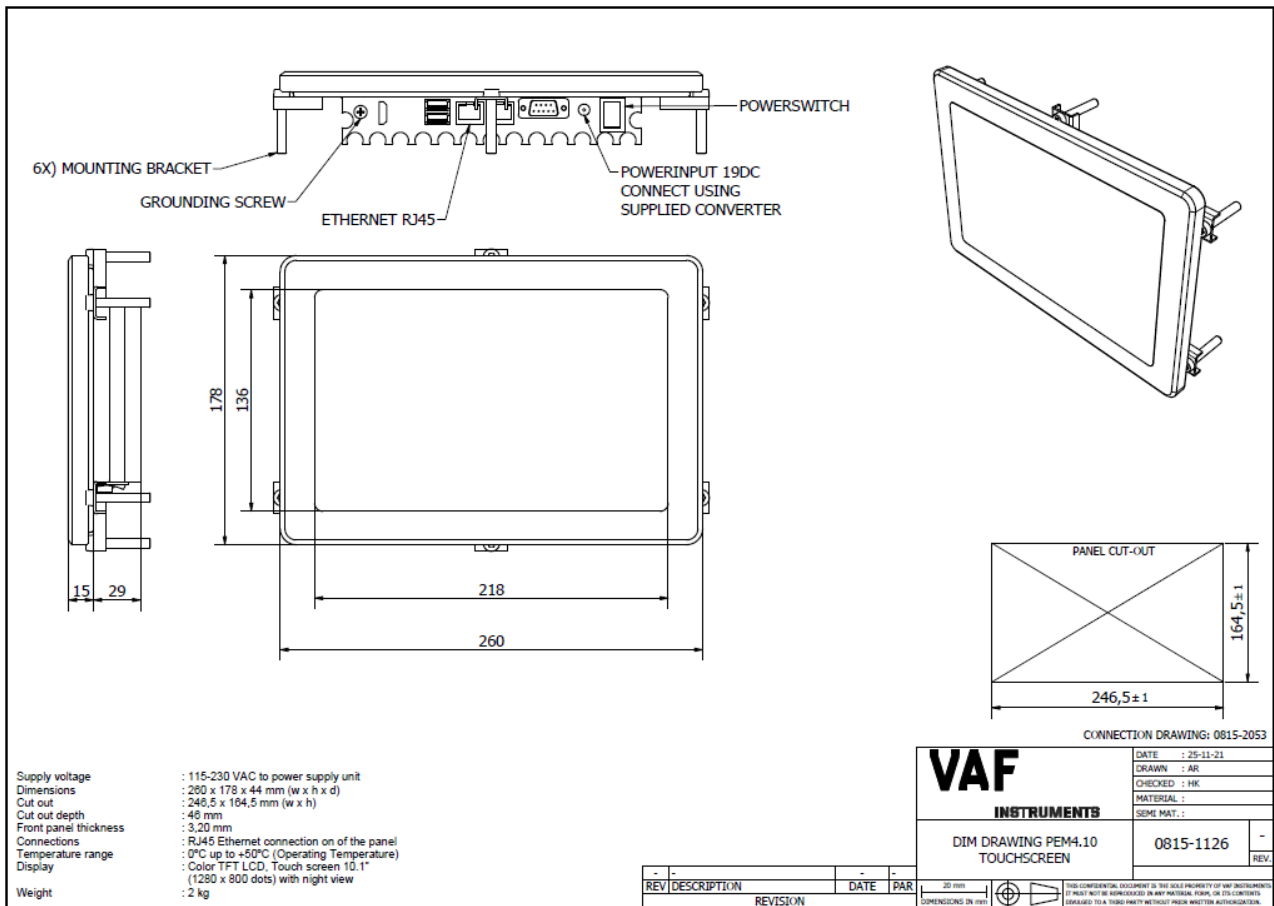
Drawing 0815-2025 Connection Drawing PEM4.7 Touch Screen



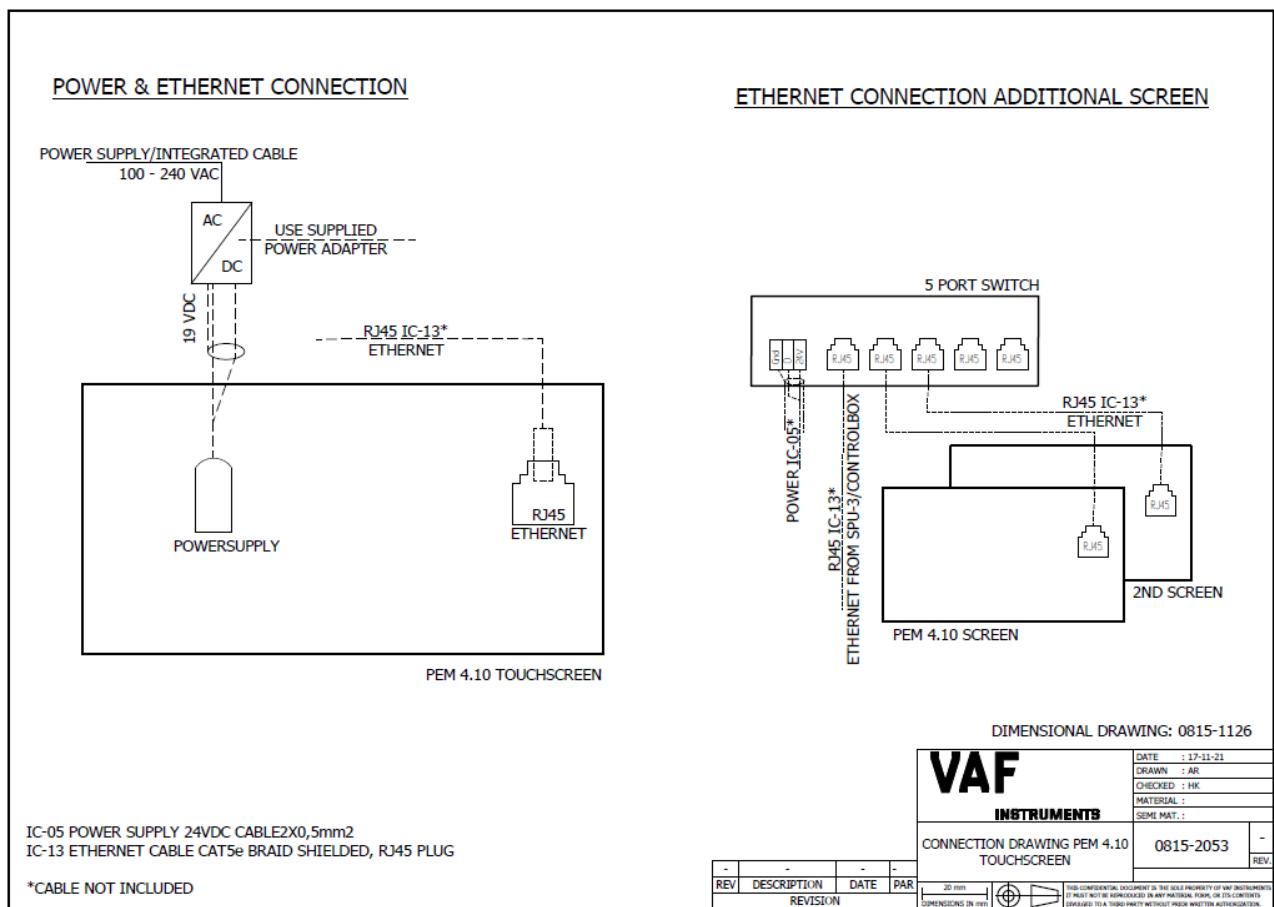
Drawing 0815-1125 Dimensional Drawing PEM4.8 Touch Screen



Drawing 0815-2052 Connection Drawing PEM4.8 Touch Screen



Drawing 0815-1126 Dimensional Drawing PEM4.10 Touch Screen



Drawing 0815-2053

Connection Drawing PEM4.10 Touch Screen

18. ABBREVIATIONS

PEM4	Touch screen for Ethernet communication
SPU3	Signal Processing Unit, part of the PEM4 efficiency monitoring system
CPU	Central Processing Unit
TFT	Thin Film Transistor - Liquid Crystal Display
PCAP	Projected Capacitive
LED	Light Emitting Diode
LCD	Liquid Crystal Display
PT100	Temperature sensor type PT100
PT2	Type of flowmeter with Hall sensor and PT100 output

19. SPARE PARTS

A recommended spare part list is not applicable.

20. WARRANTY CONDITIONS