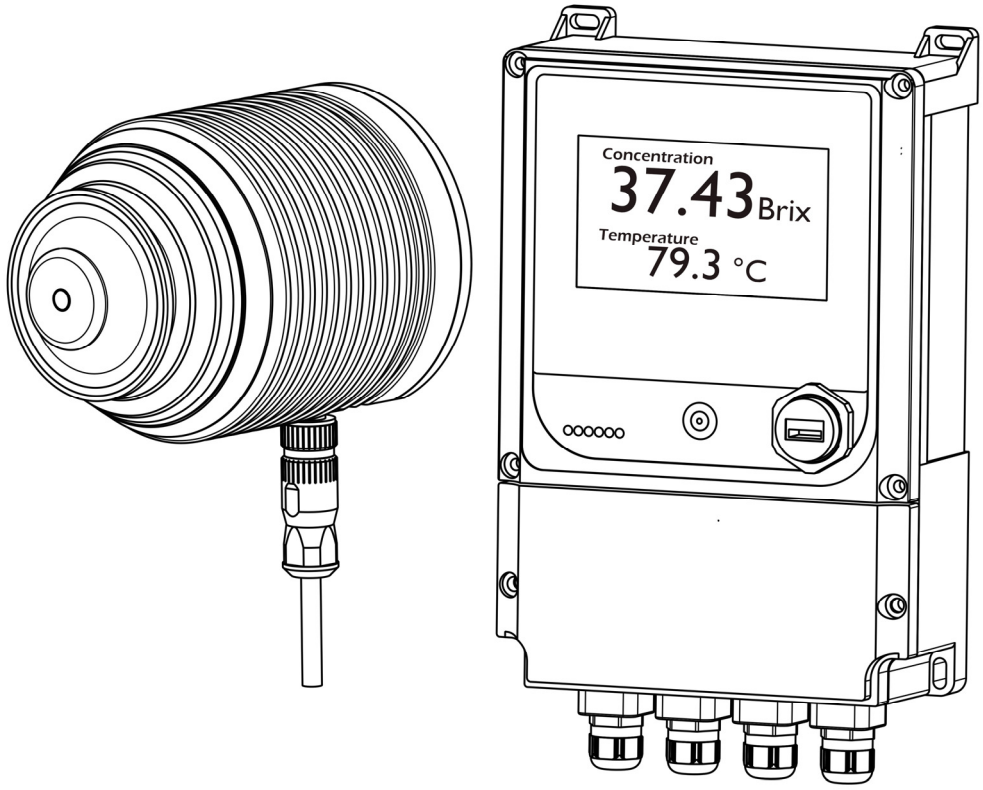
PrismaTech® Inline Refractometer

INSTRUCTION MANUAL



PrismaTech® Instrumentations
www.ControlSystemco.com
August 2017

INSTRUCTION MANUAL

FOR INLINE REFRACTOMETER
PTR100/ PTR50/ PTR100_T/ PTR100_C

WARNING!
The process medium may be hot or otherwise hazardous.

Precautions when removing the sensor from the process line:
Make positively sure that the process line is not under pressure. Open a vent valve to the atmosphere.
For a prism wash system, close a hand valve for the wash medium and disable the wash valve.
Loosen the clamp cautiously, be prepared to tighten again.
Be out of the way of any possible splash and ensure the possibility of escape.
Use shields and protective clothing adequate for the process medium.
Do not rely on avoidance of contact with the process medium.
After removal of the sensor, it may be necessary to mount a blind cover for security reasons.
Document/Revision No. INR-50/100: Rev. 1.1 Effective: August 2017

The IP67 label express the ingress protection of the *Sensor Unit* and *Display/Control Unit* respectively.

The equipment box contains a ***Prisma*Tech®** inline refractometer Sensor unit and a Control/Display unit.

This product manual is delivered to the end user with a product.

This product may be used to measure and control the concentration of liquid solutions on the process line and tanks such as in food products, chemical and petrochemical products, medicine products.

If the equipment is used in a manner not specified by the this instruction manual, the protection provided by the equipment may be impaired

Information in this manual is subject to change without notice. When the manual is changed, a revised copy is published at: *http://www.ControlSystemco.com/*.

The default password of all models is "7777777"

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1 Introduction

The **PrismaTech®** inline refractometer is an instrument for measuring and controlling liquids concentration in the process line. The measurement is based on the refraction of light in the process medium, an accurate and safe way of measuring liquid concentration.

The inline refractometer sensor (See **Figure 1-1**) measures the refractive index nD and the temperature of the process medium. This information is sent via the interconnecting cable to the Control/Display Unit. The Control/Display Unit calculates the concentration of the process liquid based on the refractive index and temperature, taking pre-defined process conditions into account. The output of the Control/Display Unit is two 0/4 ~ 20 mA DC output signal proportional to process solution concentration or the process concentration.

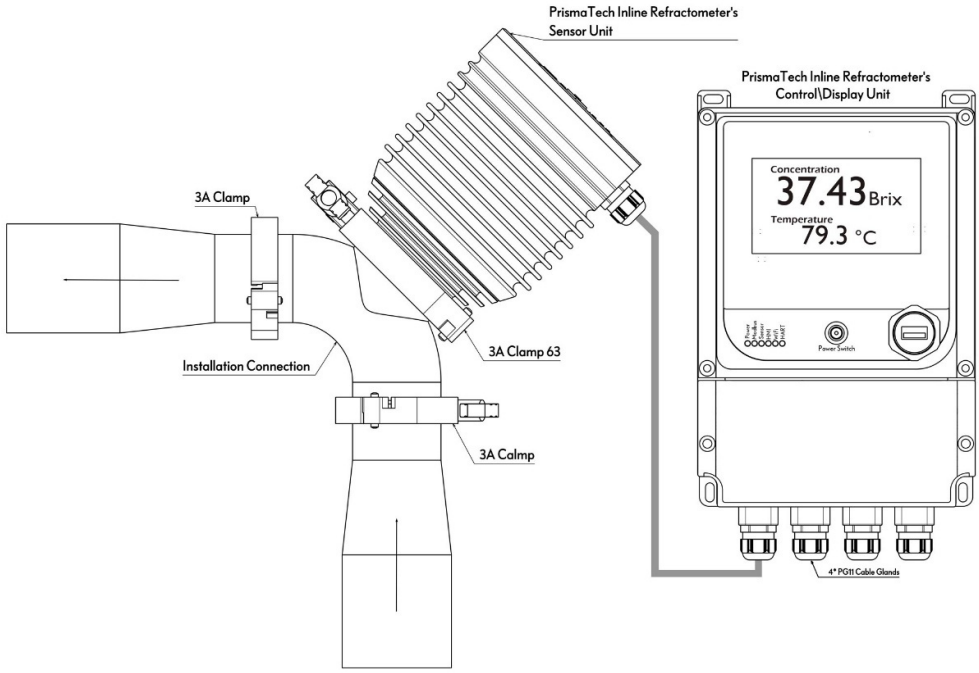


Figure 1-1 Refractometer Equipment

1.1 Principle of measurement

The **PrismaTech®** inline refractometer sensor determines the refractive index nD of the process solution. It measures the critical angle of refraction using a yellow LED light source with the same wavelength (580 nm) as the sodium Dline (hence nD). Light from the light source (L) in **Figure 1-2** is directed to the interface between the prism (P) and the process medium (S). Two of the prism surfaces (M) act as mirrors bending the light rays so that they meet the interface at different angles.

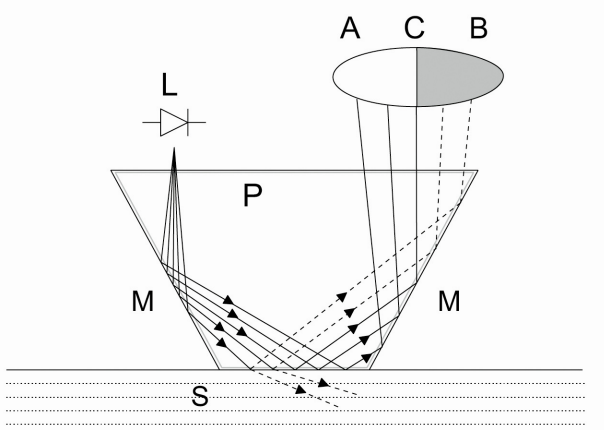


Figure 1-2 Refractometer Principle

The reflected rays of light form an image (ACB), where (C) is the position of the critical angle ray. The rays at (A) are totally internally reflected at the process interface, the rays at (B) are partially reflected and partially refracted into the process solution. In this way the optical image is divided into a light area (A) and a dark area (B). The position of the shadow edge (C) indicates the value of the critical angle. The refractive index nD can then be determined from this position. The refractive index nD changes with the process solution concentration and temperature. When the concentration changes, the refractive index normally increases when the concentration increases. At higher temperatures the refractive index is smaller than at lower temperatures. From this follows that the optical image changes with the process solution concentration as shown in **Figure 1-3** the color of the solution, gas bubbles or undissolved particles do not affect the position of the shadow edge (C).

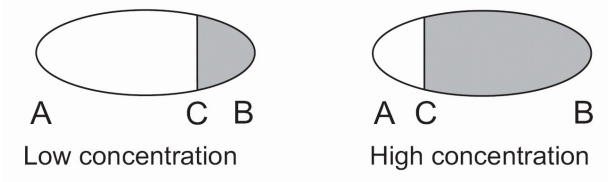


Figure 1-3 Optical Image

The position of the shadow edge is measured digitally using a CCD element (**Figure 1-4**) and is converted to a refractive index value nD by a processor inside the sensor. This value is then transmitted together with the process temperature via an interconnecting cable to the Indicating transmitter for further processing, display and transmission.

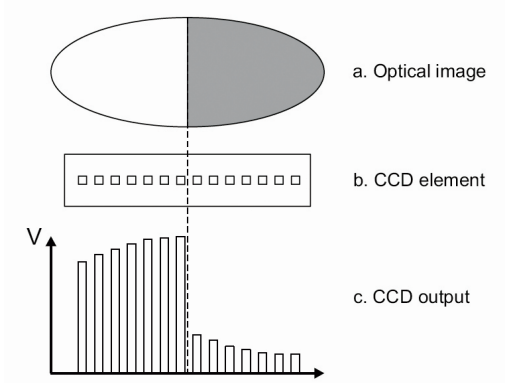


Figure 1-4 Optical Image Detection

1.2 General safety considerations

The process medium may be hot or otherwise hazardous. Use **shields and protective clothing** adequate for the process medium - do not rely on avoiding contact with the process medium.

Precautions when removing a standard sensor from the process line:

- Make positively sure that the process line is not under pressure. Open a vent valve to the atmosphere.
- For a prism wash system, close a hand valve for the wash medium and disable the wash valve.
- Loosen the clamp cautiously, be prepared to tighten again.
- Be out of the way of any possible splash and ensure the possibility of escape.
- After removal of the sensor, it may be necessary to mount a blind cover for security reasons.

1.3 Disposal

When disposing of an obsolete instrument or any parts of an instrument, please observe the local and national requirements for the disposal of electrical and electronic equipment. An aluminum or stainless steel sensor housing can be recycled with other metallic waste of the same type.

2 Inline Refractometer Sensor

2.1 Sensor description

Figure 2-1 below shows a picture of a ***Prisma*Tech®** inline refractometer sensor showing the basic description of general parts of ***Prisma*Tech®** inline refractometer which is applicable for all models of ***Prisma*Tech®** inline refractometer. The measurement prism (A) is flush mounted to the surface of the probe tip. The prism (A) and all the other optical components are fixed to the solid core module (B), which is springloaded against the prism gasket. The light source inside the CoreOptic module (B) is a yellow Light Emitting Diode (LED), and the receiver is a CCD element (E). The electronics is protected against process heat by the cooling fins (D). The sensor processor card (C) receives the raw data from the CCD element (E) and the Pt-1000 process temperature probe then calculates the refractive index nD and the process temperature T. This information is transmitted to the Indicating transmitter called Display/Control unit.

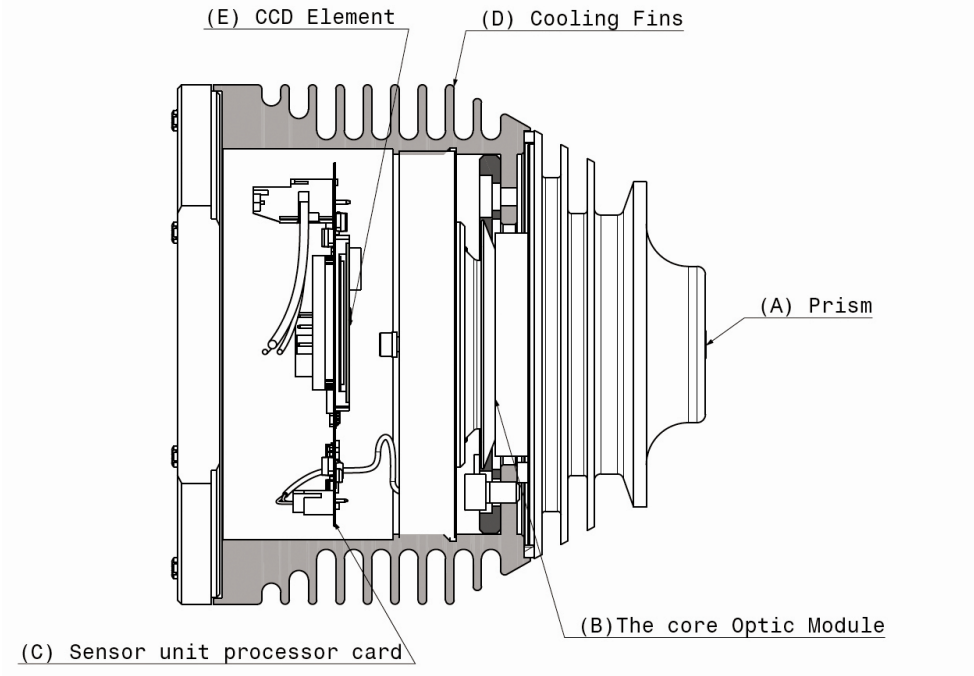


Figure 2-1 Sensor Structure

2.2 Sensor models

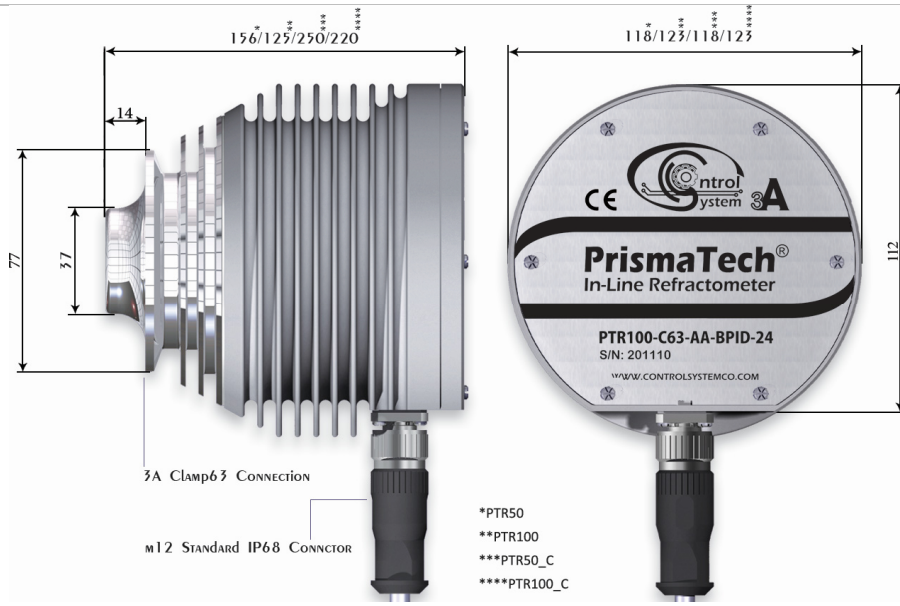
Four different models of **PrismaTech®** *inline refractometer sensor unit* are available for different concentrations and process temperatures. The table below shows the models specifications:

Model	PTR50	PTR100	PTR100_C	PTR100_T
Refractive Index Range	1.32500 ~ 1.43000	1.32500 ~ 1.55000	1.32500 ~ 1.55000	1.32500 ~ 1.55000
Brix Range	0 ~ 50 %Brix	0 ~ 100 %Brix	0 ~ 100 %Brix	0 ~ 100 %Brix
Measurement Accuracy	0.05 %Brix	0.07 %Brix	0.07 %Brix	0.07 %Brix
Max Process Critical Condition	115°C, 12Bar	115°C, 12Bar	210°C, 12Bar	115°C, 12Bar
Optical Sensor	CCD 3648 Pixel			
Prism Material	Sapphire			
Board Voltage and Temperature	19 to 29V,DC/ -5 to 60°C			
Sensor Enclosure	IP67			
Wetted Parts Material	AISI316L/PTFE/Hastelloy			
Internal Sensors	Processor Voltage and Temperature/ Sensor Enclosure Humidity			
Installation Connections	3AClamp 63mm			

2.3 Mounting the sensor

The sensor mounting location should be chosen with care to ensure reliable readings from the process. Some basic rules, described in this section, apply to all sensor models.

Important: Before choosing a place for mounting the sensor consider the sensor unit dimensions as **Figure 2-2** below:



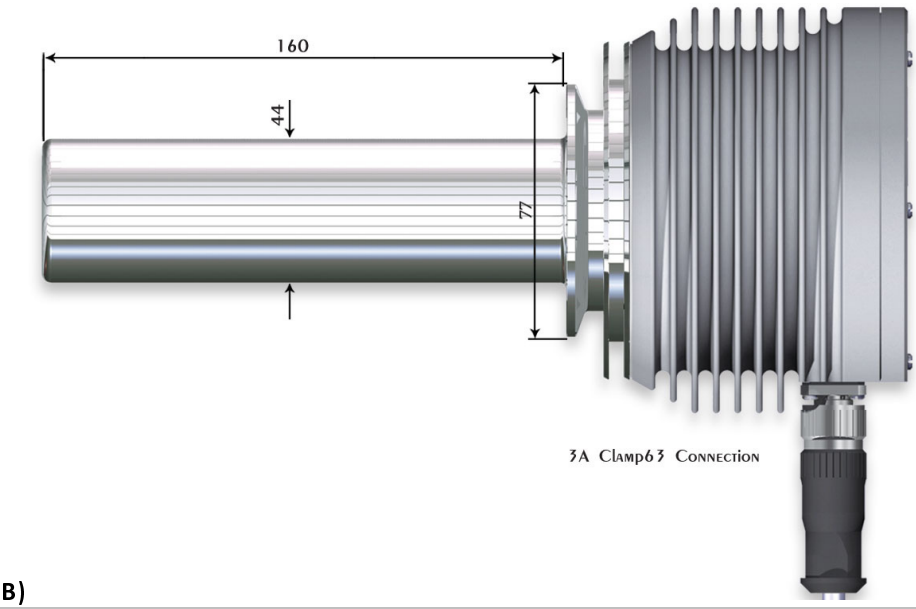


Figure 2-2 Sensor unit dimensions

2.3.1 Choosing sensor mounting location

A ***PrismaTech®*** inline refractometer sensor can be located either indoors or outdoors in most climates. However, when a sensor is located outdoors, some basic protection against direct exposure to sunlight and rain should be provided. Special care should be taken if the pipe wall is translucent (e.g. of fiberglass), as light from outside reaching the prism through the pipe wall may disturb the measurement.

The mounting location needs to be such that sediments or gas bubbles cannot accumulate by the sensor. Good flow velocity is essential in keeping the prism clean.

Important: If the process pipe vibrates, support the pipe. A vibrating pipe might damage the in-line sensor mounted on it.

Always check that the sensor head is kept cool enough; the sensor head should not be too hot (hotter than 100°C). The sensor cover should not be exposed to high temperature radiation. In most cases, draft and natural convection provide sufficient air cooling if the air gets to flow freely around the sensor head.

Additional cooling is necessary when the ambient temperature is higher than 45°C (113°F) or when the process temperature is above 115°C (239°F) and the ambient temperature is above 35°C (95°F). The air cooling is improved by blowing pressurized air against the sensor cover. The pressurized air can be supplied by the ventilation system. If no air is available it is also possible to wind a copper coil for cooling water around the sensor head cover.

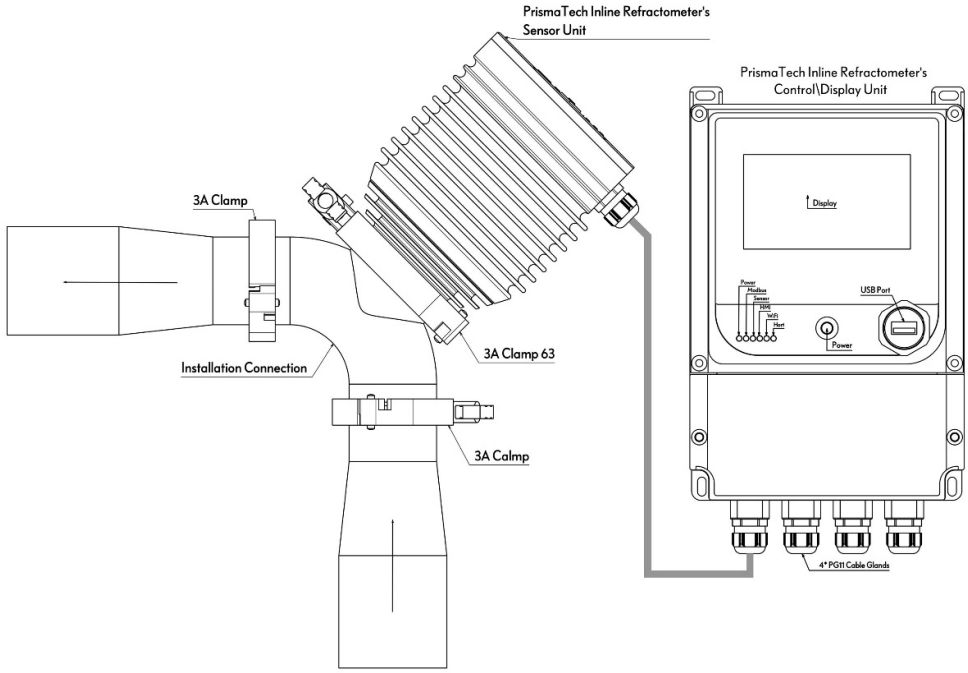


Figure 2-3 Refractometer Sensor Mounting

Important: Always mount the sensor so that the interconnecting cable points downwards from the sensor head as **Figure 2-4** below.

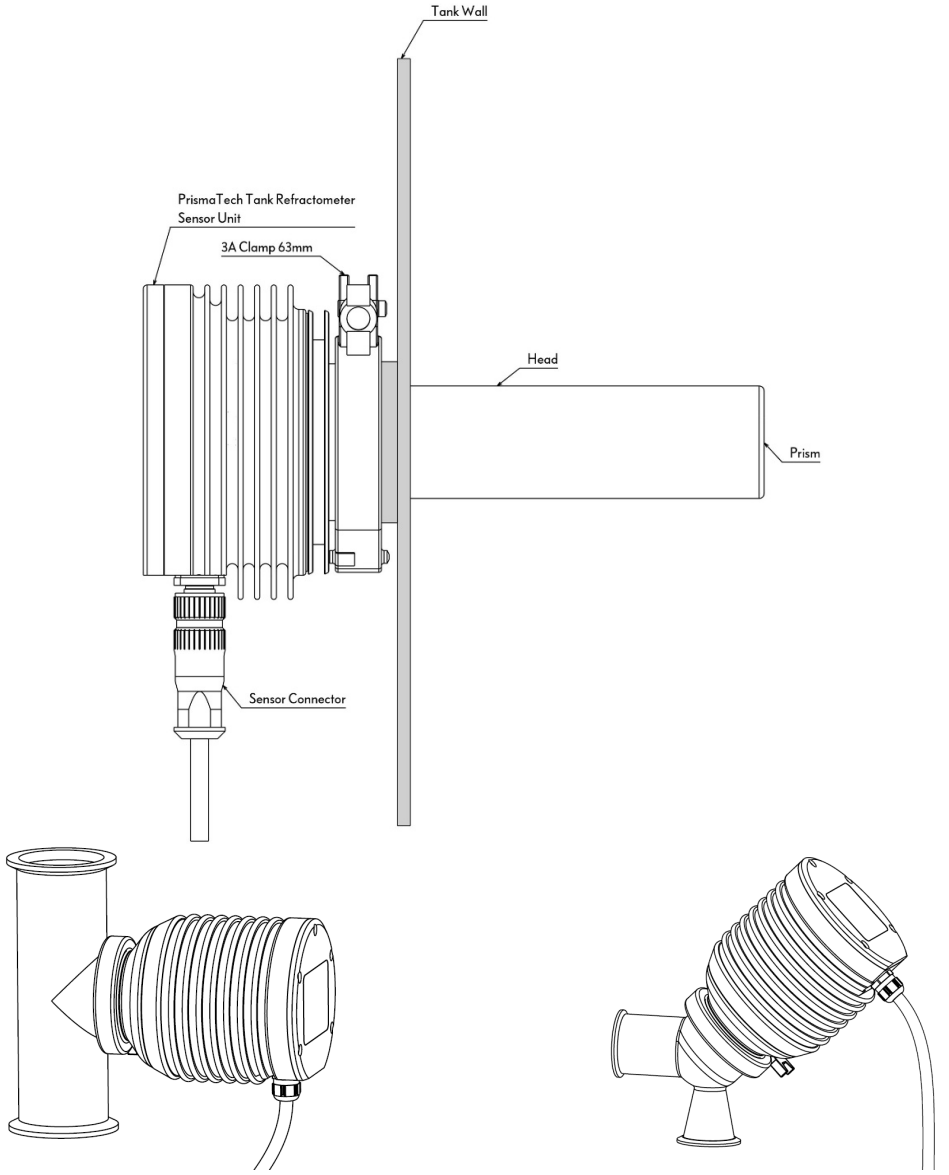


Figure 2-4 Downward pointed Interconnection Cable

2.3.2 Different Possible pipe installation Setup

Depending on the fluid type, its viscosity and flow rate the appropriate connection should be selected to reduce the coating risk on the refractometer prism. These connections are designed in such a way that the flow rate is increased at the front of the prism and this reduces the likelihood of coating formation on the surface of the prism. It should be noted that in some processes due to the nature of the solution adhesion and its low flow rate these connections is not appropriate. It is recommended to use an automatic prism wash Unit in those cases. **Figure 2-5** shows possible pipe installation setups.

a) Vertical Setup b) Horizontal Setup c) Elbow Setup d) Reducer Setup e) PrismWash Setup

Figure 2-5 Different possible pipe installation setup

2.3.3 Tank installation

***Prisma*Tech®** Sanitary Tank Refractometer PTR-100_T has been designed fo for installations in large pipes, tanks, cookers, crystallizers and kettles, and for higher temperatures up to 115°C. Installation through 3A sanitary clamp 63mm as **Figure 2-6** Tank installation setup below.

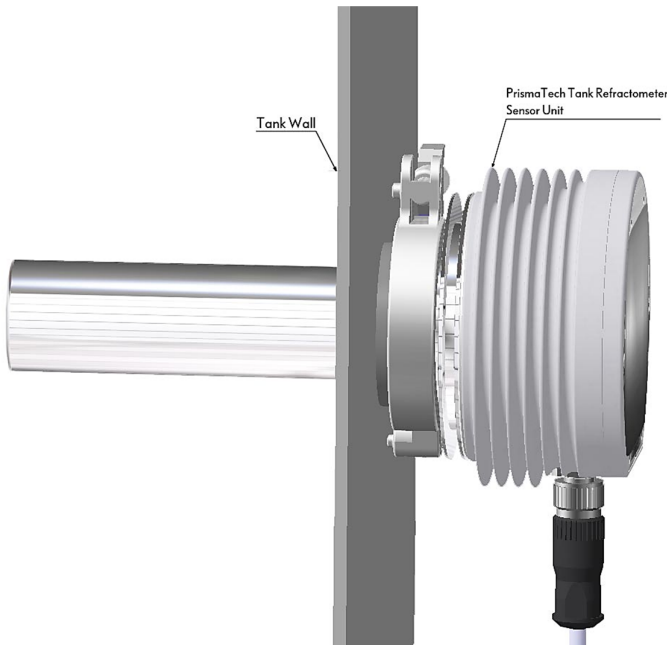


Figure 2-6 Tank installation setup

2.4 Check list for pipe mounting

The **PrismaTech®** inline refractometer models are often mounted in a pipe. **PrismaTech®** recommends a minimum flow velocity of 1.5 m/s (5 ft/s). The diameter and form of the pipe and the process temperature all affect the measurement and need to be taken into account.

1. If the process pipe diameter varies, select the *position with the smallest diameter* (and accordingly highest velocity). Then the prism keeps better clean.
2. If the refractometer is used in a feed-back control loop, *make the time lag short*. E.g. when a dilution valve is controlled, mount the refractometer close to the dilution point. However, make sure complete mixing has occurred at mounting location.
3. If the temperature varies along the process pipe, select the *position with the highest process temperature*. Then the risk of prism coating is minimized, because higher temperature means higher solubility and also lower viscosity.
4. Often the *position with the highest process pressure* (= after pump + before valve) has favorable flow conditions without sedimentation or air trapping risks.
5. The sensor should be conveniently accessible for service.
6. The liquid in pipe or tank which the sensor unit is installed in, should not freeze due to icy winters or low ambient temperature. Freezing will cause harmful effects on the prism and sealing system.

2.4.1 Check list for mounting in a tank, a vessel or a large pipe

A probe sensor can be inserted with clamp into tanks and vessels which either don't have a scraper or where the mixer doesn't touch the vessel wall. A probe sensor can also be flush mounted in a cooker where the scraper touches the wall.

1. The inserted probe sensor is mounted close to a stirrer to ensure representative sample of the process liquid and to keep the prism clean.
2. The sensor should be conveniently accessible for service.

3 Control/Display Unit

3.1 The Control/Display unit description

The Control/Display unit is a specialized computer designed to process data received from a sensor. The Control/Display unit enclosure (**Figure 3-1**) contains a 4.3inch wide touch screen display. The front panel terminal-cap (see **Figure 3-4** Opening the Front panel of the Control/Display unit) can be opened to give access for connections and service.

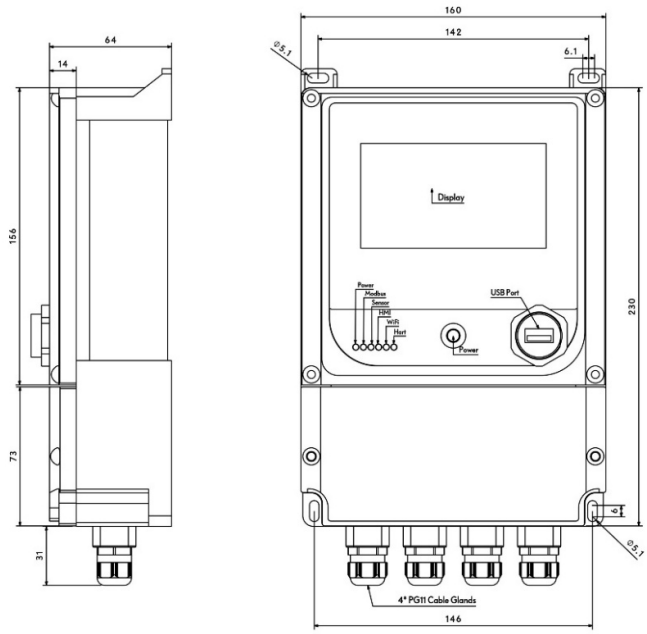


Figure 3-1 Control/Display Enclosure

The sensors send the values of the refractive index nD and the process temperature T to the Control/Display unit. The microprocessor system then linearizes the concentration reading (example in **Figure 3-2**), and performs an automatic temperature compensation.

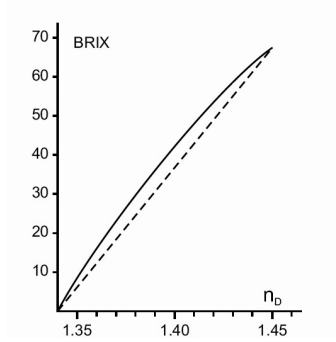


Figure 3-2 A linearized Curve

3.2 Mounting Control/ Display unit

The Control/Display unit should preferably be located in an easily accessible, well lit and dry area. The enclosure must not be exposed to rain or direct sunlight. Avoid vibration. Take interconnecting cable length into consideration when choosing the mounting location.

The enclosure is mounted vertically on an upright surface (wall) using four mounting bolts, see **Figure 3-3** Mounting Control/Display unit.

The display is best viewed when approximately on the eye level of the user.

Important: Do not drill mounting holes in the enclosure as that will affect the protection class of the enclosure and damage the electronics.

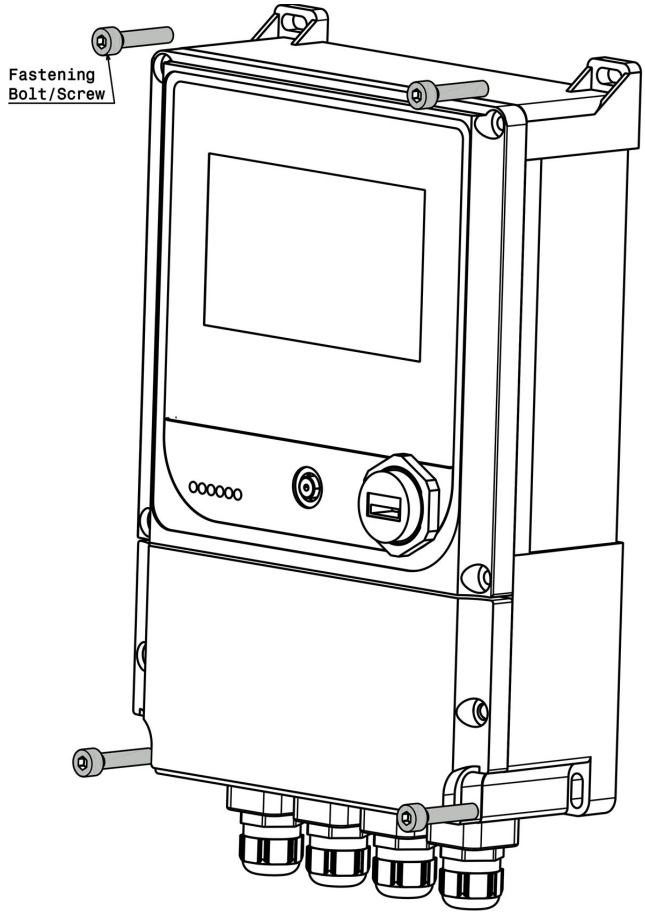


Figure 3-3 Mounting Control/Display unit

Note: The display has an operating temperature range of -20 ~ 75°C and a storage temperature range of -5 ~ 65°C.

3.3 Electrical connections

3.3.1 Communication cable

The cable contains four twisted (A/blue, B/red, +/brown, -/white) wires and a cable shield (black). Standard delivery is 10 meters (33 feet) of cable. The maximum length of an interconnecting cable is 800 m (2640 ft).
The RS485 serial signal wires (A/blue, B/red) transmit the data between the Sensor unit and Control/Display unit. The cable shield is connected to the protective earth at the Control/Display unit.

3.3.2 Connecting the Control/Display unit

All the electrical terminals of the Control/Display unit are behind the Terminal-cap. To access them, loosen the Terminal-cap two screws (**Figure 3-4**) and open the Terminal-cap. All terminals are now accessible.

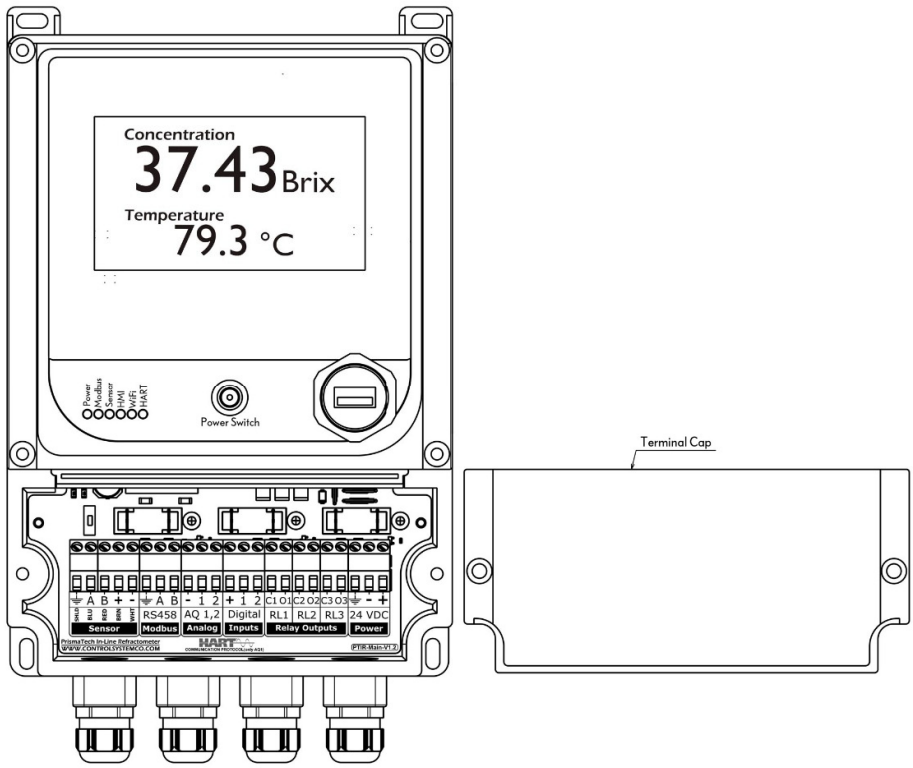


Figure 3-4 Opening the Front panel of the Control/Display unit

3.3.3 Control/Display unit Terminals

The Control/Display unit PCB and its terminals have been shown in **Figure 3-5**. Note that each terminal has been indicated by a foot print label below it.

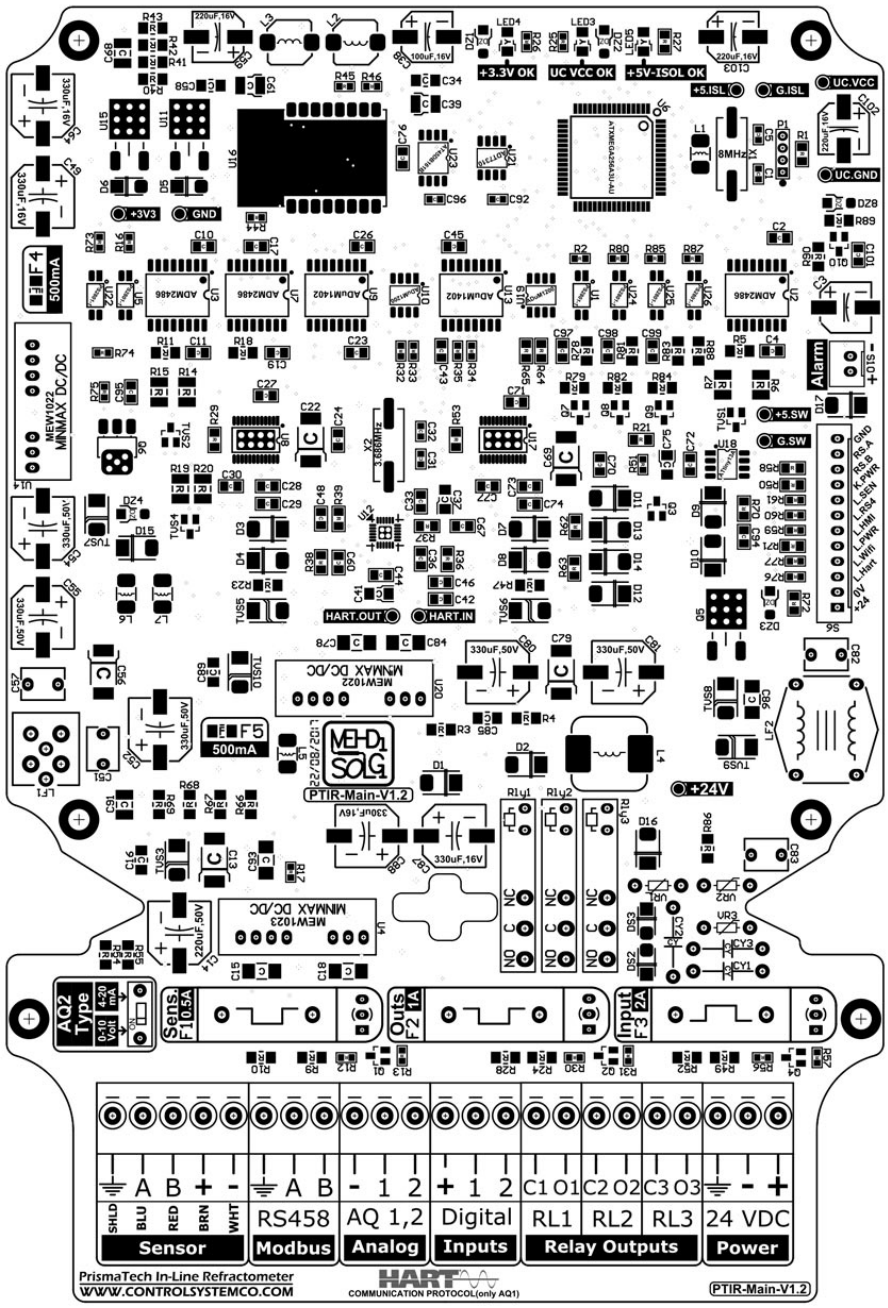


Figure 3-5 Control/Display unit Terminals

Description of the terminals on the Control/Display unit main board (**Figure 3-5**) has been shown in table below:

Input Power	⏚	**Power protective Earth**
	-	Power Supply 0V-DC
	+	Power Supply 24V-DC
Relay Outputs RL1, RL2, RL3	C	Relay Common port
	O	Relay Normally Open contact
Digital Inputs DI1, DI2	+	Digital input 24V-DC
	1	The first digital input
	2	The second digital input
Analog Outputs mA1, mA2	-	Analog outputs negative signal
	1	Analog output 1 positive signal
	2	Analog output 2 positive signal
RS485	⏚	RS485 protective Earth
	A	RS485 Data Communication port A
	B	RS485 Data Communication port B
Sensor	⏚ (SHLD)	Sensor protective Earth
	A (BLU)	Sensor RS485 Data Communication port A
	B (RED)	Sensor RS485 Data Communication port B
	+ (BRN)	Sensor power 12V
	- (WHT)	Sensor power 0V

- ☑ The power supply must provide at least 1.5A current and 24VDC.
- ☑ The maximum allowable current for relay outputs is 5A.
- ☑ The analog outputs provide 0/4~20mA current proportional to the process concentration, temperature or PID controller output (Max load 1000Ω)
  - ➢ The analog output 2 can also provide a 0~10V voltage proportional to the concentration, temperature or PID controller output by switching the dip switch indicated by AQ2 Type located above the sensor terminals. (Max load: 20mA).
- ☑ The minimum current for digital inputs is 15mA and its voltage must be 24VDC.
- ☑ It is highly recommended to connect protective Earthing on all Input Power, Analog Outputs, Sensors and RS485 terminals to ensure protection.

4 Prism wash systems

4.1 Prism coating

Deposit build-up on the prism surface disturbs the measurement. Look out for *an abnormally high concentration reading* or *an upward concentration (CONC) drift*.

In most applications the prism will keep clean due to the self-cleaning effect. If coating occurs, check the following:

- Sufficient flow velocity, see **Section 2.3** and **Section 2.3.22.4.**
- A temperature difference between process fluid and sensor probe may cause coating. This may happen with small flows if the thermal insulation is inadequate. In some cases it helps to also insulate the clamp connector.

In case of a coating problem, the preferred solution is to try to increase the flow velocity, e.g. by installing a pipe portion with smaller diameter.

Installing a wash nozzle can be considered, if increasing the velocity or using a flow booster does not provide a solution (**Figure 2-5** Different possible pipe installation setup).

4.2 Prism wash

Two alternative media can be used for prism wash: *steam* and *high pressure water*. The built-in relays and digital outputs of the Control/Display unit can be configured to control the prism wash cycle, see **Section 6.4**

4.2.1 Prism wash systems

The prism wash system for high pressure water is described by **Figure 4-1** and **Figure 4-2**.

Warning! In high pressure wash systems, pressure increase can occur in a closed pipe section when the high pressure pump is operated. **PrismaTech®** recommends to mount a pressure relief valve in the pipe section. Relief pressure should be according to pipe pressure rating.

☑ See for **Section 6.4** Setting prism wash parameters

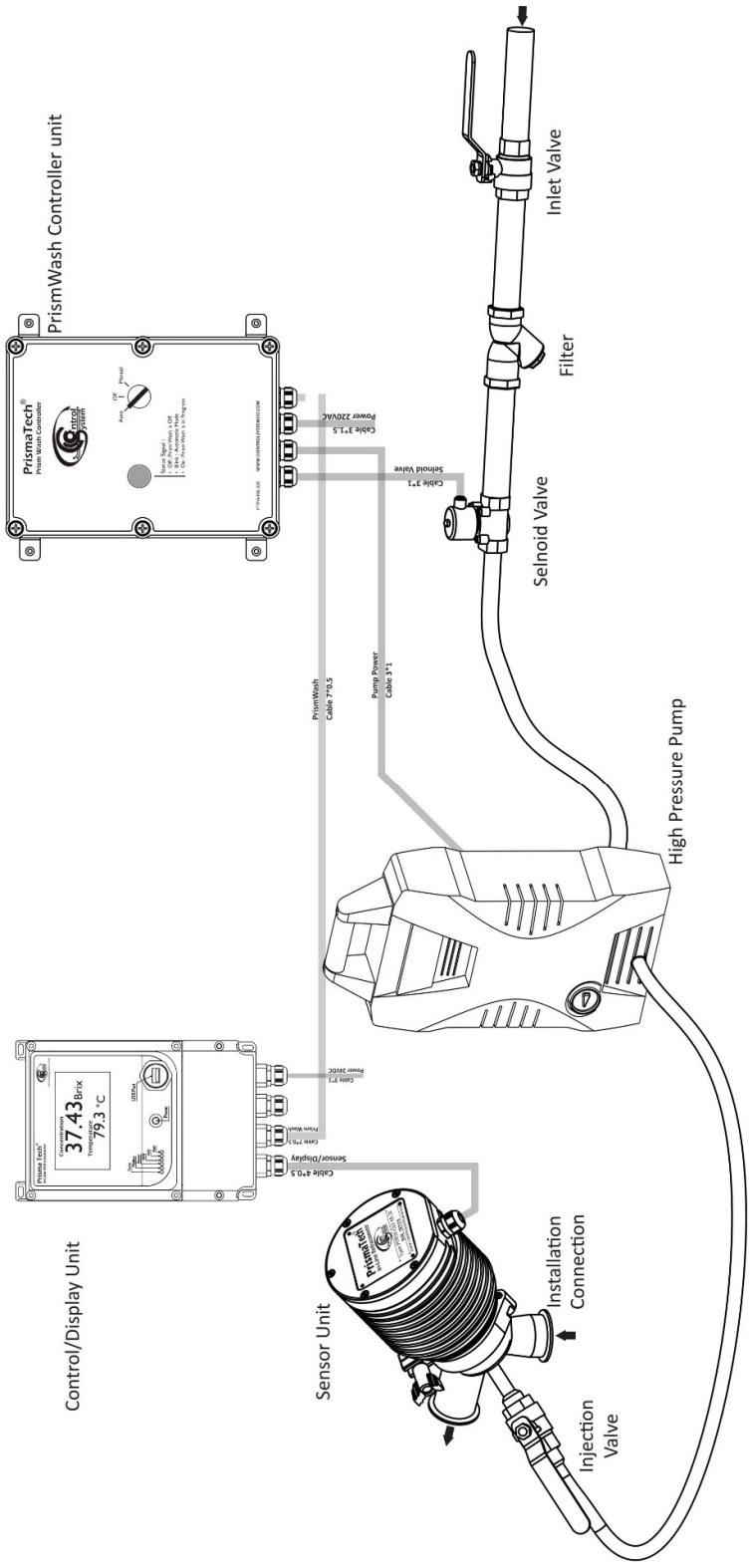


Figure 4-1 PrismWash System for high pressure water

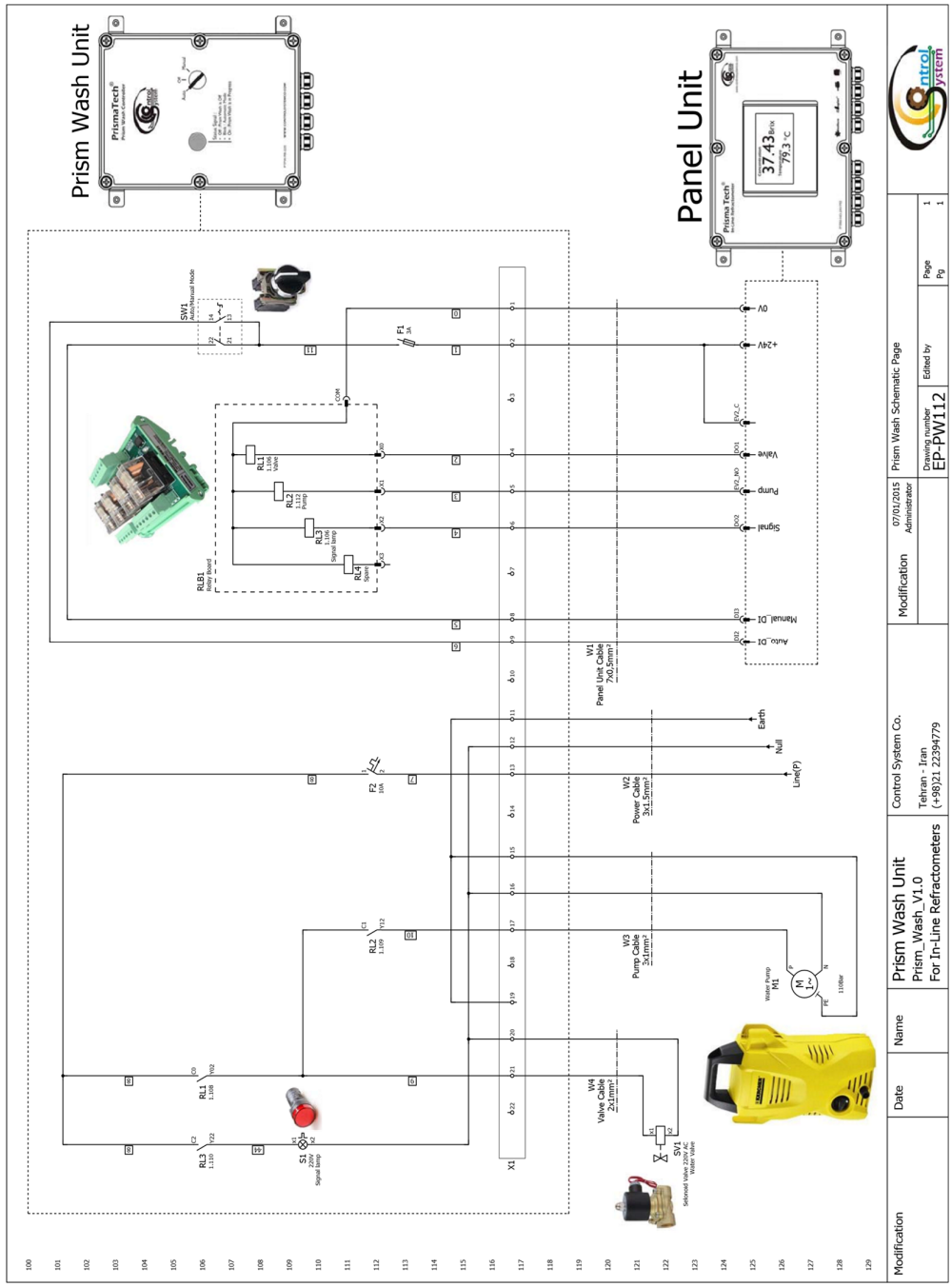


Figure 4-2 PrismWash System circuit

5 Startup and use

5.1 Startup

5.1.1 Initial check

1. Check the wiring, **Section 3.3.3 Control/Display unit Terminals**, "Electrical connections".
2. Connect the power, press the power switch. The Power LED light (**Figure 3-1**) and the screen should light up within a few seconds.
3. The Main display should come up on the display after ControlSystemco logo and checking the hardware in hardware check page**, Figure 5-1**

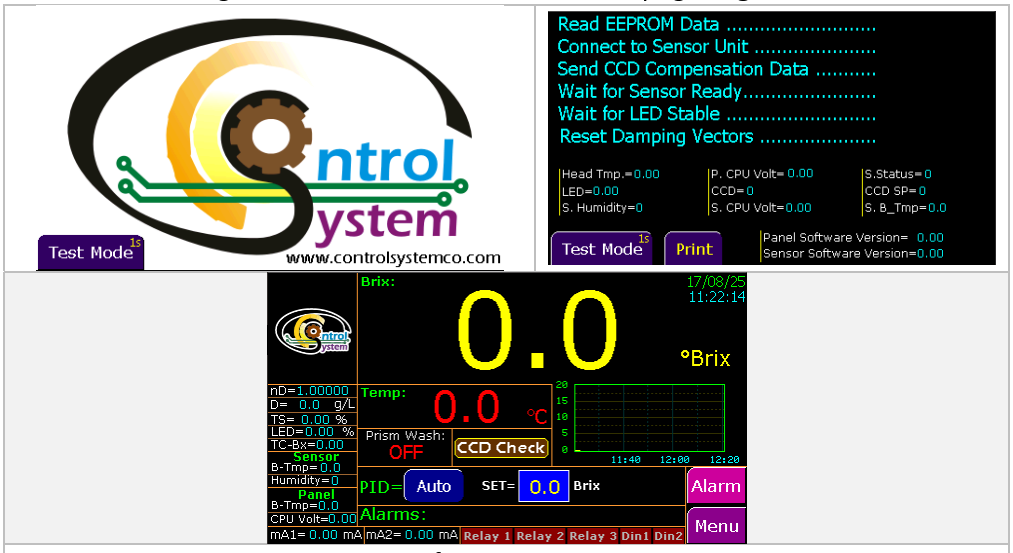


Figure 5-1 Refractometer Startup pages

Brix	The Concentration in Brix Unit	**Temp**	The Process Temperature
PID	Mode of the PID Controller *Automatic/Manual*	**Set**	The set point for PID automatically concentration controller
nD	Refractive Index	***Sensor-*** **B_Tmp**	The temperature of the main board
D	The process density	***Sensor-*** **Humidity**	The humidity inside the sensor enclosure
TS	The process total solid	***Panel-*** **B_Tmp**	The temperature of the main board
LED	LED Illumination percent	***Panel-*** **CPU Volt**	The temperature of the main processor
TC Brix	Temperature compensated Brix	**Alarms**	Activated Alarms
mA1	The first Analogue output current	**mA2**	The second Analogue output current

4. In case the display shows an alarm indicating "sensor communication error", there is no corresponding sensor (for example in Figure 5.1, upper left, there's no sensor)
5. The TEMP value should show the current process temperature.
6. The state of each one of input/outputs is shown in the bottom of the Home page with their names: mA1, mA2, Relay1, Relay2, Relay3, Din1, Din2.
7. The value and the correct setup of the two mA output signals can be checked by following below menu address:

Menu>>4- Output & input Setting>>4-1 Current Outputs

8. If digital outputs are used, their settings can also be checked in following menu address:

Menu>>4- Output & input Setting>>4-2 Digital Outputs

9. If relay outputs are used, their settings can also be checked in following menu address:

Menu>>4- Output & input Setting>>4-3 Relay Outputs

10. If digital inputs are used, their settings can also be checked in following menu address:

Menu>>4- Output & input Setting>>4-4 Digital Inputs

5.2 Power switch function

There is a power switch and power LED on the Control/Display Unit's front panel as shown in **Figure 3-1**. The ***PrismaTech®*** inline refractometer provides two power options in the case of power outages which can be changed by the user. When the device is turned off the power LED illustrates the state of power function as below:

- Blinking power led with equal On/Off times implies the **Off** state. In this state if the power supply goes out and again it backs on the Refractometer will not turn on automatically.
- Blinking power led with unequal On/Off times implies the **Standby** state. In this state if the power supply goes out and again it backs on the Refractometer will turn on automatically.

❖ To change trough the behavior of the power functions, first switch the main power supplier off then hold the power switch and switch the main power supplier on again. This changes the power state from Off to Standby or visa versa.

5.2.1 Calibration check

Wait until normal process conditions occur. The concentration reading is precalibrated at delivery and If there is not any alarm or warning massage on the display, but the concentration reading does not agree with the laboratory results, then consult, “Calibrating the concentration measurement” section **6.3 Calibration** .

6 Using the Control/Display unit

The control/display unit receives the refractive index value nD and the process temperature from the sensor(s). Starting from these values, it calculates the concentration of the process media for display and further transmission. The control/display unit can also be programmed to give alarm for high or low concentration. If the refractometer has a prism wash system, the control/display unit can control the wash with its built-in timer. For information on how to use the Indicating transmitter

All changes of configuration and calibration are made through the menus selected from the Control/Display unit.

Password: It may be necessary to enter a password before proceeding to some basic Calibration and setting menus. The password is printed on the first page of this manual.

The password function can be changed by the end user using the following menu:

Menu>> 1-Display Setting>> 1-1- HMI Setting>> 1-1-3- Password List

6.1 Data Logger

The data logger is accessible in the home page below the Brix. If you touch the chart the following page will be opened as **Figure 6-1**.

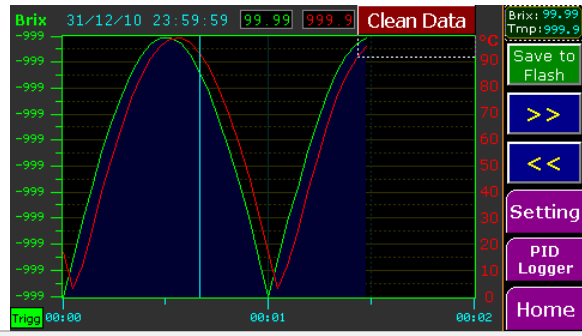


Figure 6-1 Data Logger chart

Save to Flash	Connect a USB flash to the USB port and transfer the logged data to the flash	**Setting**	Data logger setting
PID Logger	PID Controller output logged data	**Temp Logger**	Temperature Logged data
Clean Data	Clean the logged data	**Home**	Back to Home page

6.2 Configuring the refractometer system

Go to the following address to set the parameters of the display:

Menu>>1- Display Setting

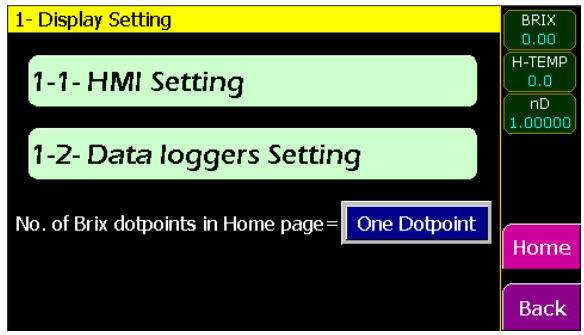


Figure 6-2 Display Setting page			
1-1- HMI Setting	Basic setting of the HMI	**1-2 Data Logger Setting**	Setting related to the data logger
No. of Brix dotpoints in the main page		The decimal points of the Concentration shown on the main page can be changed here	

6.2.1 Data Loggers Setting

Data loggers sampling time and the charts axis properties can be adjusted with the available parameters at the following address:

Menu>>1- Display Setting>> 1-2 Data Logger Setting

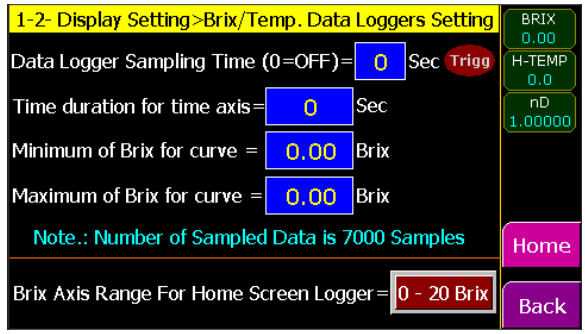


Figure 6-3 Data Logger Setting			
Data Logger Sampling Time	Specify how often the data logger logs the data.	**Time Duration for time axis**	Specify the time duration of one screen in the logger chart along horizontal axis.
Minimum/Maximum of Brix for curve		The range of Brix for the vertical axis of the data logger chart.	
Brix Axis Range for Home Screen Logger		The range of Brix for the vertical axis of the small chart on the Home page.	

6.2.2 Output & Input Setting

The Control/Display unit has **two** built-in **0/4~20 mA outputs** (mA1, mA2), **Three relay contact outputs** (EV1, EV2) and **Two digital inputs** (DI1, DI2).
The setting of input and outputs can be accessed in the address below:

Menu>>2- Output & Input Setting

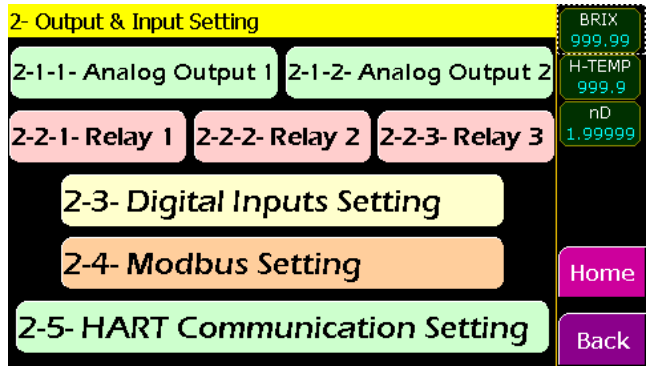


Figure 6-4 Output & Input Setting Menu

6.2.3 Configuring Analog Outputs

For the electrical properties of the two output signals, see **Section 3.3.3Control/Display unit Terminals**.

For the configuration follow the address below:

Menu>>2- Output & Input Setting>> Analog Output

where the output can be configured.

The parameters on this menu have been described in the **Figure 6-5** below:

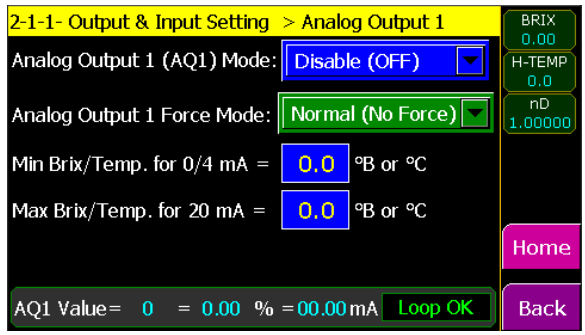


Figure 6-5 Analog Outputs Configuration page

Analog Output1/2 Mode	OFF	Always transmits 0 mA
	Brix 0-20mA	0-20mA proportional to Concentration
	PID 0-20mA	0-20mA proportional to PID output
	Temp 0-20mA	0-20mA proportional to Temperature
	Brix 4-20mA	4-20mA proportional to Concentration
	PID 4-20mA	4-20mA proportional to PID output
	Temp 4-20mA	4-20mA proportional to Temperature
Analog Output 1/2 Force Mode	Normal(No Force)	Automatically converts the measurements to proportional analog current.
	Force 0mA ~ 20mA	Forces the analog outputs to 0, 4, 8,..., 20mA for testing purposes
Min Brix/temp for 0/4 mA	Minimum limit of concentration/Temperature proportional to 0/4 mA	
Max Brix/Temp for 20 mA	Maximum limit of concentration proportional to 20 mA	

Note: If you want to 'turn off' the mA output, set the ***current output mode,*** **OFF** in this menu.

- The state of the analog output have been indicated at the bottom of the screen.
  - If the analog output wires intrupts the green colored **Loop OK** indicator turns to red colored **Open Loop**

6.2.4 Configuring Relay outputs

For the electrical properties of the built-in Relay outputs, see **Section 3.3.3Control/Display unit Terminals**.

To configure the Relay outputs, follow the address below:

Menu>>2- Outputs, Inputs>>2-2-1- Relay1/2-2-2- Relay2/2-2-3- Relay3

The parameters on this menu have been described in the **Figure 6-6** below

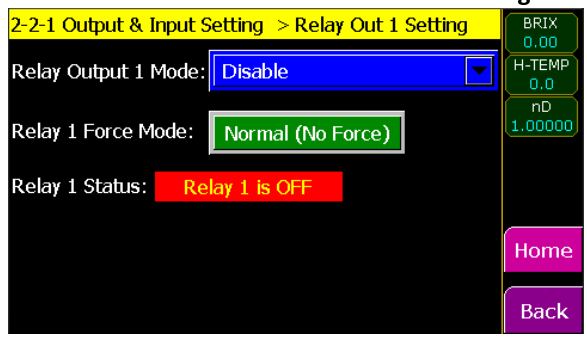


Figure 6-6 Relay Outputs Configuration page

Relay Output 1/2/3 Mode	**Disable**	Always Off
	High Brix Alarm	When the Concentration exceeds the ***High Brix Limit*** specified in "*Alarm Setting"* menu turns on and when it falls below the ***High Brix Limit*** minus its ***Hysteresis*** turns Off.
	Low Brix Alarm	When the Concentration falls from the ***Low Brix Limit*** specified in "*Alarm Setting*" menu turns on and when it exceeds the ***Low Brix Limit*** plus its ***Hysteresis*** turns Off.
	Brix Out of Range Alarm	When the Concentration goes outside of the range specified as ***Brix is out of range*** in the "*Alarm Setting*" menu turns on otherwise turns off.
	System OK	ON in system normal operation
	High Temperature Alarm	When the process temperature exceeds the ***High Product temperature*** specified in "*Alarm Setting"* menu turns on and when it falls below the ***High Product temperature*** minus its ***Hysteresis*** turns Off.
	Low Temperature Alarm	When the process temperature falls from the ***Low Product temperature*** specified in "*Alarm Setting*" menu turns on and when it exceeds the ***Low Product temperature*** plus its ***Hysteresis*** turns Off.
	Temp Out of Range Alarm	When the process temperature goes outside of the range specified as ***Product temperature out of range*** in the "*Alarm Setting*" menu it turns on otherwise it turns off.
	Alarm Horn	The relay turns on if every alarm with active horn occurs. (see "*Alarm Setting"* menu)
	Prism Wash Pump/Valve	Turns the Prismwash Pump/Valve on
	AQ1/2 Open loop	The relay turns of if the current output1/2 intrupts.
Relay Force Mode	**Normal**: Automatically controlled according to ***Relay Output mode*** **Force to ON/OFF**: Manually forces the relay ON/OFF.	
Relay Status	Shows if the relay is on or off.	

- The Relay outputs can be forced on or off manually, mainly to test them
- The **Hysteresis** value indicates how soon the digital output opens after the process has temporarily gone over or under the limit. For example if the high limit is 50 and the hysteresis is 2 the relay will not reopen until the process drops below 48.

6.2.5 Configuring Digital inputs

The Built-in digital inputs provides a very useful ability for the ***PrismaTech®*** Inline refractometer which makes it capable of control different kind of processes which cannot be controlled without using these digital inputs accurately.

The configuration of digital inputs can be accessed on the following address as shown in **Figure 6-7**.

Menu>>2- Outputs, Inputs>>2-3- Digital Inputs Setting

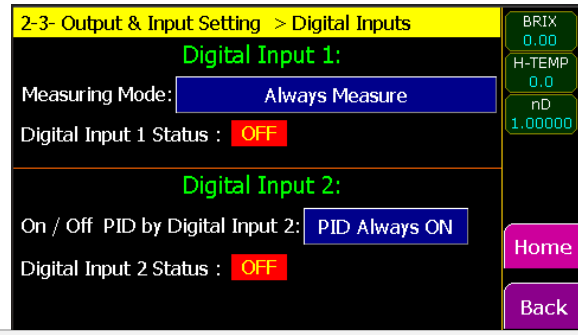


Figure 6-7 Digital Inputs Setting

Digital Input 1 Measuring Mode	Always Measure	The device measures the concentration continuously
	Measure when Digital input 1 is ON	The device measures the concentration only when the digital input 1 is ON
Digital Input 2 Measuring Mode	PID Always ON	The device controls the process with the PID controller continuously
	PID ON by Din_2	The device controls the process with the PID controller only when the Digital Input2 is ON
Digital Input1/2 Status	Indicates if the digital input1/2 is ON or OFF	

- For the electrical properties of the built-in digital inputs, see **Section 3.3.3Control/Display unit Terminals**

6.2.6 The HART Communication and Modbus Setting

The setting of HART communication setting and Modbus can be accessed in the address below:

Menu>>2- Outputs, Inputs>>2-5- Hart Communication Setting Menu>>2- Outputs, Inputs>>2-4- Modbus Setting

- For the electrical properties of the Modbus and HART outputs, see **Section 3.3.3Control/Display unit Terminals**

6.3 Calibration

To access the calibration menu follow the address below:

Menu>> 3- Calibration

In this menu the display will show the calibration options as **Figure 6-8** below:

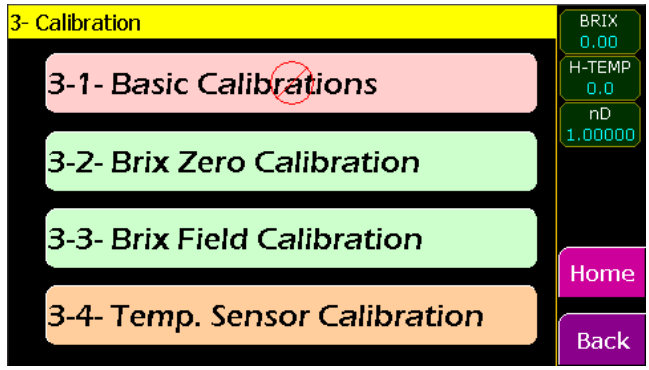


Figure 6-8 Calibration menu

Basic Calibration	Basic calibration (done in the factory)
Brix Zero Calibration	Calibration option to specify the 0%Brix using distilled water
Brix Field Calibration	Calibration of concentration using 5 points and adjusting damping and average time.
Temp. Sensor Calibration	Calibration of process temperature sensor using gain, offset and damping cycles.

- *Basic Calibration* is done in factory and the end user does not have access to this menu
- Menus *Brix Zero Calibration, Brix Field Calibration, Temp. Sensor Calibration* are protected with a security password (by default 7777777)

6.3.1 Brix Zero Calibration

PrismaTech® inline refractometer provides a zero brix calibration using distilled water.
In order to access the *Zero Calibration* page follow the below address:

Menu>> 3- Calibration>> 3-2 Brix Zero Calibration

In this menu the display will show the Zero Calibration options as **Figure 6-9** below:

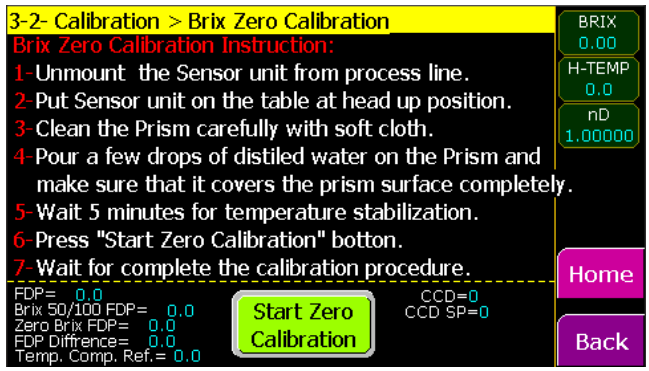


Figure 6-9 Brix Zero Calibration

The instruction below illustrates the Zero Calibration procedure step by step:

1. Unmount the sensor unit from process line.
2. Put the sensor unit on the table at head up position.
3. Clean the prism carefully with soft cloth.
4. Pour a few drops of distilled water on the prism and make sure that it covers the prism surface completely.
5. Wait 5 minutes for temperature stabilization.
6. Press "Start Zero Calibration" button.
7. Wait for complete the calibration procedure.

6.3.2 Field Calibrating the concentration measurement

PrismaTech® provides a *Concentration field calibration service* that adapts the calibration to the factory laboratory determinations based on the data supplied. The field calibration procedure should be made under normal process conditions using standard laboratory determinations of sample concentration.
For a complete calibration, 5 valid data points (see below) are needed. A data point is of use for calibration only when the sensor in operating normally. If prism wash is employed, do not take samples during the wash.

Accurate calibration is only achieved if the sample is taken correctly. Pay special attention to following details:

- The sampling valve and the refractometer should be installed close to each other in the process

! **Warning!** Wear protective clothing appropriate to your process when operating the sampling valve and handling the sample.

- Use a tight container for the sample to avoid evaporation.

Important: Offline calibration using process liquid very seldom gives reliable results, as problems are caused by:

- Low flow which makes sample to form an unrepresentative film on the prism.
- Sample evaporation at high temperature or undissolved solids at low temperature giving deviations from laboratory determinations.
- An ageing sample which is not representative.
- Outside light reaching the prism.

Thus *calibration using the process liquid is always better to be made inline*

- The concentration field calibration must be done inline using accurate brix calibration solution which is done in the factory Calibration & setting unit before marketing.

To access the concentration field calibration menu follow the address below:

Menu>> 3- Calibration>> 3-3- Brix Field Calibration

In this menu the display shows the Brix Field Calibration options as **Figure 6-10** below:

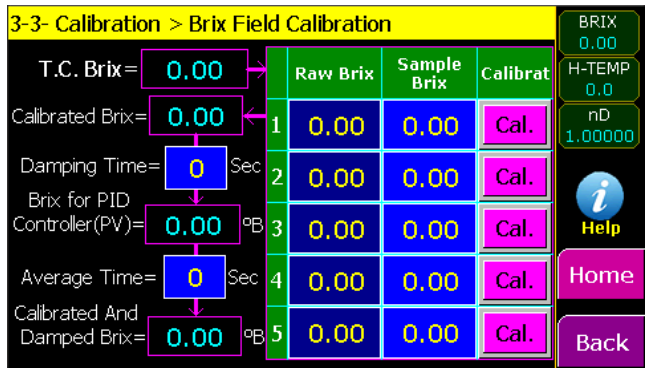


Figure 6-10 Brix Field Calibration

Raw Brix	Measured Concentration before the calibration and damping	**Sample Brix**	Reference concentration measured by a reference measurement method
Cal. Button	Push this button to automatically insert the current concentration in raw brix field instead of manually insert it.		
T.C. Brix	Temperature compensated Brix	**Calibrated Brix**	Concentration after calibration
Damping Time	Time for damp the Concentration	**Brix for PID Controller**	Damped brix used as feedback in built-in PID Controller
Average Time	Average time to reduce the fluctuations after damping	**Calibrated Damped Brix**	Finally damped, calibrated and averaged concentrated which is displayed on the main page

- It is not necessary to complete all of the five calibration points in the *Brix Field Calibration* page. The field calibration can be done in less than all 5 points using the required rows starting from the first row in the calibration table.
- The field calibration of the refractometer must be done over all of its measurement range, it means if the process concentration exceeds the maximum sample (Reference) brix entered in the table the refractometer will turn inaccurate results.

6.3.3 Temperature Sensor Calibration

To calibrate the temperature sensor of **PrismaTech®** inline refractometer install a recently calibrated reference temperature sensor along with the **PrismaTech®** inline refractometer both in a same circulating closed water loop then turn on the refractometer go to the temperature calibration page bellow:

Menu>> 3- Calibration>> 3-4- Temp. Sensor Calibration

Figure 6-11 shows the temperature sensor calibration page.

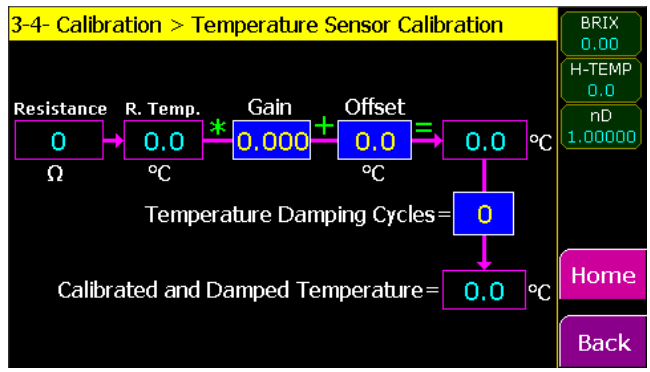


Figure 6-11 Temperature sensor Calibration

Resistance	Resistance of RTD	**R.Temp**	Raw temperature before calibration
Gain	Calibration gain	**Offset**	Calibration offset
Temperature Damping Cycles	Time for damp the Temperature	**Calibrated and Damped Temperature**	The temperature after calibration and damping

6.4 Setting prism wash parameters

To set the prism wash go to the following page from the Main menu:

Menu>> 8-Prism Wash Setting

The **Figure 6-12** below shows this page and the parameters.

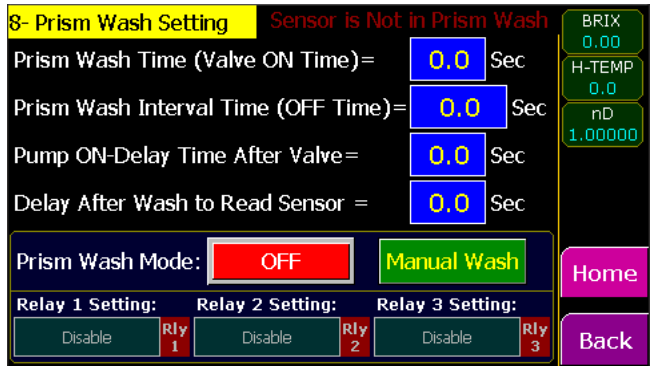


Figure 6-12 Prism Wash Setting page

PrismWash Mode	*OFF*	Disable the prism wash
	Auto	Automatic prism wash mode
Prism Wash Time	The time of spraying the fluid jet (the time in which the valve is ON).	
Prism Wash Interval Time	Interval between injections (the time in which the valve is OFF).	
Pump ON-delay after valve	The time which after that the pump will be ON after opening the solenoid valve.	
Delay after wash to read sensor	The delay time which after that the Control/Display unit starts reading data from the sensor.	

- ✓ ***The timing of the wash cycle*** is controlled by the *Prism Wash Time*, *Prism Wash Interval Time, Prism Wash ON-delay after valve* and *Delay after wash to read sensor*.
- ✓ ***To stop the measurement during the prism wash***, set *Delay after wash to read sensor* which means after this delay time the Control/Display unit starts reading the data from the sensor unit.

7 Regular Maintenance

The need for regular maintenance is minimal, due to the construction with no moving parts, no mechanical adjustments and with a solid-state light source. The following rules apply:

- Keep the sensor head and the Indicating transmitter clean and dry.
- Check that the ambient temperature is not above +65°C (149°F).The sensor head should not be too hot to keep a hand on.
- If your refractometer has prism wash, check that it works correctly.

7.1 Checking the sensor humidity level

The ***PrismaTech®*** inline refractometer sensor unit has an internal humidity detector. The humidity reading can be checked on the Control/Display unit display main page in the left side sensor parameters.

Increasing humidity level indicates either condensate forming in the sensor head (if the process temperature is below ambient) or prism leakage. If the humidity reading exceeds 30%, contacts to the local ***PrismaTech®*** support and service department.

- Relative humidity exceeding 30% will produce a diagnostic alarm message HIGH SENSOR HUMIDITY.

7.2 Checking the prism and prism gaskets

Once a year check that the prism surface is smooth and clean. If the prism is scratched or the gaskets seem to leak, contact to the local ***PrismaTech®*** Support and Service department.

8 Troubleshooting

8.1 Hardware

To troubleshoot **PrismaTech®** refractometer hardware problems, it is often important to localize the different LEDs inside the Control/Display unit main board. The Diagnostic LEDs on the cards help solve the problems and give an indication on whether a connection is good.

8.1.1 Diagnostic LEDs

There are several diagnostic LEDs on the Control/Display unit main board. These LEDs can be categorized in three different groups:

1- ***Fuse LEDs:*** beside to each fuse (which is marked with F letter on the main board foot print) are a red and a green LED that indicate the status of the protective fuses. If the LED is green the fuse is working otherwise if it is red the fuse is broken and must be changed according to the footprint beside the broken fuse. (see **Figure 8-2**)

2- ***Voltage check LEDs:*** On the middle top of the Control/Display unit main board there are three indicating LEDs marked as ***+3.3V OK,+5V ISOL OK, UC VCC OK.*** In the normal operation of the main board these LEDs must be ON otherwise there is a problem on the different voltage of the board. (see **Figure 8-2**)

3- ***Front Panel LEDs:*** There are six LEDs on the Display/Control unit bellow the Touch Screen display, Power, Modbus, Sensor, HMI, WiFi and Hart which indicate the normal status of the device operation. (see **Figure 8-1**)

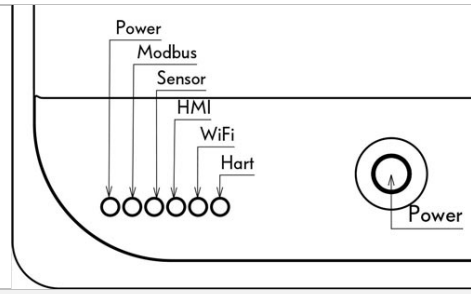


Figure 8-1 Front Panel LEDs

LED	Normal Status	LED	Normal Status
Power	Always bright when the device in ON state.	Modbus	blinking when the Modbus terminal is in use
	blinking with equal On/Off time in Sensor OFF state.		
	blinking with unequal On/Off time in Sensor Standby state.		
Sensor	blinking when the sensor is connected.	HMI	blinking when Display is Connected
WiFi	blinking when the Wifi is in use	Hart	blinking when Hart is in use

- Blinking power led with equal On/Off times implies the **Off** state. In this state if the power supply goes out and again it backs on the Refractometer will not turn on automatically.
- Blinking power led with unequal On/Off times implies the **Standby** state. In this state if the power supply goes out and again it backs on the Refractometer will turn on automatically.
    - To change the behavior of the power in the case of power outages, first switch the main power supplier off then hold the power switch and switch the main power supplier on again. This changes the power state from Off to Standby or visa versa.

Figure 8-2 assists to localize the diagnostic LEDs.

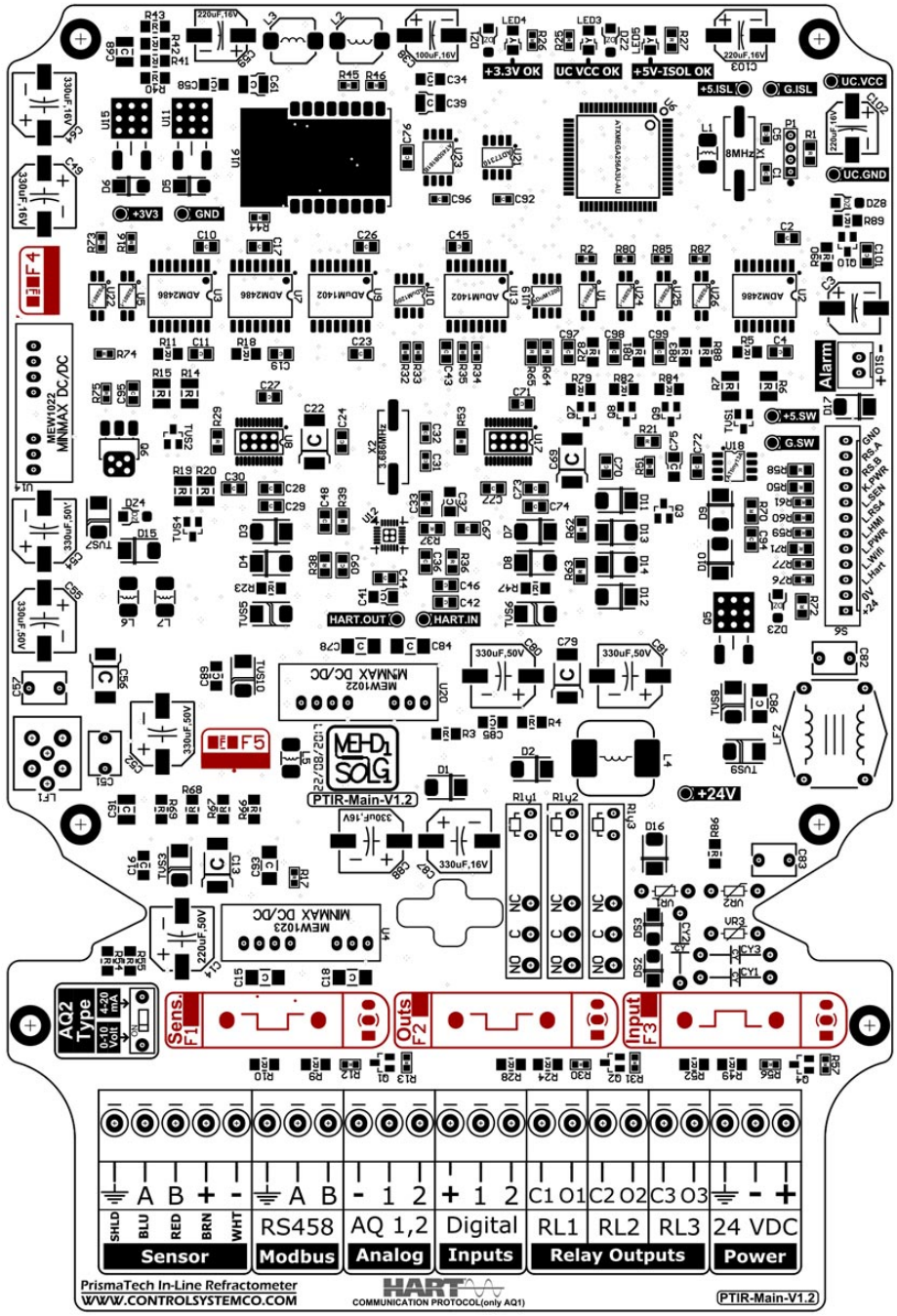


Figure 8-2 Diagnostic LEDs

- In the case that each one of the ***Fuse green LEDs*** turned OFF and the red one turned ON when the refractometer is ON then replace the corresponding fuse with a new one according to the table below easily.

Fuse Number	Current	Usage
F1	500mA	Sensor power protection(12V)
F2	1 A	Outputs protection (24V)
F3	2 A	Input power protection (24V)
F4	500mA	Internal circuit problem
F5	500mA	Internal circuit problem

- If each one of the ***Voltage Check LEDs*** turned off there may be a significant problem in the main board internal voltages. In this case turn the main power off and contact with the local **PrismaTech®** Support& Service.
- In the condition that each one of the ***Front Panel LEDs*** stopped blinking turn the main power off and contact with the local **PrismaTech®** Support& Service.

8.2 Alarms

8.2.1 Alarm Setting

PrismaTech® Inline Refractometer generates different Alarms in bad conditions. These alarm may be useful for immediate diagnostics.

Alarms can be configured using the list of alarms available in the "Alarms setting page" in address below:

Menu>> 7-Alarm Setting>> 7-3- Alarms Setting

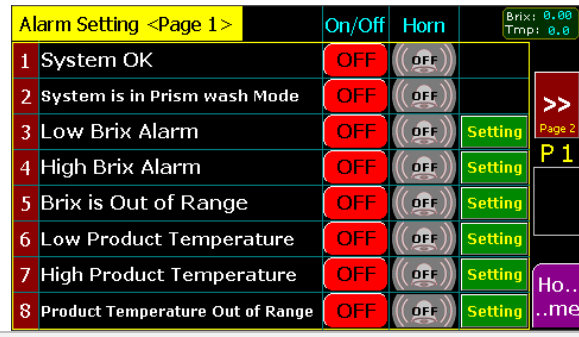


Figure 8-3 Alarms Setting Page

System OK/ System prism Wash/ Low Brix/ High Brix …	Name of Alarms	**On/Off**	Turning the alarm On/Off
Horn	Activate the horn and allocate one of the relay outputs to "Alarm Horn" to blare horn in the case of each one of the alarm whom their horn is On	**Setting**	Use the setting to set the parameters such as alarm limits and hysteresis,

Activated Alarms: Follow the address below to see the current activated alarms:

Menu>> 7-Alarm Setting>> 7-1- Active Alarms

- Active Alarms list also can be accessed on the Main page>> Alarm as a shortcut.

Alarm History: *PrismaTech®* Inline Refractometer also provides a thorough Alarm history in which the occurred alarms over a long period of time is shown there. The Alarm History page can be accessed here:

Menu>> 7-Alarm Setting>> 7-2- Alarm History

Here some of the important alarms generated by **PrismaTech®** Inline Refractometer have been described:

8.2.1.1 Alarm Sensor Communication Failure

Cause: Normally this means that there's no sensor connected to the Control/Display unit or that the communication cable has been disrupted. If this message comes up while a sensor properly is connected, the most likely cause of this message is a fault in the sensor. It is also possible that the cable is totally dead for example if it is accidentally cut through. See also Diagnostic LED ***Sensor***.

8.2.1.2 Alarm Sensor High Board Humidity

Tells that humidity measured at the Sensor processor card exceeds 30% relative humidity. The reason may be moisture leaking in through prism seal or the cover being open. In this case the prism gasket must be replaced by our service technicians so contact to the local **PrismaTech®** Support& Service.

8.2.1.3 Alarm Sensor High Board Temperature

The temperature on the Sensor processor card exceeds 65°C (167°F). To read this temperature, take a look at the left side parameters on the main screen page of the Control/Display unit display. For action consult our local Support& Service

8.2.1.4 Alarm Panel High Board Temperature

The temperature of the main board of the Control/Display unit exceeds 75°C (167°F). To read this temperature, take a look at the left side parameters on the main screen page of the Control/Display unit display. If the warning persists, the unit should be moved to a cooler place (for example out of sun).

8.2.1.5 Alarm Sensor High Product Temperature

The temperature on the head of the sensor unit exceeds 115°C (239°F). This temperature in hazardous for the processor card inside the sensor. When the process temperature is above 115°C (239°F) and the ambient temperature is above 35°C (95°F). The air cooling is improved by blowing pressurized air against the sensor cover. The pressurized air can be supplied by the ventilation system. If no air is available it is also possible to wind a copper coil for cooling water around the sensor head cover

- Before any action you first turn off the equipment.
- You can order a High-Temp sensor unit model PTR-50/100C for the process lines which their temperature is above 115°C (239°F).

8.2.1.6 Alarm Sensor Voltage (3.3V) Error

There is a problem with the 3.3V internal voltage of the Control/Display unit main board. In this case the corresponding indicator LED will be off (See **Figure 8-2**). For action turn off the main power of the equipment and contact local Support & Service center of **PrismaTech®**.

8.2.1.7 Alarm Sensor Voltage (12V) Error

There is a problem with the 12V internal voltage of the Control/Display unit main board. In this case the corresponding indicator LED will be off (See **Figure 8-2**). For action turn off the main power of the equipment and contact local Support & Service center of **PrismaTech®**.

8.2.1.8 Alarm Head Temp. Sensor Open Circuit

Indicates faulty temperature element. This may occur if the PT1000 temperature sensor is broken or disrupted and the sensor must be replaced by a new one. In this case contact the local **PrismaTech®** Support& Service Center
Note: The prism gasket must be replaced, too.

8.2.1.9 Alarm Prism Coated

The most likely cause for this message is scaling on the prism. There still is an optical image available, but the measurement quality may not be optimal.
Action: Open the sensor unit cautiously from the process pipes and clean the prism using a soft and clean cloth.

8.2.1.10 Alarm Empty Pipe Detected

The operation of the equipment is OK but there is no process liquid on the prism.

8.3 Diagnosis Pages

PrismaTech® Inline Refractometer provides some diagnostics information which can help in the case of errors.
The diagnostics page is available in the following address:

Menu>> 4-Diagnostics

8.3.1 Display Unit Diagnostics page

Some basic parameters of the Control/Display unit board can be observed in the *Display Unit Diagnostic* page. Follow the address below to access the page:

Menu>> 4-Diagnostics >> 4-1- Display Unit Diagnostics

The **Figure 8-4** below shows this page.

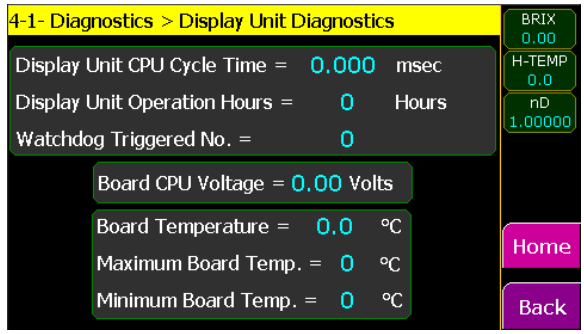


Figure 8-4 Display/Control unit Diagnostics page

		Allowed Max	Allowed Min
Display unit CPU Cycle time	The cycle time of the micro controller software	-	-
Display Unit Operation hours	The Operation hours from the last turning ON till now.	-	-
Watchdog Triggered No	The number of the CPU freezes from the last turning ON. till now	0	0
Board CPU Voltage	The Voltage of the CPU	3.5V	3.0V
Board Temperature	The current temperature of the main board	75°C	-20°C
Maximum Board Temp.	The maximum temperature of the CPU from the last turning ON.	75°C	...
Minimum Board CPU Temp.	The minimum temperature of the CPU from the last turning ON.	...	-20°C

- If each one of the Control/Display unit parameters shown in **Figure 8-4** exceeds their range check the troubleshooting guides in **Section 8.1** and **Section 8.2.** If the problem remained then you can contact to the local Support& Service center of **PrismaTech®**.

8.3.2 Sensor Diagnostics

Some basic parameters of the Sensor unit can be observed in the *Sensor Diagnostics* page. Follow the address below to access the page:

Menu>> 4-Diagnostics >> 4-1- Sensor Unit Diagnostics

The **Figure 8-5** below shows this page.

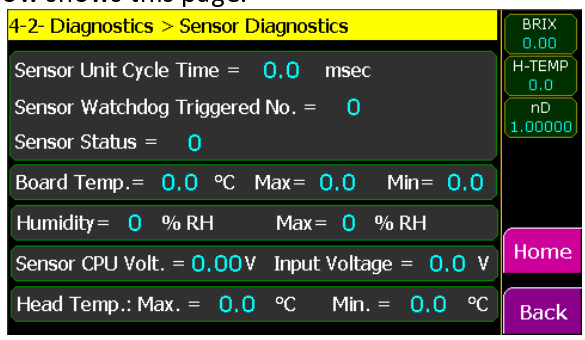


Figure 8-5 Sensor Diagnostics page

		Allowed Max	Allowed Min
Sensor Unit Cycle Time	The cycle time of the micro controller software	-	-
Sensor Watchdog Triggered No.	The number of the freezes of the CPU from the last turning ON. till now	-	-
Sensor Status	The current working status of the sensor unit	Normal Operation: C1	
Sensor Board Temperature	The current temperature of the CPU	65°C	1°C
Sen. Max. Board Temp.	The maximum temperature of the CPU from the last turning ON.	65°C	...
Sen. Min. Board Temp.	The minimum temperature of the CPU from the last turning ON.	...	0°C
Humidity	The current humidity of the sensor board	30%	0
Sensor Board Humidity max	The maximum humidity of the sensor board from the last turning ON. till now	30%	...
Sensor CPU Volt.	The current voltage of the CPU	3.5V	3.0 V
Input Voltage	The voltage of the 5V sensor power supplier	13V	11V
Sensor Max Head Temp	The maximum temperature of the Sensor head from the last turning ON.	115°C	...
Sensor Min Head Temp	The minimum temperature of the Sensor head from the last turning ON.	...	1°C

- In normal operating state the *Sensor Status* should be C1 otherwise contact local Support & Service center of **PrismaTech®** for diagnostics.

8.3.3 CCD Image

The optical image detected by the CCD detector can be seen in the CCD Image diagnostics page with the following address:

Menu>> 4-Diagnostics >> 4-2- Sensor Diagnostics

The **Figure 8-6** Sensor Diagnostics page shows the optical image in its normal operation.

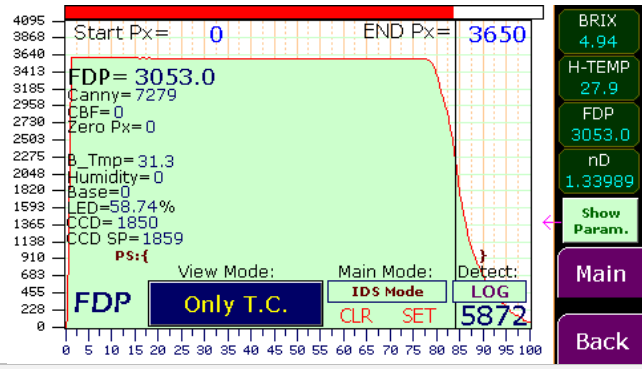


Figure 8-6 Sensor Diagnostics page

- If each one of the Sensor unit parameters shown in **Figure 8-5** exceeds their allowable range check the troubleshooting guides in **Section 8.1** and **Section 8.2.** If the problem remains then you can contact to the local Support& Service center of **PrismaTech®**.
- Some of the parameters shown in **Figure 8-4** and **Figure 8-5** causes alarm on the main screen if they exceeds their range.