



# INSTALLATION AND USER MANUAL

## POLARMOIST

### Water Content Monitoring System for aggregates

Revision 2.2 04.10.2017



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## Introduction

This document is the installation and user manual of Polarmoist Water Content Monitoring System. The probe is designed to measure moisture in coarse and fine aggregates on belt conveyors or flowing down out of bins. The probe sends infrared light and measures the amount of retro-reflected light. The measurement is based on absorption of infrared light while passing through a thin water layer on the surface of the aggregate being measured. The probe is of solid-state design and does not have moving nor wearing parts.

Although the probe is pre-calibrated in the factory, it is necessary to calibrate the probe after installation to correspond to the right aggregate and measuring environment. The probe shall be calibrated in the working environment by taking first two samples and adjusting the reading. When there will be calibration data over a broader range of moisture, the calibration can be redone. The probe measures surface moisture. Absorbed moisture is taken into calculations by burn-offs and calibration. Windows PC based VipuNET user interface supports calibration by registering all the reference measurements and by setting the calibration parameters of the probe.

VipuNET software collects the data messages from the probe and stores them on the computer with date and time. The program shows also the numeric moisture reading and represents it as a function of time on the screen as a graph. In addition, to support the probe calibration the program can be used for upgrading/updating the probe firmware or setting up all the parameters of the probe.

The probe system has different analog outputs available. Factory setup is 4...20 mA.

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## Delivery content

Polarmoist is suitable for stand-alone assembly or electrical cabinet assembly if needed. In the electrical cabinet assembly, Control room connection Box components are located in a batch plant electrical cabinet. See electrical diagrams for different set-ups at the end of this manual.

The following main components are included:

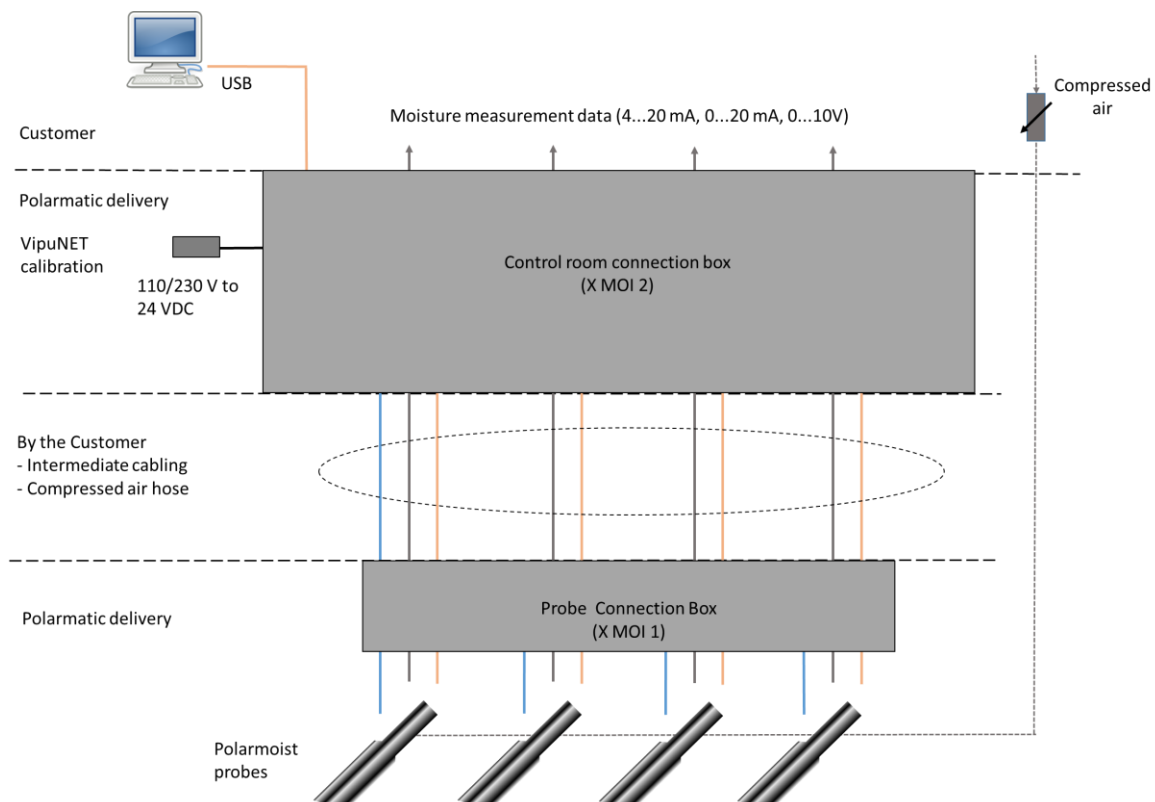
- Probe assembly
- Probe cables
- Probe connection box (X MOI 1)
- Control room connection box, including Power, Signal and USB connections (X MOI 2)
- VipuNET calibration and monitoring software
- Vipunet software and user manual can be downloaded from <https://polarmatic.studio.crasman.fi/bank/polarmoist>. Password is: aggregate

This delivery content **does not include** the following required components:

- Control PC
- Signal cable between Probe box and electrical cabinet. Cable type is screened data transmission cable, **LiyCY twisted pairs 2x2x0,5 (2x2xAWG20). Max length 50 m.**
- Compressed air plastic hose 8/6 mm, T-joints or flow adjustment device.



**Note!** The figures below shows an example of typical delivery content. However, single PC USB connection can have maximum of 7 probes connected. If more probes are required, more USB connections are required in the PC.



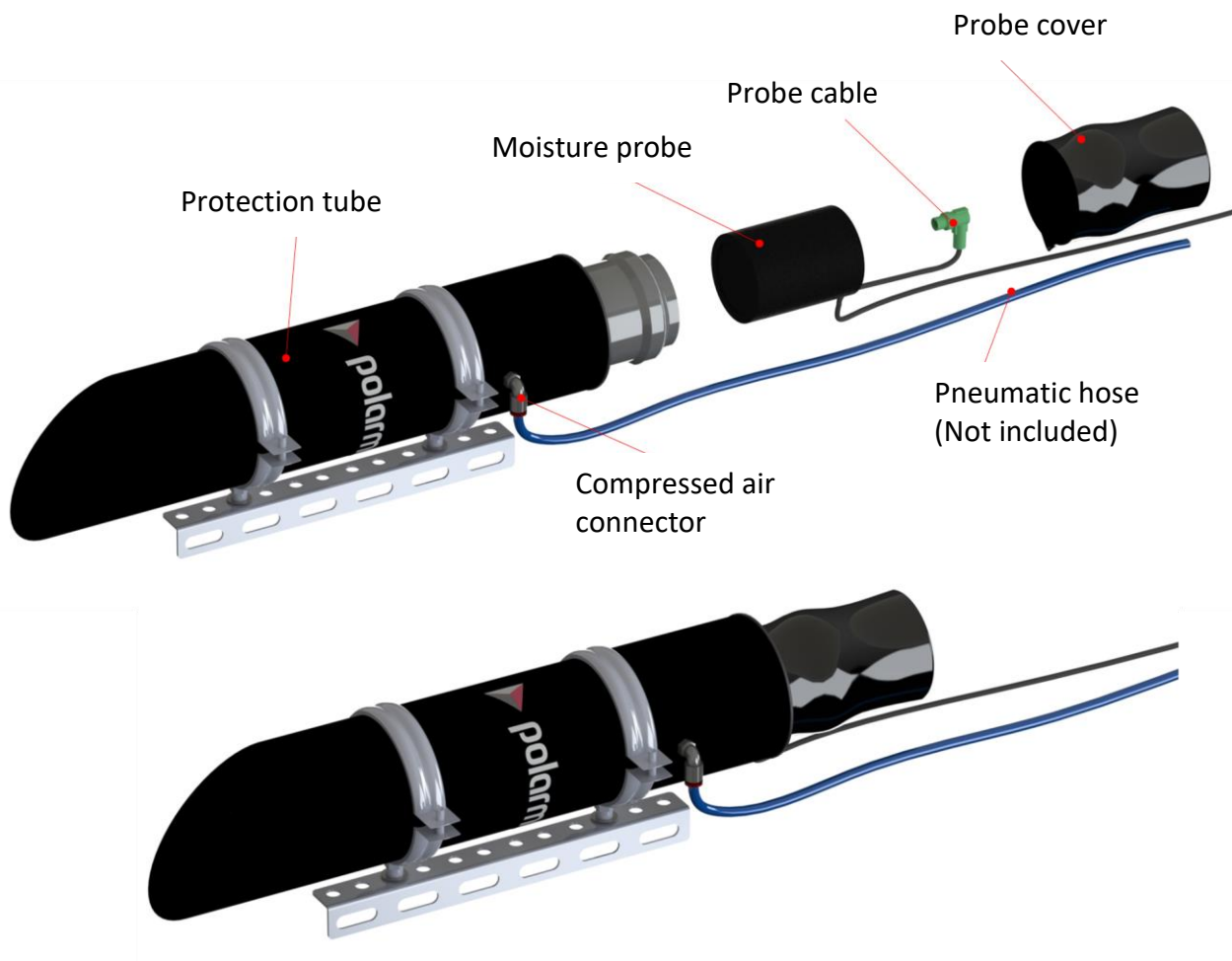


## Mechanical and electrical assembly

### Probe assembly

The probe assembly includes the main components shown below. Probe and probe cover are delivered separately in order to avoid any damages during the delivery. Pneumatic hose shown in the figure is not included thus should be purchased separately. The probe assembly shall be assembled into protection tube as shown in the figure.

Compressed air is used to arrange a counter flow to prevent contamination of the probe window.



The probe is typically installed over a belt conveyor or under a sector gate at a distance of approx. 0.70–0.90 meters (25-35 in.) from the aggregate when measured from the top of the probe. The tube can be fixed with M8 mm bolts or similar to fixed structures like L bars. The figure below shows an example of the installation over a bin belt feeder.



*Figure 1. Probe installed over a bin belt feeder.*

The measuring beam is cone shaped and has a diameter of 10 cm [4 in.] at a distance of 1 m [40 in.]. The probe must only see the aggregate measured and no other targets under its beam. One can check the location of the measurement area by moving hand or white paper while following the signal output.



**Note!** *The measurement must be taken from a moving sample, because a standing aggregate may be optically inhomogeneous causing unwanted offset of reading.*

The protection tube visor shall be turned against possible flow of dust or stones released for example by operation of pneumatic valves. When using heated moist aggregates, the visor should be turned down to prevent moisture getting collected in the tube while the moisture is flowing upwards. In that case, the possible pneumatic shocks should be prevented with additional shields.

The probe placing is shown in the figure below. Recommended tilting angle is 60°, however it can be between 40° and 80°. For more details, see the figures below.

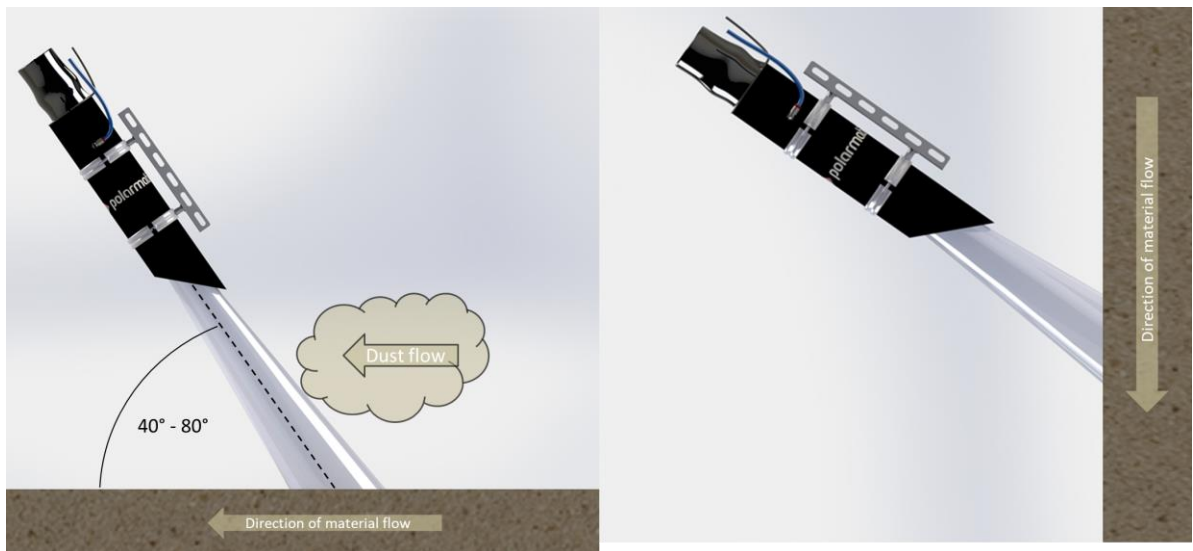
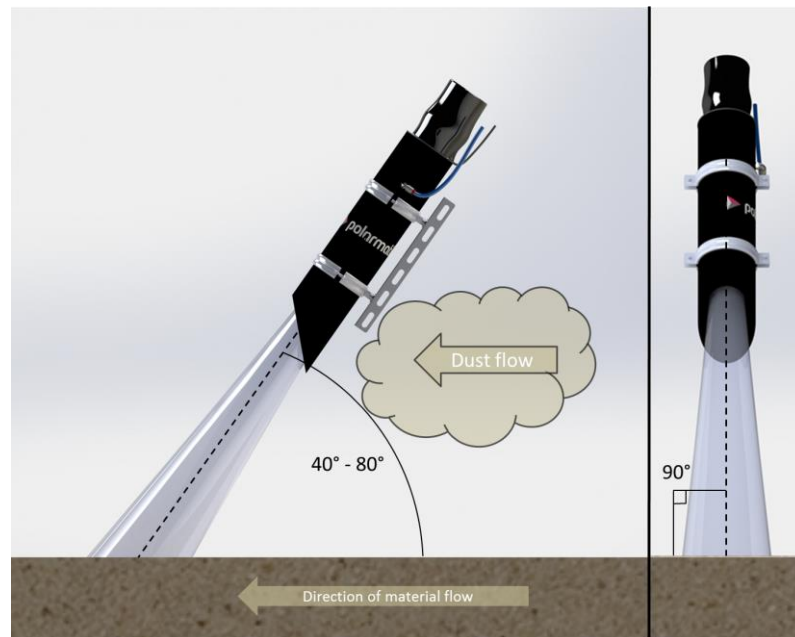


Figure 2. Probe position over aggregate flow

### Probe connection box

Each Probe is connected to a probe connection Box (X MOI 1) with a probe cable. Up to four probes can be connected to each connection box. For the wiring, see wiring diagram at end of this manual. Connect the probe cable to probe with ready installed connector after completing mechanical assembly of the probe unit.

From the probe connection box, the signals are led to Control room Connection Box via intermediate cable. This cable is type **Screened data transmission cable, twisted pairs 2x2x0,5 (2x2xAWG20)**.



**Note!** The intermediate cable between Probe connection Box and Control room control box is not included.



**Note!** Maximum length of the intermediate cable is 50 m (165 ft)

The connection Box should be located close to probes in a place where the box is in as dry and secured location as possible. The cable glands shall point downwards.

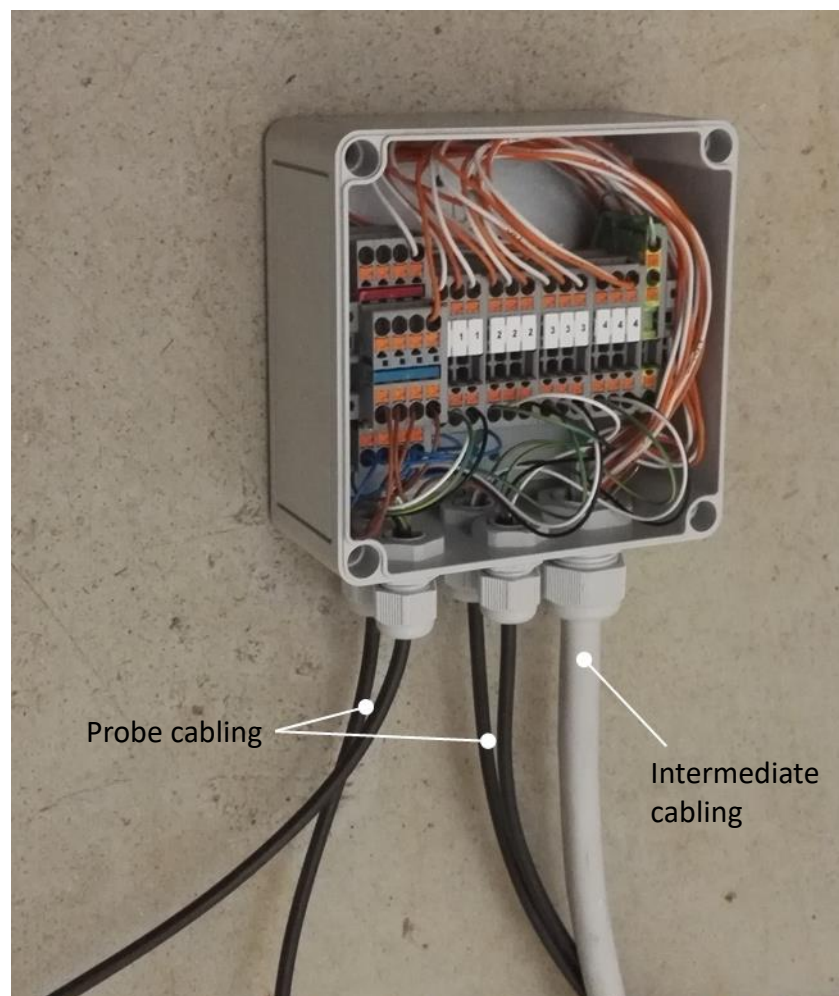


Figure 3. Probe connection box X MOI 1



**Control room connection box**

All the Probe connection Boxes are connected to Control Room Connection box (X MOI 2). The Control Room Connection Box is built in the factory for the correct amount of probes. Analog signal output to the batching automation systems is located here. Control PC is also connected here via USB connection. The Control room Connection Box should be located in the control room close to the PC on which the VipuNET software is installed. For the wiring, see wiring diagram at end of this manual.

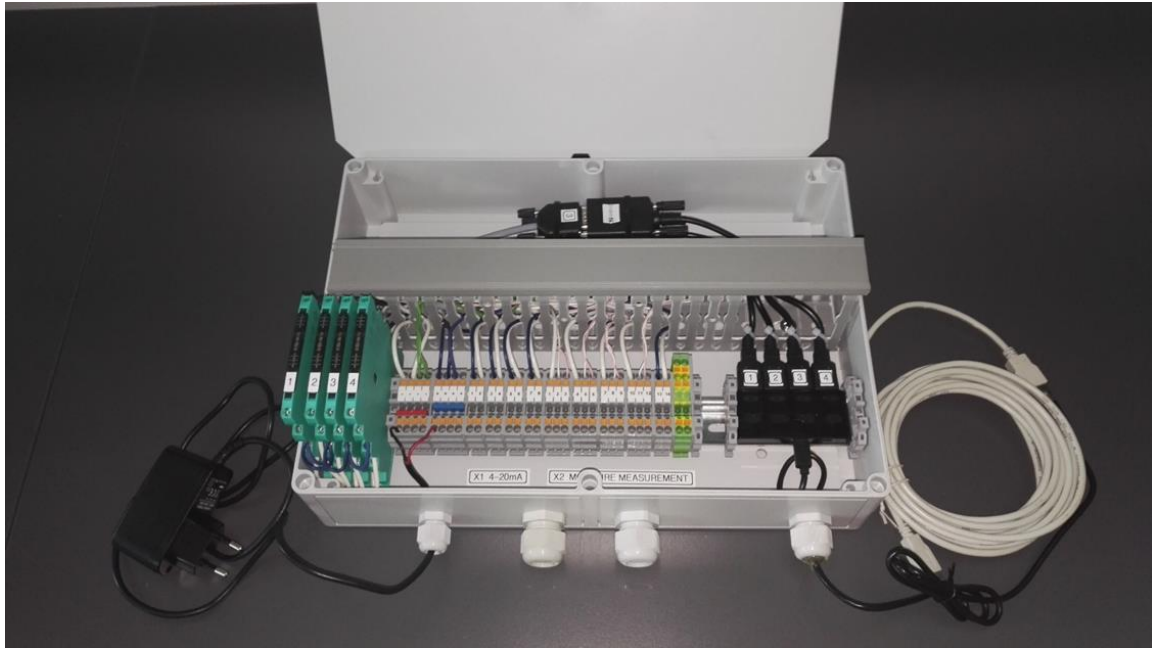
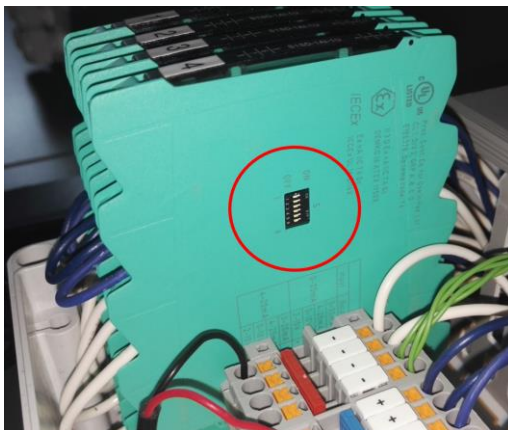


Figure 4. Control room Connection Box for four probes

**Changing the output signal type**

The output signal can be selected to match the input required by the batch plant control system. A signal conditioner is located inside the Control room connection box. Signal conditioner is used for providing galvanic isolation between field circuits and control circuits. This ensures reliable function of the measured moisture signal. Factory setting is 4...20 mA signal, but the signal type can be changed. The signal corresponds to moisture reading 0...16%. The following probe analog signals are available by configuring DIP switches:



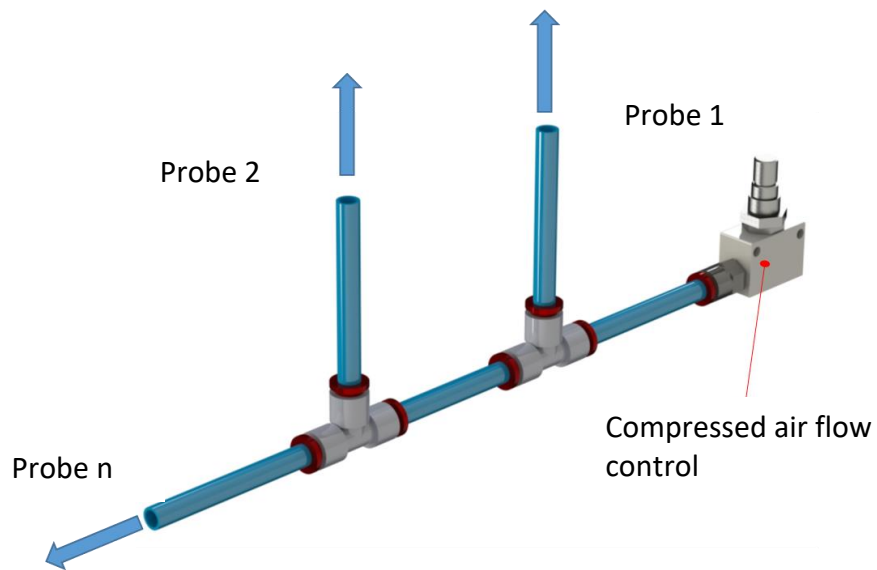
Output	Dip position (S)					
	1	2	3	4	5	6
0 mA ... 20 mA					x	
4 mA ... 20 mA						
0 V ... 10 V	x	x			x	
2 V ... 10 V	x	x				

**Compressed air**

Compressed air is recommended to be used to provide a counter flow to prevent contamination of the probe window. Each probe assembly has a connector for compressed air. For example, polyurethane compressed air tube diameter of 8 mm (5/16 in.) can be used. The system shall have airflow control device to set the flow to approx. 1-2 l/s.



**Note!** Compressed air tubing, connectors and air flow control are not included in delivery



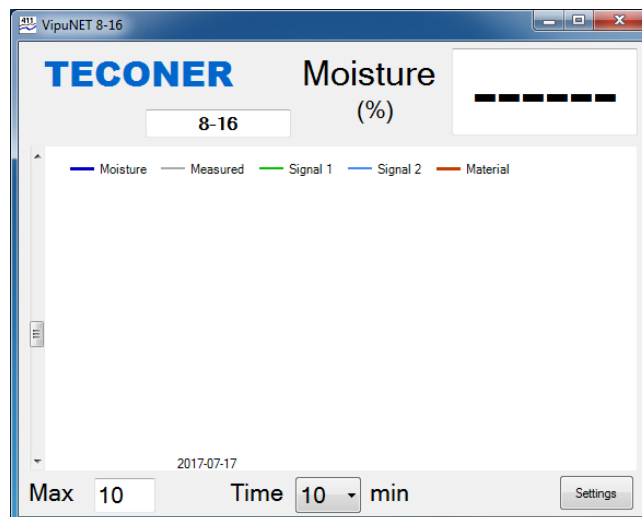
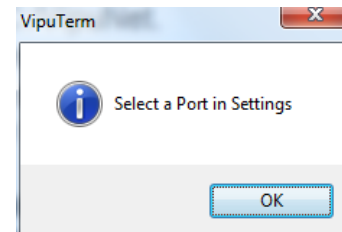
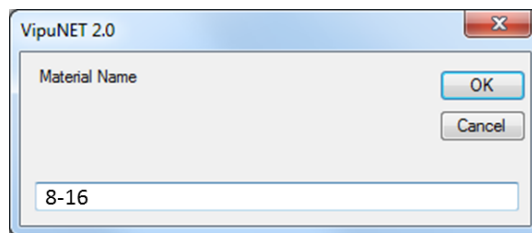
## VipuNET software

VipuNET software is provided for setting automatically calibration parameters to the moisture probe. The software is also used for registering the calibration and reference values, to follow the measured moisture numerically and graphically and for saving the collected data with date and time. The program runs in Windows PCs with Windows 7 or newer.

### Installing

To install VipuNET:

1. The software is delivered in VipuNet.zip format
2. Unzip the Vipunet.zip to a desired directory for example on desktop
3. Start the installation by clicking on Setup.exe
4. The setup file may need .NET Framework support files from Microsoft. If you do not have an Internet connection, the support files can be installed with a separate installer program.
5. VipuNET starts at the end of the installation and asks for material name (give name of the aggregate measured by this probe)
6. There is a notice for setting of the serial port. Press OK button.
7. VipuNET main page opens.

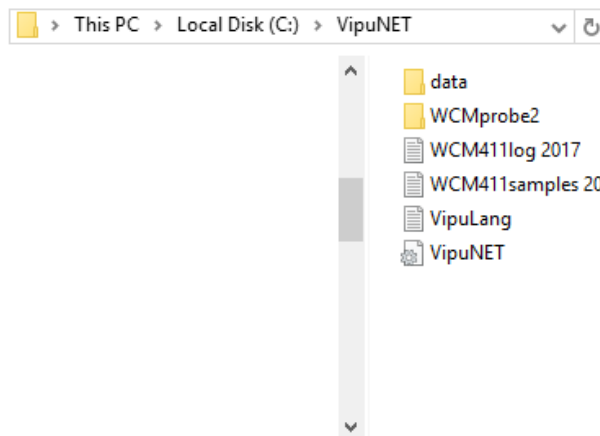


8. VipuNET is now installed and a startup icon is created to desktop
9. VipuNET folder "C:\VipuNET" is created
10. If you have more than one probe, close VipuNET at this point. Otherwise, you may move on to the next chapter.

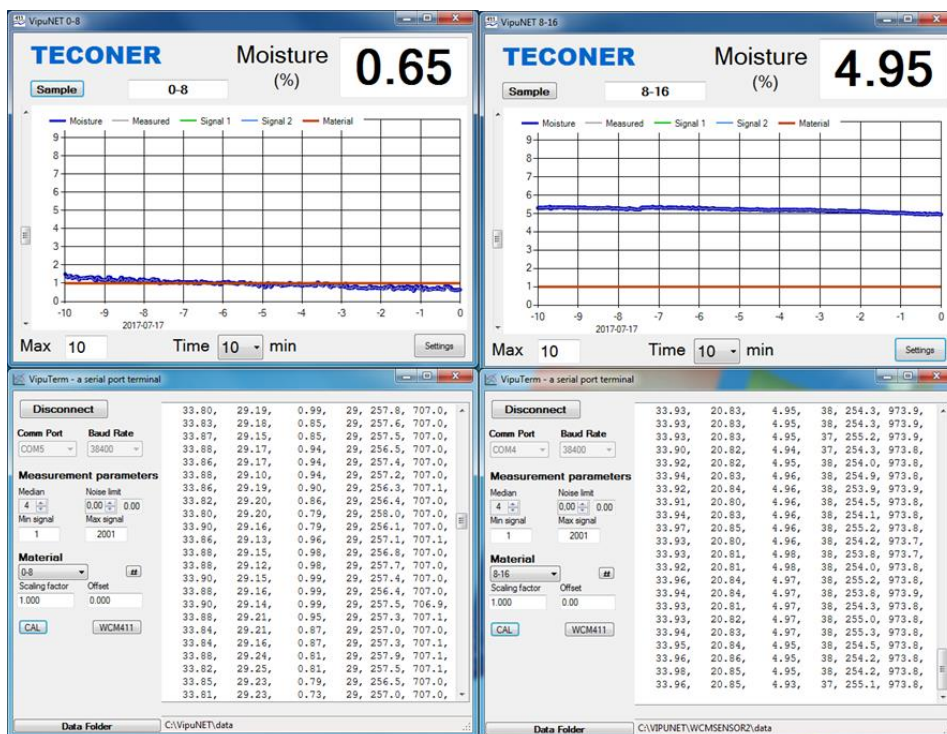
### Multiple probe assembly

If VipuNET software is used for more than one probe connected to the same computer, then a new subfolder for example C:\VipuNet\WCM2probe2 must be created for each additional probe, in which the name of the folder starts with the letters WCM and the rest differs from each other. This folder contains the corresponding files as the main folder (ie. c:\VipuNET) for the first probe.

*Example: You have two probes. In this case you need to create one additional folder under C:\VipuNet (for example WCMprobe2 in this case). The VipuNET software reads the amount of folders on start-up and based on the amount, the software identifies that there is one additional probe and two in total.*

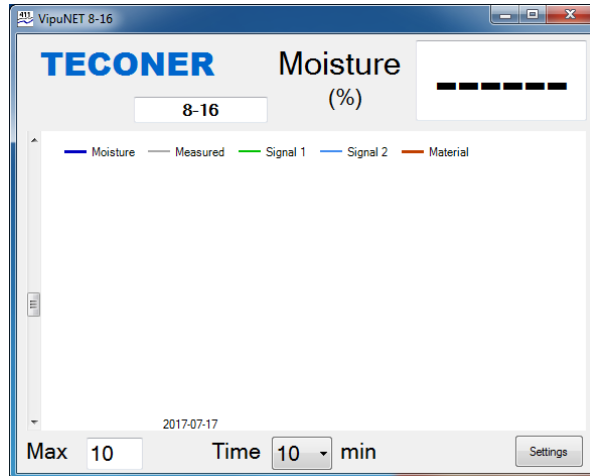


After completing this, two main windows are opened each time when opening VipuNET. One window can be seen and the rest are minimized on Windows taskbar. VipuNET writes the information of each probe into separate folders and files.



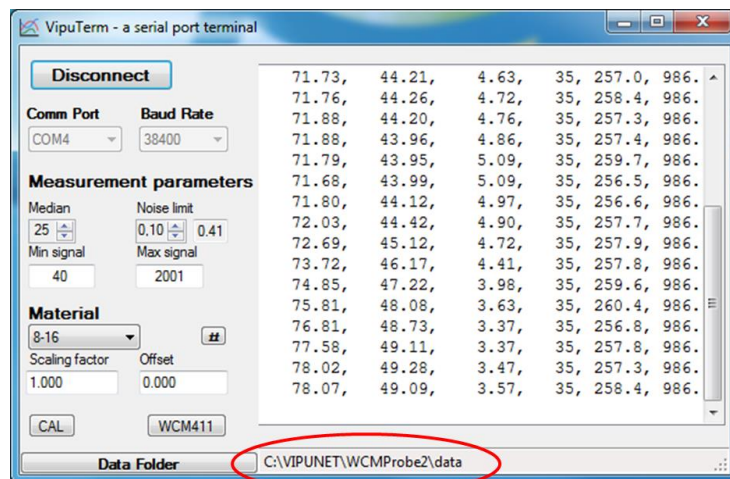
### Basic set-up

Before you start, some initial settings must be set. This can be done on the settings page, which can be opened from the main page by pressing “settings” button.



### Connecting probes to VipuNET

On the settings page, select correct “Comm port”. Set Baud rate to 38400. Press “Connect”. When the probe is working, you can see data flow lines as shown in the figure below. Repeat these for each probe if you have multiple probes. Now all probes are connected.



Each probe has its own separate data folder. Folder path is shown on the bottom of the settings page. Check that all probes have different data folders.



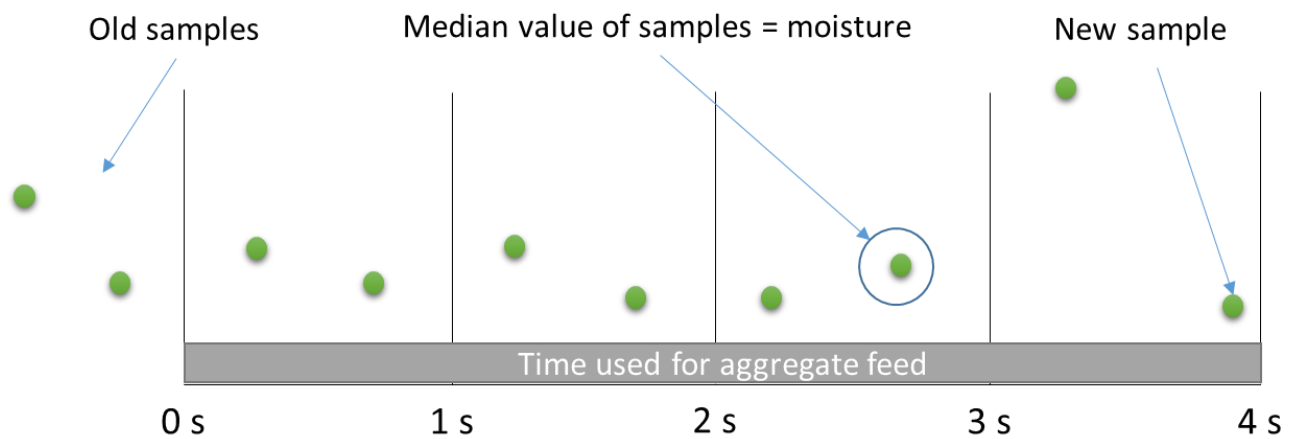
**Median value setting**

Median value setting is the amount of readings taken from the aggregate to calculate moisture. The median value setting is a moving value. After taking a new reading, the reading is counted in and the oldest reading is counted out. Mathematically, median is the middle value of a group.

Median value setting is done according to the characteristics of the current probe assembly and use profile of conveyors and bin gates. The system takes approx. two readings per second. This value should be set according to the measurement time available ie. actual dosing phase time of dosing your aggregate. You should set it so that your smallest batch will have at least as many readings as the median value. It should be set to be long enough but not too long so that the aggregate movement stops before measurement stops.

**Example:** Aggregate feeding from bin to conveyor takes about 4 seconds. What should the median value setting be?

The system takes two readings per second. Ideal median value setting in this case is 8.



We recommend to set the median value so that the fine dosing is not interfering the moisture value. This is done by using as long median value setting as possible, when a single value does not have significant influence on the median.

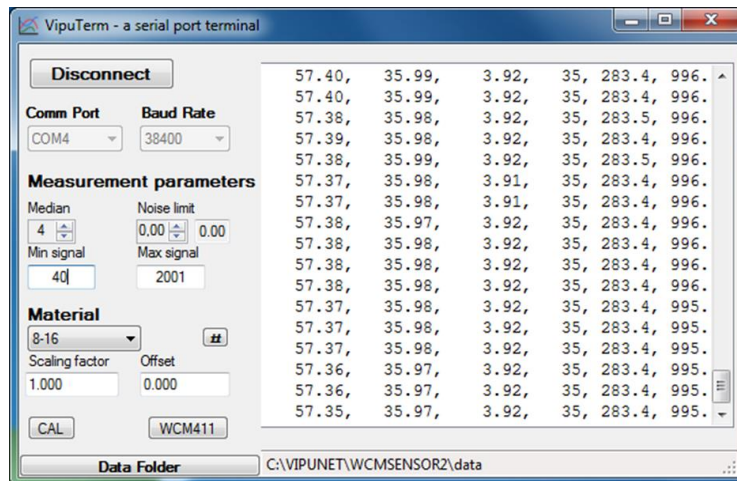


*Note! Median value should be set as close as possible but not over to maximum time available.*

**Min signal setting**

Min signal is set to stop measurement with small signals. This is useful for example with bin sector gates. Since without an aggregate flow, the signals are typically very small and there is no reason to measure. When the flow starts, the signal grows, and when it is bigger than the Min signal, the measurement is initiated.

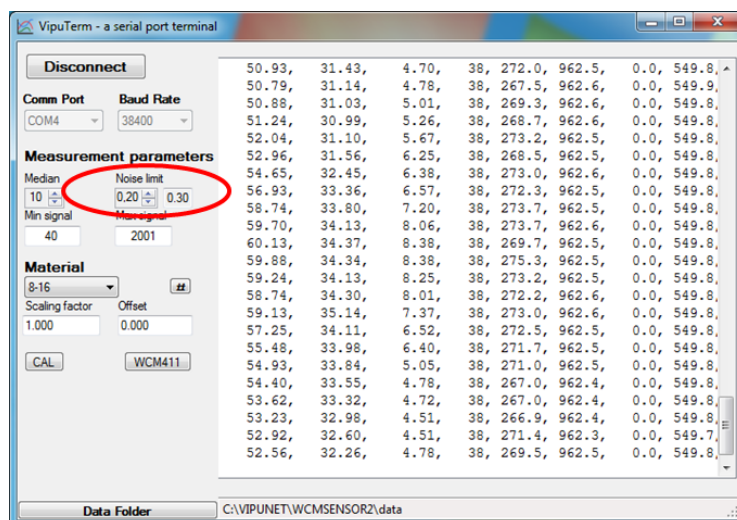
The Exact value of Min signal depends on the probe assembly and on the aggregate that is measured. Typical value is between 40 and 50. The first number on the data flow is the Min signal. Check first what is the signal level when aggregate is not flowing. Then check what is the signal level when aggregate is flowing. Set the Min signal level so that probe is taking readings only when aggregate is flowing. This will help you when calibrating the probes.



*Note! Min signal level setting is not mandatory setting, but can be used to control moisture measurement on and off.*

### Noise limit setting

When nothing is happening ie. aggregates are not moving, noise level is very low. Noise level starts to grow when aggregates are moving on conveyor. By this setting the system can recognize the moving aggregates and it starts to measure only when noise level is increasing. If this setting is 0.00, the measurement is on at all times except when min signal level prohibits it. The window on the right side of the Noise limit setting shows the current noise level. This can be set to a right value by checking the noise levels when the aggregates are moving and when it is not moving. Note that the probe is measuring all the time, but when noise limit is under setting, the values are ignored.



*Note! Noise limit setting is not a mandatory setting, but can be used to control moisture measurement output signal being on or off.*

### Setting parameters to the probe

When using mA signal, “median”, “Noise limit” and “Min signal” parameters must be set to the probe manually to match the ones that are used in VipuNET. When calibrating the probe, these parameters are not set when pressing “Cal” button.

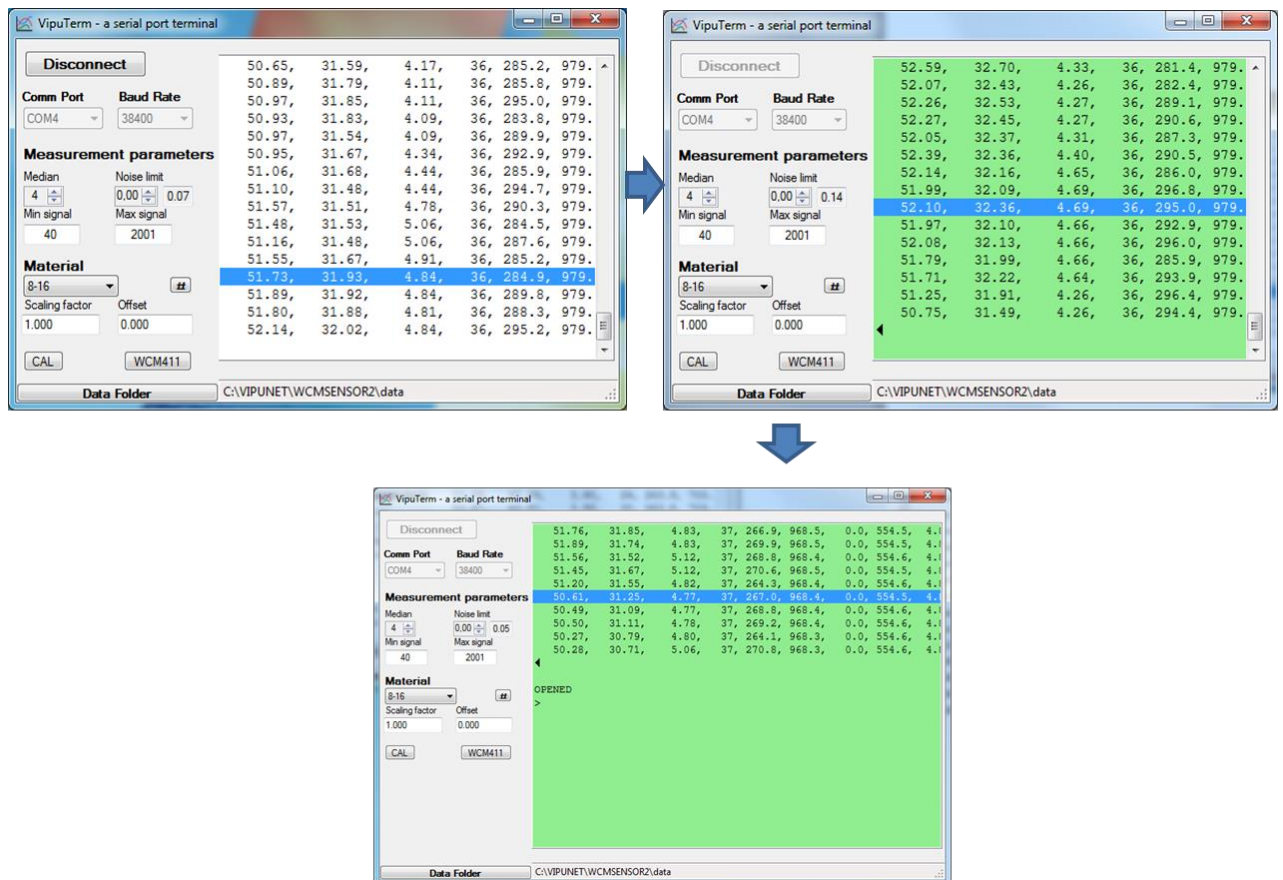


*Note! Before making any settings on the probe do them and test them first at VipuNET*

Probe settings are done in command mode. Command mode is initiated from the settings page, by:

- click data stream
- press “Esc” button (display turns to green) and
- immediately type “open”
- press “Enter” from keyboard.

Note that you need to be fast while doing this, since there is only limited time when commands are accepted. The display should look as shown below. When connection to the probe is opened, the display shows “OPENED”. Note that connection will close shortly if no commands are given. To re-open the connection, repeat the same steps as described above.



The first screenshot shows the 'Measurement parameters' section with the following values:

Median	4	Noise limit	0.00	0.07
Min signal	40	Max signal	2001	

The second screenshot shows the 'Noise limit' parameter updated to 0.14:

Median	4	Noise limit	0.00	0.14
Min signal	40	Max signal	2001	

The third screenshot shows the terminal displaying 'OPENED' after the connection is established.

Before setting new values, you should check what are the current values set to the probe.

To do that, type: *conf*

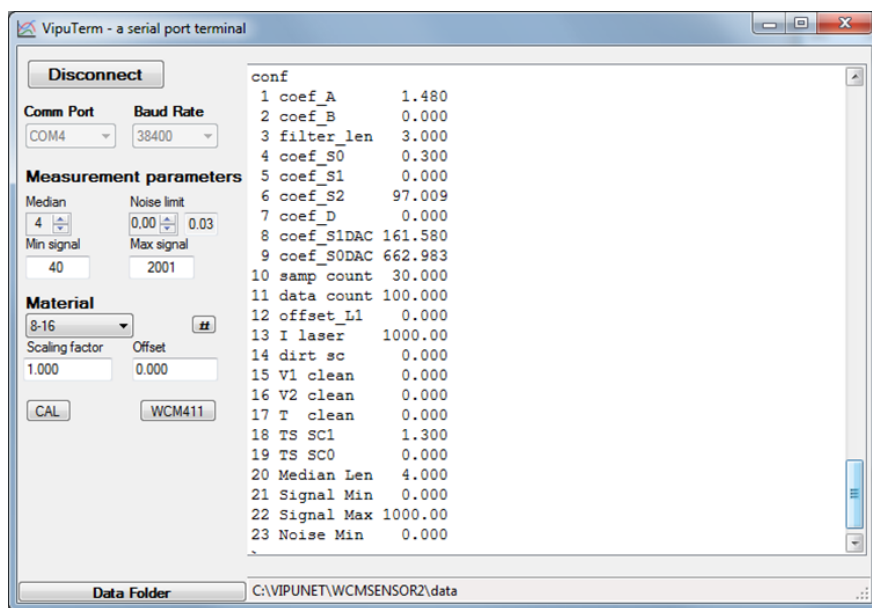
Press "Enter"

List of the current configuration opens. The parameters that need to be changed to match the parameters in VipuNET are as follows:

Median value setting = parameter # 20, Median Len

Min signal = parameter #21, Signal Min

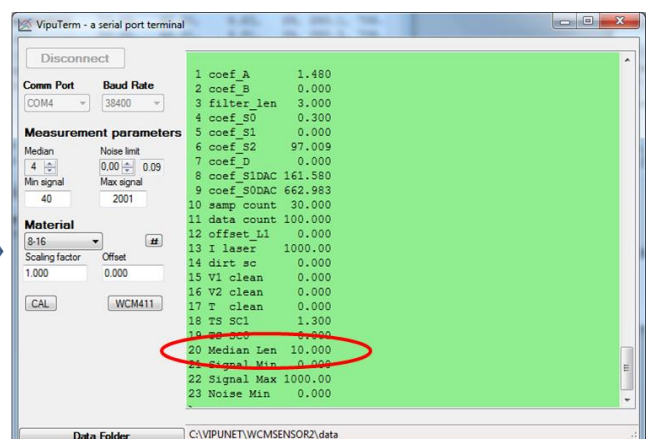
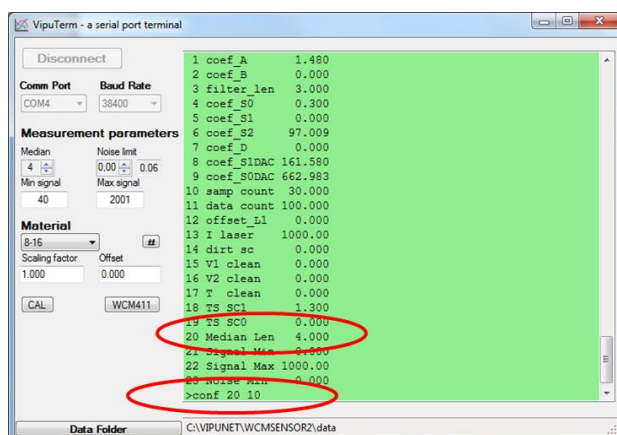
Noise Limit = parameter # 23, Noise Min



Example of changing "Median setting" parameter # 20 value from current 4 to new 10:

Type: *conf 20 10*

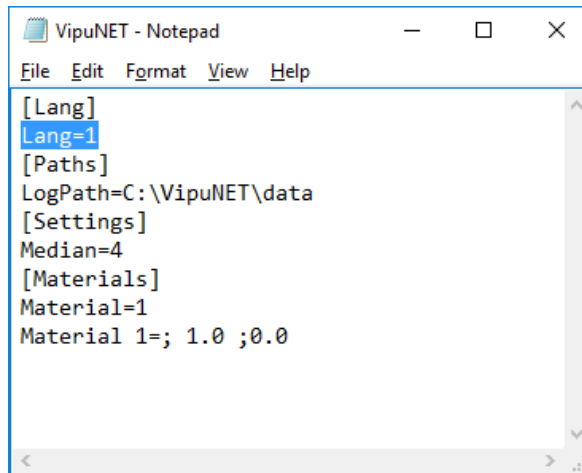
Press "Enter"



Command mode closes automatically or it can be closed by typing: *close*

## Language settings

Language is changed in configuration settings file: C:\VipuNET\VipuNET.ini



```

VipuNET - Notepad
File Edit Format View Help
[Lang]
Lang=1
[Paths]
LogPath=C:\VipuNET\data
[Settings]
Median=4
[Materials]
Material=1
Material 1=; 1.0 ;0.0
    
```

Language can be selected by changing *Lang* variable. The following language options are available.

Language	[Lang]
Windows language	Lang=-1
Finnish	Lang=0
English	Lang=1
Swedish	Lang=2
German	Lang=3
Russian	Lang=4
French	Lang=5



## Calibration procedure

Each probe has been pre-set in the factory. However, each probe must be calibrated for the aggregate that it is intended to be used for. The calibration of the probes is as follows:

1. Check that the probe is mounted as described above
2. Use the VipuNET software for calibration
  - a. If not open, Start VipuNET(s) and check that probe(s) is measuring. New data lines are shown in settings page and moisture curve is drawn in start page.



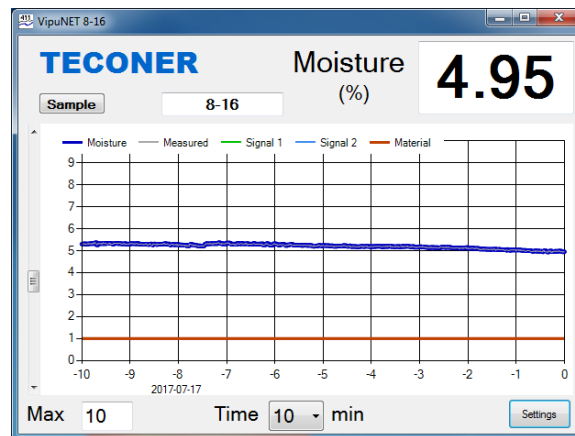
**Note!** There must be one VipuNET open for each separate probe.

- b. take 1-3 shovels of aggregate and close them tightly into a bucket and mix well manually
- c. If you have set your Min signal setting correctly you can first take physical samples and after that you can press “sample” button to take corresponding sample to VipuNET. When Min signal setting is correct VipuNET measures only when aggregate flows.

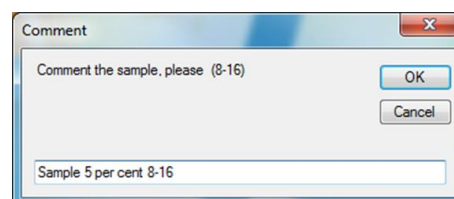
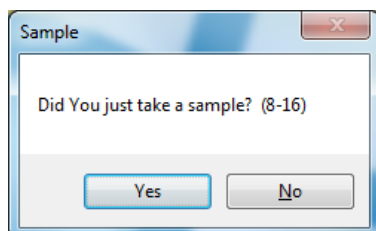


**Note!** When using Min signal setting method to calibrate, make sure that measurements shown in VipuNET are the ones that you have taken the physical samples.

If you are not sure or Min signal setting is not set correctly, you need to press the “Sample” button on VipuNET main page window at the same time when taking the last physical sample.

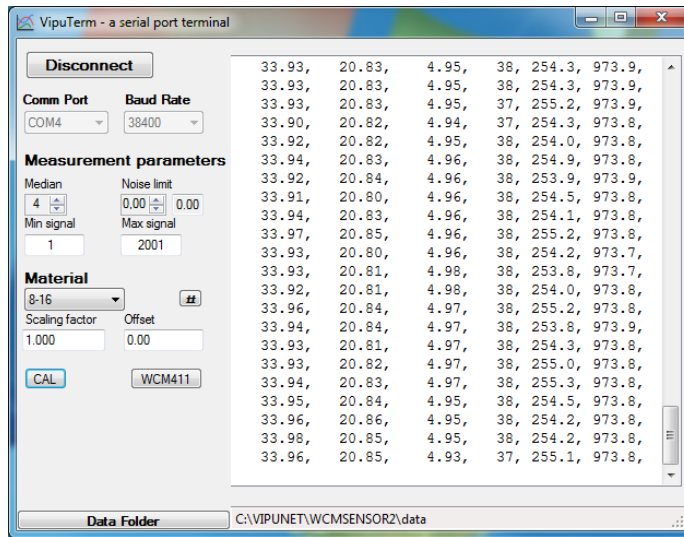


- d. The system verifies that you are actually taking a sample. Press “Yes” and give name to the sample.



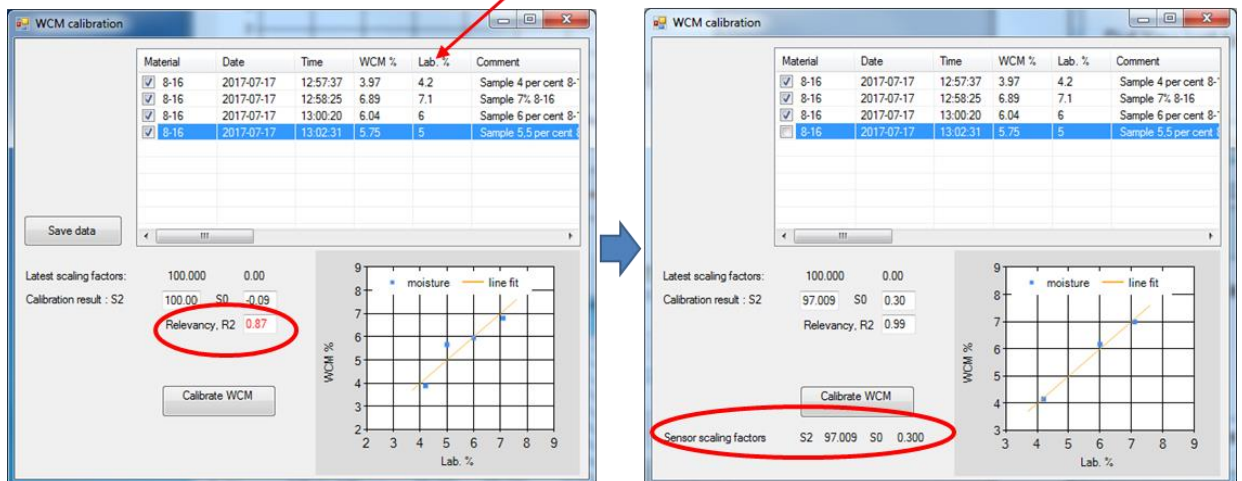
Repeat this at least two times so that your samples have minimum of 2% moisture difference.

- e. do your burn-off and record the results on VipuNET. To register your results, open Calibration table. Press “CAL” button on settings page.



- f. Place your calibration data on the correct line to “Lab%” column. In the end you should have nice linear curve and “Relevancy, R2” reading as close to 1 as possible. The system shows relevancy in red if it is not accurate enough. You can untick unwanted results to make the curve more accurate. Press “Save data” when you are satisfied with curve. “Save data” button disappears when there is no new data and appears again when new calibration samples are taken.

Burn-off results



- g. once you have the points that are at least 2% apart on the line and it looks good to you, you can press calibrate WCM, which then sends the data into the probe. Once the probe has been calibrated, calibration values are shown at the bottom of the calibration window.



**Note!** You should first see a nice linear curve on VipuNET and then press calibrate WCM. If one or more points are off chart (i.e. something went wrong in burn-off), you can simply untick that line and it will be removed from the curve and thus not effect the calibration of the probe

- h. Once you are happy with what you see as moisture reading on VipuNET, you can connect it to your control system. You can still keep the VipuNET open to double check the values. You can also update the values at any point by using the same method as shown above.



**Note!** The Polarmoist reading is a surface moisture or total moisture reading and typically in your batch plant control system you would input an absorbed moisture value per aggregate, which the system then deducts from the total moisture value. This must be kept in mind when comparing these two.

### How to do the burn-off

First weigh the sample. This is the Start weight. Be extra careful that all the aggregate stays in weighing loop. Use for example a clean new paintbrush to remove all the aggregate from the mixing shovel. Dry the sample totally dry in microwave or other oven. Mix the sample to make sure that it stays homogeneous. Repeat drying and weigh until the weight is not changing. This is the End weight. Note also that some scales are sensitive to high temperatures. Use insulation between the sample and the scale. The moisture percent is calculated with the following formula.

$$\text{Moisture \%} = \frac{\text{Start weight (wet)} - \text{End weight (dry)}}{\text{End weight (dry)}}$$

Repeat the described steps with two to three samples per moisture percent. Calculate the average value of these samples and use that as a moisture percent value in VipuNET.

$$\text{Average moisture \%} = \frac{\text{Sample 1 \%} + \text{Sample 2 \%} + \dots + \text{Sample } n \%}{\text{Number of samples } (n)}$$



**Note!** Weight of the container used must not be part of the calculations. Scale must be set to zero with the container.

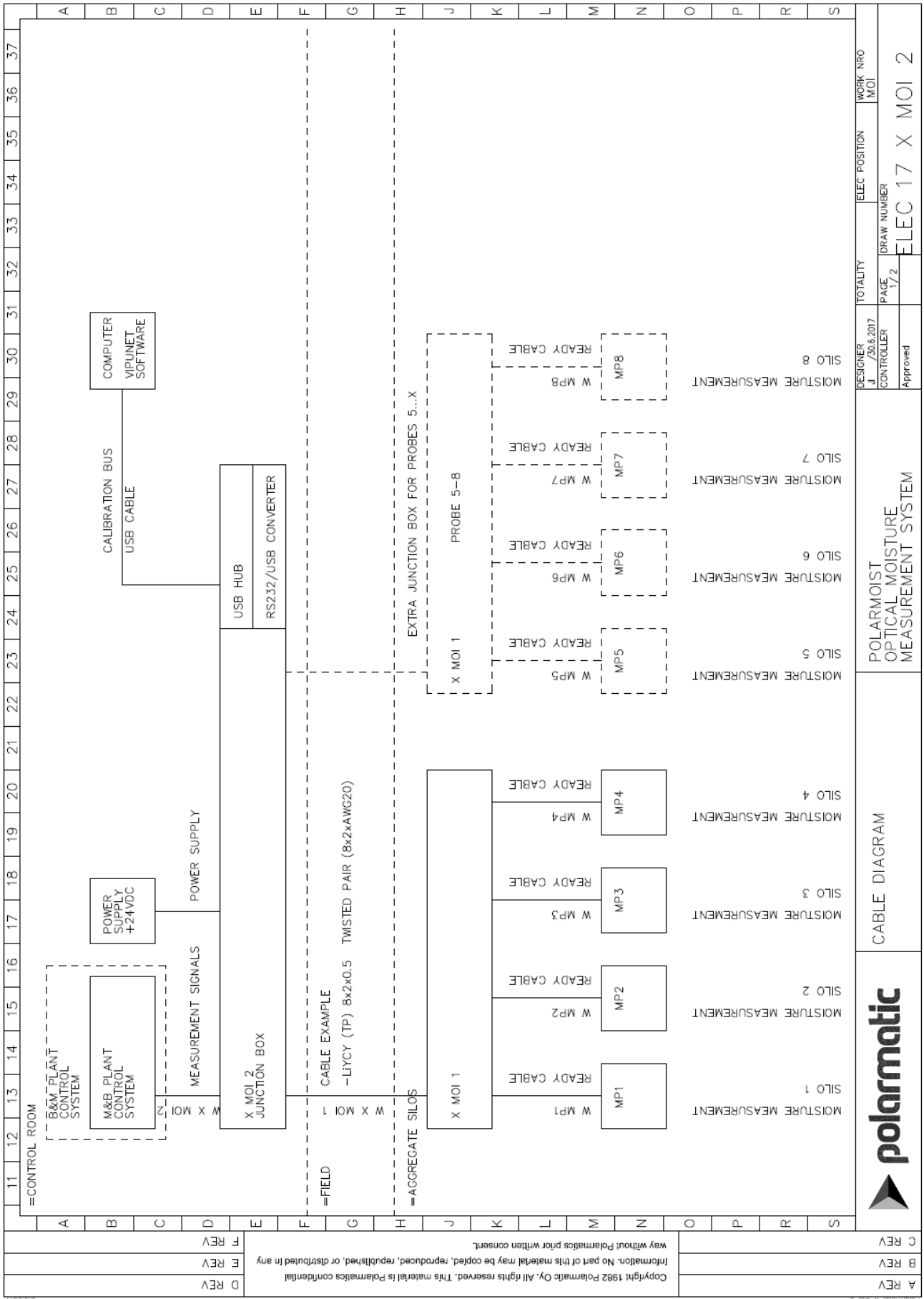
## Troubleshooting

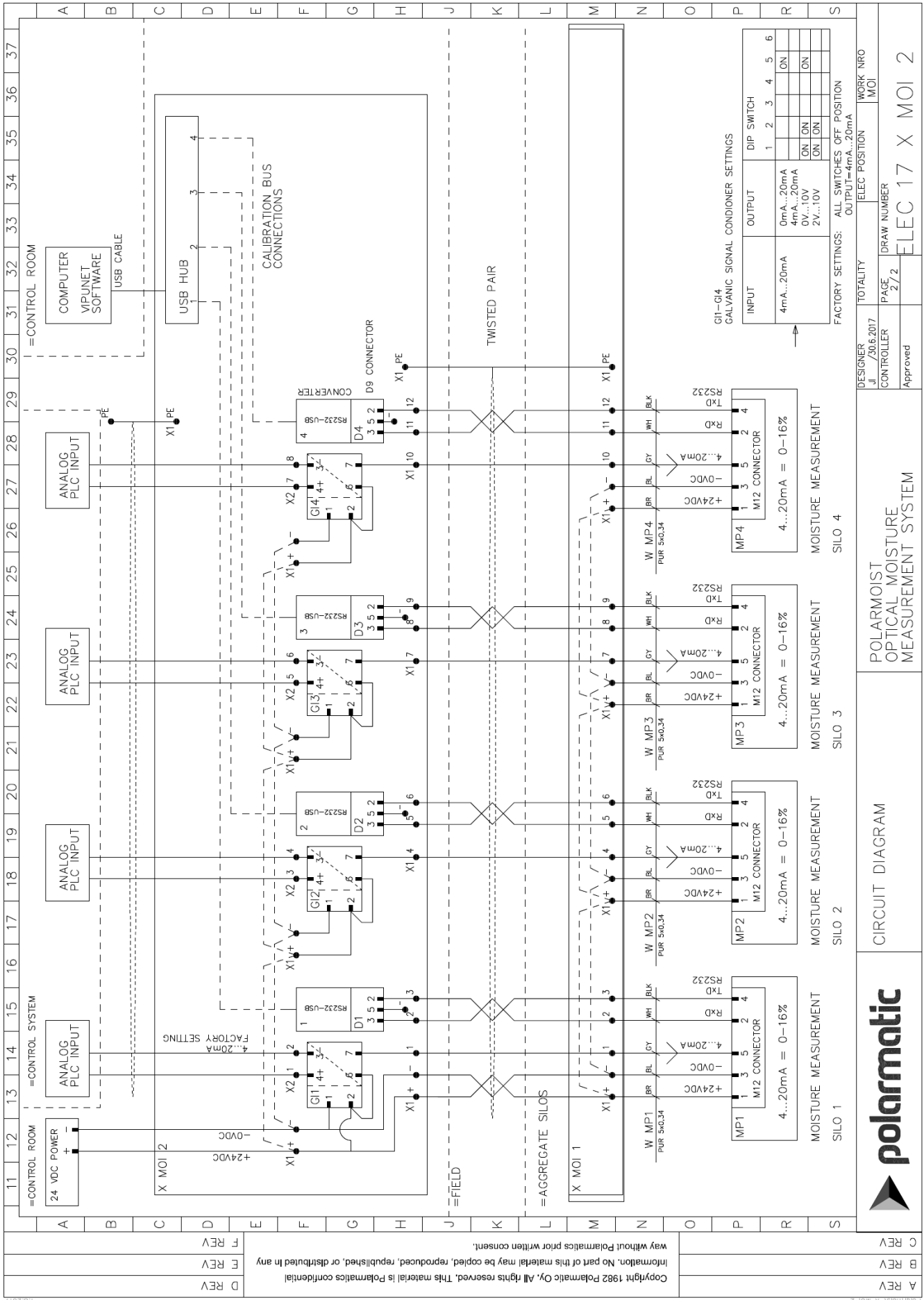
Error code	Fault	Possible reason	Action
Err1	No output data from probe or data flow too slow	No / Loose connections of the power supply	Ensure that all the connections are connected and wires are connected as per instructions
		No / Loose probe signal cabling from probe to the connection boxes	Ensure that all the connections are connected and wires are connected as per instructions.
		COM and Baud rate settings are not correct	Check settings, see chapter: Basic set-up
		USB ports are not connected	Check in the Windows Devices & Printers that there are USB ports for each probe available.
		VipuNET is not working properly	Re-start VipuNET
		Too much light for the probe to measure right	The reading in the 5th column on the message line must be well under 2000 at the time of batching aggregate. Higher readings saturate the probe. Provide shade around the probe measurement cone to avoid sunlight disturbing measurement
		Too long intermediate cabling	Length of the cabling shall not exceed 50 m. To check functionality, check all the connections first. After that, connect probe directly to PC to verify probe functionality.
		Faulty probe	First, connect probe directly to computer to check functionality. Contact supplier
	Output with improper characters	The baud rate is different in VipuNET software and the probe	Reset the baud rate setting

	Moisture value -200	Probe is measuring but the median amount of samples is less than median value setting	Wait for a while so that the amount of samples is more than median.
	Improper moisture values like -1000	Calibration points are too close to each other.	Redo calibration with minimum of 2 % moisture difference. See chapter: Calibration procedure.
		VipuNET is writing data from different probes to one file.	Create separate folders for each additional probe. If you have 4 probes, create 3 files starting with initials WCM. See chapter: Multiple probe assembly.

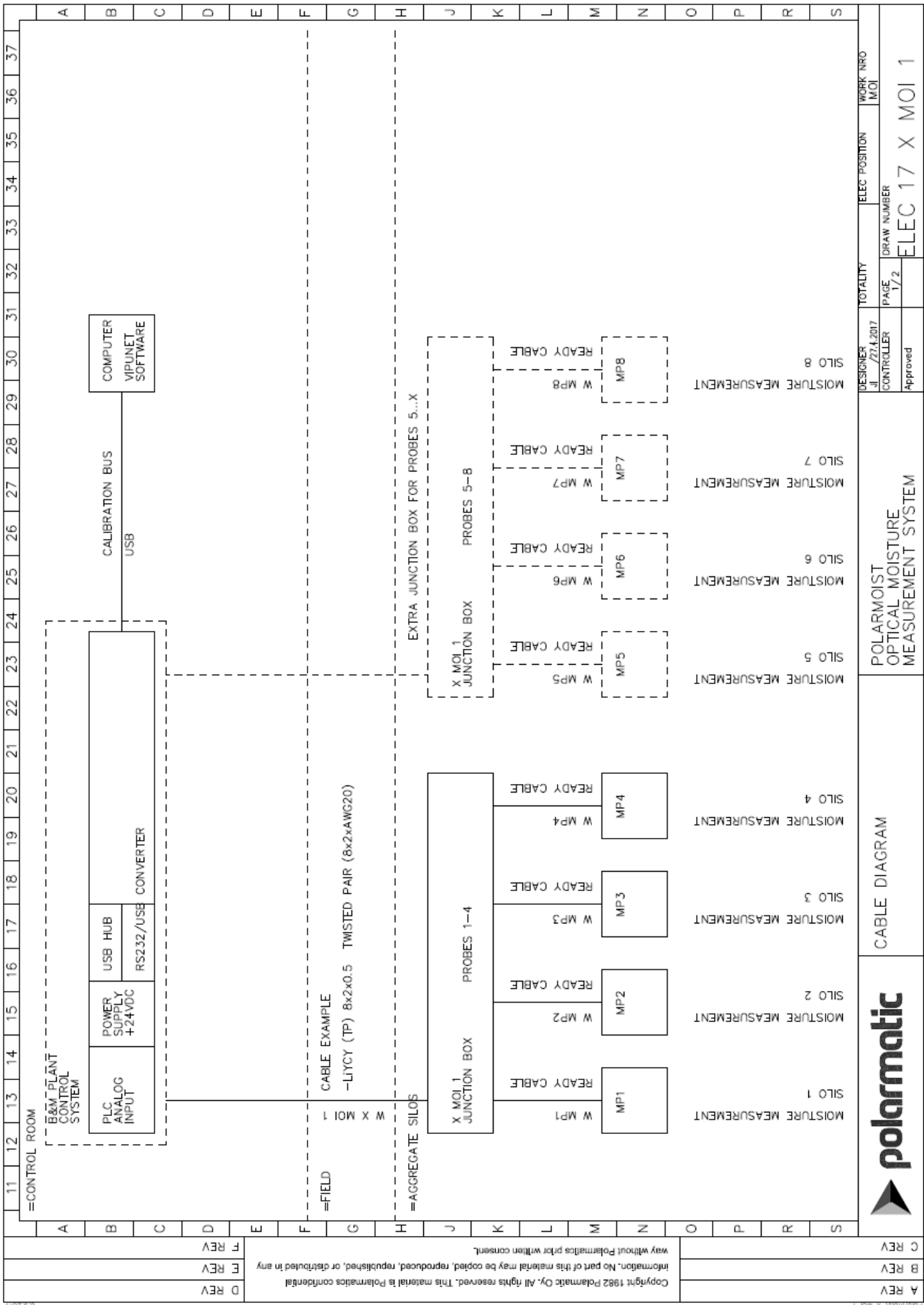


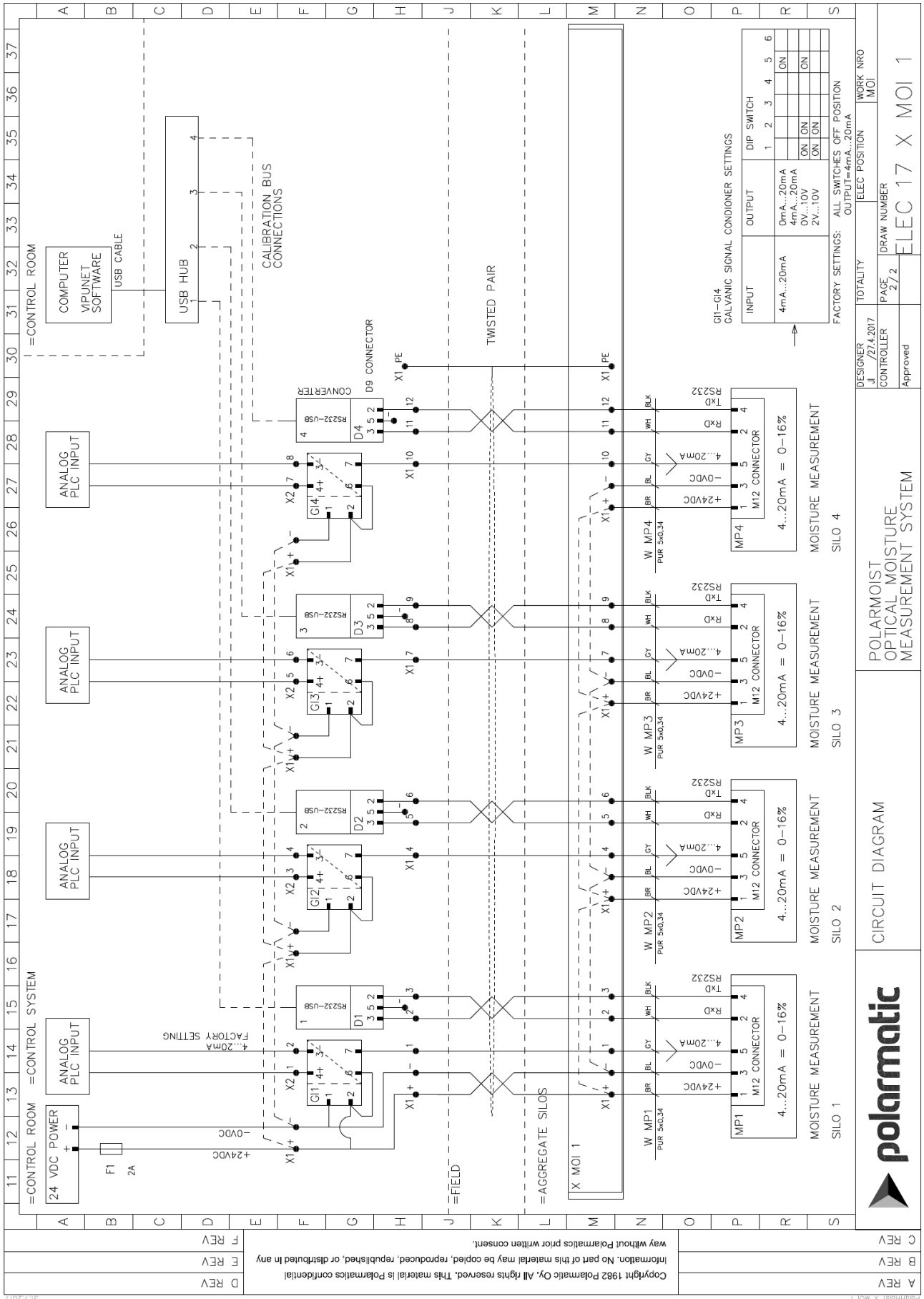
### Drawings for stand alone assembly





### Drawings for electrical cabinet assembly





13 12 2017

A REV  
B REV  
C REV

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CIRCUIT DIAGRAM

POLARMOIST OPTICAL MOISTURE MEASUREMENT SYSTEM

DESIGNER: JI / 27.4.2017  
CONTROLLER: Approved  
TOTALITY: WORK NRO MOI  
PAGE: 2/2 DRAW NUMBER: ELEC 17 X MOI 1

G11-G14 GALVANIC SIGNAL CONDITIONER SETTINGS

INPUT	OUTPUT	DIP SWITCH
4mA...20mA	0mA...20mA	1 ON
4mA...20mA	4mA...20mA	2 ON
0V...10V	0V...10V	3 ON
2V...10V	2V...10V	4 ON

FACTORY SETTINGS: ALL SWITCHES OFF POSITION  
OUTPUT=4mA...20mA