Calisto™ T1

User Guide

TP-CT1-UG Rev A

02/2024

Contents

Preface

The Calisto™ T1 encapsulates the functionality of a bushing monitor, partial discharge monitor and Input/Output modules in a single configurable package in a cost-effective manner. It provides a clear user interface through a built-in server and manages user access, alerts setting, alert management and data visualization — bringing together data from Doble and third-party devices. Standard communication protocols include Modbus and DNP3 with optional IEC 61850, that allows data to be moved between Calisto™ T1 and other applications such as SCADA

This guide is intended for anyone who works with the Calisto™ T1. It is assumed that the reader is familiar with professional standards and safety practices.

This document uses two special typefaces to indicate particular kinds of information:

- **Bold**—Used for software controls and user-entered text, such as buttons, check boxes, or other items that are clicked or selected. Example:

  Click **Close**.

  Also, any text you must type in is shown in this typeface:

  Example: Type in **1500 ms.**

- `Monospace`—Used for text displayed in the user interface, such as an error message or prompt. Example:

  `Uploading test results.`

Notes, Cautions, and Warnings

This document uses icons to draw your attention to information of special importance, as follows.

Note: Notes provide supplemental information that may apply to only some circumstances.

Caution: Cautions provide information that prevents damage to hardware or data.

Warning: Warnings provide information about anything that can affect operator health.

Support

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1. Overview

The Calisto™ T1 can be scaled from a single monitor to a comprehensive transformer monitor covering partial discharge (PD), bushings, operational data that connects to Dissolved Gas Analysis (DGA) and third-party monitors.

- PD Guard - Doble PD-Guard™ monitors partial discharge (PD) via the transformer bushings, neutral and inside the main tank; it provides local alarms and will communicate data and notifications across standard interface channels and to networked supervisory systems. Doble PD-Guard analyzes PD and EMI signals in the HF, VHF and lower UHF ranges with built-in diagnostic tools.
- IDD - Doble IDD™ bushing monitor detects deterioration in bushings, finding abnormalities in the insulation and issuing actionable alerts. It provides leakage current, phase, capacitance, power factor, and harmonics analysis for up to six bushings individually. If a voltage reference is available, the Doble IDD will perform both Relative and True Power Factor to detect issues in bushings and voltage reference devices.
- iO - Doble iO™ is a data recorder that accepts current, voltage, temperature, and relay inputs and integrates and displays data from multiple sensors and sources, including load or operational data, tap position indicators and inputs from other vendor devices.

The Calisto™ T1 can be applied to:

- Transformers (where BTA, HFCT, and drain valve probes are the primary sensors)
- Rotating machines (e.g. generators)
- Cables
- GIS

The Calisto™ T1 may be installed in several schemes:

- Standalone (no host PC required; channel control, expert system, local visual alerts, and alarm relays are included)
- Networked to any doblePRIME condition monitoring module
- Networked to a third-party supervisor (e.g. SCADA system with Modbus, DNP3, TCP, or IEC61850 protocols)

2. Hardware Reference

This section describes the components of the Calisto™ T1.

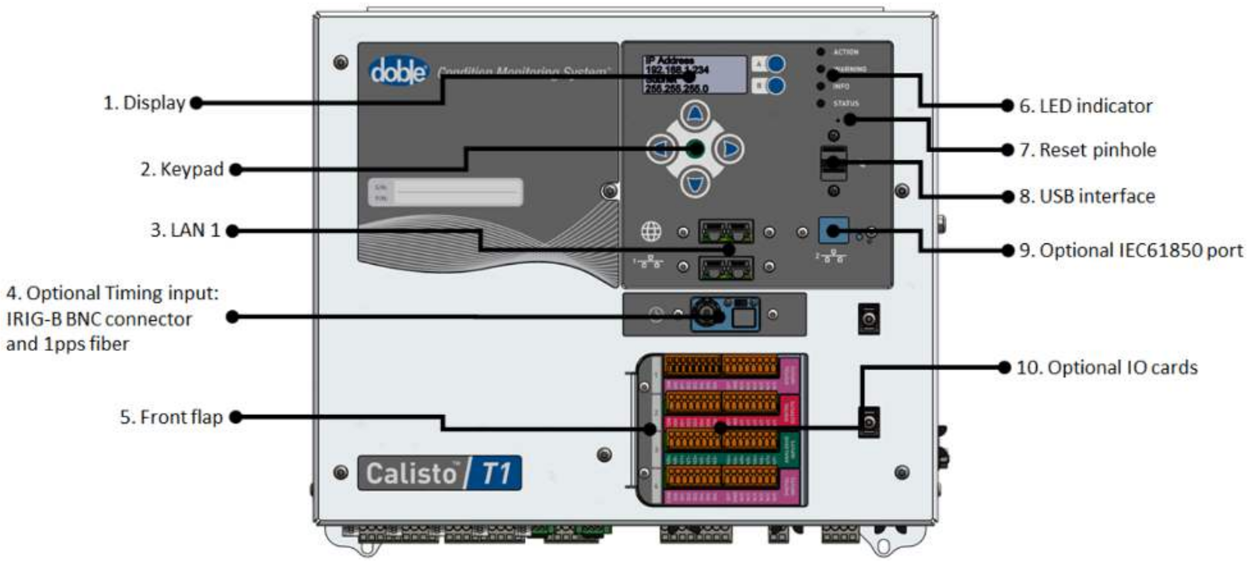


Figure 1 - Calisto™ T1 Components: Front

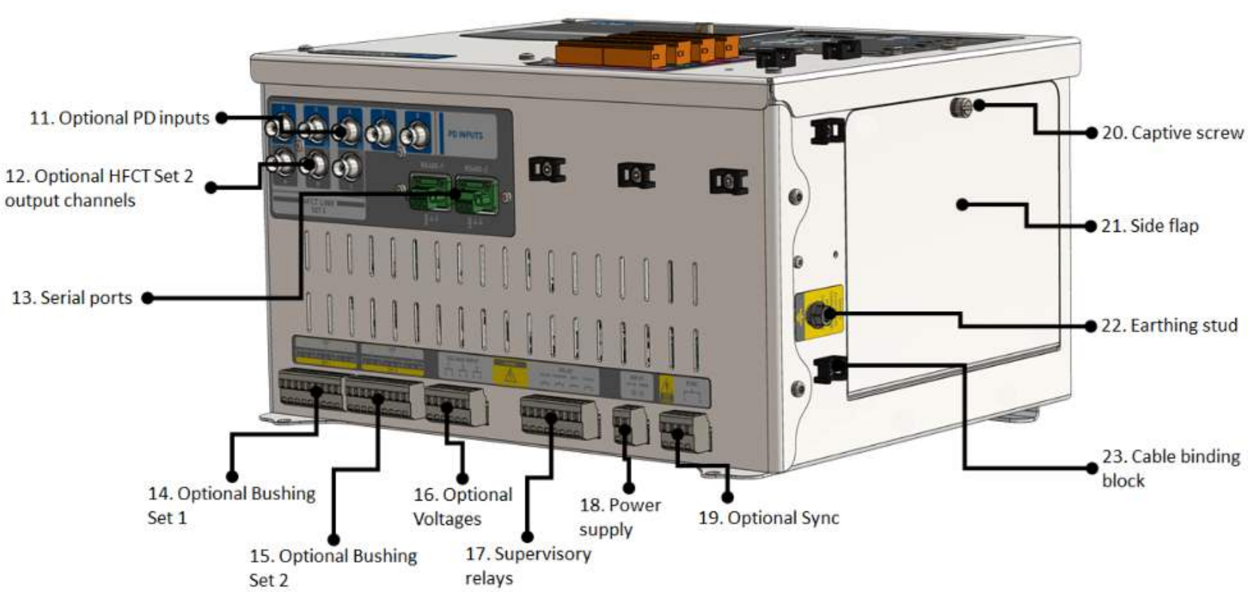


Figure 2 - Calisto™ T1 Components: Side

Reference of Components

Callout	Component	Description
1	Display	Shows system details and latest measurements
2	Keypad	LCD navigation control
3	LAN 1	Quad Ethernet switch ports
4	Optional Timing input	Optional card to sync time to a GPS source. IRIG-B BNC connector and 1pps Fiber Optics
5	Front flap	Remove flap to install or replace iO cards
6	LED indicator	Indicate highest current system alert
7	Reset pinhole	Reset IP to default address
8	USB interface	Allow firmware to be updated via flash drive
9	Optional IEC61850 port	Optional port to allow an IEC61850 client to pull data from the monitor
10	Optional iO card	Support the Doble iO 8AI, 8DI, 5TI and 8DO cards. The cards are optional, and up to four cards can be fitted in the slots.
11	Optional PD inputs	The input of PD sensors. These five inputs are available when Doble PD-Guard monitor fitted in the unit. Optional board
12	Optional HFCT Set 2	HFCT-2 PD output from Bushing Set 2. These three outputs are available when Doble PD-Guard monitor is fitted in the unit. Optional board
13	Serial ports	Allow communication to DGAs in the field and SCADA systems
14	Optional Bushing Set 1 (SET 1)	The inputs of embedded HFCT-1 to decouple PD signal from leakage current. These inputs are available when Doble IDD monitor is fitted in the unit. Optional board

Reference of Components (continued)

Callout	Component	Description
15	Optional Bushing Set 2 (SET 2)	The inputs of embedded HFCT-2 to decouple PD signal from leakage current. These inputs are available when Doble IDD monitor is fitted in the unit. Optional board
16	Optional Voltages	Input from Instrument Transformers (PT/CCVT) x 3. These inputs are available when Doble IDD monitor is fitted in the unit. Optional board
17	Supervisory relays	Dry contact relays to output system alert
18	Power supply	24V DC power input
19	Optional Sync	Voltage input - from a sync transformer - to be used as a reference to PD analysis. This input is available when Doble PD-Guard monitor fitted in the unit. Optional board
20	Captive screw	Unscrew to remove the side flap
21	Side flap	Remove side flap to access main processor board for maintenance purpose
22	Earthing stud	Protective earthing connection
23.	Cable binding blocks	Keep your cables together and attached to the profile

3. Getting Started

This chapter describes the basics of how to wire the power, safety ground, and sensor, connect to a network and interpret alarm indications.

Power Supply and Grounding

The Calisto™ T1 requires a nominal power supply of 24V DC at 2A. The input voltage range can be between 9V and 36V DC. Doble recommends the Doble universal power adapter (PN 401-0597), allowing the installation of the Calisto™ T1 to any AC or DC mains supply globally.

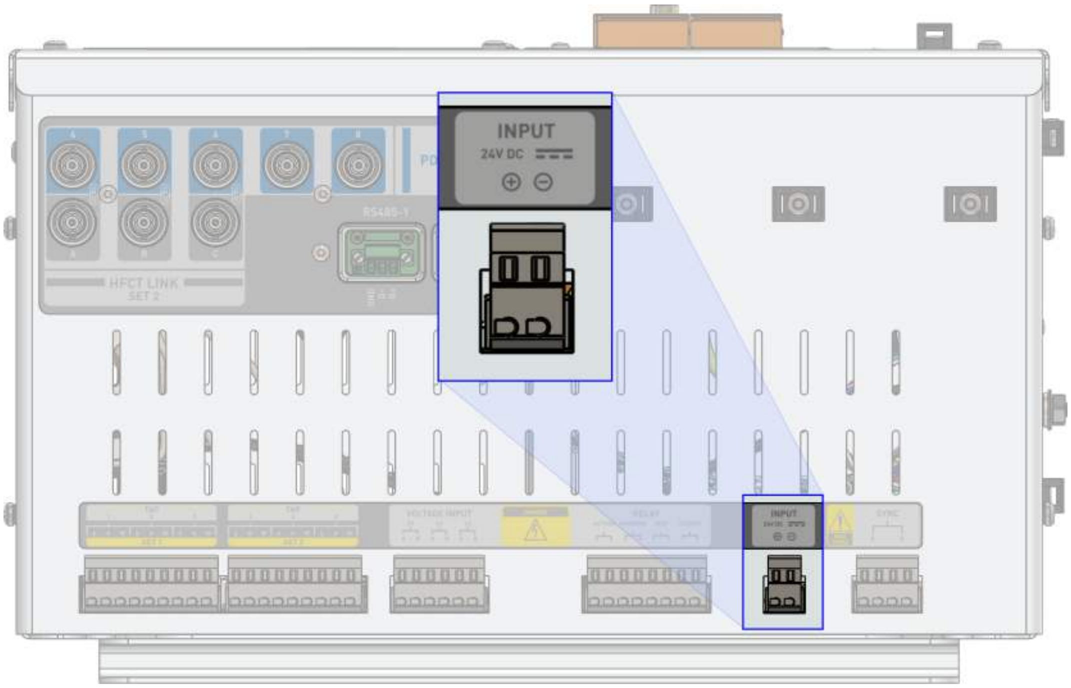


Figure 3 - Power Supply Input

Warning: Attach the earth cable to the earth stud using the nut provided. Connect the earth wire to the grounding bar in the enclosure.

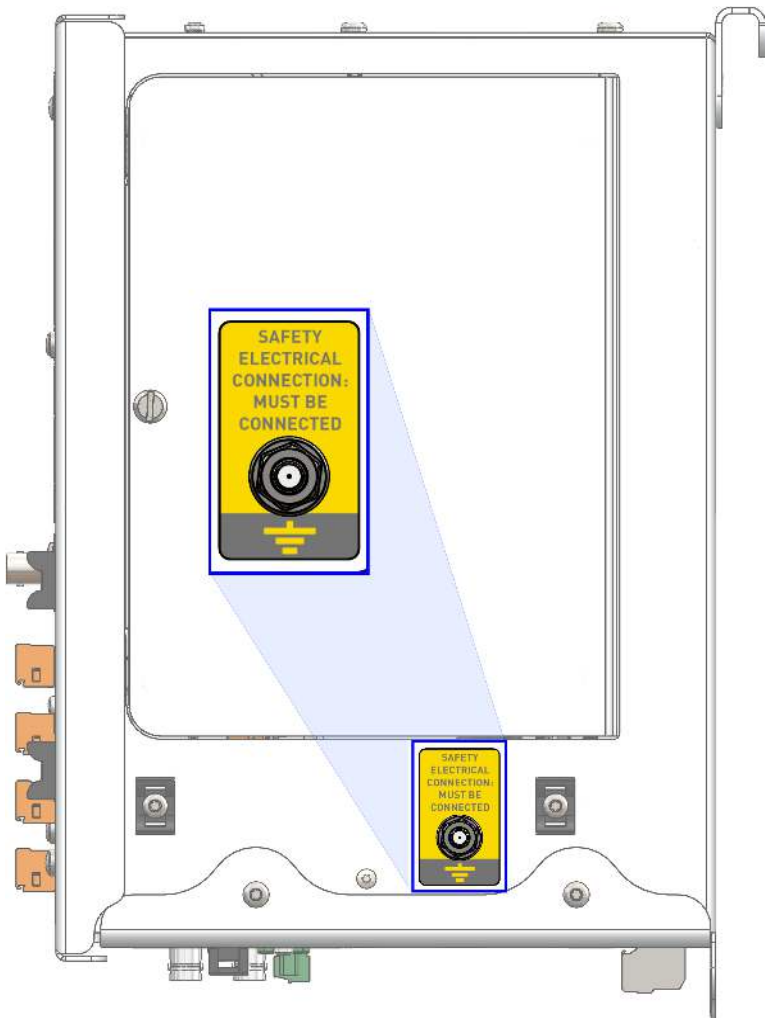


Figure 4 - Earth Stud

Sensor Connection

Depending on the application, sensors can be connected to the bushing sets, instrument transformer voltage, sync transformer, Partial Discharge, and iO cards inputs. The characteristics of each of these connections are described in the following sections.

Sensor Connection to the Bushing Sets

SET 1 and SET 2 inputs accepts signals from bushing tap adapters (BTA) to monitor leakage current. Each SET can monitor up to three bushings. An internal High Frequency Current Transformer (HFCT) mini card is connected internally to each SET to allow PD signals to be decoupled from the leakage current.

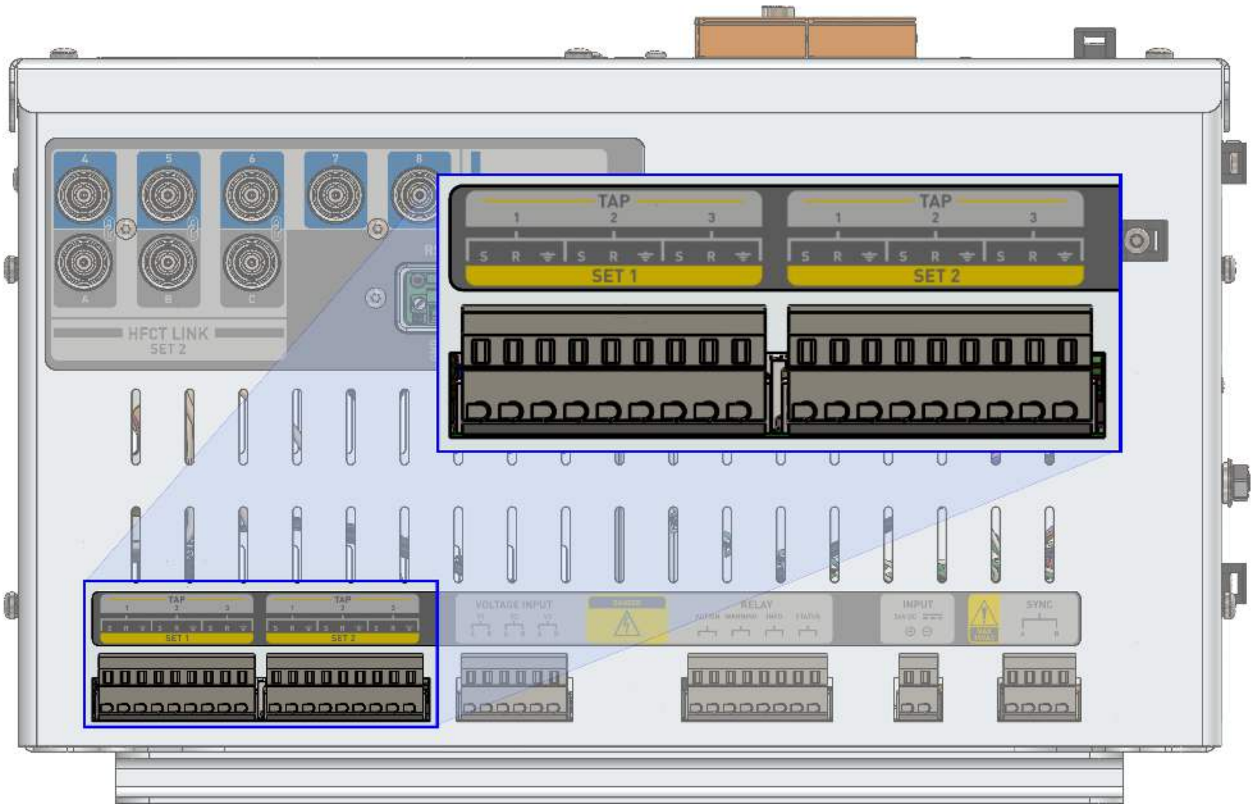


Figure 5 - Bushing SET 1 and SET 2 Inputs

Warning: Connection from BTAs must run through Shorting Blocks - found inside the enclosure - prior connection to SET 1 and SET 2. Never disconnect any of the wiring from the BTA to the shorting block when the transformer is energized. Doing so could result in high voltages which may result in an electric shock or causality and damage the insulation of the bushing being monitored. For more details about shorting block operation, please consult section Wiring the Bushing Sensor cables to the Shorting Blocks section in Chapter 10.

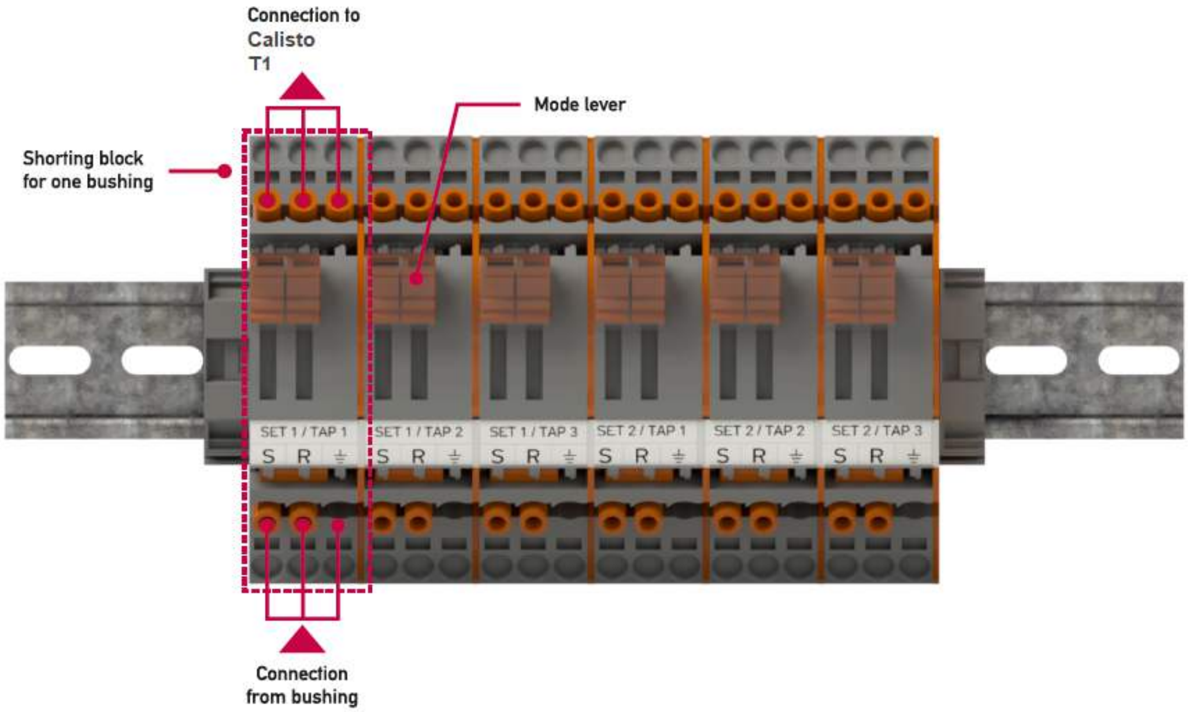


Figure 6 - Shorting Blocks in Maintenance Position

Before performing any maintenance on the unit, move the levers of the shorting blocks to MAINTENANCE position to allow the leakage current to return safely to the ground.

Sensor Connection to Voltage Input

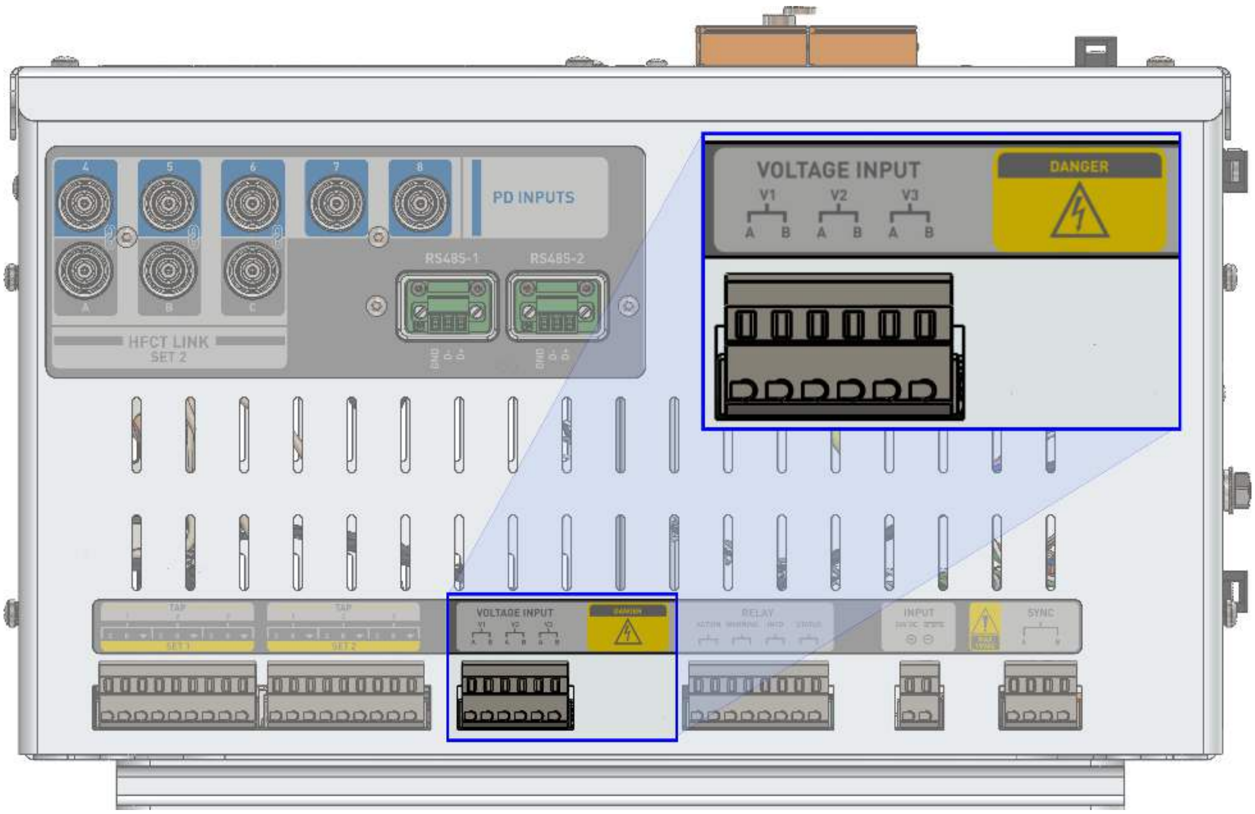


Figure 7 - Voltage Input

Voltage inputs accept signals from instrument transformers (PT or CCVT), if available at the station. Instrument transformers are connected across or parallel to the lines which are to be monitored. The voltage is used to measure the loss angle to perform True Power Factor calculation.

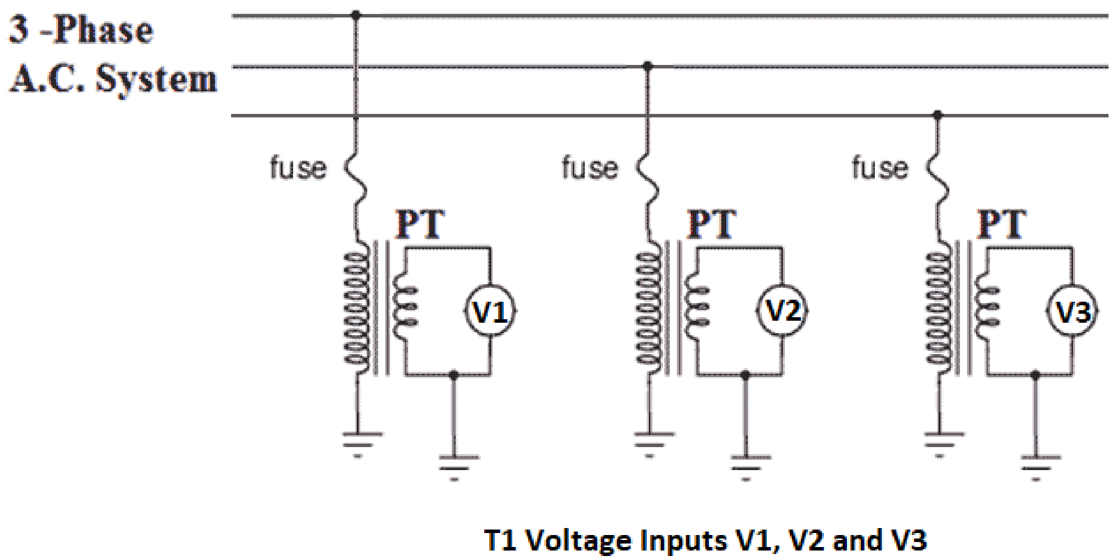


Figure 8 - Instrument Transformers Monitoring the System Voltage

Warning: Always open the V1, V2, and V3 fuses on the terminal strip before disconnecting the terminal plug from the Calisto™ T1 to avoid contact with energized voltages.

Sensor Connection to Sync Transformers

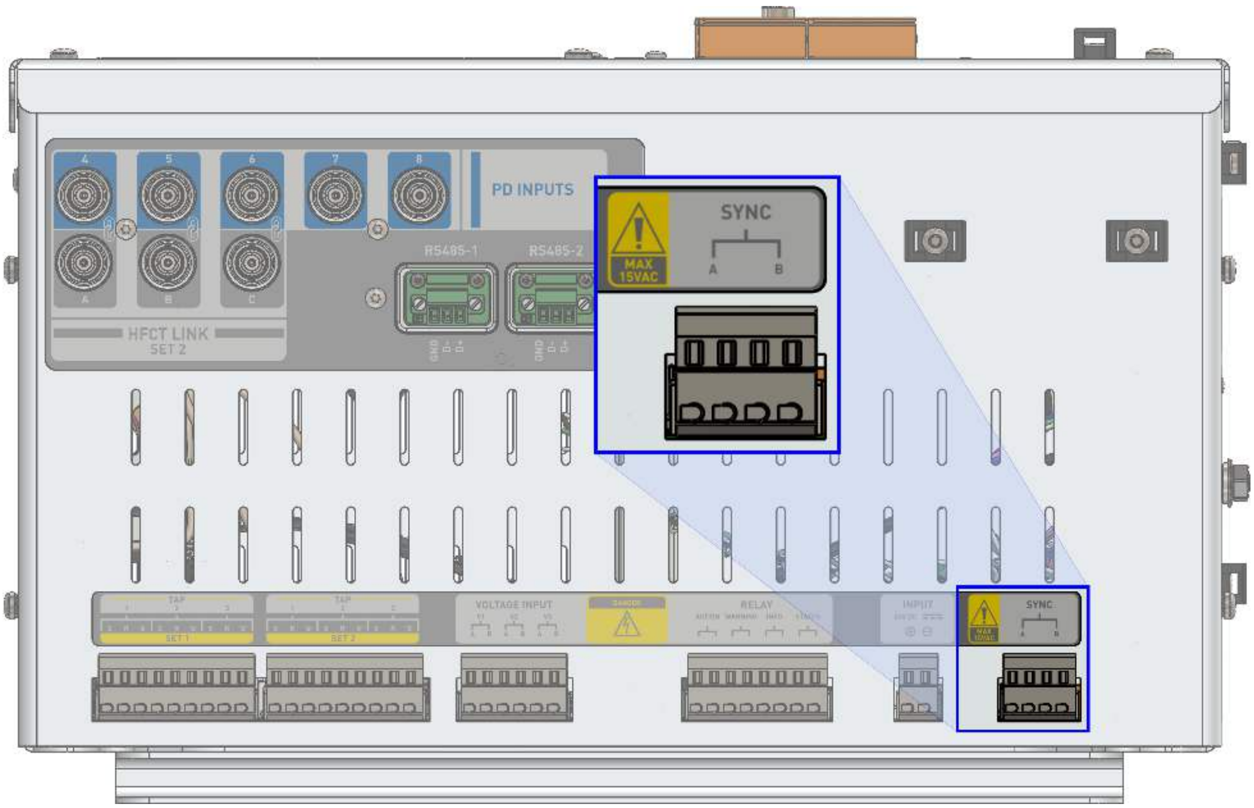


Figure 9 - Transformer Sync Input

The Transformer Sync input accepts the signal from a bell transformer, low voltage output transformer, to allow the sine wave to serve as the reference when collecting and analyzing Partial Discharge data.

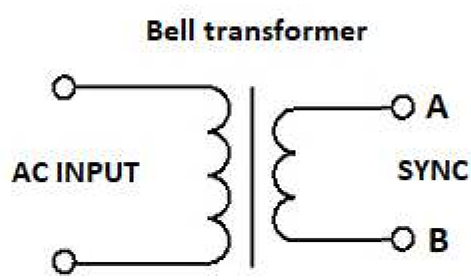


Figure 10 - Transformer Sync Detail

Sensor Connection to Partial Discharge Inputs

The PD sensor connections are by means of 50 Ohms cable with BNC termination. There are eight multiplexed channels available to monitor Partial Discharge. Only five out of these eight channels are available for general use. These are PD inputs 4, 5, 6, 7 and 8 shown in Figure 11 and Figure 12.

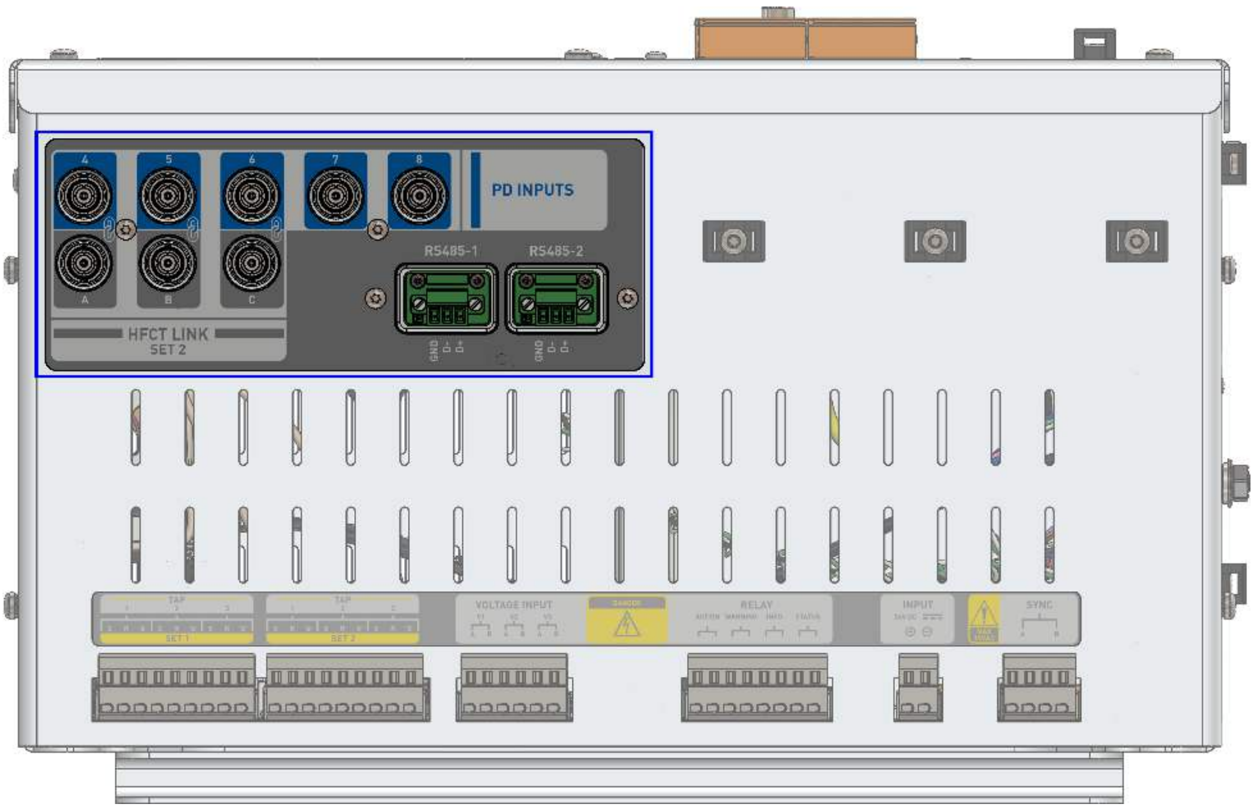


Figure 11 - PD Inputs and HFCT SET 2 Outputs

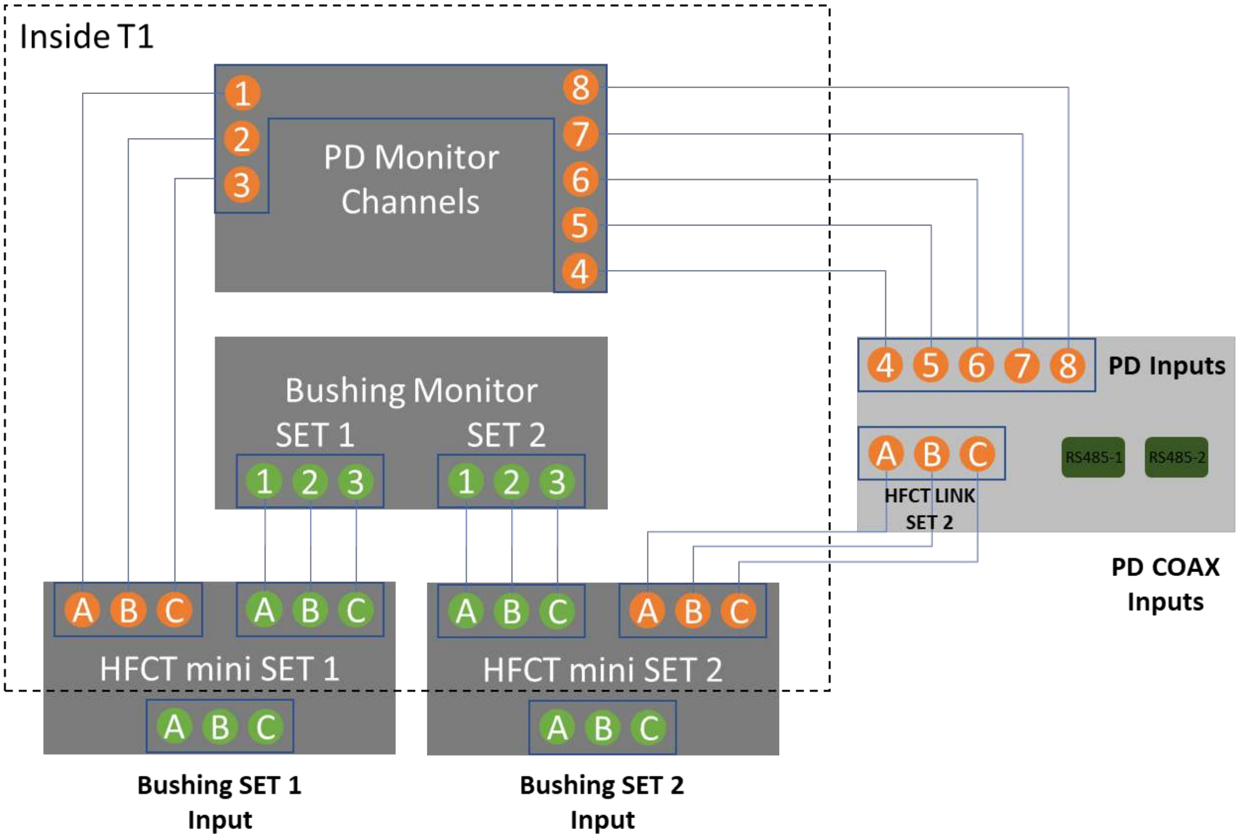


Figure 12 - PD Channels Internal Connection

If you want to monitor PD at SET 2, the correspondent HFCT coax jumper SET2 (channels A, B and C) need to be connected to the correspondent PD inputs (channels 4-5-6). Use a short coax lead to connect:

HFCT Links Connection

HFCT Link Output	PD Input
A	4
B	5
C	6

When the coax jumpers are present, the PD monitor can measure PD level at channels 4-5-6 (Figure 14). If the links are not present, channels 4-5-6 can be used to monitor other sensors - i.e., drain valve probe or LDWS-T (Figure 13).

Figure 13 - PD Accessories

Channels 1-2-3 cannot be seen in Figure 11 because these first three PD channels are internally connected to the embedded HFCT of SET 1, as illustrated in Figure 12. Channels 1-2-3 can only be used to monitor the PD from the bushings at SET 1.

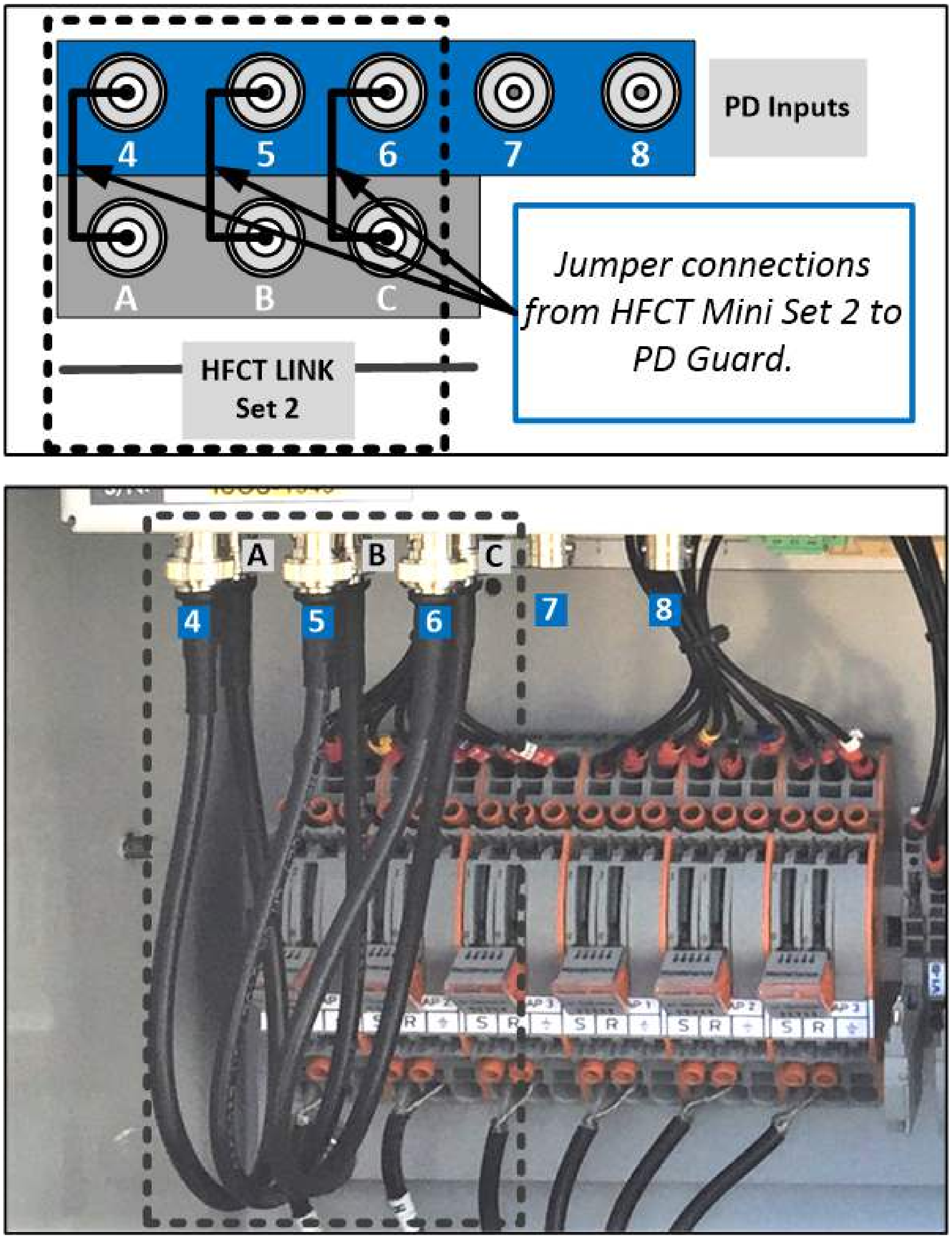


Figure 14 - Linking the HFCT Set 2 outputs to PD inputs

Sensor Connection to iO Cards

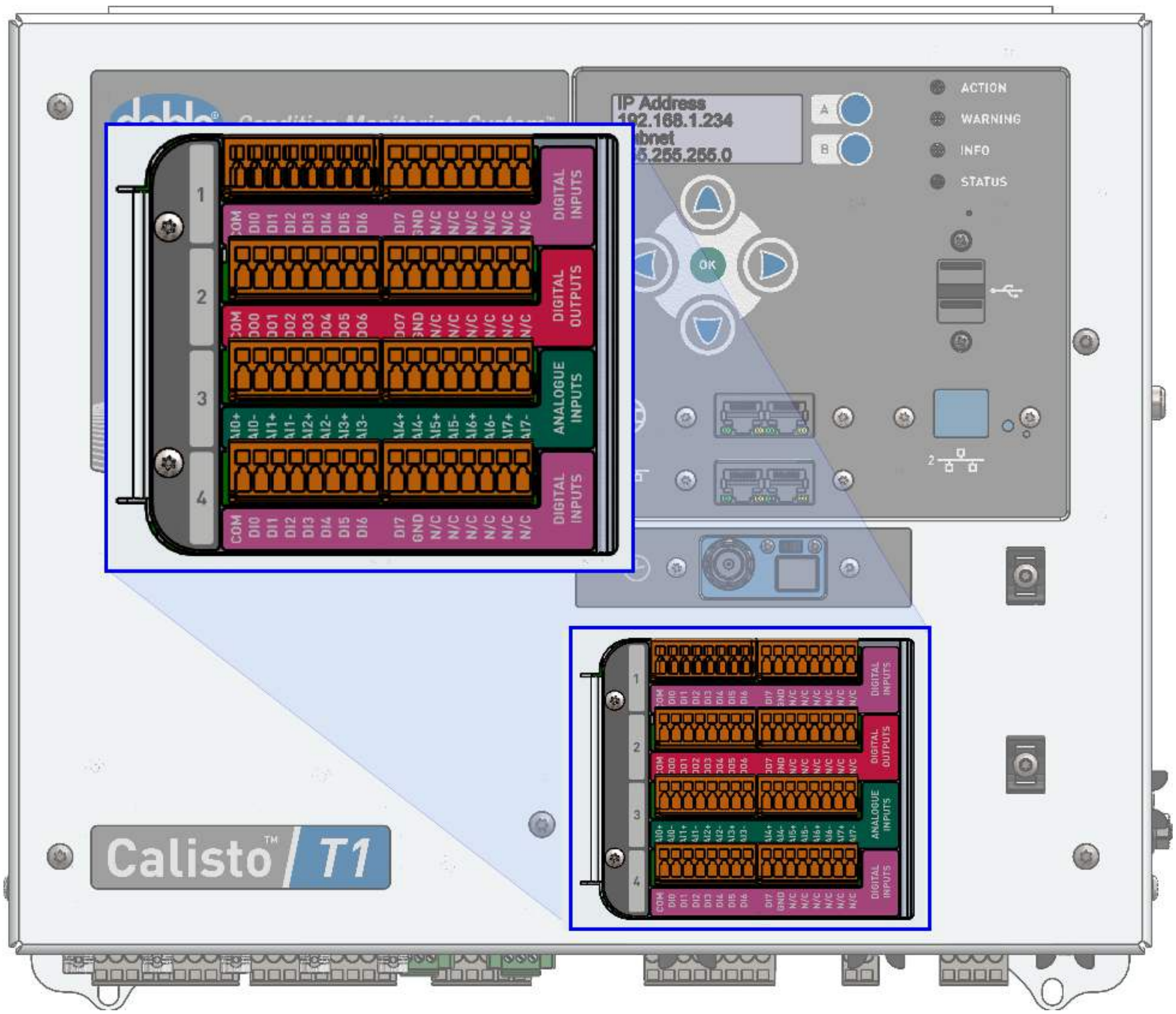


Figure 15 - iO Cards

The iO cards accept different types of signals: current, voltage, temperatures, and digital inputs. There are four slots available for expansion, and they can be added, removed, or replaced. Select any configuration suitable for your project. Cards are plug-and-play. As soon as the system starts, it recognizes the cards and creates an appropriate monitor instance in which you can configure the inputs.

Note: Any module can be installed in any slot.

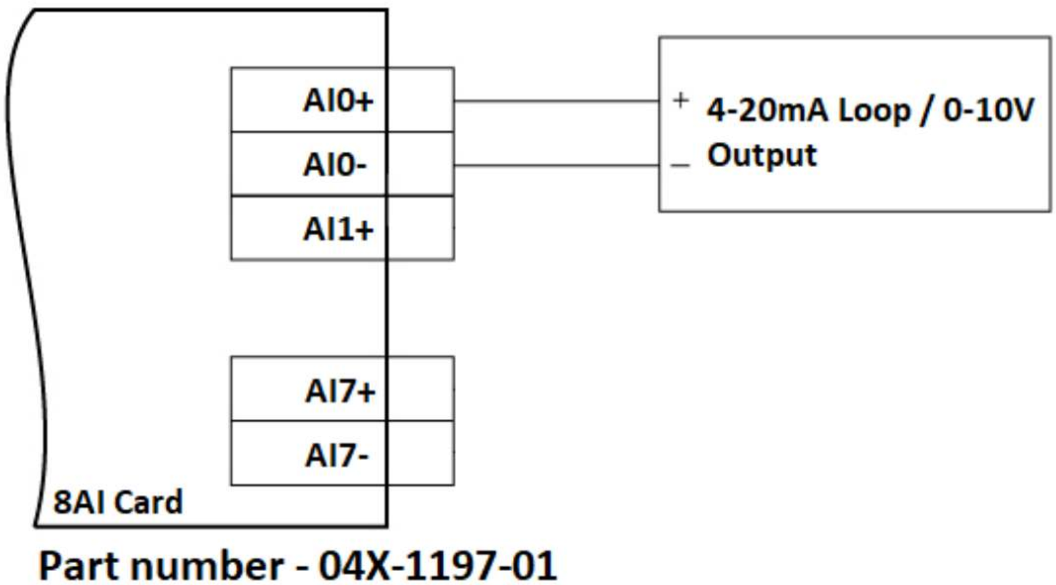


Figure 16 - 8AI Card Configuration

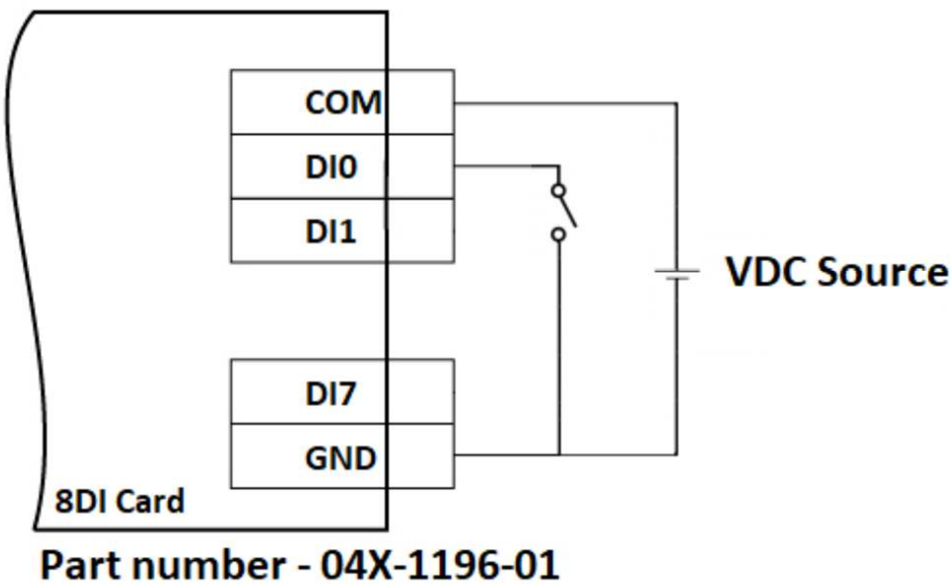


Figure 17 - 8DI Card Configuration

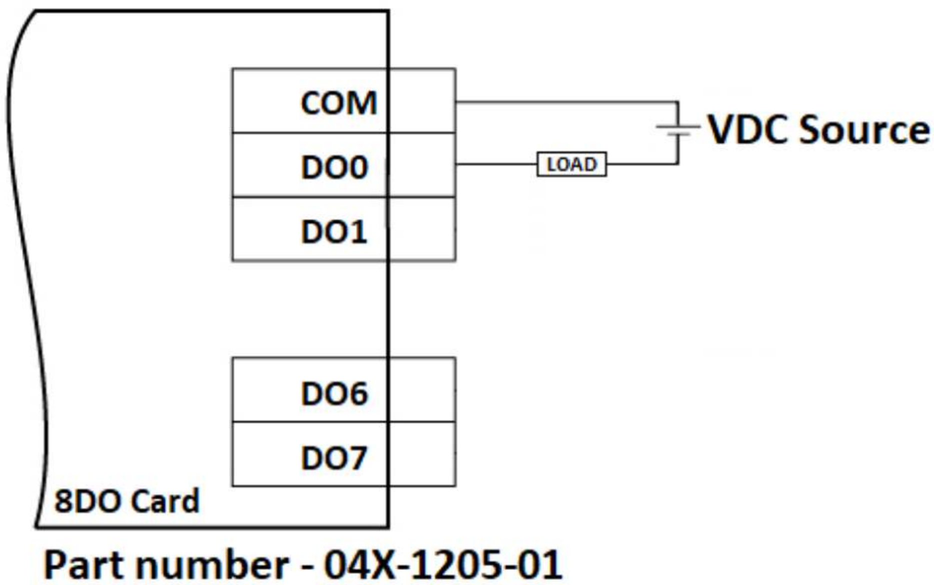


Figure 18 - 8DO Card Configuration

Network Connection

There are four network interfaces: two Ethernet and two serial. These ports allow computers, third party systems, and monitors to connect to the Calisto™ T1.

The LAN 1 and serial ports are managed in the doblePRIME™ application whereas LAN 2 requires third-party software, EasyConnect software, to configure the port and the IEC61850 protocol settings.

Ethernet - LAN 1

Figure 19 - Quad Ethernet Switch Ports

The quad Ethernet switch ports allow receiving and sending data to multiple devices at once or daisy-chaining to extend the network range. These ports provide the following services:

- HTTP/HTTPS access to the doblePRIME™ application
- MODBUS TCP master and slave
- DNP3 LAN master and outstation
- NTP – Time synchronization
- Diagnostics
- doblePRIME Sync

Ethernet - LAN 2

Figure 20 - IEC61850 Port

The Ethernet LAN 2 port is exclusively used to support the IEC61850 protocol. It provides connectivity to any compliant IEC61850 device. It does not support connection to the IEC61850 server but will accept connection from a client.

Serial Ports

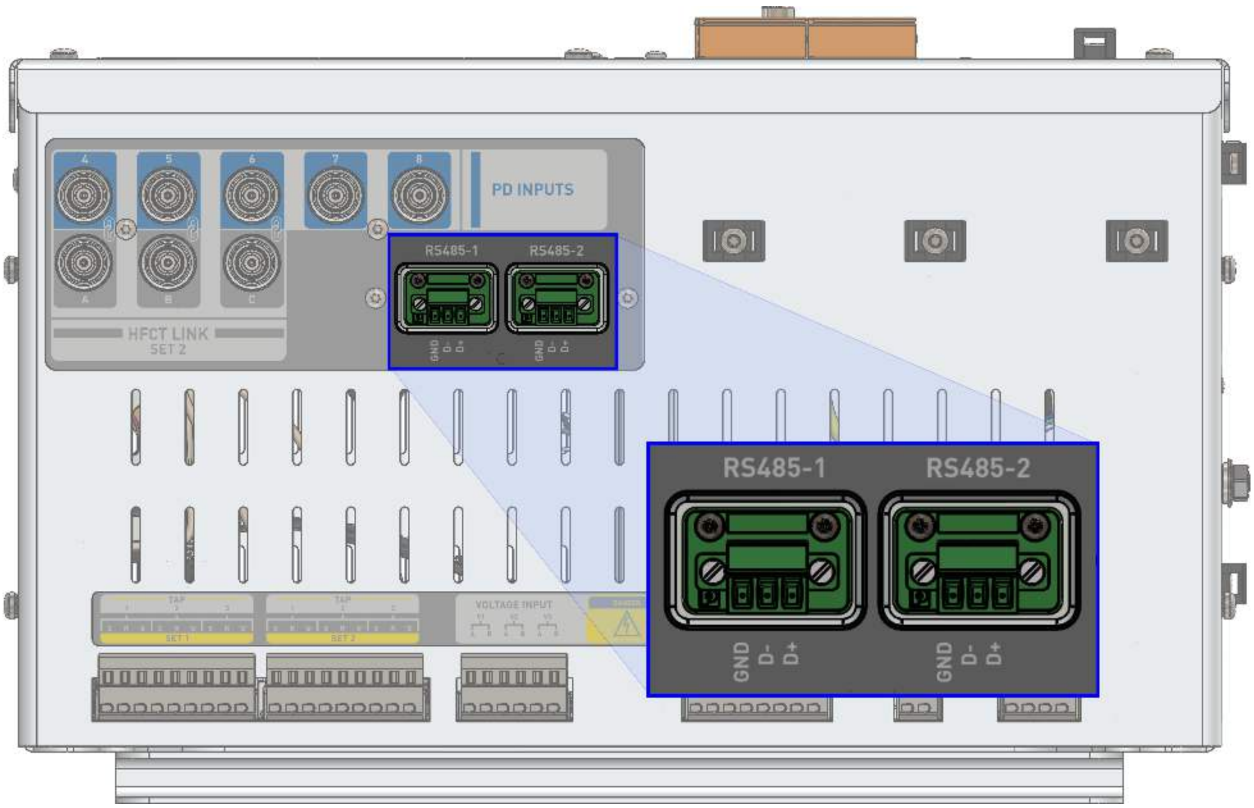


Figure 21 - Serial Ports

There are two serial interfaces: each is a 2-wire RS485. Modbus and DNP3 protocols – master and slave modes– are available to allow communication to slave devices (i.e., DGAs or energy meters) or to master instances (i.e., SCADA system or any data aggregator).

Status Indicator and IP Reset Pinhole

The front panel shows the current alert level of the assets being monitored. The reset pinhole is located below the indicator LEDs. The reset pinhole allows you to restore the default IP address of the unit when the IP is forgotten.

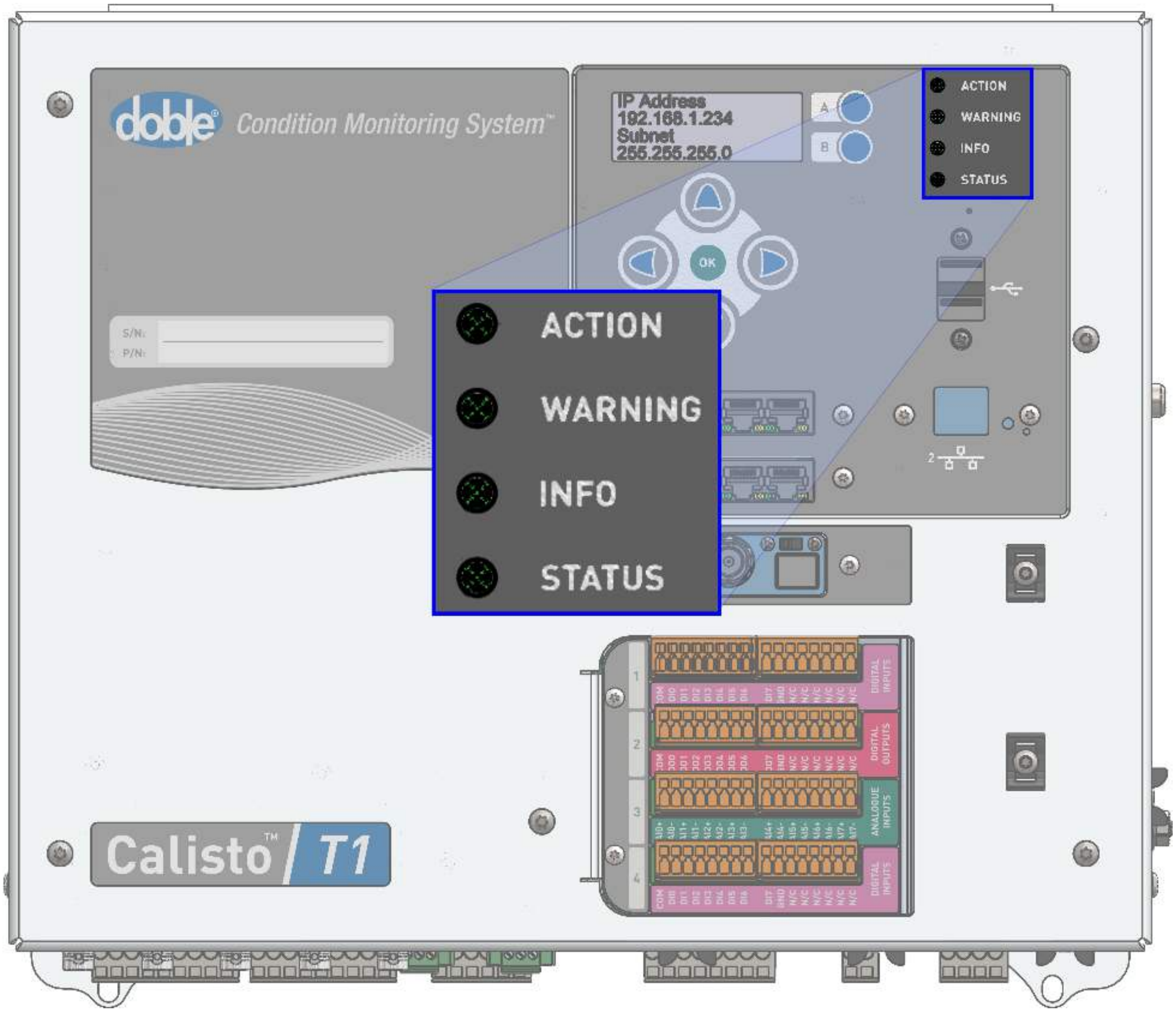


Figure 22 - Indicator LEDs and Reset Pinhole

The Calisto™ T1 supports the generation of communication, information, warning, and action alerts. These alerts are visible on the Calisto™ T1 front panel.

Status Descriptions

Color	Meaning/Significance	Description
Red	Action	A measured event requiring immediate attention
Yellow	Warning	A measured event requiring immediate attention
Green	Info	A measured event providing information
Blue	Status	Indication of device condition

Interpreting the Alerts on the Front Panel

Before the monitors are set up and commissioned, the blue and green indicators are on, indicating no abnormal measurements.

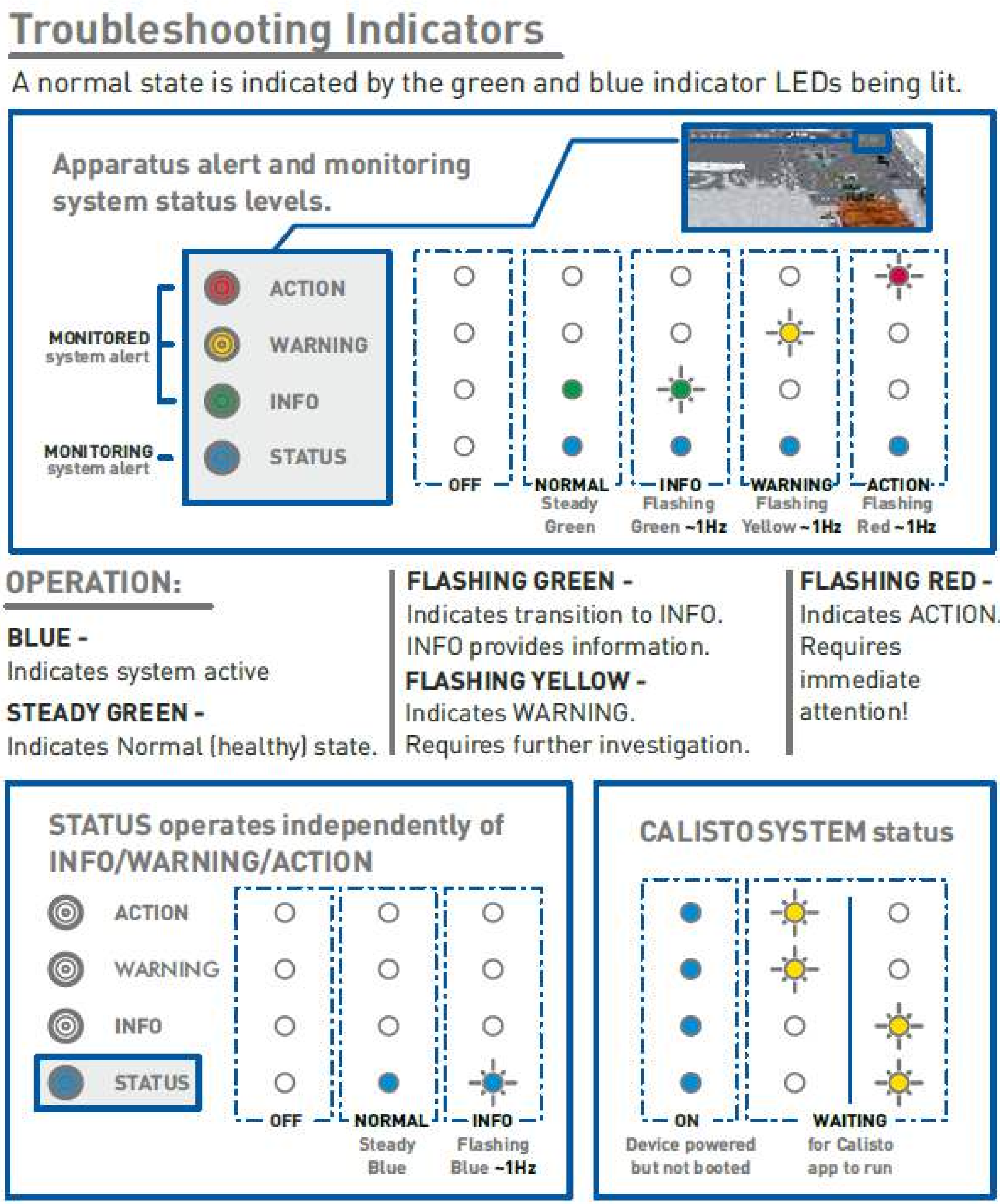


Figure 23 - Indicator LEDs Behavior

IP Reset Procedure

Just below the LED lights, you find the pinhole, Figure 24, for resetting the unit. This procedure only resets the IP address; the configuration and database are preserved. Perform the following steps to reset the IP address.

1. Insert and hold a paperclip or similar in the pinhole, Figure 24. The LEDs will go out then light up in sequence bottom to top.

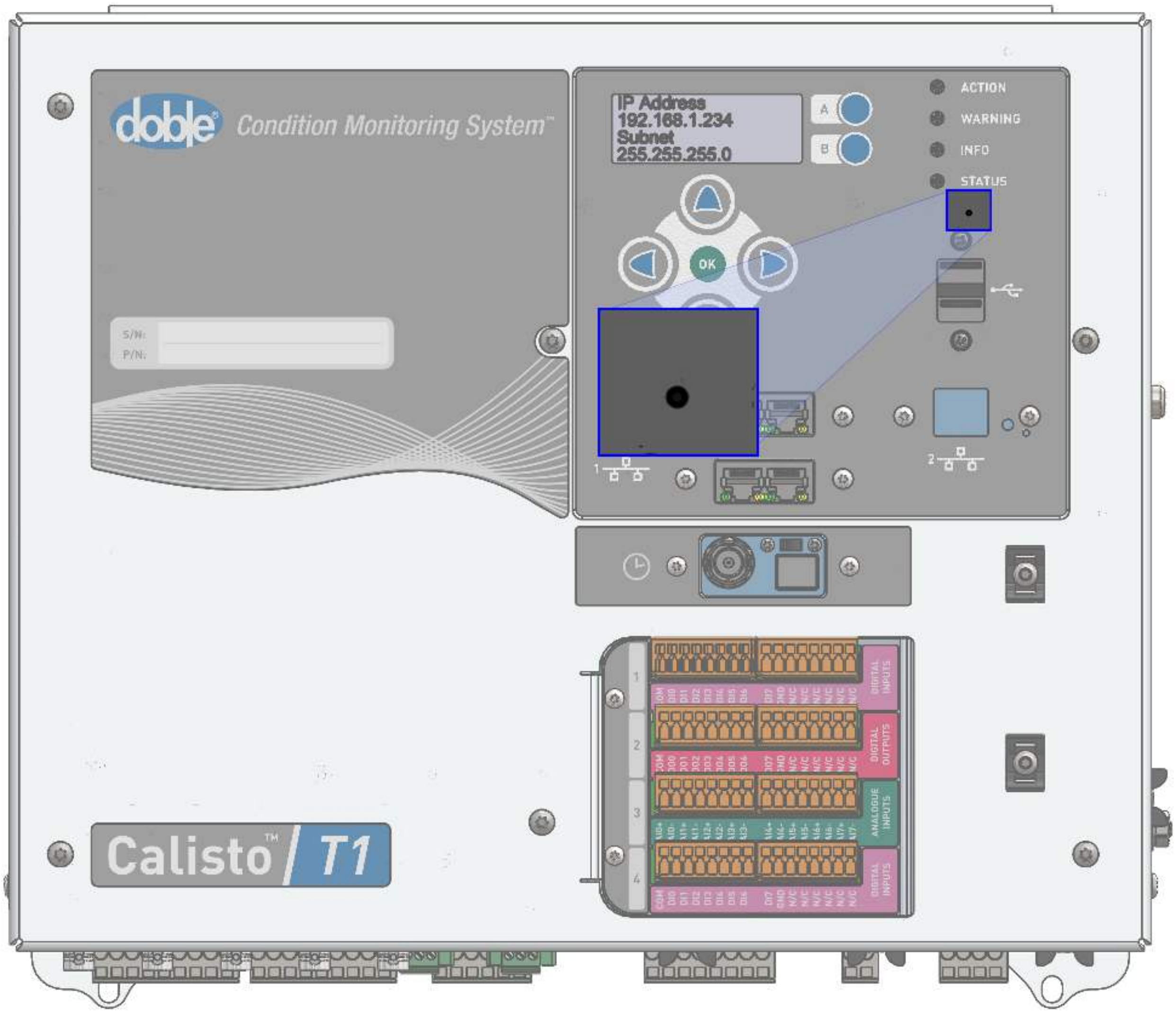


Figure 24 - Reset Pinhole

2. Remove the paperclip from the pinhole when all the LEDs start flashing at the same time. After the paperclip is removed from the pinhole, the unit will perform a reset
3. The IP of LAN 1 will fall back to the default address – 192.168.1.234 – and will wait for connection.

Supervisory Relays

Relay outputs are based on the alert status and are dry contact type. The operation of the relays can be seen in the diagram below:

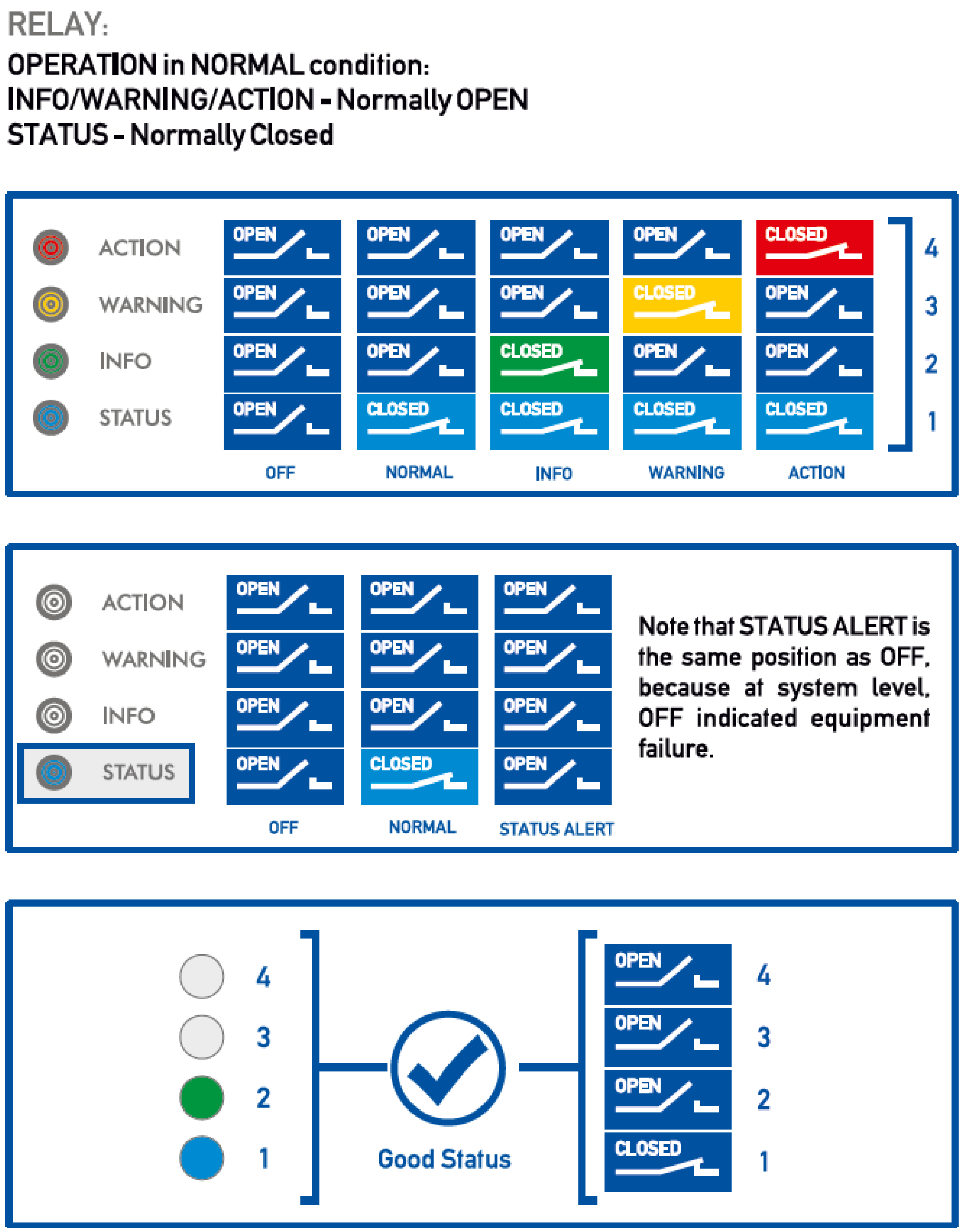


Figure 25 - Supervisory Relays

> **Note:** Supervisory relays are driven by alerts only.

The contact can be wired to an LED tower or to the control room to monitor the condition of the asset remotely.

4. Installation

The Calisto™ T1, and its basic ancillaries, comes fit into the enclosure DPEN100 (see Appendix Dimensions (page 112) for more information), which is Doble's smallest enclosure size available. Even though it might suffice for most installations, Calisto™ T1 can be installed into a bigger enclosure, such as the DPEN200 or DPEN300. Due to the variety of enclosures that could be used for the Calisto™ T1, this guide covers installation in a generic grounded enclosure. If the enclosure is not already installed and grounded, that needs to be completed before continuing.

Figure 26 - DPEN100, DPEN200, and DPEN300 Enclosures

Figure 27 - T1 DPEN100 Enclosure Installation

Planning the Calisto™ T1 Installation

The Calisto™ T1 can be used to monitor bushings on either three-phase or single-phase transformers. In both cases, the concept of bushing sets applies. A bushing set consists of the three bushings, one on each phase, on a single side. It can also monitor Partial Discharge in the bushings, inside the transformer, and other variables.

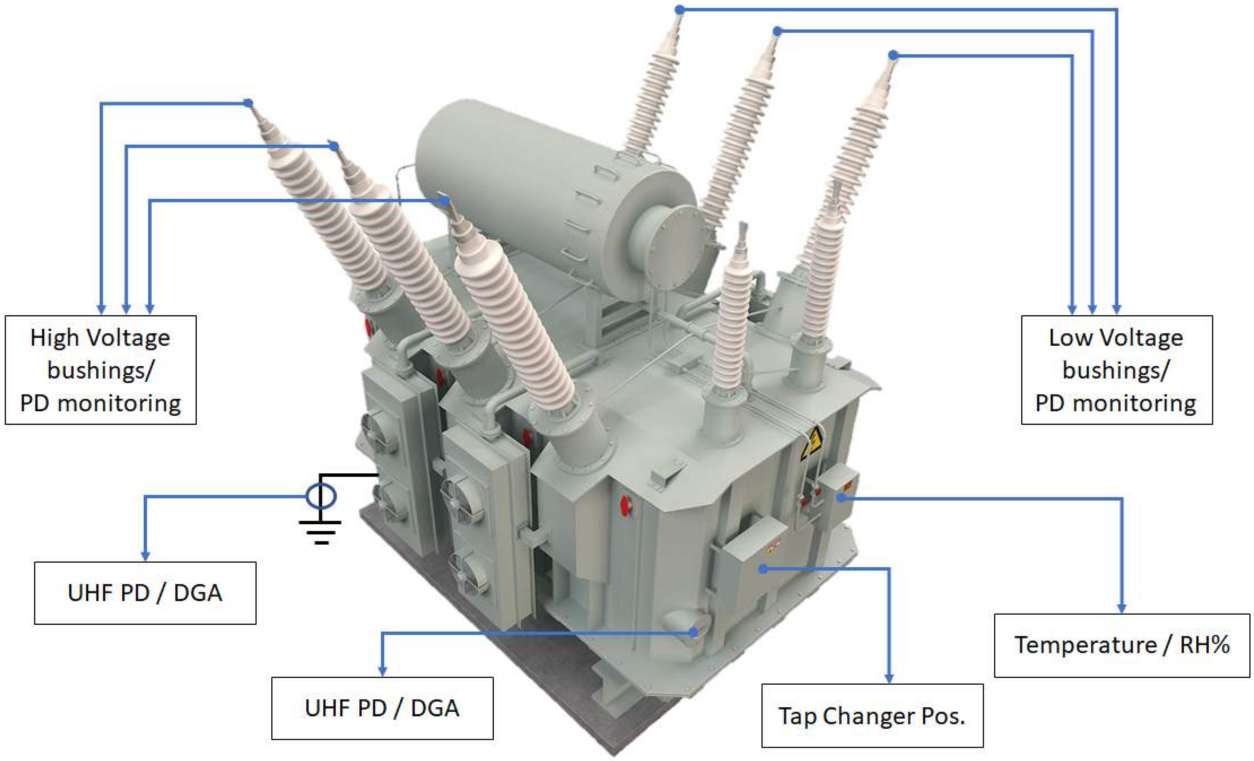


Figure 28 - Online Monitoring

Before you begin the installation, locate and review the applicable system wiring diagram and distances.

Do not exceed the maximum distance from the sensor to the associated monitor. As a rule of thumb, the maximum distance is determined by the sensor with the worst maximum distance associated.

Sensor Cable Lengths

Application	Sensor	Maximum Distance
Bushing Sensor	Bushing Tap Adapter	60 m
PD HF Sensor	HFCT300-WT	50 m
	HFCT 100	
	PDDC-17/24	
PD UHF Sensor	Drain Valve Probe	20m
	Plate Sensor	

The Calisto™ T1 installation must proceed in a certain order. The first steps can be performed in any order: install the bushing sensors and the Calisto™ T1 enclosure.

Warning: Mount the enclosure and ground it first before proceeding with the installation of the monitor. Refer to Appendix Dimensions (page 112) for more details about the enclosure ground lug.

Proceed with the following steps after the enclosure is grounded:

1. Remove the aluminum Gland Plate and drill the holes where required. Secure the Gland Plate back in place and make the connections.

Note: Ensure all connections are suitable for the environment.

2. Install the conduit and wiring between the sensors and the Calisto™ T1 enclosure.
3. Wire the sensors, power, and communications to the Calisto™ T1 enclosure.
4. Test the wiring.
5. Seal the sensors.

5. User Interface

The doblePRIME™ application has a web browser configuration and visualization utility.

Perform the following steps to access the doblePRIME™ application.

1. Connect your PC to Port LAN 1 on the front panel of the Calisto™ T1 instrument using an Ethernet cable. Assign an appropriate IP address and netmask to your Ethernet interface, e.g., 192.168.1.20 and 255.255.255.0.
2. Open a web browser and enter the IP address listed on the unit into the URL bar.

Note: The default IP of LAN 1 interface is 192.168.1.234.

The login screen appears.

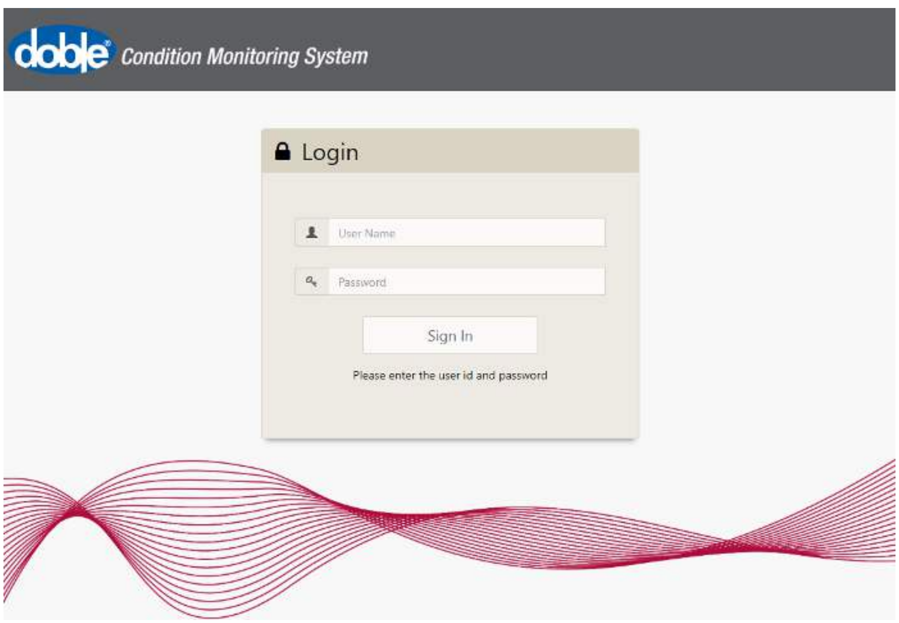


Figure 29 - doblePRIME™ Application Login Screen

For more information about setting up the PC network adapter to connect to Calisto™ T1, refer to the Calisto™ T1 QuickStart Guide (PN 72X-0330-01).

3. Enter your username and password in the corresponding fields.

Note: The default administrator username is **dobleAdmin** and the password is **dobleAdmin1!**. If this is the first time you have logged in, Doble recommends that you change your password. Do not continue with the password provided by Doble.

Note: Failing to enter the correct password three times in a row causes the user account to be locked out for an hour. If the account is locked out, you can try to log in using a different account or wait an hour to log in again using the same account. Refer to the doblePRIME User Guide (PN 72A-2812-01) for more details on other available accounts.

The doblePRIME™ application main page is shown after a valid credential is entered. From this interface, you can configure the system and check the health of your assets.

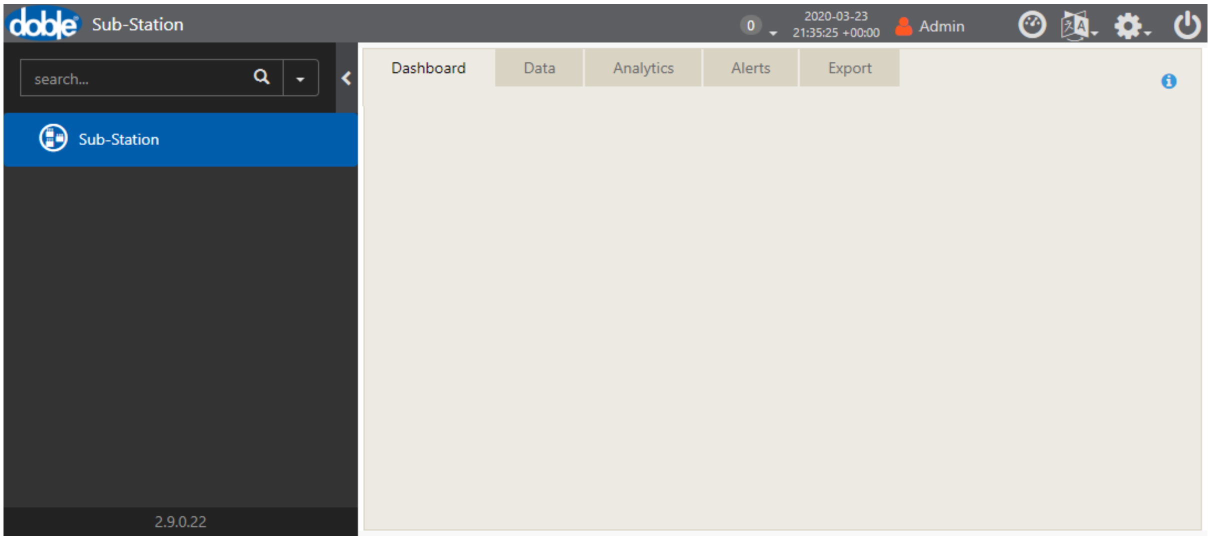


Figure 30 - doblePRIME™ Application: Main Page

Refer to the doblePRIME User Guide (PN 72A-2812-01) for more information about the doblePRIME™ application and other tools available in the doblePRIME™ application.

6. Configuration

In the real world, the asset you want to monitor has sensors mounted to it and is wired to the monitor device. The doblePRIME™ application allows us to translate this concept from the real world into entities, channels, and monitor instance in the software.

The asset entity is a representation of the real-world asset. A sensor is called a channel, and the monitor (e.g., bushing monitor, PD monitor) is named Monitor Instance.

To begin the configuration of the system, start by creating the asset in the application. Instantiate the monitor type you want to use, then link its channels to the asset.

This chapter covers how to create an asset, configure the native monitor instances of Calisto™ T1, assign a channel to the asset, then commission the monitor to start logging the data.

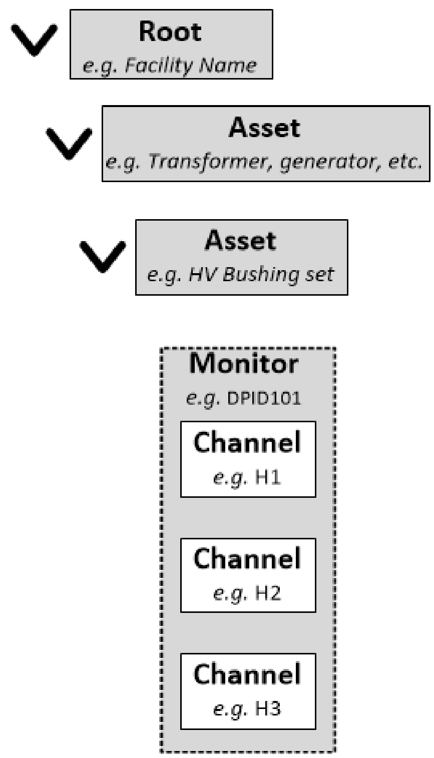


Figure 31 - Entities in Calisto Web Application

Creating an Asset

The asset is a graphic representation of the real asset being monitored and is displayed in the asset tree. They represent where the channels, e.g., current sensor or temperature sensors, are connected to when you are setting up the monitor.

Perform the following steps to create a new asset.

1. Click the settings icon on the top-right of the title bar.
2. Click **Asset Configuration**.

   The Asset Configuration tab will open in the feature panel, Figure 32

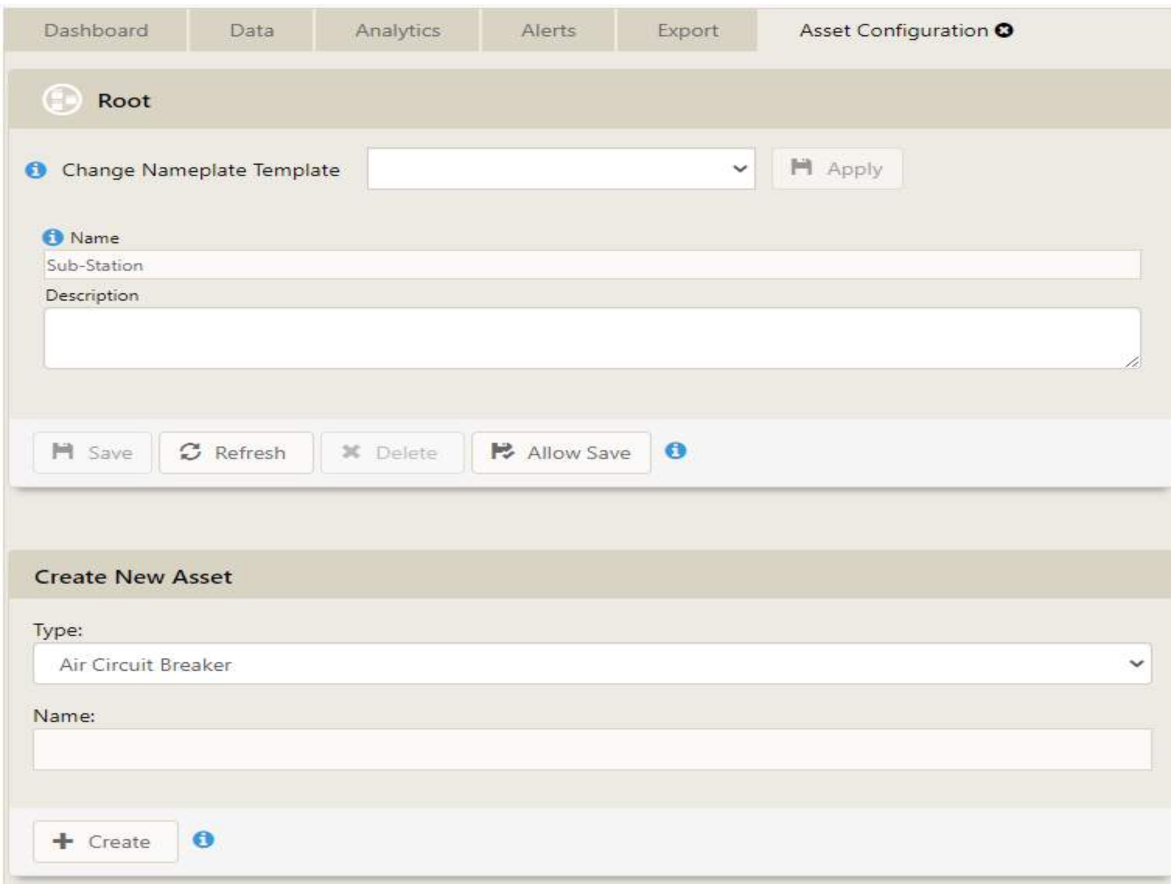


Figure 32 - Asset Configuration Tab - Create New Asset

3. Select the root from the asset tree in the navigation panel. In the Asset Configuration tab, update the root name and description if appropriate.

   The Root name may be defined as required, generally used to describe the location of the monitoring system, Substation 1, Powerplant West, Generator Set 3, etc.

4. Click the **Type** drop-down list in the Create New Asset section.

5. Click the asset type that you want to create that best represents what you are monitoring. The following lists the available asset:
    - Air Circuit Breaker
    - Auto Transformer with Tertiary
    - Auto Transformer w/o Tertiary
    - Bushing (single)
    - Cable
    - Circuit Breaker
    - Dry Type Transformer
    - Generator
    - LTC
    - Oil Circuit Breaker
    - SF6 Circuit Breaker
    - System
    - Three Winding Transformer
    - Transformer
    - Two Winding Transformer
    - Unknown Asset
    - Vacuum Circuit Breaker
    - Voltage Transformer
    - [AG] Asset Group
    - [CG] Bushing Set
    - [CG] Channel group
6. Enter the name of the asset you are creating in the **Name** field.
7. Click **Create**.

    An asset created confirmation notification will appear at the top-right of the window.
8. Click the newly created asset from the asset tree.

    The asset details will open in the navigation panel.
9. Enter the following information in the appropriate fields:
    - Description
    - Type
    - Manufacture
    - Serial Number
    - Year Of Manufacture
    - Installation Date
10. Click **Save** after filling in the appropriate information.

Creating a Bushing Set

A bushing set is a special asset that represents the bushing TAPs on the transformer. A set is a group of three bushings which could be a representation of the high voltage side, low voltage side or tertiary of the transformer. The bushing set must be attached to the transformer asset to show this relationship where the set belongs to the transformer being monitored.

Perform the following steps to create a bushing set for a transformer.

1. Click the settings icon on the top-right of the title bar.
2. Click **Asset Configuration**.

   The Asset Configuration tab will open in the feature panel.
3. Click the transformer asset in the asset tree that you want to attach a bushing set to. When the transformer is selected, it will be highlighted in blue.
4. In the Asset Configuration tab, click the **Type** drop-down list in the **Create New Asset** section and select **[CG] Bushing Set**.
5. Enter the name of the bushing set you are creating in the **Name** field of the **Create New Asset** section.

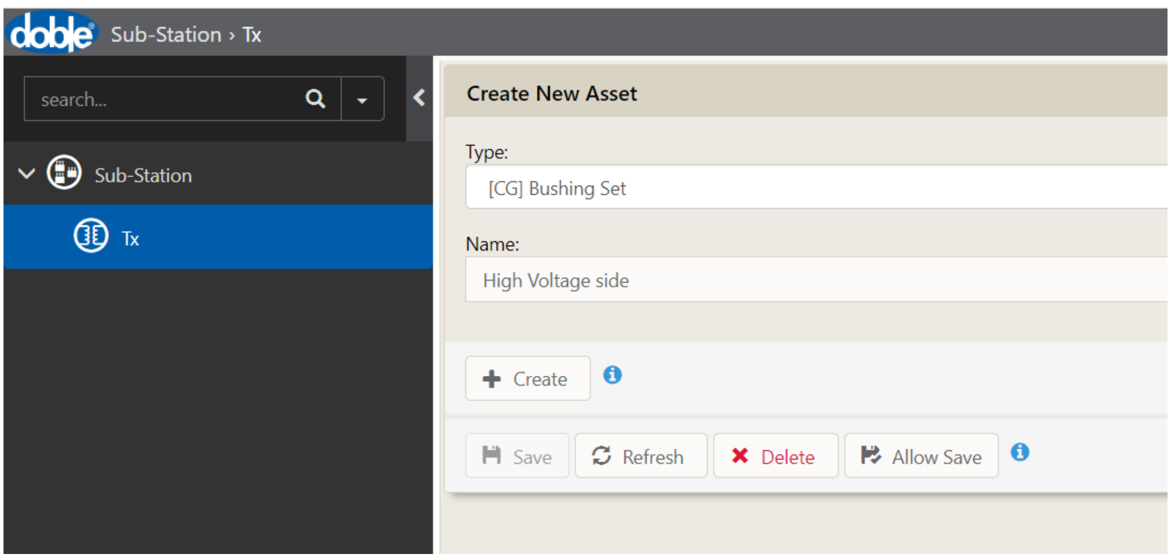


Figure 33 - Create New Asset: Bushing Set

6. Click **Create**.

   The bushing set will be created and nested under the transformer.

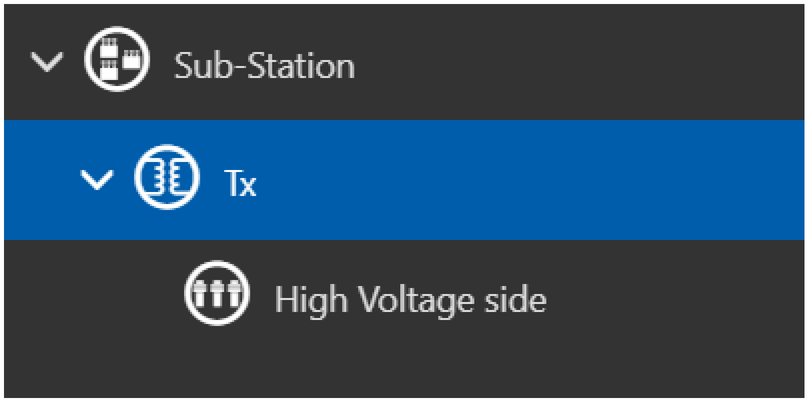


Figure 34 - Bushing Set in Asset Tree

Bushing Monitor Configuration

This section describes how to set up the bushing monitor to measure the leakage current from the bushings, and the output from instrument transformers to derive the bushing capacitance, power factor, and others. The subsection Assigning the Instrument Transformers to the Voltage Channels (page 53) apply when TPF is to be used.

Bushing Monitor Settings

The bushing monitor instance is the entity representing the Doble IDD monitor inside Calisto™ T1.

On the bushing monitor page, you can edit the communications settings and assign the asset created to the channels. The channels are entities representing the physical inputs of the unit, coming from the bushings TAP adapters and instrument transformers. When the asset is assigned to the channel, it displays the channel measurements on the doblePRIME™ application.

Perform the following steps to open the bushing monitor settings.

1. Click the settings icon on the top-right of the title bar.
2. Click **Monitors**.
3. Click Channels for the BDM-100 monitor to open its settings.

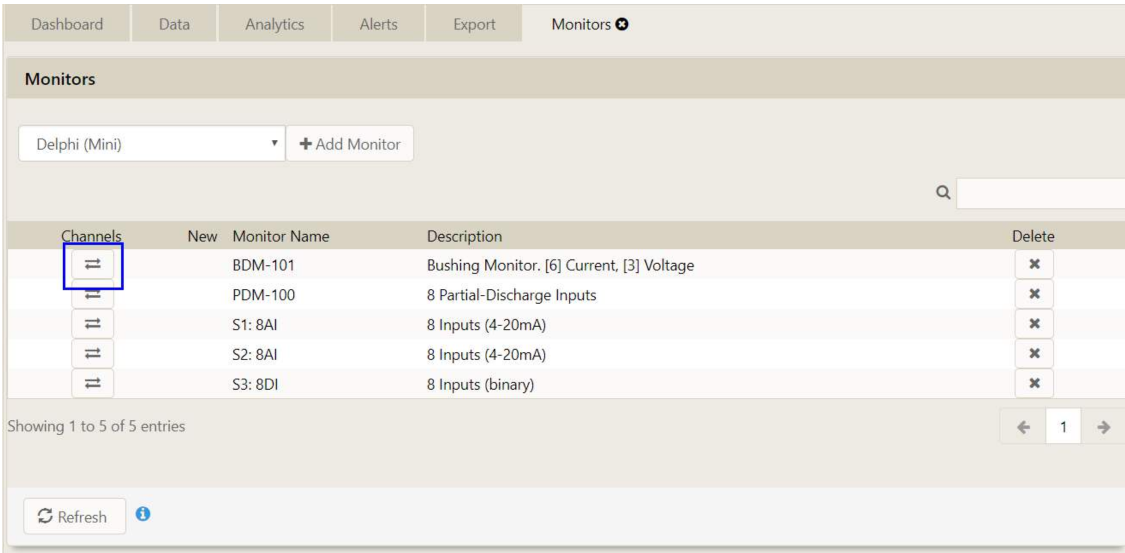


Figure 35 - Monitors: Open Settings

The Instance Details section opens; this section contains the monitor settings.

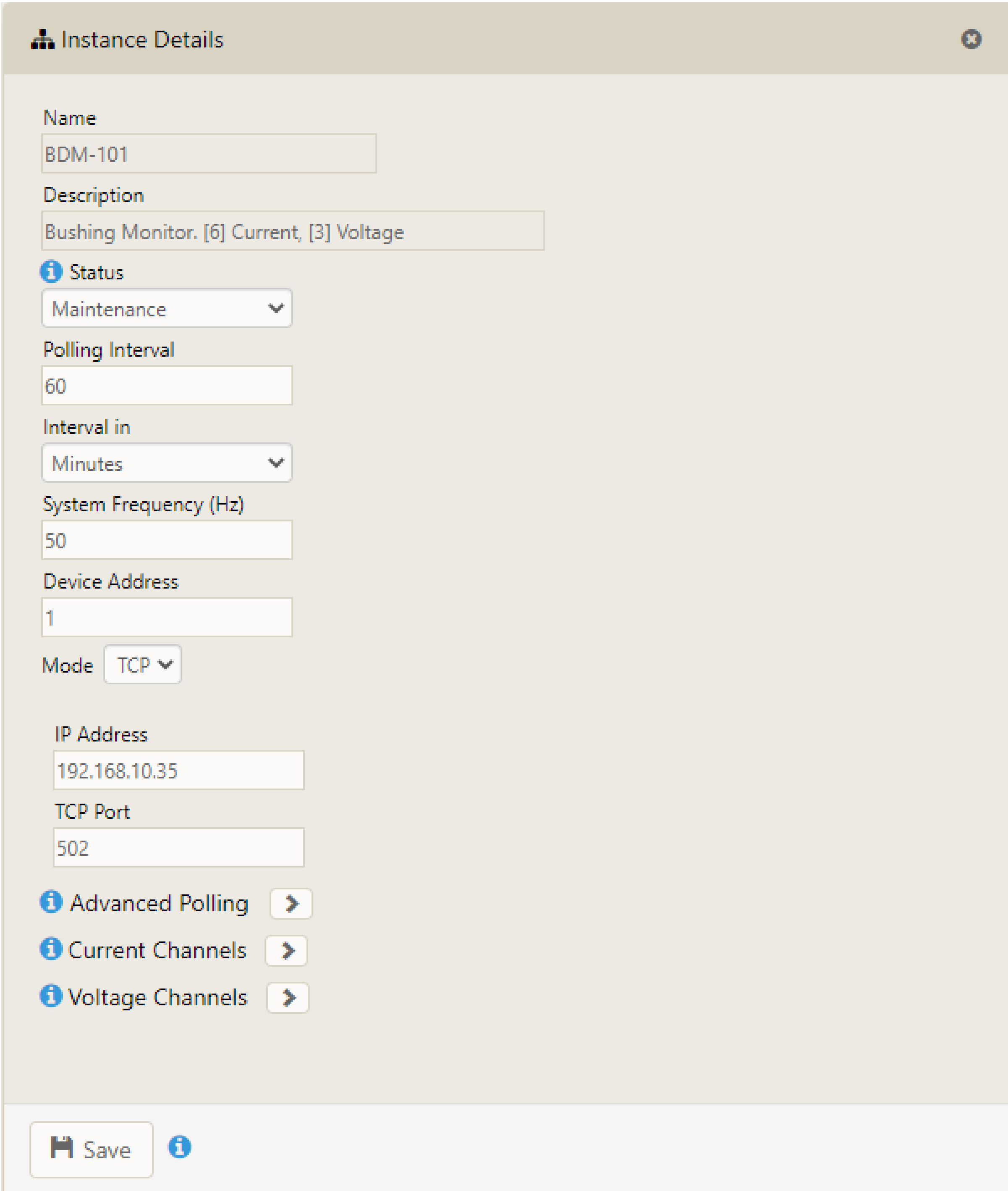


Figure 36 - Bushing Monitor Communication Settings

The following table lists the bushing monitor parameters.

Bushing Monitor Parameters

Monitor Field	Description
Name	Bushing monitor name
Description	Number and type of inputs
Status	• Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required. • Commissioned status causes the monitor to collect data if the communication settings are correct. • Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.
Polling Interval	Interval at which the Calisto™ T1 receives data from the BDM board
Interval in	Select Internal in minutes and hours
System frequency	Frequency of the installation - 50 Hz or 60 Hz
Device address	Do not change this setting. Default address 1
Mode	Communication to the internal Bushing Data Monitor is via TCP
IP address	Do not change this setting. Default IP 192.168.10.35
TCP port	Do not change this setting. Default port 502

Assigning the Bushing Set to Current Channels

There are six current channels used to monitor the leakage currents. Channels 1-2-3, which is bushing SET 1 input (see Sensor Connection to Partial Discharge Inputs (page 21)), can be assigned to one bushing set. Channels 4-5-6, which is bushing SET 2 input, can be assigned to a second bushing set.

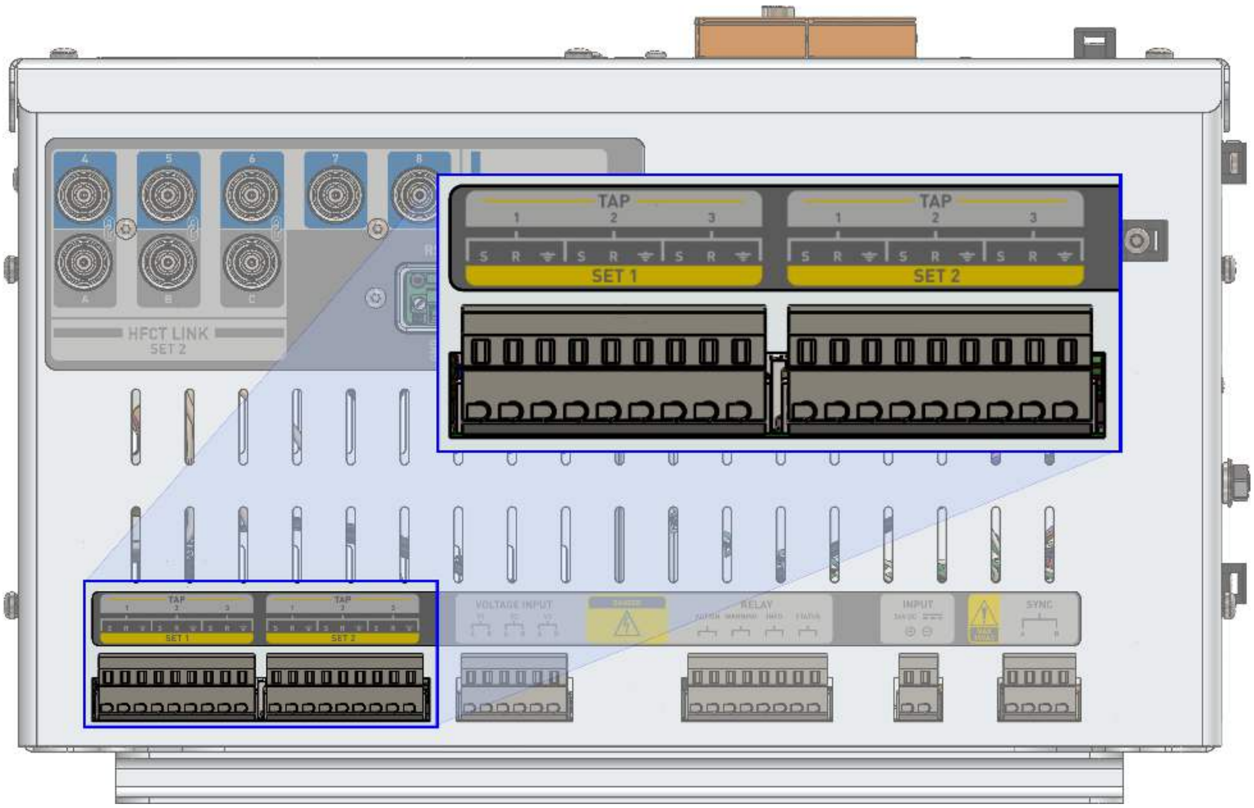


Figure 37 - Calisto™ T1: Current Channels

Perform the following steps to assign the bushing set to the current channels.

1. Create a bushing set for SET 1, or SET 1 and SET 2, if they have not been created yet.
2. Locate the bushing set created, then click on it to select. The bushing set is nested under the transformer asset in the asset tree.
3. In the bushing monitor settings, click the **Current Channels** chevron to expand the options
4. Click the **Assign** check mark next to the current channels. The name of the bushing set is copied into the **Asset** field, and the check mark will change to green.

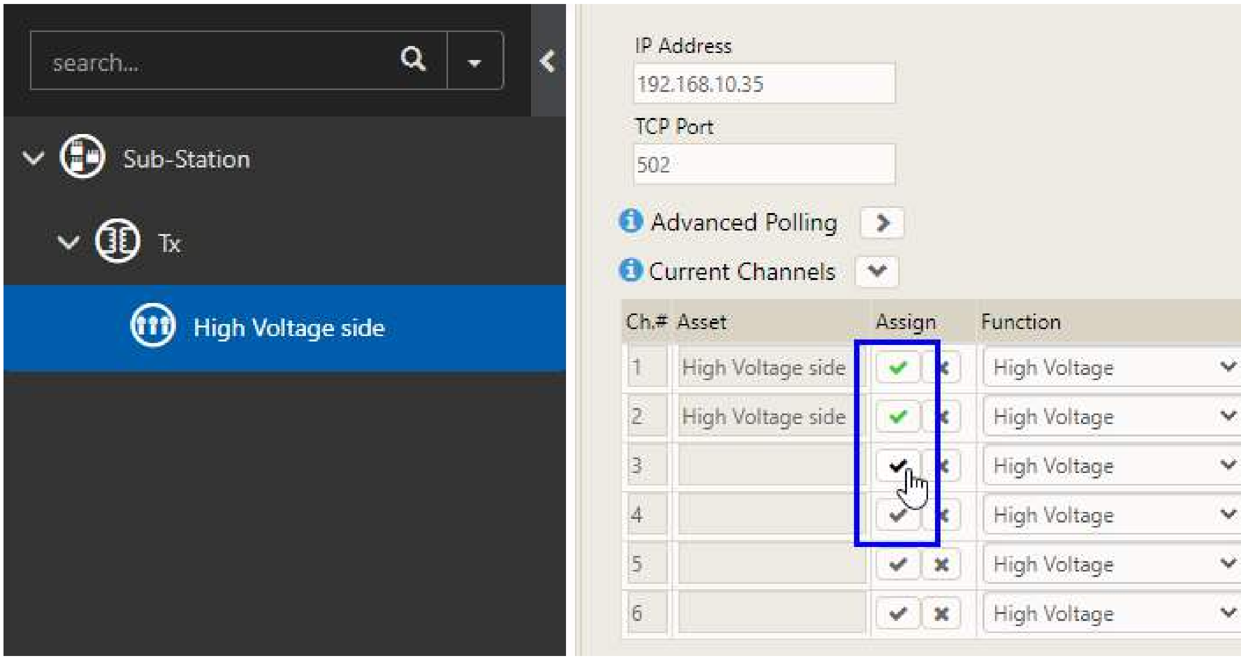


Figure 38 - Assign Check Mark

5. Select High Voltage, Low Voltage, Tertiary Voltage, or Neutral from the **Function** drop-down. The Neutral selection will only process the leakage current.
6. Repeat steps 4 and 5 to assign the remaining channels to the appropriate bushing set.
7. Click **Save** in the panel footer.

Assigning the Instrument Transformers to the Voltage Channels

There are three channels to monitor the system voltage from instrument transformers. Usually, three voltage transformers can be added to the monitor, one voltage for each phase. Voltage inputs are channels in the Bushing Monitor Instance.

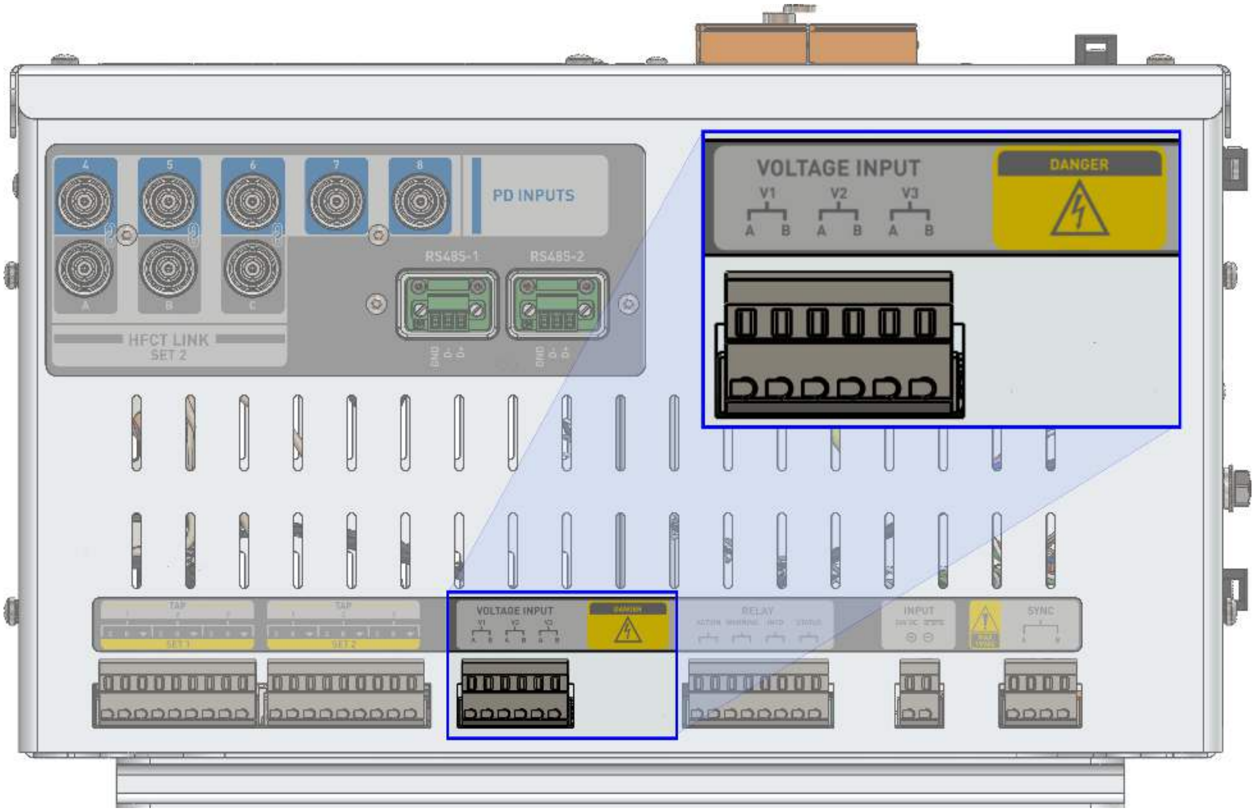


Figure 39 - Calisto™ T1: Voltage Channels 1-2-3

Perform the following steps to assign the bushing set to the current channels.

1. Create three voltage transformer assets if they have not been created yet.
2. Locate the first voltage transformer in the asset tree, then click on it to select.
3. In the monitor settings, click the **Voltage Channels** chevron to expand the options.
4. Click the **Assign** check mark next to the voltage channels. The name of the voltage transformer is copied into the **Asset** field, and the check mark will change to green.

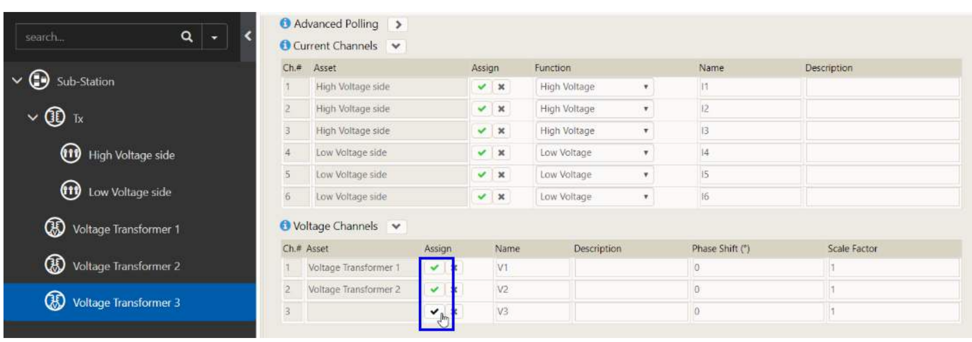


Figure 40 - Assign Check Mark

5. Each voltage transformer is assigned to an individual channel. Repeat step 4 until all voltage transformer assets are assigned to the appropriate channel.
6. Click **Save** in the panel footer.

The **Phase Shift** and **Scale Factor** fields require the instrument transformer's nameplate to fill out the fields. Enter the data from the nameplate in the fields, but later these figures have to be tweaked to calibrate the monitor to produce more accurate capacitance and power factor results. Refer to True Power Factor Calibration (page 128) for more information.

Status should only be changed to Commissioned after the bushing nameplate is entered. Please consult Configuring the Bushing Asset (page 55) before you begin collecting data from this monitor.

Configuring the Bushing Asset

After the monitor is created and the asset is assigned to current and voltage channels, the bushings can be configured by entering the capacitance and power factor from their nameplate or latest offline test.

Perform the following steps to open the bushing settings.

1. Click the settings icon on the top-right of the title bar.
2. Click **Asset Configuration**.
3. In the asset tree, drill down the transformer asset until the bushing entities are exposed. These entities, depicted with an orange circle and line, represent the bushings in maintenance mode.
4. Click the bushing entity to edit the nameplate and other configurations. The menu to edit the bushing will appear in the **Asset Configuration** tab.

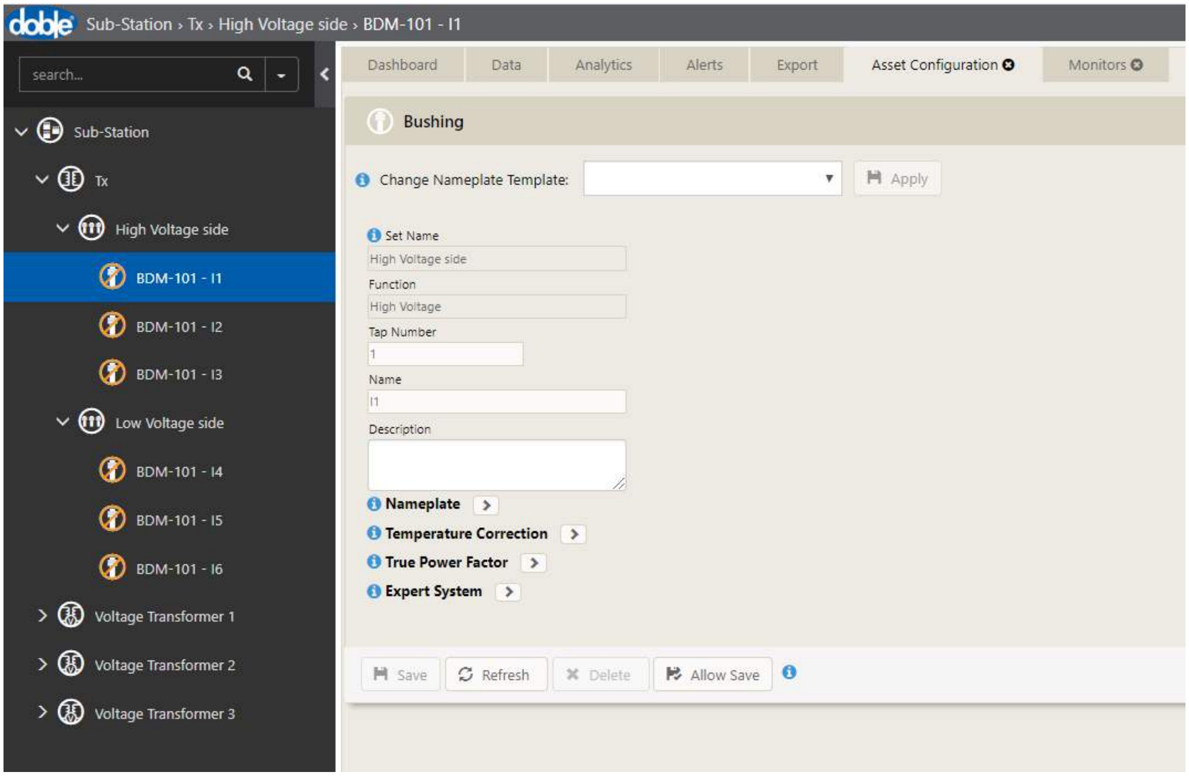


Figure 41 - Bushing Settings

The following table lists the bushing options.

Bushing Options

Option	Description
Set Name	Name of the asset the current channels belong to.
Function	Available functions are: High Voltage, Low Voltage. and Neutral.
Tap Number	Lists which bushing tap this channel is linked to.
Name	Name of the channel in the doblePRIME™ application.
Description	Additional descriptions of the bushing.
Nameplate	Nameplate contains the bushing nameplate data, system voltage, bushing model, and bushing tap details.

Bushing Options (continued)

Option	Description
Temperature Correction	The temperature correction feature allows users to compare bushing power factor results corrected to 20 degrees Celsius. Known correction curves for bushing manufacturers and models are included in Calisto by default.
True Power Factor	True Power Factor mode can be enabled in this option. The TPF will require the phase shift and scale factor according to the configuration of transformer. Link the voltage asset to the bushing to determine the relative phase angle.
Expert System	Expert System determines how much of a percent deviation from nominal values causes alert messages to be sent.

Nameplate Options

Enter the following required information of the bushing and system voltage:

- Capacitance pF - The capacitance from bushing nameplate or latest offline test
- PF % - Enter the Power Factor from bushing nameplate or latest offline test
- System voltage - Voltage level which the bushing is connected
- System voltage reference - Reference to measure the system voltage. Line to Line or Line to Ground

The following nameplate options are optional:

- Manufacturer
- Model
- Serial Number
- Year of Manufacture
- Installation data
- BTT Model
- BTT Serial Number
- BTA Model
- Installation date

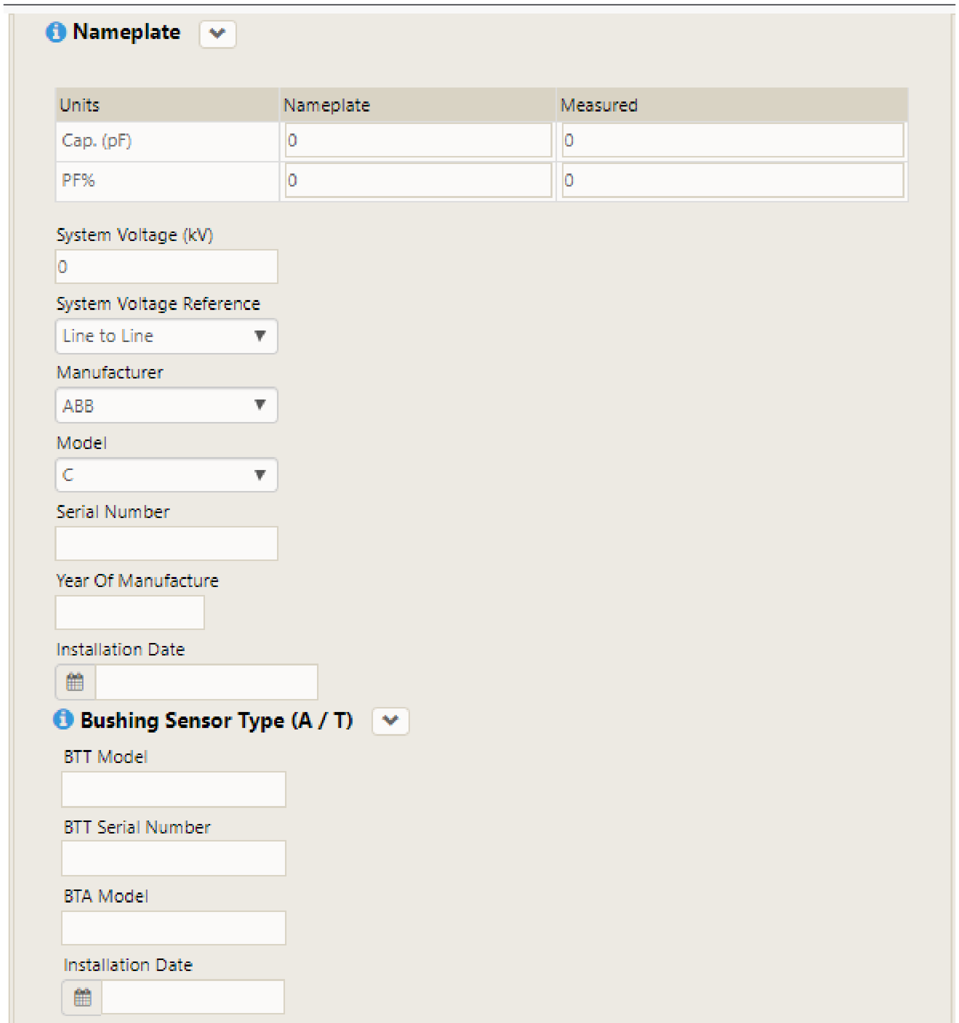


Figure 42 - Nameplate Options

Temperature Correction Options

Before enabling the Temperature Correction option, at least one bushing temperature channel must be added to the system. The temperature signal can come from a physical connection to the analog or temperature card (see iO Monitor Overview (page 73)) or from communications. To enable the temperature correction option, select **Point** or **Average** from the Mode drop-down list.

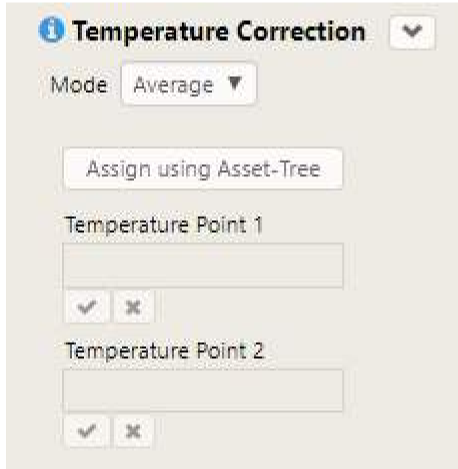


Figure 43 - Temperature Correction: Modes

Temperature Correction has two modes: Point and Average. The Point mode requires only one bushing temperature channel to be assigned from the asset tree whereas the Average mode requires two temperature channels.

Perform the following steps to enable and set up temperature correction.

1. Click the **Mode** drop-down list and select **Point** or **Average**.
2. Click **Assign using Asset-Tree**. The asset tree will show the temperature channels available.
3. Click on the appropriate temperature channel in the asset tree; it will be highlighted in blue.
4. Click the check mark to assign the channel to **Temperature Point 1**.
5. If Average mode was selected, pick a second temperature channel in the asset tree, and assign to **Temperature Point 2**.

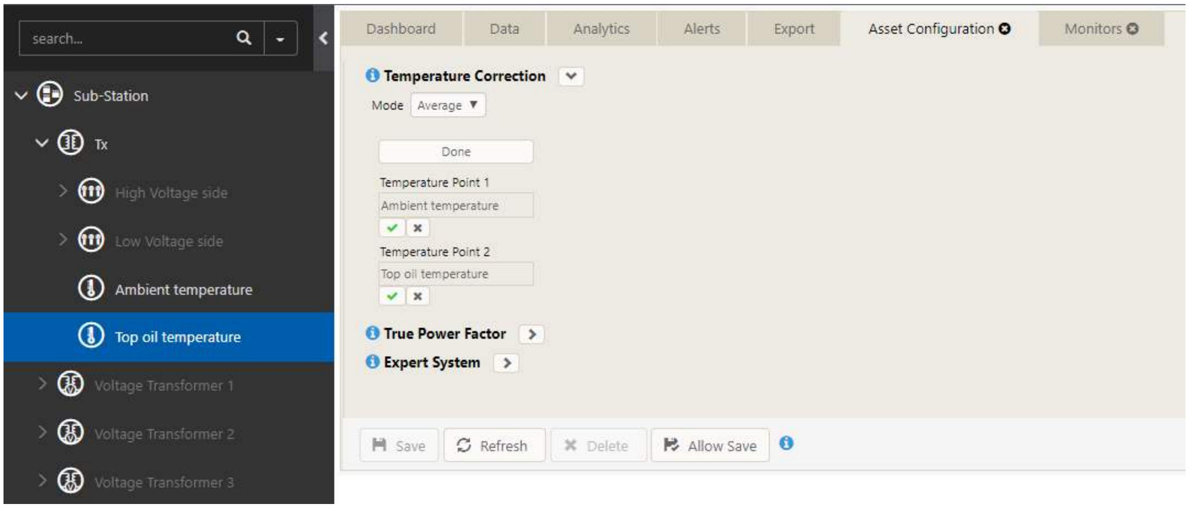


Figure 44 - Temperature Correction Options

True Power Factor Options

If the voltage transformers are present in the installation, wired up to the Calisto™ T1, and True Power Factor is required, then you will need to enable it from the Enable drop-down. The phase shift and scale factor figures depend on the transformer's nameplate and connection. For more information about phase shift and scale factor configuration, refer to True Power Factor Calibration (page 128).

The voltage transformer can be assigned to the bushing as the voltage reference to calculate the relative phase angle.

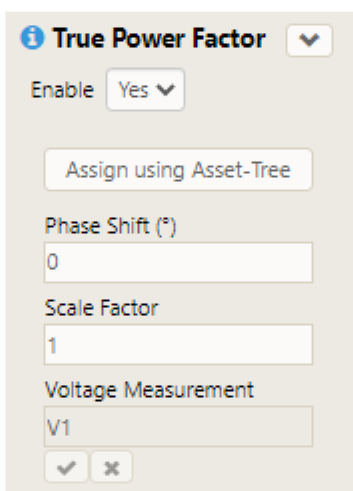


Figure 45 - True Power Factor Enabled

Perform the following steps to enable and set up True Power Factor.

1. Click the Enable drop-down menu and select **Yes**.

2. Click **Assign using Asset-Tree**. The asset tree will show the voltage channels available.
3. Click on the appropriate voltage transformer channel in the asset tree; it will be highlighted in blue. The bushing and voltage transformer must be in the same phase.
4. Click the check mark to assign the channel to the **Voltage Measurement**.

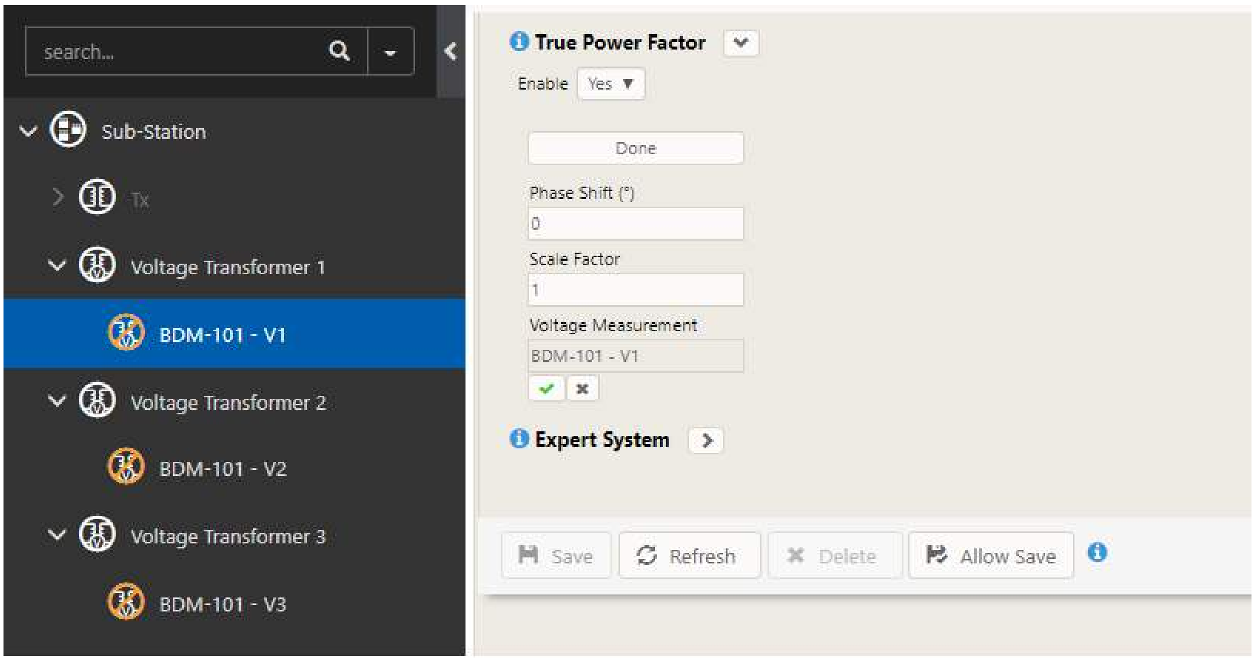
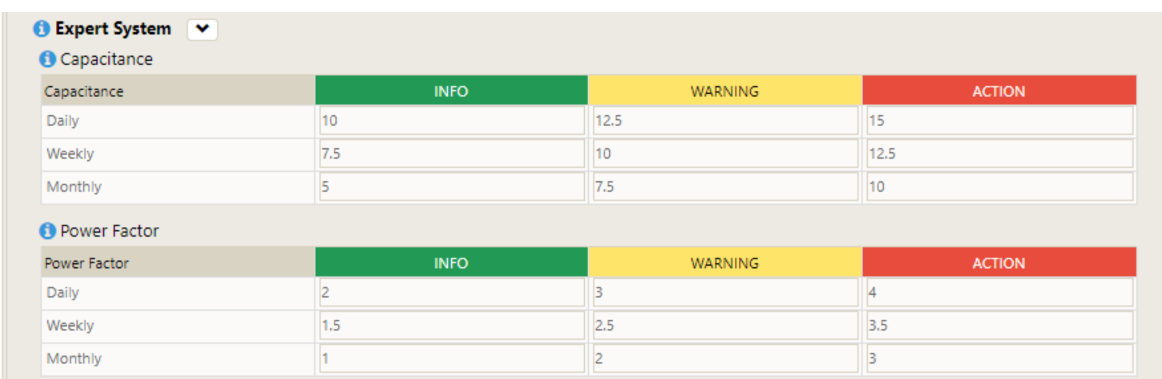


Figure 46 - Assigning a Voltage Channel

Expert System

Click **Expert System** to view the expert system parameters. The expert system determines how much of a percent deviation from nominal values causes alert messages to be sent. Those parameters come from Doble's years of expertise and should only be changed by an experienced engineer after assessing the bushing and installation.



Expert System

Capacitance

Capacitance	INFO	WARNING	ACTION
Daily	10	12.5	15
Weekly	7.5	10	12.5
Monthly	5	7.5	10

Power Factor

Power Factor	INFO	WARNING	ACTION
Daily	2	3	4
Weekly	1.5	2.5	3.5
Monthly	1	2	3

Figure 47 - Expert System

Saving the Settings

In the footer panel, click **Allow Save** to enable the **Save** option. Click **Save** to confirm the changes.

> **Note:** Changes on current bushing must be saved first before selecting a different bushing to edit, otherwise the current changes will be lost. Repeat the process for as many bushings you are monitoring.

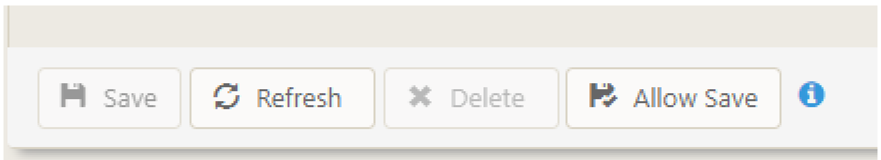
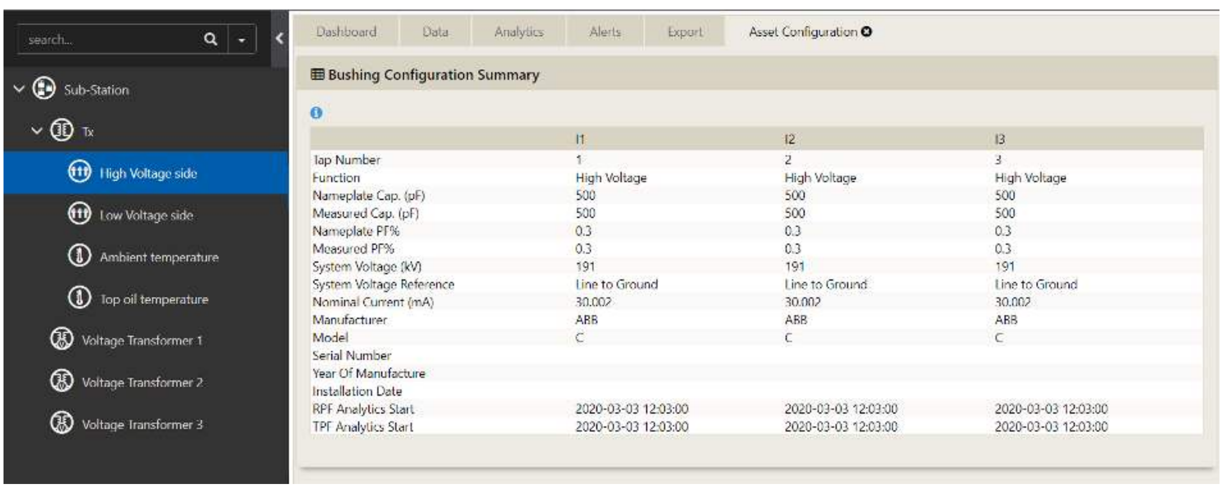


Figure 48 - Allow Save

To view a summary of the bushing configuration, open the **Asset Configuration** tab then select the bushing set in the asset tree. The Bushing Configuration Summary will open in the Asset Configuration tab.



	I1	I2	I3
Tap Number	1	2	3
Function	High Voltage	High Voltage	High Voltage
Nameplate Cap. (pF)	500	500	500
Measured Cap. (pF)	500	500	500
Nameplate PF%	0.3	0.3	0.3
Measured PF%	0.3	0.3	0.3
System Voltage (kV)	191	191	191
System Voltage Reference	Line to Ground	Line to Ground	Line to Ground
Nominal Current (mA)	30.002	30.002	30.002
Manufacturer	ABB	ABB	ABB
Model	C	C	C
Serial Number			
Year Of Manufacture			
Installation Date			
RPF Analytics Start	2020-03-03 12:03:00	2020-03-03 12:03:00	2020-03-03 12:03:00
TPF Analytics Start	2020-03-03 12:03:00	2020-03-03 12:03:00	2020-03-03 12:03:00

Figure 49 - Bushing Configuration Summary

Commissioning the Bushing Monitor

A commissioned monitor can read the measurements from sensors and save the results into the database. Review the settings of your monitor before setting to Commissioned mode. Data logged by the monitor cannot be deleted or altered in the database.

Checklist Before Commissioning the Bushing Monitor

Monitor Settings	Polling Rate	Must be greater than 15 minutes. The monitor can be set to one-minute polling for a short time, during the commissioning or when investigating an issue with the bushings
	System Frequency	Enter the system frequency of the grid
	Current Channels	Current channels must be linked to a bushing set or bushing sets
	Voltage Channels	If applicable, voltage channels must be linked to voltage transformer assets
Bushing Settings	Nameplate	Check nameplate/offline data and system voltage
	Temperature Correction	If applicable, link temperature channels to increase the accuracy of TPF calculations
	True Power Factor	If applicable, enable True Power Factor and enter fine-tuned phase shift and scale factor. Refer to True Power Factor Calibration (page 128).

After you have confirmed the settings are correct, go to the bushing monitor settings and change the Status from **Maintenance** to **Commissioned**.

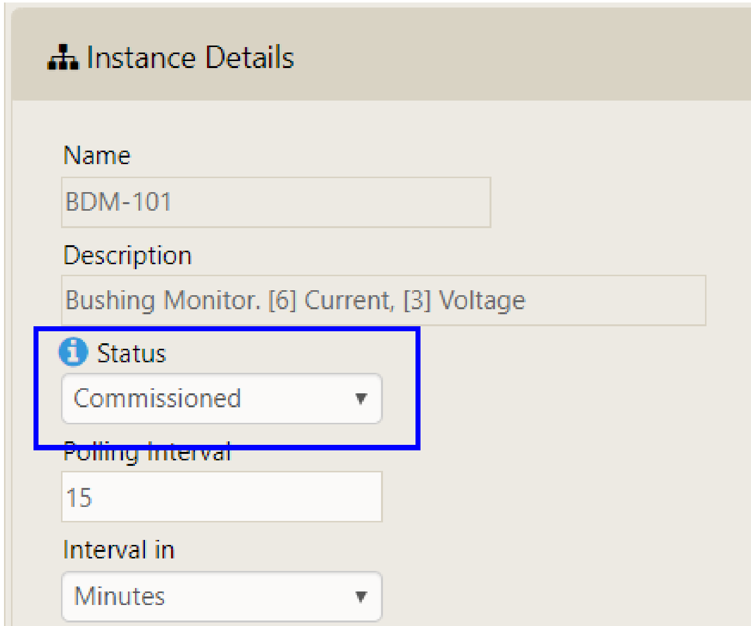


Figure 50 - Bushing Monitor Status

To save the changes click **Save** in the panel footer of the bushing monitor. Allow the doblePRIME™ application to acknowledge the changes (this is an automatic process and can take up to 3 minutes). After this process, you will start seeing data in the Dashboard tab. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

Figure 51 - Dashboard Tab - Bushing Data

Configuring the Partial Discharge Monitor

In this section, the procedure to monitor PD at Bushing Set 1 and Bushing Set 2 is described. A generic configuration of the remaining channels to monitor PD inside the transformer using a Drain Valve probe and the Plate Sensor is also shown.

Partial Discharge Monitor Settings

On the partial discharge monitor page, you can edit the communications settings and assign the asset created to the channels. The channels are entities representing the eight multiplexed inputs, which could be connected to a HFCT sensor, UHF Drain Valve Probe, UHF Plate sensor, and many others. The channels assigned to the asset are "owned" by the asset so data can be presented in the doblePRIME™ application.

The partial discharge monitor instance is the entity representing the Doble PD-Guard monitor inside the Calisto™ T1.

Perform the following steps to open the partial discharge monitor settings.

1. Click the settings icon on the top-right of the title bar.
2. Click **Monitors**.

The Monitors tab will open in the feature panel.

3. Click Channels for the PDM-100 monitor to open its settings.

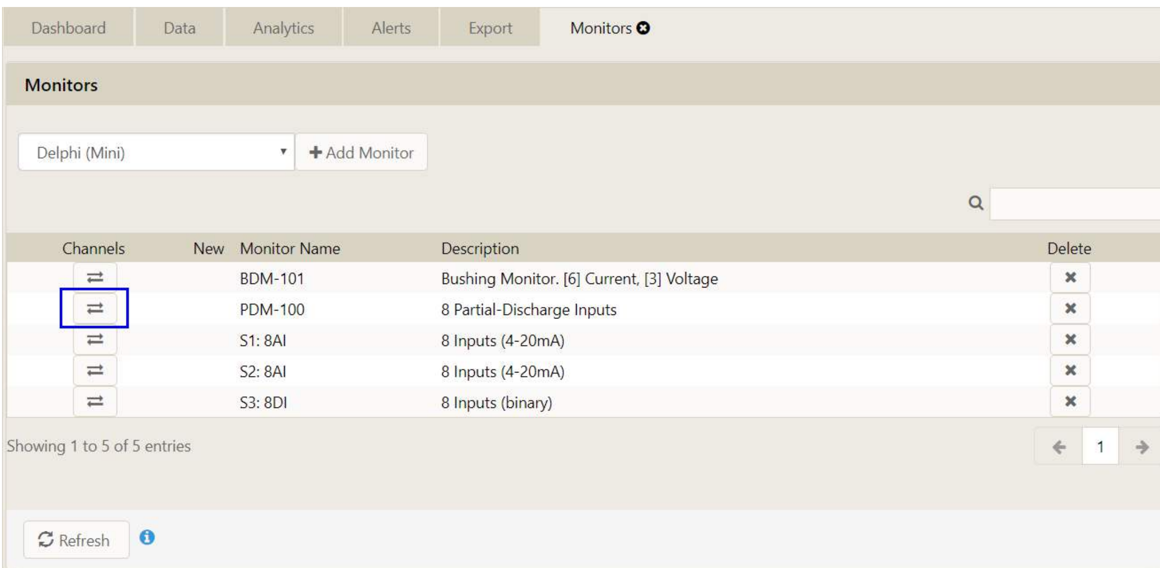


Figure 52 - Monitors: Open Settings

The Instance Details section opens; this section contains the monitor settings.

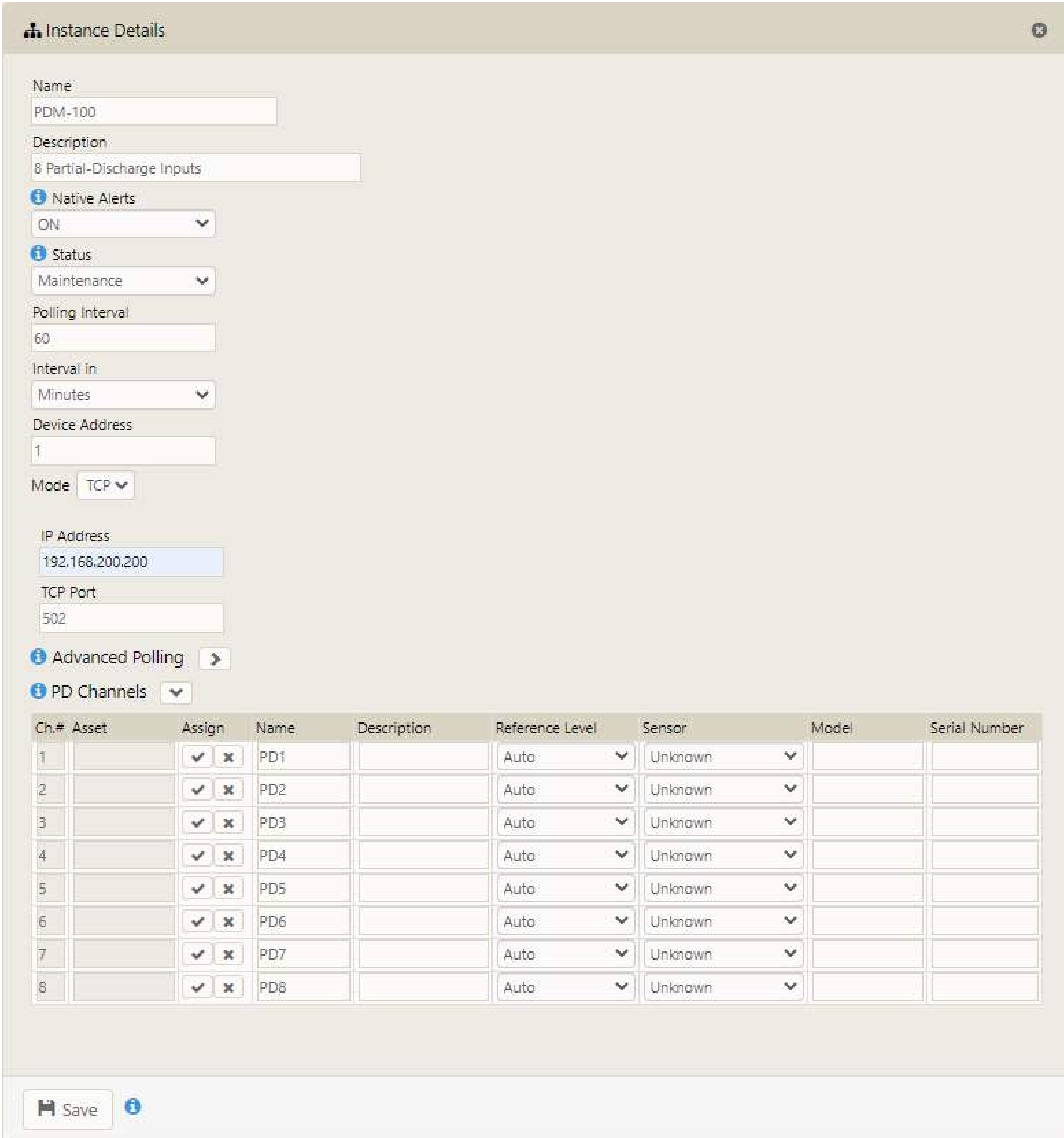


Figure 53 - Partial Discharge Monitor Settings

Signals from SET 1 and SET 2

The signals from SET 1 (current channels 1-2-3) are connected internally to the HFCT inside the unit. The purpose of the HFCT is to decouple the PD signals from SET 1 so it can be monitored by PD channels 1-2-3. The output of HFCT SET 1 is internally connected to PD channels 1-2-3. Therefore, the first three PD channels must be used with HFCT SET 1, and no other sensor can be connected to any of these channels.

Similarly, the signals from SET 2 (current channels 4-5-6) are internally connected to the second HFCT inside the unit. The outputs from HFCT SET 2 are available from HFCT LINK A-B-C BNC connectors, just below the PD input BNC connector. Should the PD signals from SET 2 have to be monitored, then use three coax leads to link output A to PD input 4, output B to PD input 5, and output C to input 6. If SET 2 current channels are not used, or there is no interest to monitor the PD signal at this set, then PD inputs 4-5-6 can be used with any other sensor.

The inputs 7 and 8 can be used to any sensor available as they are not linked to any internal instrument.

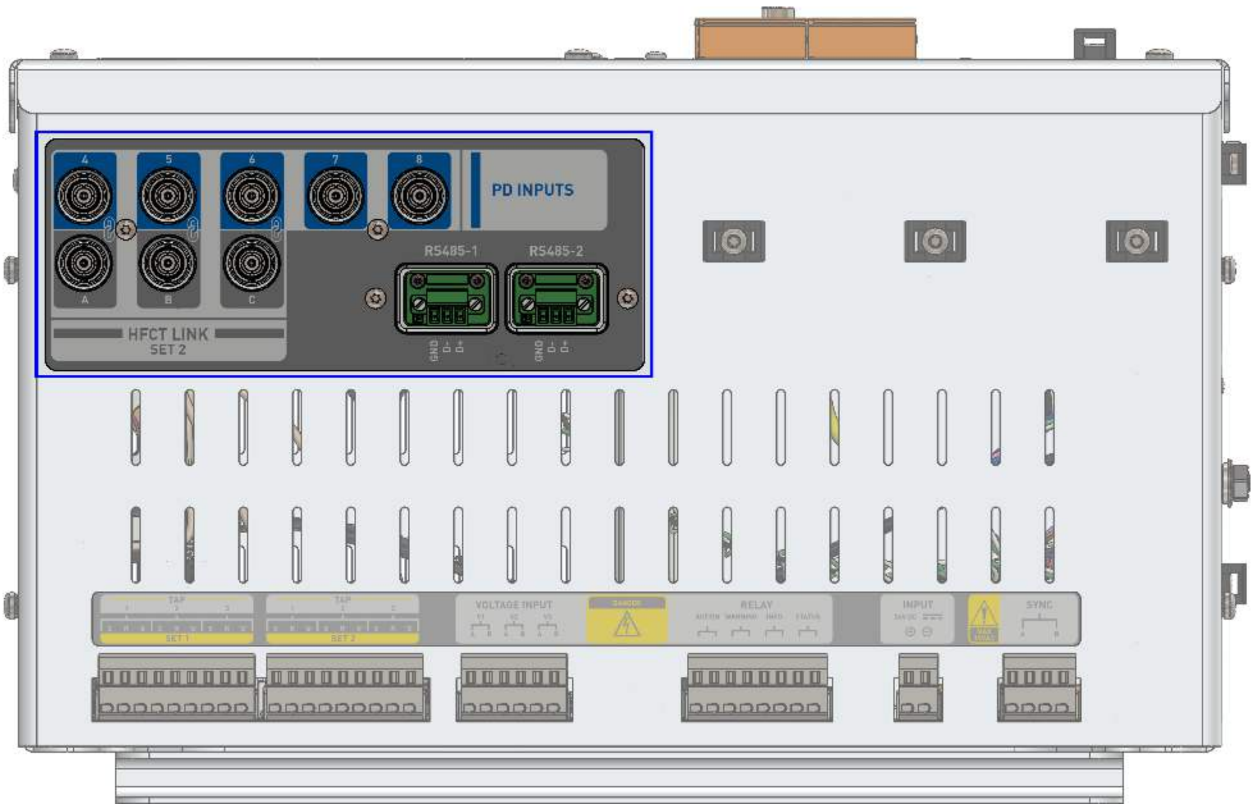


Figure 54 - Calisto™ T1: PD Inputs and HFCT Link - SET 2 Output

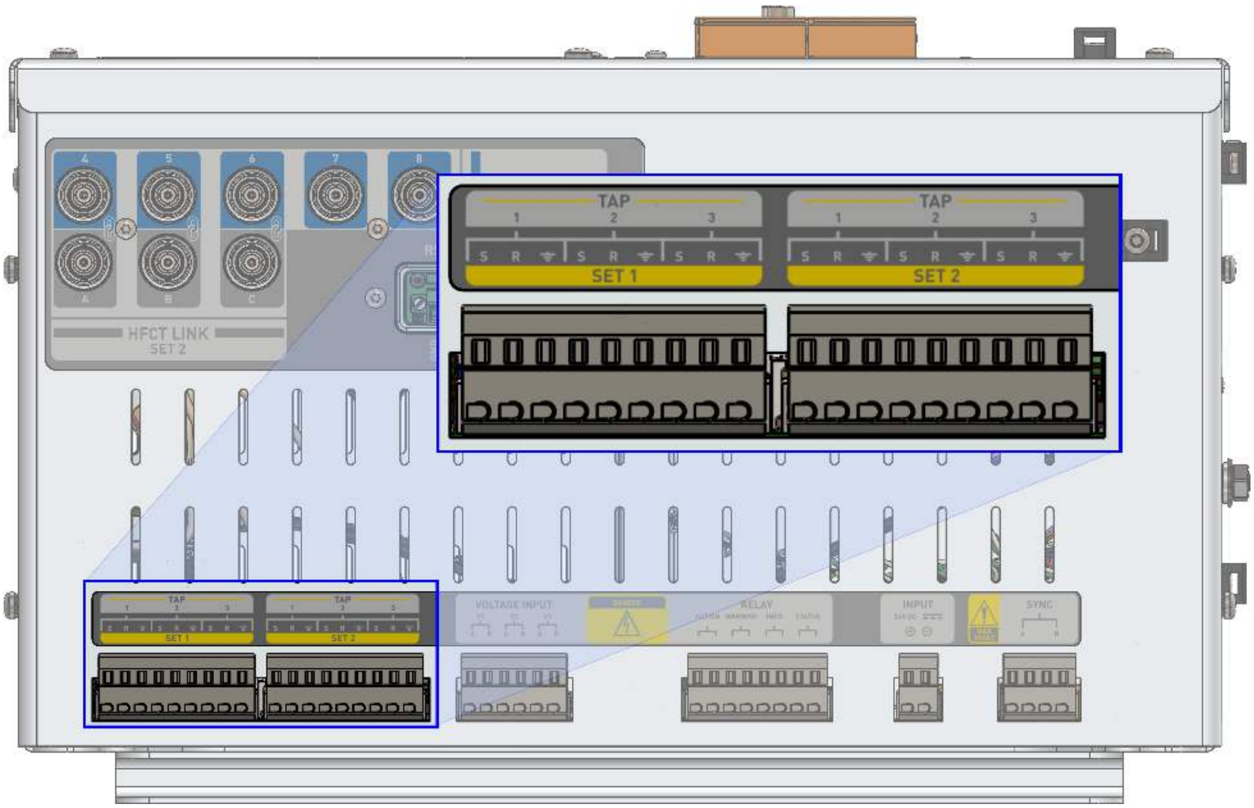


Figure 55 - Calisto™ T1: SET 1 and SET 2 Inputs

Assigning the Partial Discharge Monitor at Bushing SET 1

Perform the following steps to monitor PD at bushing SET 1.

1. Locate and select the created bushing set linked to SET 1 in the asset tree.
2. Click the **Assign** check mark next to channels 1, 2, and 3. The name of the bushing set is copied into the Asset field and the check mark will change to green.
3. Enter an appropriate name for the channels being monitored in the **Name** field.
4. Select the appropriate reference level from the **Reference Level** drop-down.
5. Select the HFCT sensor from the **Sensor** drop-down.
6. Click **Save** in the panel footer.

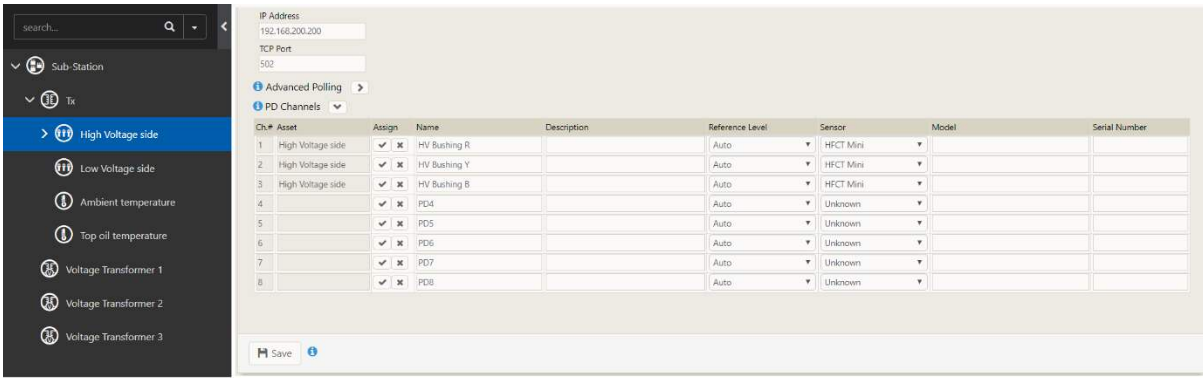


Figure 56 - PD Channels Options

Assigning the Partial Discharge Monitor at Bushing SET 2

Perform the following steps to monitor PD at bushing SET 2.

1. In the doblePRIME™ application, locate and select the created bushing set linked to SET 2 in the asset tree.
2. Click the **Assign** check mark next to channels 4, 5, and 6. The name of the bushing set is copied into the Asset field, and the check mark will change to green.
3. In the doblePRIME™ application, locate the created bushing set linked to SET 2 in the asset tree. Drill down the transformer asset and click on the bushing set of interest.
4. Select the **Assign** check mark next to channels 4, 5, and 6. The name of the bushing set will be copied into the Asset field and the check mark will change to green.
5. Enter an appropriate name for the channels being monitored in the **Name** field.
6. Select the appropriate reference level from the **Reference Level** drop-down.
7. Select the HFCT mini sensor from the **Sensor** drop-down.
8. Click **Save** in the panel footer.

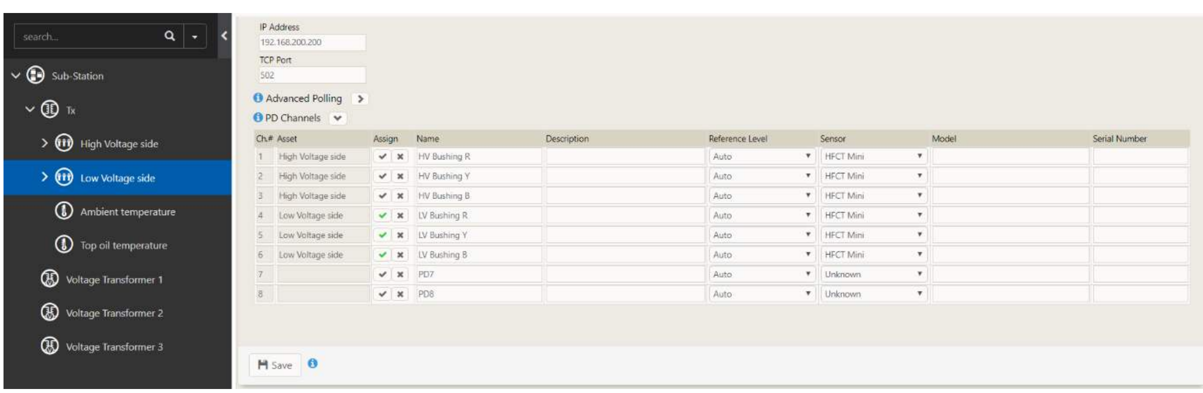


Figure 57 - PD Channels SET 1 and SET 2 Configuration - Example

> **Note:** Use the coax leads to link the HFCT outputs A-B-C to the PD inputs 4-5-6.

When there is no need to monitor bushing SET 2, you can use channels 4-5-6 to monitor PD signals from different sensors. Plug the sensor at PD input 4, 5, or 6 then select the asset from the asset tree which best represents the location of the sensor. Select the reference level and appropriate sensor preset.

Assigning the Partial Discharge Monitor at Channels 7 and 8

These channels are for general use and can be used with any type of PD sensor with a preset available.

Perform the following steps to monitor channels 7 or 8.

1. Plug the sensors in at PD input 7 or 8.
2. Select the asset from the asset tree which best represents the location of the sensor.
3. Select the appropriate reference level from the **Reference Level** drop-down list.
4. Select the appropriate sensor from the **Sensor** drop-down.

PD Sensor	Sensor Preset
HFCT mini	HFCT mini
HFCT-300	HFCT 300
LDWS-17	PDDC 17
LDWS-24	PDDC 24
UHF Drain Valve	DN50/80
UHF Plate	DN50/80

5. Click **Save** in the panel footer.

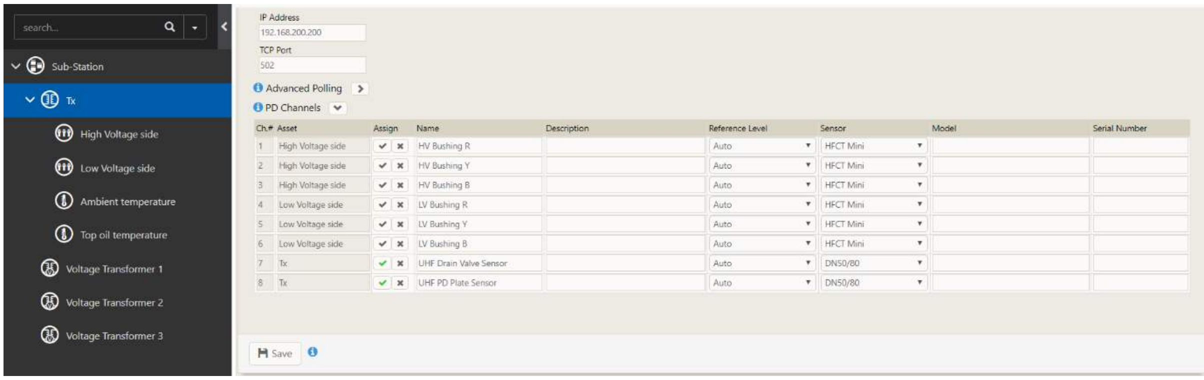


Figure 58 - PD Channels - Example

Commissioning the Partial Discharge Monitor

A commissioned monitor can read the measurements from sensors and save the results into the database. Review the settings of your monitor before setting up to commissioned mode. Data logged by the monitor cannot be deleted or altered in the database.

Partial Discharge Monitor Settings

Monitor Field	Description
Name	PD monitor name
Native Alerts	Block the alerts coming from the internal PDM board. If alerts are blocked, then use the ASM scheme to create your alerts. For more information about ASM configuration refer to the doblePRIME User Guide (PN 72A-2812-01).
Description	Number of inputs
Status	• Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required. • Commissioned status causes the monitor to collect data if the communication settings are correct. • Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.
Polling Interval	Interval at which the Calisto™ T1 receives data from the internal PDM board
Interval In	Select internal in minutes and hours

Partial Discharge Monitor Settings (continued)

Monitor Field	Description
Device Address	Do not change this setting. Default address 1
Mode	Communication to the internal PDM board is via TCP
IP Address	Do not change this setting. Default IP 192.168.200.200
TCP Port	Do not change this setting. Default port 502

After you have confirmed the settings are correct, go to the partial discharge monitor and change the Status from **Maintenance** to **Commissioned**.

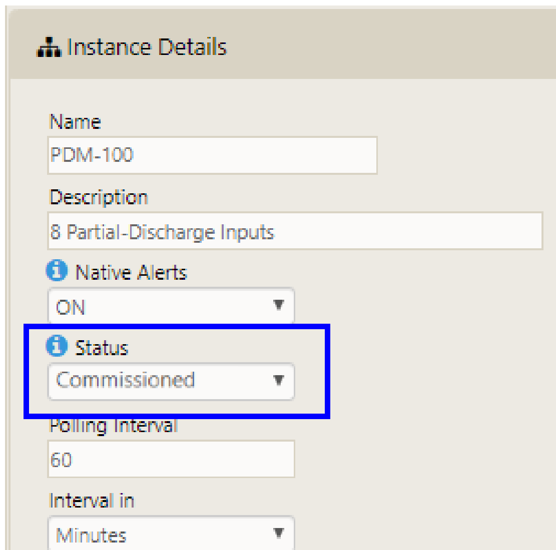


Figure 59 - PD Monitor Status

To save the changes, click **Save** in the panel footer of the PD monitor. Allow the doblePRIME™ application to acknowledge the changes, this is an automatic process and can take up to 3 minutes. After this process you will start seeing data in the Dashboard tab. Refresh the web browser tab according to the polling rate and latest measured time stamp to see new data in the Dashboard tab.

Configuring the iO Monitor

This section describes how to configure the iO monitor to log analog and digital data. Feeding extra information into the monitor adds some context regarding the operation of the asset and help to investigate issues that may arise.

iO Monitor Overview

The iO monitor instances, 8Ai and 8DI, are the entities representing the Doble iO monitor inside the Calisto™ T1.

There are two different iO monitors instances available to use:

- 8AI - 8 Analog Input channels. For more information see 8AI Monitor Settings (page 73)
- 8DI - 8 Digital Input Channels. For more information see 8DI Monitor Settings (page 77)

There are four slots, on the front panel of the Calisto™ T1 where the iO cards can be inserted. When a card is inserted in the slot, the Calisto web application will detect and create the monitor instance for the card. The name of the card instance carries the position at which it was inserted, e.g., S1 is the first slot, S2 is the second slot and so on.

> **Note:** For more information about iO card upgrade and replacement see Hardware Expansion (page 94).

8AI Monitor Settings

On the 8AI monitor page you can edit the communications settings and assign the asset created to the channels. The channels are entities representing the physical inputs of the card, connected to various types of transducers (e.g., temperature, current, voltage). The channels assigned to the asset are “owned” by the asset so data can be presented on the doblePRIME™ application.

Assigning the Asset to the 8AI Monitor Channel

There are eight channels available to use. Any asset created can be assigned to the channels.

Perform the following steps to assign an asset to the channel.

1. Click the settings icon on the top-right of the title bar.
2. Click **Monitors**.
3. Click **Channels** for the appropriate 8AI monitor to open its settings.

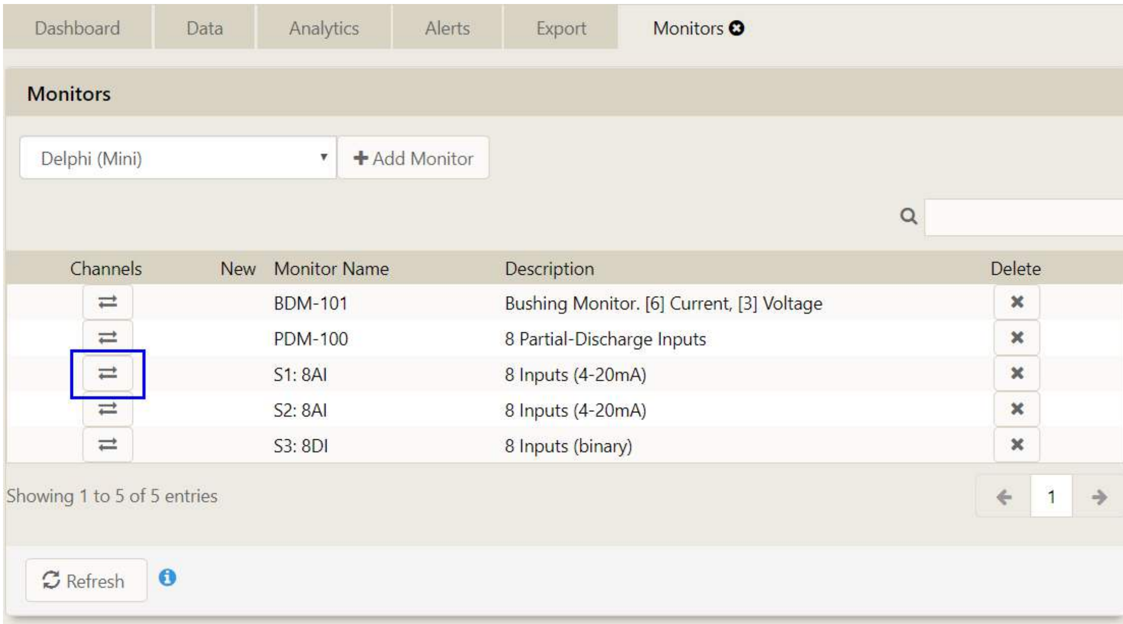


Figure 60 - Open Monitor Settings

4. Select an asset in the asset tree; the selected asset will be highlighted in blue. In the **Monitor Instance Details** section, click the **Assign** check mark next to channels that you want to associate to the asset.

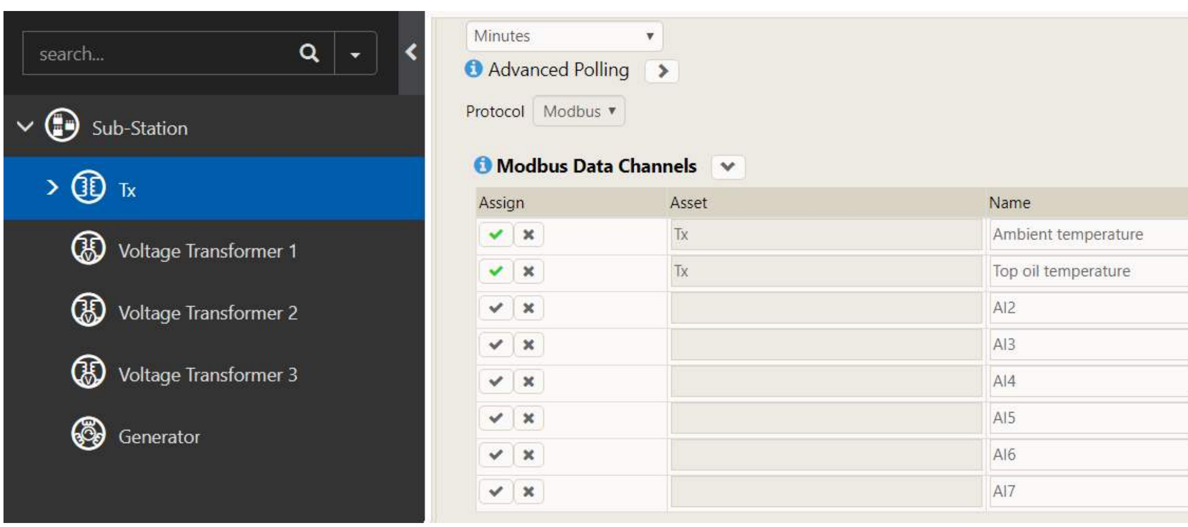


Figure 61 - 8AI Options

The name of the asset will be copied into the Asset field and the tick box will change color to green.

5. Enter a suitable name for the channel so you can easily identify it in the asset tree.

Channel Settings

Readings from the 8AI card come in a raw format. Scaling is required to convert raw data to an appropriate engineering value and measurement unit. The scaling and unit of measurement can be applied to each channel.

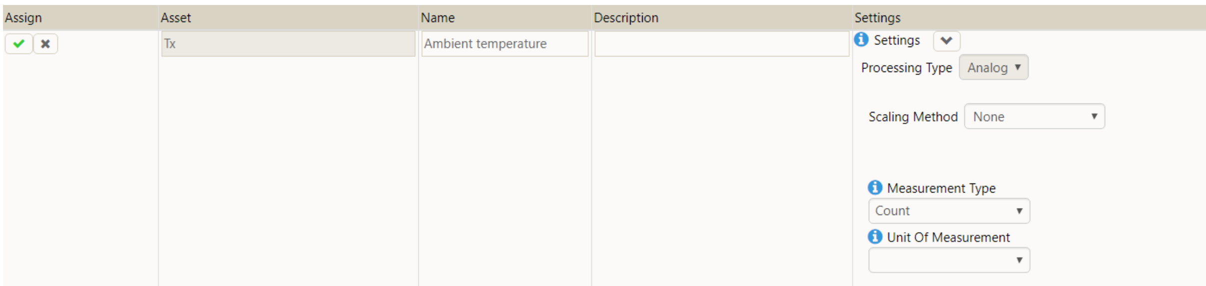


Figure 62 - Analog Channel Settings

General Settings

Analog Channel Settings

Setting	Description
Processing Type	Analog Type channel
Scaling Method	None: Raw values range • 4000 to 20000 when in Current mode • 0 to 10000 when in Voltage mode
	y=mx+c: Convert raw data to the engineering units by using the slope-intercept formula.
	Linear interpolation: Convert raw data to the engineering units by using the point-slope formula.
Measurement Type	Select the Measurement Type for the presentation of results, e.g., temperature, concentration.
Unit of Measurement	UoM options are filtered according to Measurement Type selection

The y=mx + c Scaling Method

When y=mx + c is selected, you can enter the coefficients of the slope-intercept formula.

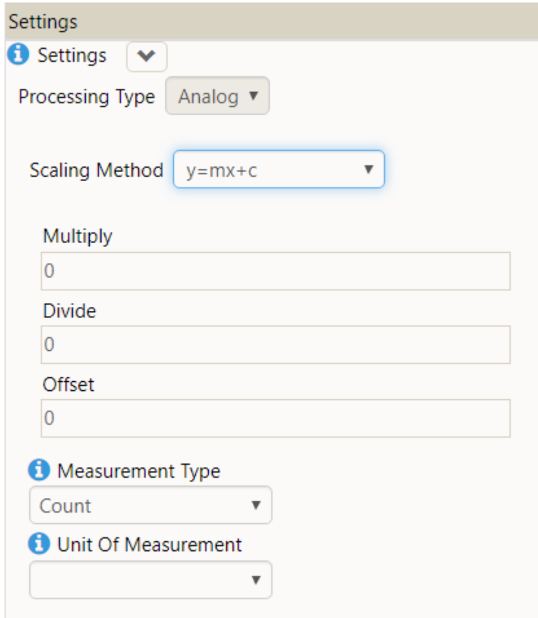


Figure 63 - Scaling Method: Slope-Intercept Parameters

The slope method requires you to enter the Multiply, Divider, and Offset constants. See example below:

m=Multiply/Divide and c=Offset

8AI Scaling Example, Slope-Intercept Formula

Transducer Input	Transducer output	8AI card raw output	Slope-intercept form	Multiply	Divide	Offset
0 to 1600 A	4 to 20 mA	4000 to 20000 counts	y = 0.1x - 400	1	10	-400

The Linear Interpolation Method

When linear interpolation is selected, you only need to enter the transducer input scale. See example below:

8AI Scaling Method, Linear Interpolation

Transducer Input	Min Raw Value	Max Raw Value	Zero Value	Full Scale Value
0 to 1600 A	4000	20000	0	1600

Commissioning the 8AI Monitor

A commissioned monitor can read the measurements from sensors and save the results into the database. Review the settings of your monitor before setting up to commissioned mode. Data logged by the monitor cannot be deleted or altered in the database.

8AI Monitor Settings

Monitor Fields	Description
Name	Slot position and name of the card.
Description	Number and type of inputs.
Status	• Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required. • Commissioned status causes the monitor to collect data if the communication settings are correct. • Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.
Polling Interval	Interval at which the Calisto™ T1 receives data from the 8AI card
Interval in	Select Internal in seconds, minutes.

To save the change click **Save** in the panel footer. Allow the doblePRIME™ application to acknowledge the changes (this is an automatic process and can take up to 3 minutes). After this process you will start seeing data in the Dashboard tab. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

8DI Monitor Settings

On the 8DI monitor page you can edit the communications settings and assign the asset created to the channels. The channels are entities representing the physical inputs of the card, connected to switches (e.g., circuit breaker state, alarms). When the asset is assigned to the channel, it owns and displays the channel measurements in the doblePRIME™ application.

Assigning the Asset to the Channel

There are eight channels available to use. Any asset created can be assigned to the channels.

Perform the following steps to assign an asset to the channel.

1. Click the settings icon on the top-right of the title bar.
2. Click **Monitors**.

3. Click **Channels** for the appropriate 8DI monitor to open its settings.

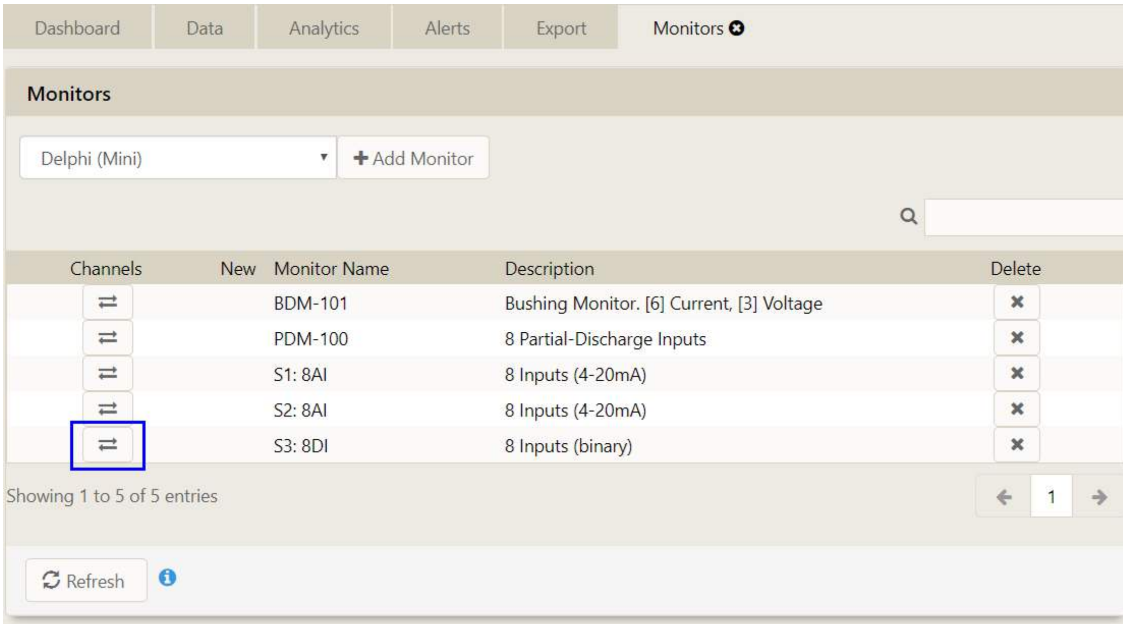


Figure 64 - Open Monitor Settings

4. Select an asset in the asset tree; the selected asset will be highlighted in blue. In the **Monitor Instance Details** section, click the **Assign** check mark next to channels that you want to associate to the asset.

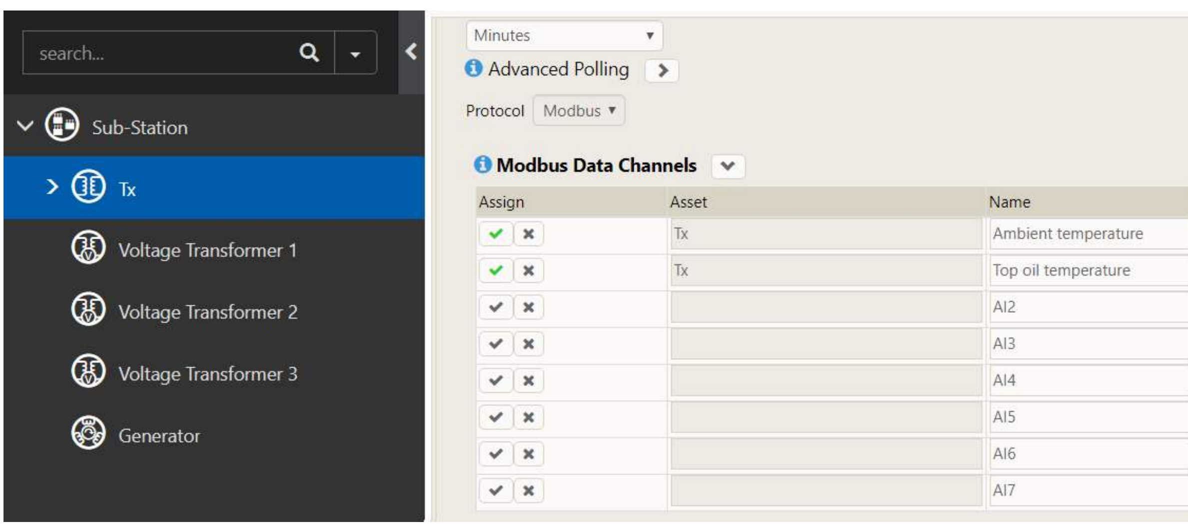


Figure 65 - 8DI Options

The name of the asset is copied into the Asset field, and the tick box will change color to green.

5. Enter a suitable name for the channel so you can easily identify it in the asset tree.

Channel Settings

Readings from the 8DI card comes in a raw format. Scaling is required to convert raw data to its corresponding meaningful engineering value and measurement unit. The scaling and unit can be applied to each channel.

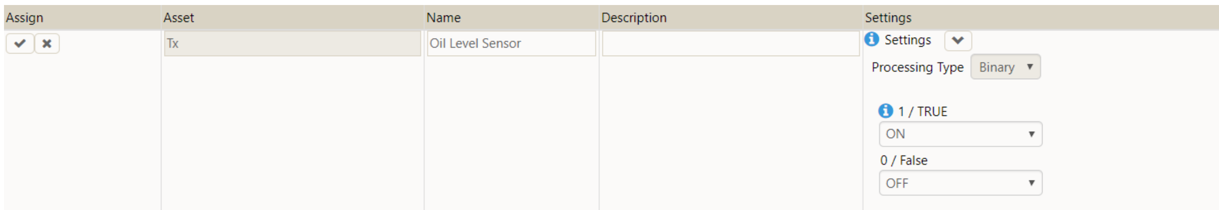


Figure 66 - Digital Channel Settings

General Settings

Digital Channel Settings

Setting	Description
Processing Type	Binary Type channel
1/TRUE	Pick a label to describe the state of the channel when the input is in high-state
0/FALSE	Pick a label to describe the state of the channel when the input is in low-state

Commissioning the 8DI Monitor

8DI Monitor Settings

Monitor Field	Description
Name	Slot position and name of the card.
Description	Number and type of inputs.
Status	• Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required. • Commissioned status causes the monitor to collect data if the communication settings are correct. • Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.

8DI Monitor Settings (continued)

Monitor Field	Description
Polling Interval	Interval at which the Calisto™ T1 receives data from the 8DI card.
Interval in	Select Internal in seconds and minutes.

To save the change click **Save** in the panel footer. Allow the doblePRIME™ application to acknowledge the changes (this is an automatic process and can take up to 3 minutes). After this process you will start seeing data in the Dashboard tab. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

7. Network Configuration

This section describes how to configure the network settings using the doblePRIME™ application.

Configuring the Ethernet Interfaces

Ethernet interfaces allows the Calisto™ T1 to communicate with monitors and supervisory systems. Additional features may also be configured, e.g., security and time reference.

Perform the following steps to edit the Ethernet interfaces.

1. Click the settings icon on the top-right of the title bar.
2. Click **System Configuration**.
3. In the System Configuration tab, click **Ethernet Interface**. There are three network interfaces available.

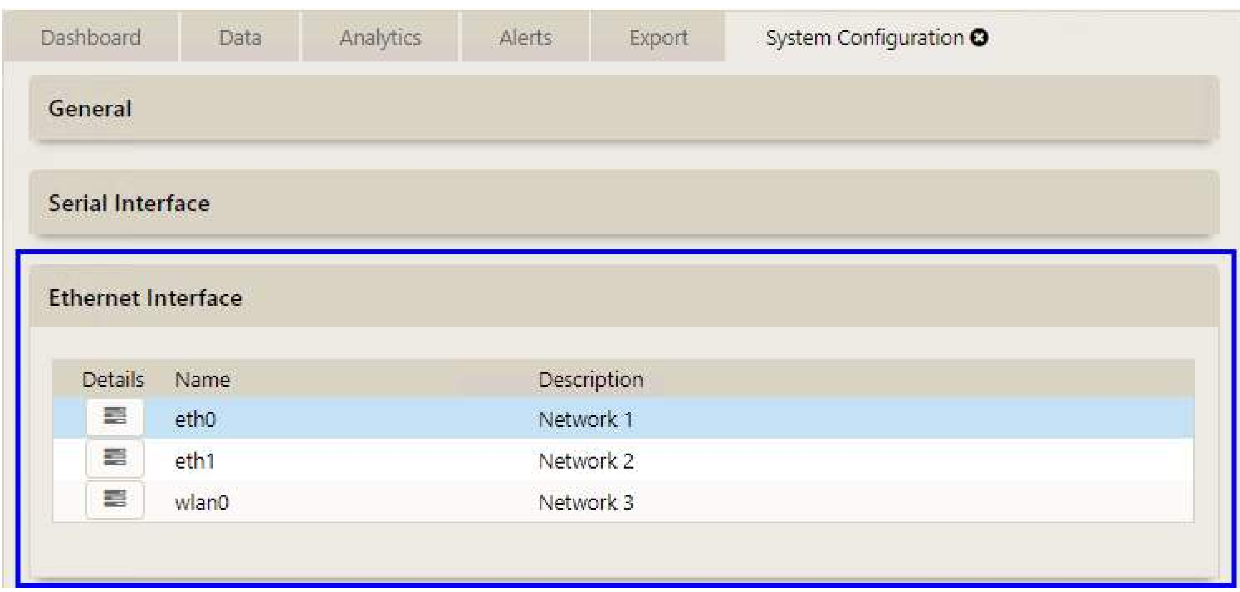


Figure 67 - System Configuration: Ethernet Interface

Caution: The interfaces eth0 and eth2 – Network 1 and Network 3 – are dedicated ports to communicate with the Bushing Data Monitor and Partial Discharge Monitor, respectively, found inside Calisto™ T1. Changing the IP address of those interfaces will disrupt the communication between the mainboard and these monitors. Do not change the IP address of these interfaces unless you understand the consequences of it. Default IP addresses are: **eth0 – 192.168.10.19** and **eth2 – 192.169.200.1**.

The interface eth1, LAN 1 on the front panel, is the only interface that you have to edit when the IP of the unit must be changed.

4. Click **eth1** details to show the settings and firewall settings.

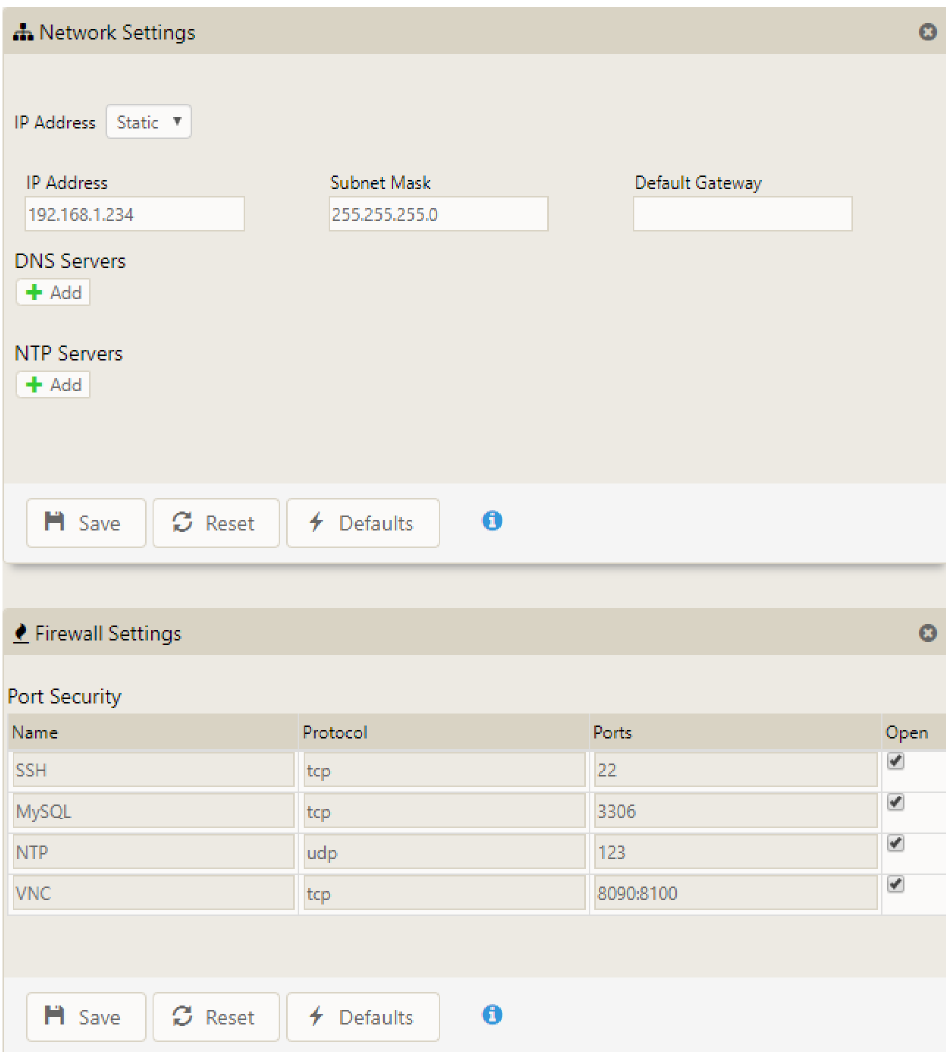


Figure 68 - LAN 1 (eth1) Network and Firewall Settings

Network Settings

The network settings are described in the following table.

Network Settings

Option	Description
IP Address (mode)	Select either Static or DHCP mode from the drop-down. Static mode allows you to enter the IP address of your choice. DHCP mode requires a DHCP server in the network to automatic lease an IP address to the interface.
IP Address (field)	Enter the IP address in this field when Static mode is selected.
Subnet Mask	Enter the subnet mask in this field when Static mode is selected.
Default Gateway	Enter the gateway address in this field when Static mode is selected.
DNS Servers	Only add the DNS server if it is required. It is used to resolve names to IP address.
NTP Servers	Add an NTP server address to synchronize time to a network time source.

Click **Save** in the Network Settings section to save your changes.

Firewall Settings

The firewall settings are described in the following table.

Firewall Settings

Port Name	Description
SSH	Maintenance port. The Doble engineer can dial into the unit over ssh to troubleshoot the device.
MySQL	Data Source port. Enables a higher doblePRIME or Calisto™ T1 instance to pull information from this device
NTP	Local Timer Server. Enable an external device to synchronize its clock using doblePRIME as a time source.
VNC	PD-Guard VNC Viewer. Enable a remote connection to the internal PD Board inside a PD-Guard or Calisto™ T1.

Click the tick box of the appropriate server to allow clients to connect to the service.

Click **Save** in the Firewall Settings section to save your changes.

Configuring the Serial Ports

Serial interfaces allow Calisto™ T1 to communicate with monitors or supervisory systems using the RS485 interfaces.

Perform the following steps to view and edit the serial ports.

1. Click the settings icon at the top-right of the title bar.
2. Click **System Configuration**.
3. In the System Configuration tab, click **Serial Interface**.

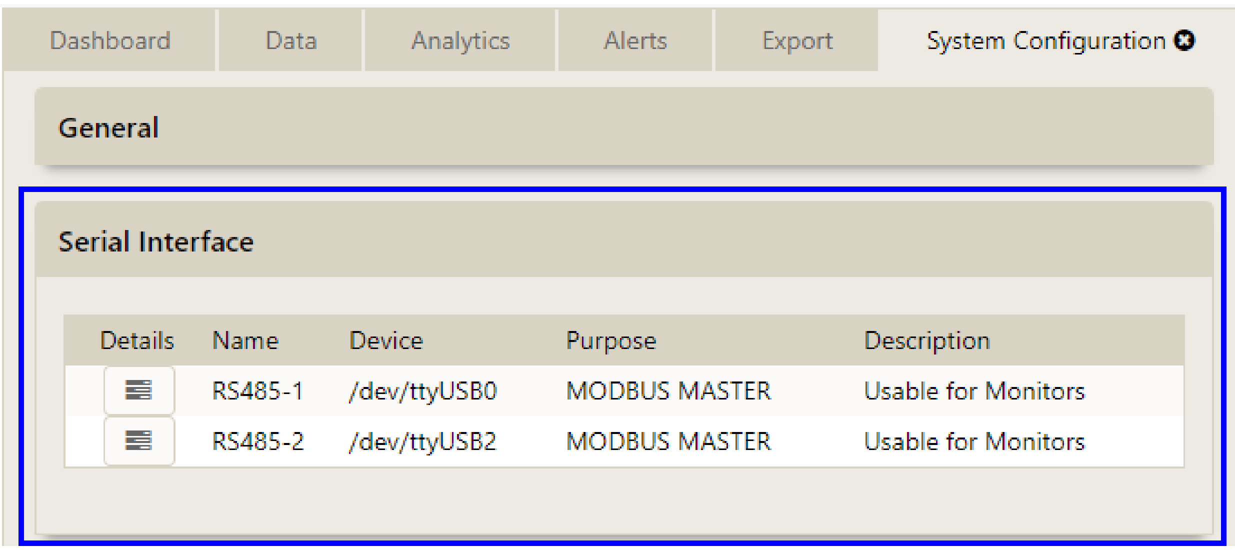


Figure 69 - System Configuration: Serial Interfaces

4. Click **Details** for the appropriate port you need to edit.

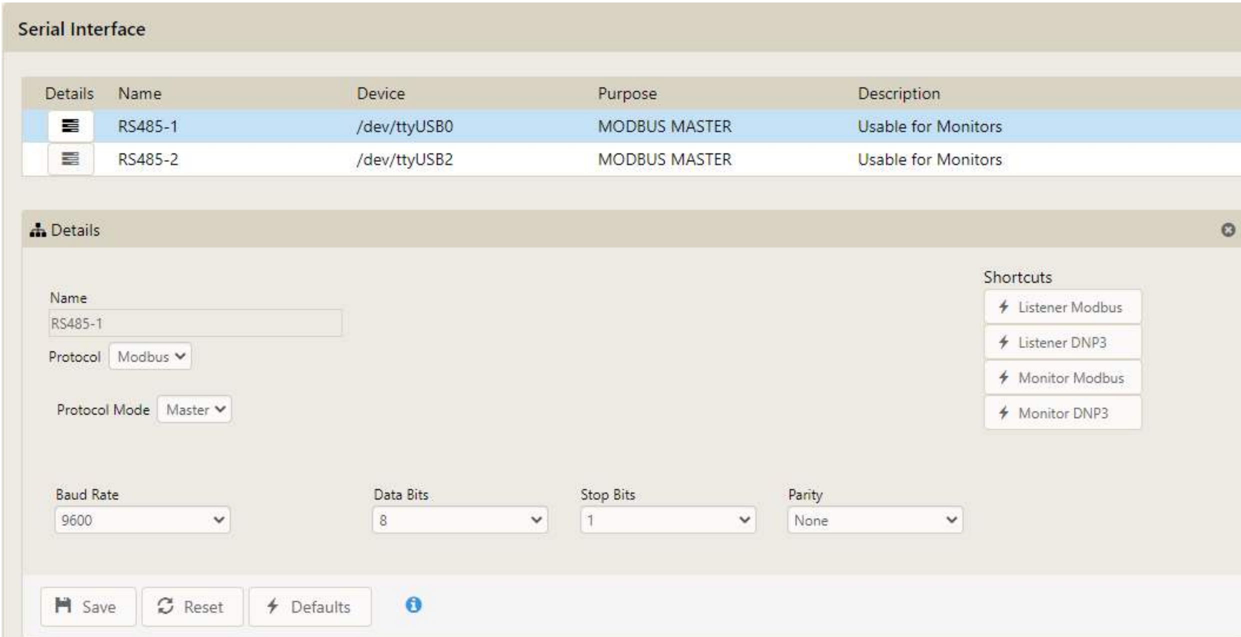


Figure 70 - Serial Interface Configuration Options

5. Select the communication protocol that will be bounded to this port.
6. Select the appropriate Protocol Mode from the drop-down list. **Master** mode enables the device to pull data from external monitors, e.g., DGA, and remote I/Os. **Slave** mode allows higher instances, e.g., SCADA systems, to pull data from this device.

Note: When deploying a serial Monitor, set a port in Master mode whereas when configuring a serial StationBus port set a port as Slave mode. Both Monitor and StationBus will only present the appropriate port for each application.

7. Select the serial communication parameters, Baud Rate, Data Bits, Stop Bits, and Parity. When in Slave mode, you can select an address for the Modbus or DNP3 protocol. The DNP3 master address can be configured at Comms Settings.
8. Alternatively, use the Shortcuts to quickly set up the protocol and protocol mode. Listener sets up the serial port in Slave mode. Monitor sets up the port in Master mode.
9. Make the appropriate configuration changes and click **Save**.

Comms Settings

Comms settings contains the Modbus and DNP3 protocol address settings. Edit the Modbus and DNP3 addresses as required.

Perform the following steps to edit the Modbus and DNP3 addresses.

1. Click the settings icon on the top-right of the title bar.
2. Click **System Configuration**.
3. In the System Configuration tab, click **Comms Settings**.

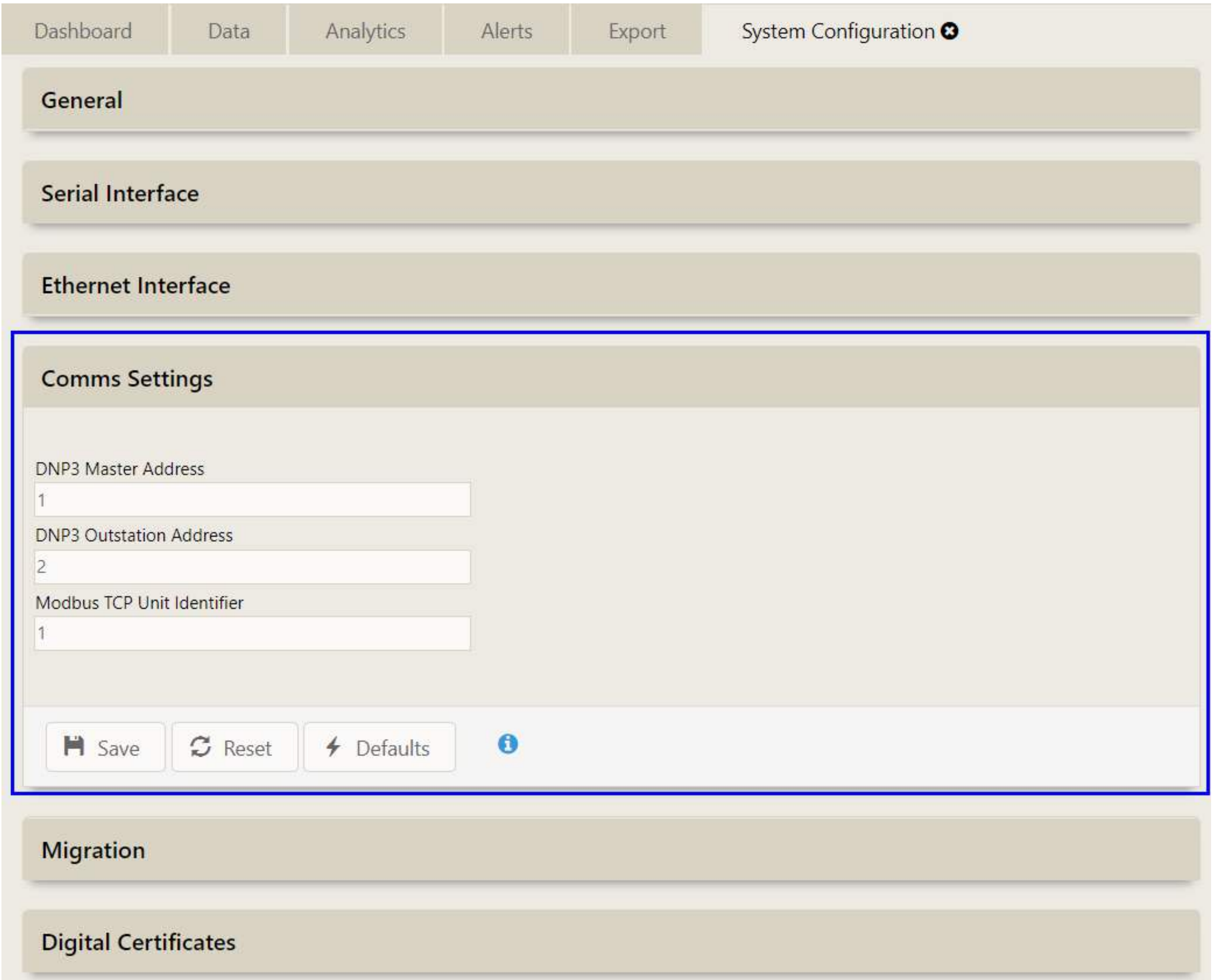


Figure 71 - System Configuration: Comms Settings

4. Edit the following addressing options as required:
   - DNP3 Master Address - A global address valid or both serial and TCP connections.
   - DNP3 Outstation Address - An address valid for TCP connection only. On serial connection, the outstation address can be set in the serial interface.
   - Modbus TCP Unit Identifier - The slave address for TCP connections. On serial connection, the slave address can be set in the serial interface.
5. Click **Reset** to reset the changes to the previous saved settings.
6. Click **Default** to reset the changes back to factory settings.
7. Click **Save** after making any changes.

Refer to Configuring the Serial Ports (page 84) for more information on setting up the DNP3 outstation address and Modbus slave address.

Configuring the LAN 2 Port

The IEC61850 protocol is available by adding an optional card – Kalkitech 221 module. This card runs the IEC61850 server which allows a client to request the tags and receive goose messages. Doble provides the icd file containing the description of the capabilities of the device. For more information, consult the doblePRIME 2.9 User Guide.

8. Operation

This section gives an overview of the monitors found inside Calisto™ T1, explain how the data is collected from monitors and saved into a database for further analysis. The data collection scheme is required the monitors to be configured and in Commissioned state, please see Configuration (page 43) for more details.

Overview

Calisto™ T1 is a complex system which comprises different monitors inside of its enclosure.

- Calisto Interface Gateway - CIG
- Bushing Data Monitor - BDM
- Partial Discharge Monitor - PDM
- iO monitors – 8AI / 8DI

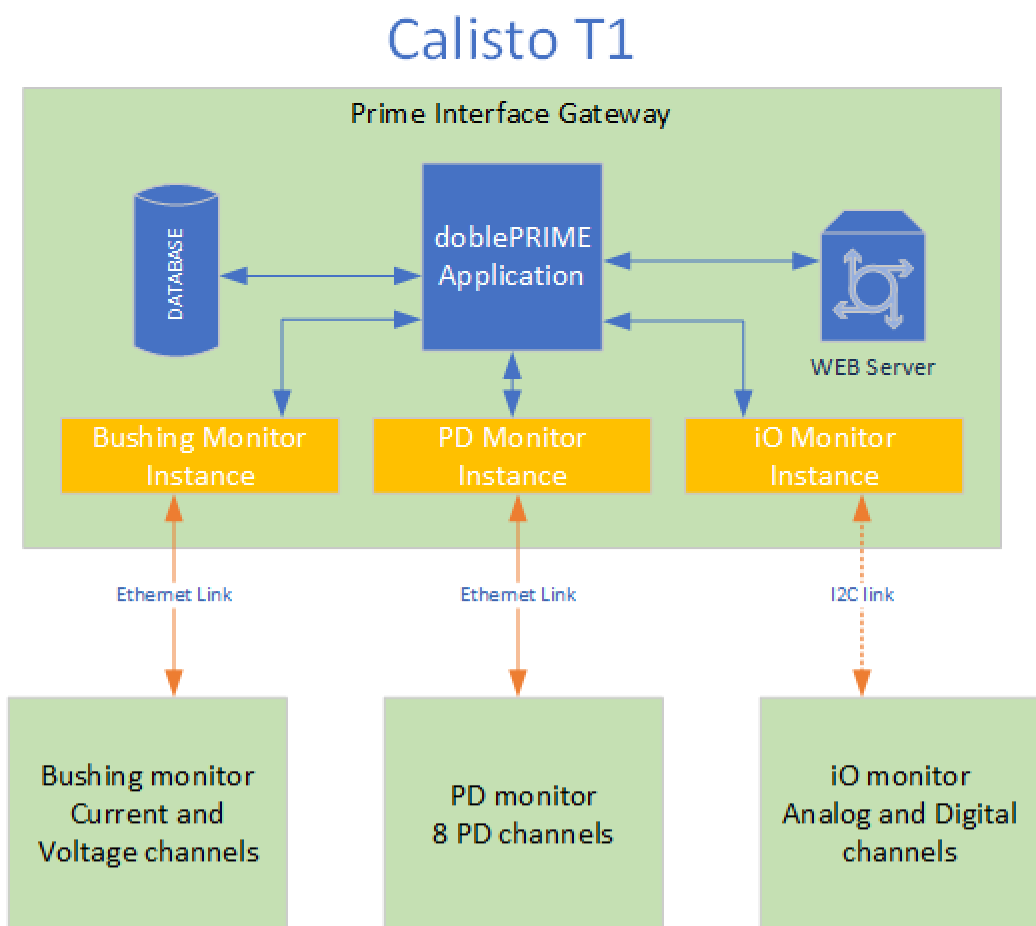


Figure 72 - Calisto™ T1: Internal Communication Architecture

The Prime Interface Gateway is the main board which is responsible for running services such as the doblePRIME™ application, web interface, database management, communication to internal and external monitors and many others. The process of saving the measurements from the monitors is based on the polling method. The doblePRIME™ application polls the monitors according to the polling rate entered at each monitor instance. When the monitor responds to the polling, the measurements are saved into the database, and the user is able to assess the data.

The Bushing Data Monitor is a current and voltage acquisition instrument which measures the leakage current, voltage, and relative phase angles to derive the capacitance, power factor, and harmonics of the bushing. The process of acquisition and derivation of the data is time-consuming and requires the BDM’s CPU to process thousands of points. During this time, where the CPU is busy performing the calculations, it will not listen to any request from the doblePRIME™ application. Once the data is processed, the results are saved into a buffer and available over MODBUS registers, waiting for the doblePRIME™ application to pull the data. The next time the process starts over, the processed data will overwrite the previous data saved into the buffer.

The Partial Discharge Monitor is a multiplexed instrument that scans its channels in sequence one after the other. It typically takes about 8 minutes to scan all eight channels in VHF mode, and 40 minutes in EMI mode. The results from each channel are made available over Modbus as soon as scanning of that channel has been completed.

The iO monitors are responsible for the acquisition of analog and digital signals. It is a reasonably simple process compared to the bushing and Partial Discharge monitors data scanning. The results of the acquisition are available over Modbus, in raw format, waiting for the doblePRIME™ application to pull the data.

Results

The doblePRIME™ application pulls the data from the monitors, saves it to the database and presents the data to the user via the doblePRIME™ application and is available in the Dashboard tab. The Dashboard tab displays the overall health of every asset being monitored in a selected location, such as a substation, and the number of open alerts. There are also other tools to show charts, trending, and data tables.

The bushing monitor results can provide more than only capacitance and power factor. Other derived data supplied by the monitor:

- Loss Angle
- System Voltage
- Phase Angle Normalized to Zero
- Total Harmonic Distortion of the leakage current
- Current and Voltage Phasor

The bushing monitor can derive two different types of power factor results: Relative Power Factor (RPF) and True Power Factor (TPF).

The RPF method does not need a voltage reference to calculate power factor. It is calculated comparing the phase angle of the three leakage currents to each other. By default, the system always calculates RPF.

The TPF method measures the leakage current and a reference voltage input from instrument transformers on the station bus. The phase angle of each bushing leakage current is compared to the bus voltage on that particular bushing. By default, TPF is not enabled. Verify if the voltage input requirement is met before enabling TPF.

Figure 73 - Bushing Monitor Measurements

Figure 74 - TPF and RPF Trending in the Same Period

The Partial Discharge presents the results based on a metric created by Doble to determine the presence and quantify the energy of a PD signal. This metric allows a straightforward interpretation of the spectral scan to novice users. The results of a spectral scan are presented in statistical form as derived statistics for the band: “IPwr” and “PAPR”:

- IPwr is a statistical analysis which indicates the energy content of the band
- PAPR is the Peak-to-Average-Power ratio which indicates the presence of PD

Figure 75 - PD Monitor Measurements

Data coming from the iO monitors does not give you the real picture of what you want to measure unless it is applied to a scale factor and unit of measurement. For instance, the analog data comes in raw format from the analog card, where 4000 counts represent 4mA and 20000 counts equal to 20mA. The transducer of your choice provides those limits and figures in their datasheet so you can apply the scale factor to the monitor instance.

Figure 76 - 8AI Monitor Measurements

Alerts

An "Alert Status" is generated according to the value of a channel on a direct comparison with the thresholds (user-configurable levels) which yield three indications: information, warning, and action. The overall alert status is computed from the individual channel alerts on the basis of “highest alert wins”; this is presented on the front panel LEDs and supervisory relays along with a system indication. The system indication operates independently of Info/Warning/Action. The alerts can be viewed in detail and acknowledged in the doblePRIME™ application, where they are displayed per asset or channels. The Alerts tab shows the current and acknowledged alerts.

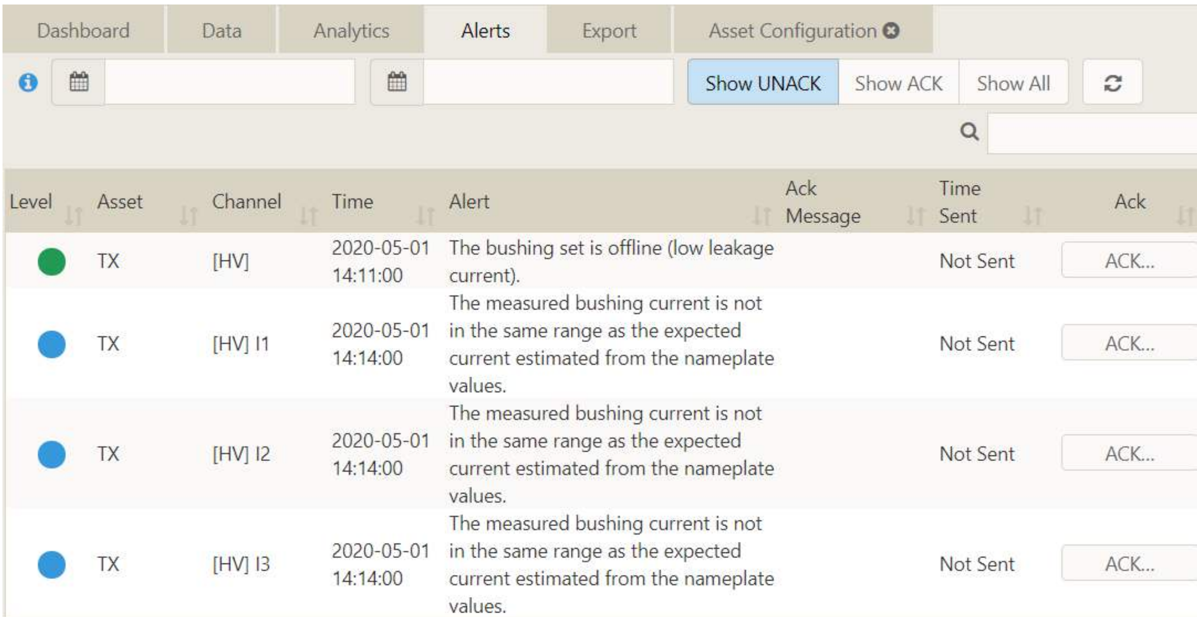


Figure 77 - Alerts Tab

The doblePRIME™ application has a particular alert engine to raise bushing alerts. It uses the embedded Expert System to provide notifications and alarms based on the comparison between offline and calculated on-line data. Another alert detection mechanism, the Alert State Machine, can be enabled to increase confidence in alert outputs.

By default, the PD Alerts are generated in the Partial Discharge Module and sent to the doblePRIME™ application when the monitor is polled. The alerts will then be raised by the doblePRIME™ application and presented to the user. Since there is no means to edit the threshold of the “native alerts” in the PD monitor, the Partial Discharge Monitor Instance allows you to disable these alerts coming from the monitor so you can create your alerts using the ASM tool.

In the iO Monitor, alerts must be created using the ASM tool. Select the channel and create the appropriate alert.

For more information about viewing the results on Calisto web application and handling alerts and ASM configuration, refer to the doblePRIME User Guide (PN 72A-2812-01).

9. Hardware Expansion

This section describes how to expand the iO cards.

Expanding the iO Cards

Any type of card can be replaced or added to any slot in case expansion is required. Up to four cards can be fitted on the expansion board.

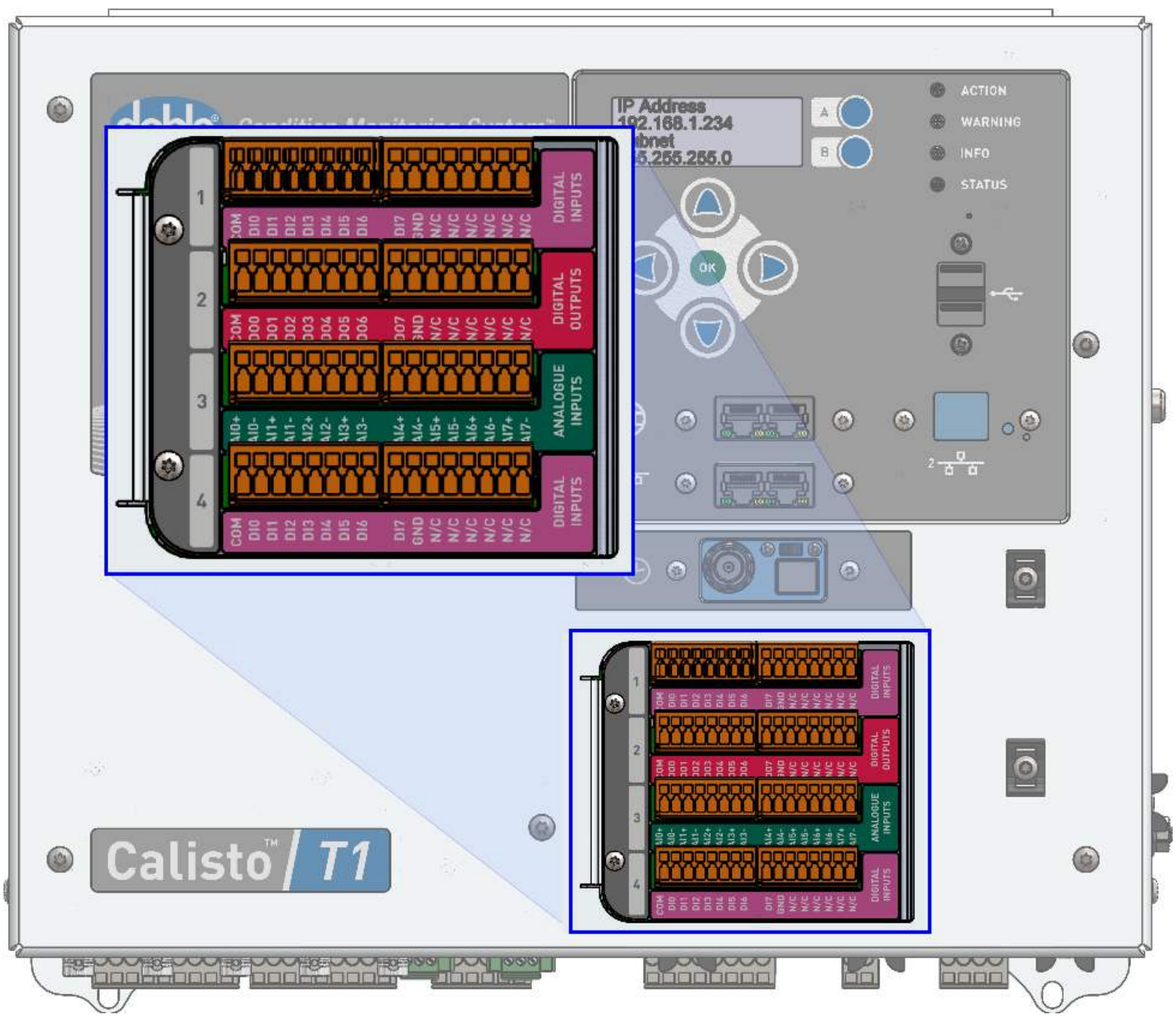


Figure 78 - iO Cards and Flap

Perform the following steps to access the expansion board.

1. Power off the Calisto™ T1.
2. Remove the connection blocks from the iO cards
3. Remove the two screws to the left of the iO cards and remove the flap

The card may now be removed or inserted into the empty slot.

The 8AI Jumper Configuration

There are two modes which the 8AI can operate:

- Current: 4-20mA
- Voltage: 0-10V

The operation mode is jumper selectable. There is one set of two jumpers for each input, sixteen jumpers total.

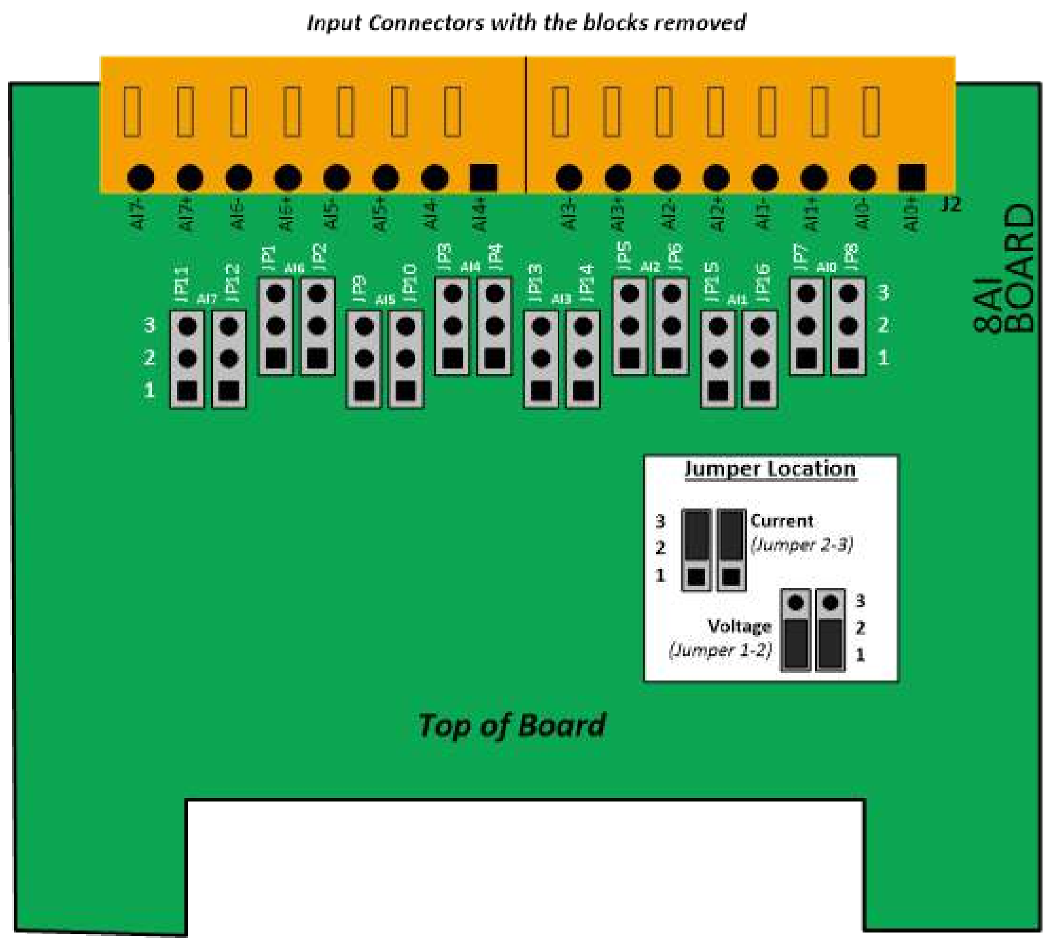


Figure 79 - 8AI Card Jumper Configuration

8AI Jumper

AI Channels	AI Jumper Set	Current Mode	Voltage Mode
AI0	JP7 and JP8	Short pins 2-3	Short pins 1-2
AI1	JP15 and JP16	Short pins 2-4	Short pins 1-3
AI2	JP5 and JP6	Short pins 2-5	Short pins 1-4
AI3	JP13 and JP14	Short pins 2-6	Short pins 1-5
AI4	JP3 and JP4	Short pins 2-7	Short pins 1-6
AI5	JP9 and JP10	Short pins 2-8	Short pins 1-7
AI6	JP1 and JP2	Short pins 2-9	Short pins 1-8
AI7	JP11 and JP12	Short pins 2-10	Short pins 1-9

After the cards are fitted into place and the T1 powers up, the cards are detected by the system, and the corresponding monitor instance will be available in the list.

10. Wiring Sensors to the Calisto™ T1

This section describes how to wires sensors to the Calisto™ T1.

Wiring Sensors to iO Cards

The following wiring guide explains how to wire the two different types of iO channels.

These terminal block plugs have a screwless cage clamp termination for quick and easy connection. A locking latch ensures a secure connection to the mating header.

Analog Input Wiring – 8AI Card

Caution: Do not wire a 0 to 10V sensor when the jumper position is in current mode. Please see the jumper configuration in Hardware Expansion (page 94).

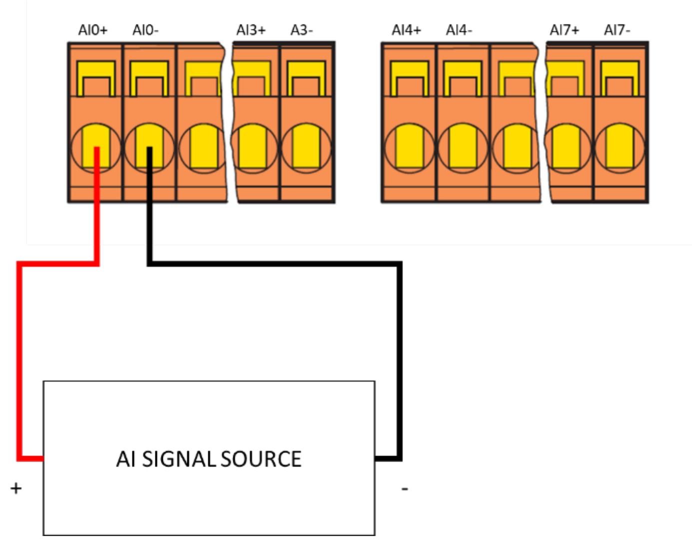


Figure 80 - Wiring a 4-20mA/0-10V Sensor to the 8AI Input

Digital Input Wiring – 8DI Card

DI Dry Contact

Operation mode:

- On: Short to GND
- Off: Open circuit

> **Note:** A DC power source can be used to raise the threshold level to indicate the channel is in low-state, e.g., the channel is OFF or 0 state in the doblePRIME™ application. Max DC Power Source: 30 VDC.

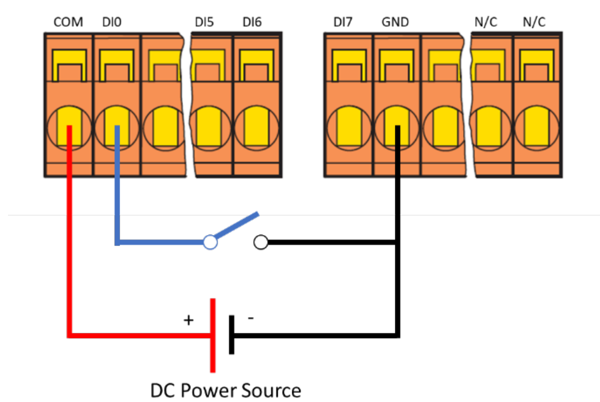


Figure 81 - Wiring a Digital Input, Dry Contact Sensor

DI Wet Contact (NPN Sensor)

Operation mode:

- On: 10 to 30 VDC
- Off: 0 to 3 VDC

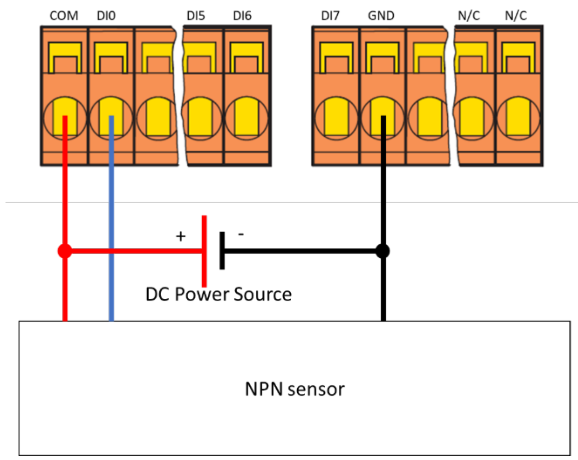


Figure 82 - Wiring a Digital Input, Wet Contact NPN Sensor

DI Wet Contact (PNP Sensor)

Operation mode:

- On: 10 to 30 VDC
- Off: 0 to 3 VDC

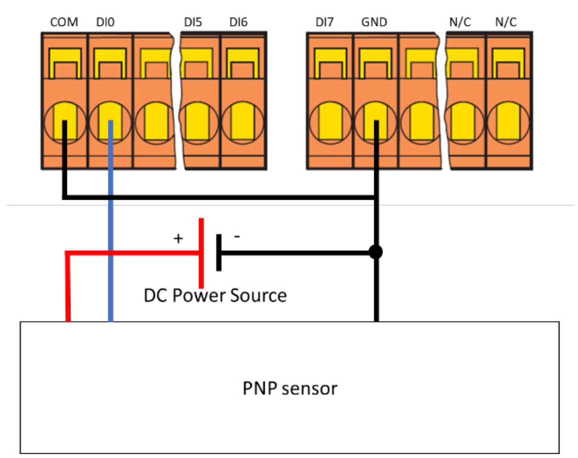


Figure 83 - Wiring a Digital Input, Wet Contact PNP Sensor

Wiring the Bushing Sensor Cables to the Shorting Blocks

Each shorting block is comprised of individual segments that can connect or disconnect one circuit. Each sensor has a three-wire connection; a “wire group” consisting of three shorting block segments is required for each bushing sensor. A set of sensors consists of three sensors; a group of six shorting block segments is required for each set of two sensors. The segments are mounted on a Type O 35 mm DIN rail that is attached to the mounting plate of the enclosure. Shorting blocks must be installed between the bushing sensors and the Calisto™ T1 HFCT inputs SET 1 and SET 2.

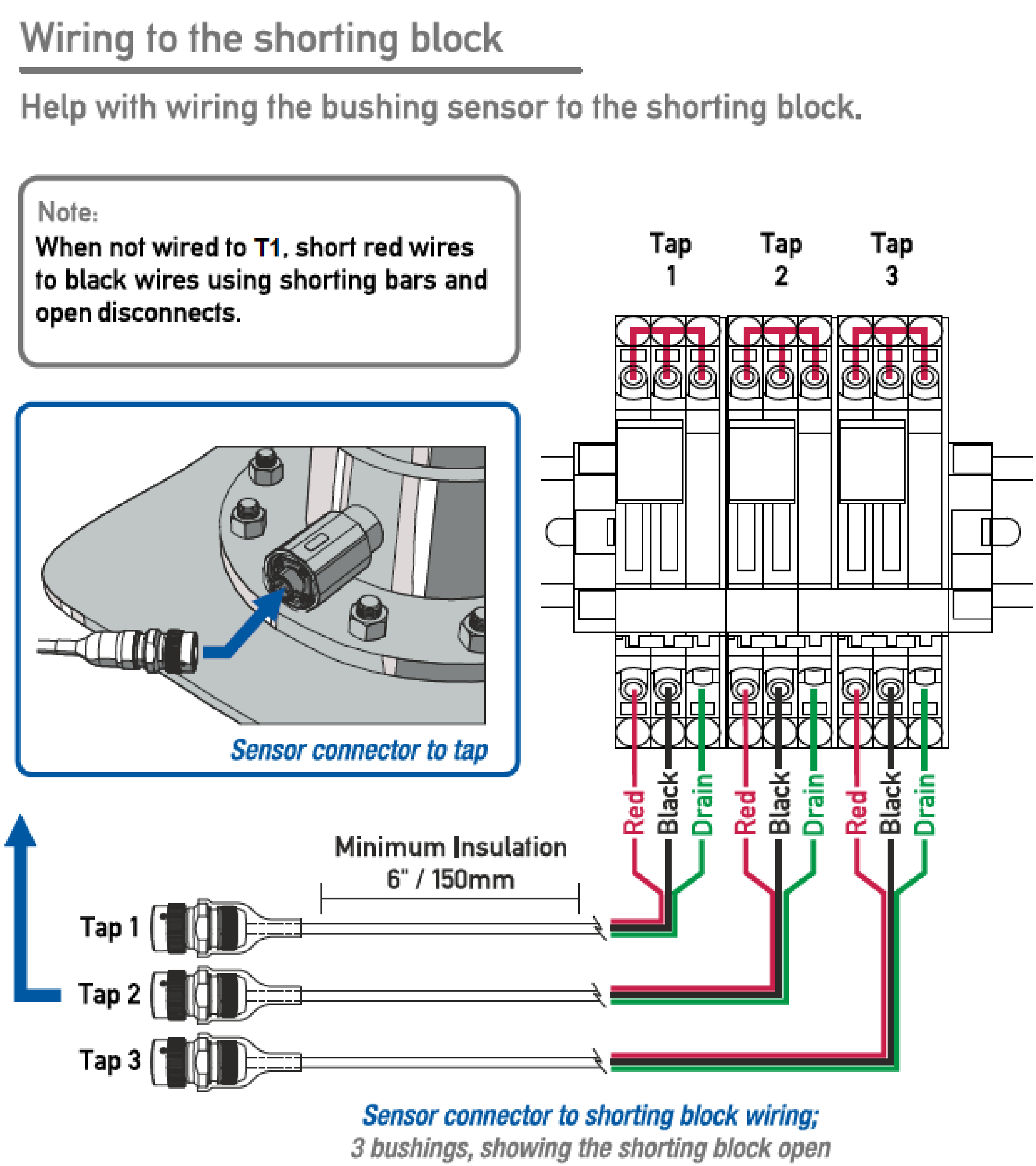


Figure 84 - Wiring the Bushing Sensor to Shorting Blocks

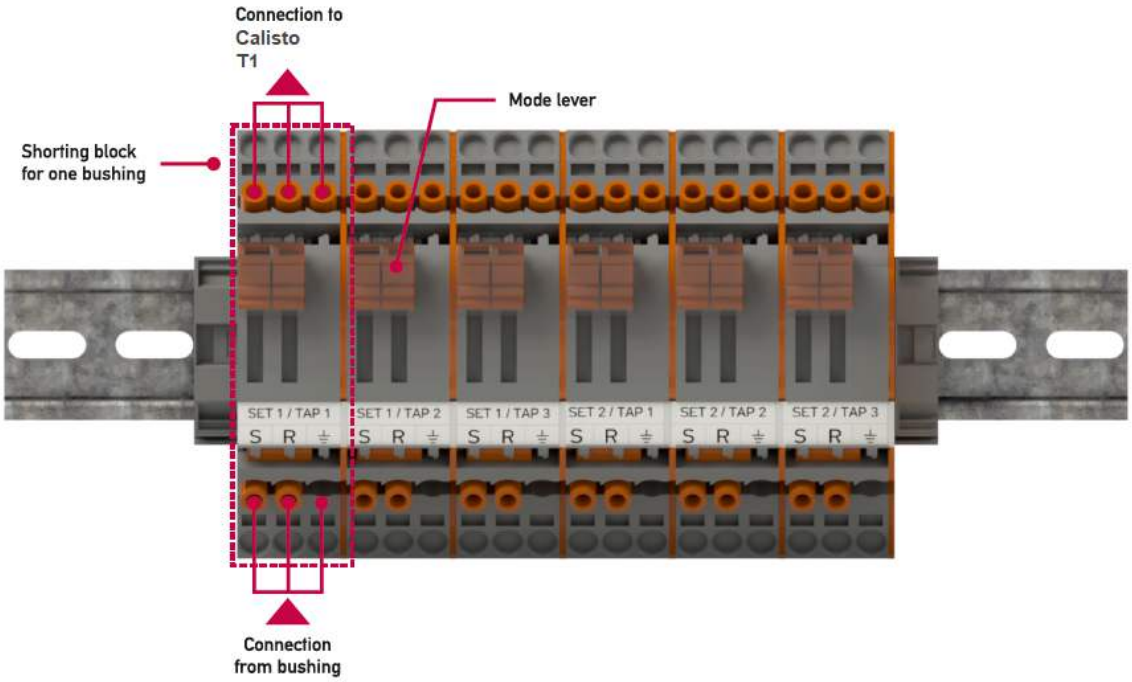


Figure 85 - Shorting Block Segments

Operating the Shorting Block

Each bushing sensor connects to a shorting block with three wires: signal, return, and shield. Each wire is connected to a segment.

Each segment of a shorting block can be opened or closed. Segments are opened or closed using the mode lever by moving the lever up to “In Service” position (I) and down to “in Maintenance” position (0). During the installation, be sure the mode lever is “in Maintenance” position (0) prior wiring the sensor.

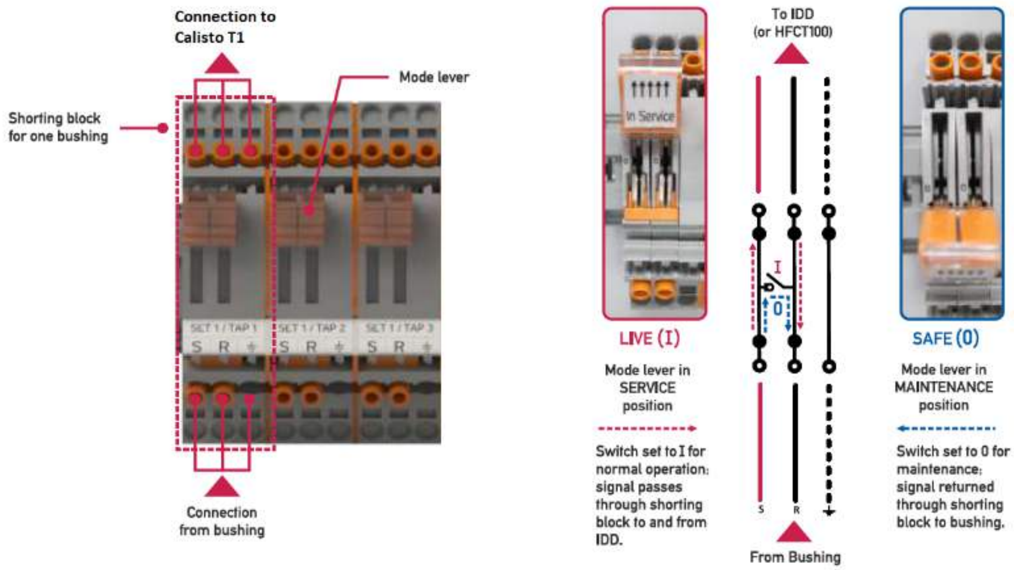


Figure 86 - Wiring and Operating the Shorting Blocks

Warning: Always wire the Bushing Sensor cable to the bottom of the Shorting Block and Calisto Bushing Set inputs to the top of the Shorting Block for correct operation.

Test Points and Termination

To open the cage clamp terminal, insert a flat blade operation tool 5.5 x 0.8 mm into the cage clamp release and push it until reaching the end. Insert the wire into the cage clamp terminal, keep the wire in position, then remove the tool from the cage clamp release to secure the cage clamp terminal.

A test point is available to verify the signal going through the Shorting Block. Do not insert the test probe into the cage clamp terminal when the wire is present.

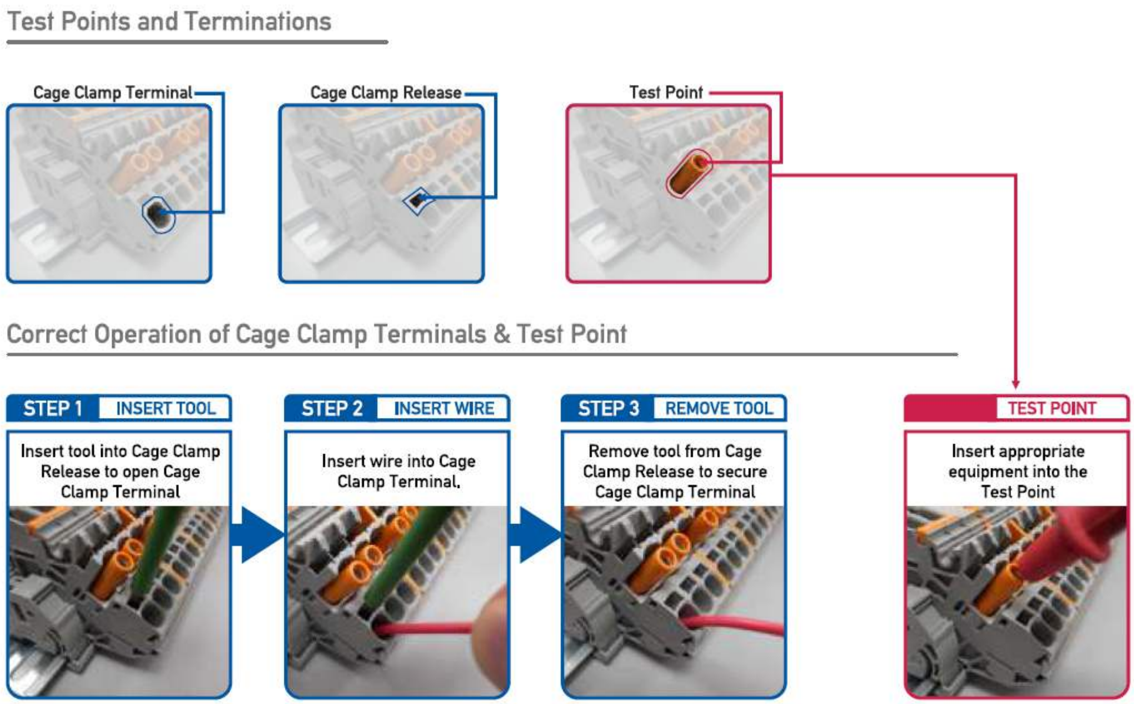


Figure 87 - Wiring to the Shorting Block and Test Point Location

A. LEGAL NOTICE

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The meaning of **WARNING** messages used in this material:

A procedure, practice, or condition that could cause bodily injury or death.

Before operation, ensure you have reviewed all the risks associated with the equipment listed in this material and other product materials.

WARNING

If the equipment is used in a manner not specified by the manufacturer, including, without limitation, in connection with abnormal operating conditions, the protection provided by the equipment may be impaired.

WARNING

Do not open the equipment cabinet during rain, snowstorms, or other inclement weather.

WARNING

User must have the capability to continuously monitor for alerts. If this requirement is not met, delayed reaction to alerts may result in otherwise avoidable asset failure that may result in bodily injury or death.

User is responsible for developing and following an appropriate plan for de-energization in the event of potentially unsafe operating conditions. Potentially unsafe operating conditions include, but are not limited to, the results of vandalism, flooding, severe snow and/or ice storms, by which water or contaminants enter into the asset.

WARNING

There may be cases where the monitored asset(s) suddenly fails (between measurements at the normal measurement interval). The user should be aware that online monitoring equipment is not always capable of detecting such rapid (often catastrophic) failures. Asset monitoring is designed to detect incipient, slow-developing faults, but may also be able to detect more rapidly-developing faults, depending on the specific monitoring device that has been deployed. Other protective devices should be

used in conjunction with monitoring equipment to provide more complete protection for the transformer.

WARNING

If the transformer bushings are replaced, then bushing adaptor circuit integrity checks shall be implemented and the bushing nominal parameters updated before the transformer is returned to service. Refer to the instruction manual. If the bushing is replaced by a mechanically and/or electrically different bushing a new bushing adaptor may be required.

WARNING

If the transformer bushings are subjected to routine maintenance, then the bushing adapter circuit integrity checks should be implemented before the transformer is returned to service. Refer to the IDD, T1 manual.

Liability and guarantee

Doble is not liable for damages that occur due to improper use. Proper use also includes the knowledge of, and compliance with, this material. User changes to the equipment that have not been expressly approved by Doble will result in the loss of guarantee. We reserve the right to modify or improve the designs or specifications of our products at any time without notice.

ALERT SETTINGS

The product is supplied with default settings for alert values. As every installation and operating environment is different due to design, manufacturing tolerances, operating regime, etc., there are no settings that can be applied to every asset. It is the user's responsibility to set appropriate alert values. Alert values must also be routinely reviewed and revised, as appropriate, by user depending on bushing behavior.

Alert value settings for online bushing monitoring should not be based on traditional offline results, including, for example those recommended by the IEEE C57.19.100

Warranty

Equipment Limited Warranty

Doble Engineering Company (DOBLE) warrants the products that it manufactures to be free from defects in material and workmanship for a period of one year from the date shipped from the factory.

During the one year warranty period, DOBLE will repair or replace, at its option, any defective products or components thereof at no additional charge, provided that the product or component is returned, shipping prepaid, to DOBLE. The Purchaser is responsible for insuring any product or component so returned and assumes the risk of loss during shipment. All replaced products and components become the property of DOBLE.

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Software Limited Warranty

THIS SOFTWARE PRODUCT IS PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THIS SOFTWARE PRODUCT IS WITH PURCHASER SHOULD THE PRODUCT PROVE DEFECTIVE. PURCHASER (AND NOT DOBLE OR AN AUTHORIZED DEALER) ASSUMES THE ENTIRE COST OF ALL NECESSARY SERVICING, REPAIR, OR CORRECTION.

Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply. This warranty gives the purchaser specific legal rights and the purchaser may also have other rights which vary from state to state.

DOBLE warrants the disks on which the software product is furnished to be free from defects in materials and workmanship under normal use for a period of one hundred and twenty (120) days from the date of shipment from DOBLE.

Limitations of Remedies

DOBLE's entire liability and Purchaser's exclusive remedy shall be:

The replacement of any disks not meeting DOBLE's "limited warranty" which are returned to DOBLE.

If DOBLE is unable to deliver replacement disks which are free from defects in materials and workmanship, Purchaser may terminate this agreement. By returning the software product and all copies thereof in any form and affirming compliance with this requirement in writing, DOBLE will refund the purchase price.

IN NO EVENT WILL DOBLE BE LIABLE TO PURCHASER FOR ANY DAMAGES, INCLUDING ANY LOST PROFITS, LOST SAVINGS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH SOFTWARE PRODUCT, EVEN IF DOBLE

OR AN AUTHORIZED DEALER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR FOR ANY CLAIM BY ANY OTHER PARTY.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply.

Maintenance

For equipment maintenance, contact:

Doble Engineering Company

123 Felton Street

Marlborough, MA 01752 (USA)

Telephone: 617-926-4900

FAX: 617-926-0528

Email: support@doble.com

Web: www.doble.com

B. Specifications

T1 Base Model Specifications

T1 BASE MODULE	
CPU, MEMORY AND BUSES	
Host CPU	ARMv8 1.2GHz
Memory	1 GB RAM, 32GB Flash
STORAGE	
32GB eMMC Flash for application and data storage	
PERIPHERALS	
USB 2.0	
2x Isolated RS485 (MODBUS, DNP3)	
10/100 Base T Ethernet (DNP3, MODBUS, HTTP)	
Alert LED (Status, Info, Warning, Action)	
Status Relay, 240VAC 5A (Status, Info, Warning, Action)	
LDC Display 4x20 and keypad	
GPS 1PPS time sync (Fibre/IRIG) option	
IEC61850 option	
Enclosure climate control option	
ENVIRONMENTAL	
Humidity	0-95% non-condensing
TEMPERATURE*	
Operating temperature	-20°C to +50°C
Extended temperature	-40°C to +60°C
Storage temperature	-20°C to +70°C
MECHANICAL DATA	
Height	720mm / 28.4 in
Width	550mm / 21.7 in
Depth	363mm / 14.4 in
Weight	51kg / 113 lbs
Construction	Powder stainless steel
POWER SUPPLY	
External supply	24 V DC @ 2 A
An optional power adapter can be supplied to suit global mains voltage	
*Note: Temperature is extended when using a climate-controlled enclosure	

PD Monitor Specifications

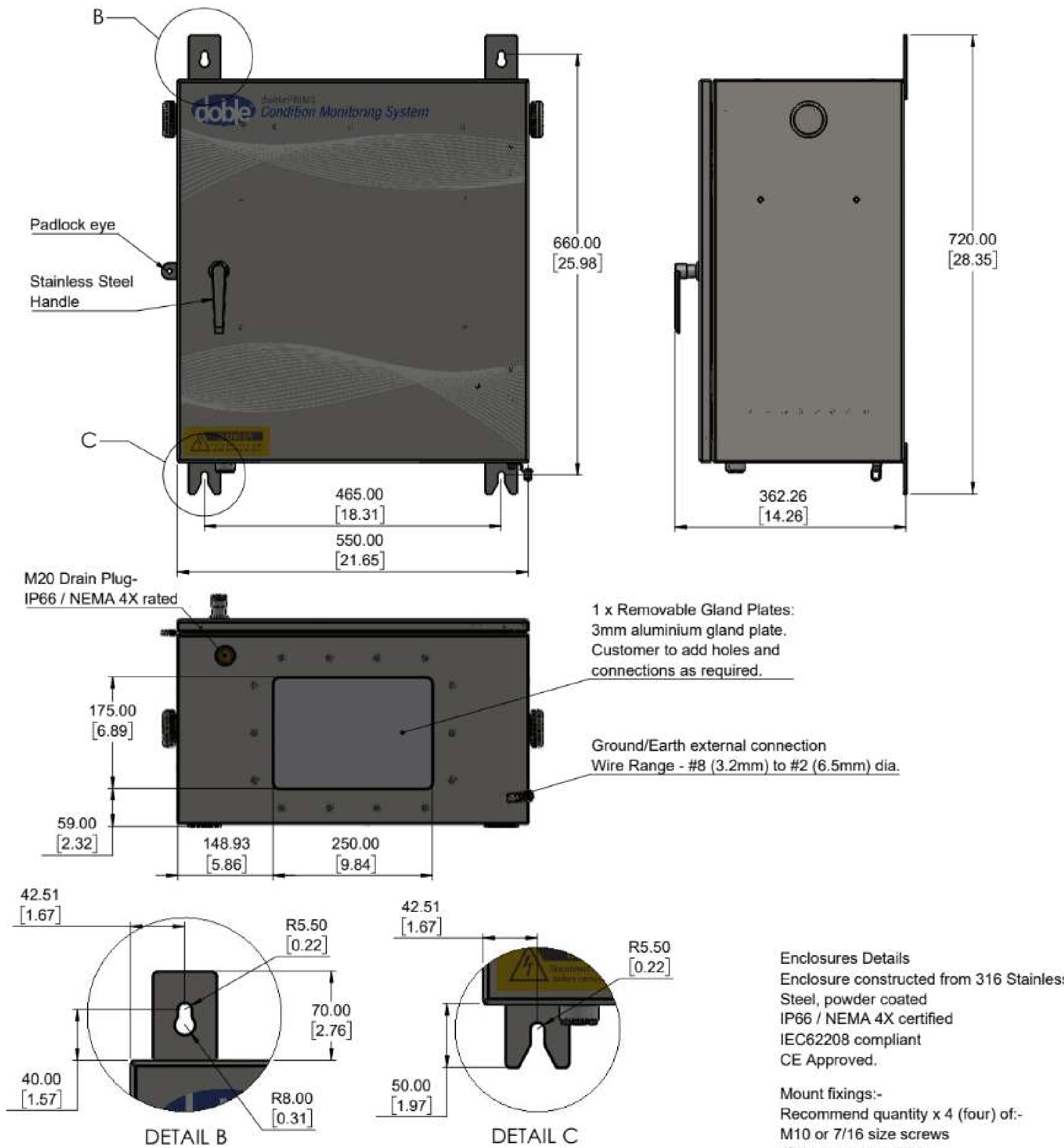
PD MONITOR	
PARTIAL DISCHARGE DATA ACQUISITION	
TUNERS (BOTH)	
Inputs	8 channels multiplexed, 6 built-in HFCTs are available for bushing monitoring; CT, UHF, VHF sensors can be connected as required.
Connector	BNC
Input impedance	50 Ω
Maximum Input	+20 dBm for Reading
Dynamic range	60 dB
Detection types	Peak, quasi-peak and average detector
Sweep processing	Continuous, Average, Max Hold and Differential
RFI TUNER 1	
Bandwidth	50 kHz to 50 MHz
Resolution Bandwidth	9 kHz / 120 kHz
Noise floor	Approximately -90 dBm for peak detect or -100 dBm for average detect (RBW 9 kHz)
RFI TUNER 2	
Bandwidth	50 MHz to 1000 MHz
Accuracy	± 100 kHz
Resolution Bandwidth	120 kHz / 1 MHz / 6 MHz
Noise floor	Approximately -80 dBm for peak detect or -90 dBm for average detect (RBW 6 MHz)
EMI MODE	
Bandwidth	50 kHz to 100 MHz
Resolution Bandwidth	9 kHz / 120 kHz
AC SYNCHRONIZATION	
Wired sync to external AC source	
MEASUREMENT MODES	
RF modes	Spectrum Oscilloscope (Time-resolved) Level meter
Results output	IPwr (Integrated Power) PAPR (Peak-Average Power Ratio) PRPD (Phase Resolved PD) QIEC (IEC 60270 compliant) Quadratic rate (QR)

Bushing Monitor Specifications

BUSHING MONITOR	
BUSHING DATA ACQUISITION	
Inputs	6 bushing channels: 2 sets of 3 bushings
Voltage reference	3x instrument transformer input option
Connector	Push-in termination
Measurement method	Leakage current/voltage raw sinusoid waveform, rms current and phase
Tap Current Range	1-200 mA
Bushing-Bushing Isolation	>2500 V
Bushing-Host Isolation	>2500 V
Magnitude Accuracy	± 1% of reading
Phase Accuracy	0.01 Degrees
Capacitance Range	0-1000 pF
Power Factor Range	0-100%
iO CARDS	
DATA ACQUISITION	
Connector	Push-in termination: 4 slots available
8AI	8 channel analog input, 4-20 mA or 0-10V. Jumper selectable
5TI	5 channel input,2/3-wire connection PT100
8DI	8 channel digital input, dry or wet contact
8DO	8 channel digital output, sink type only

C. Dimensions

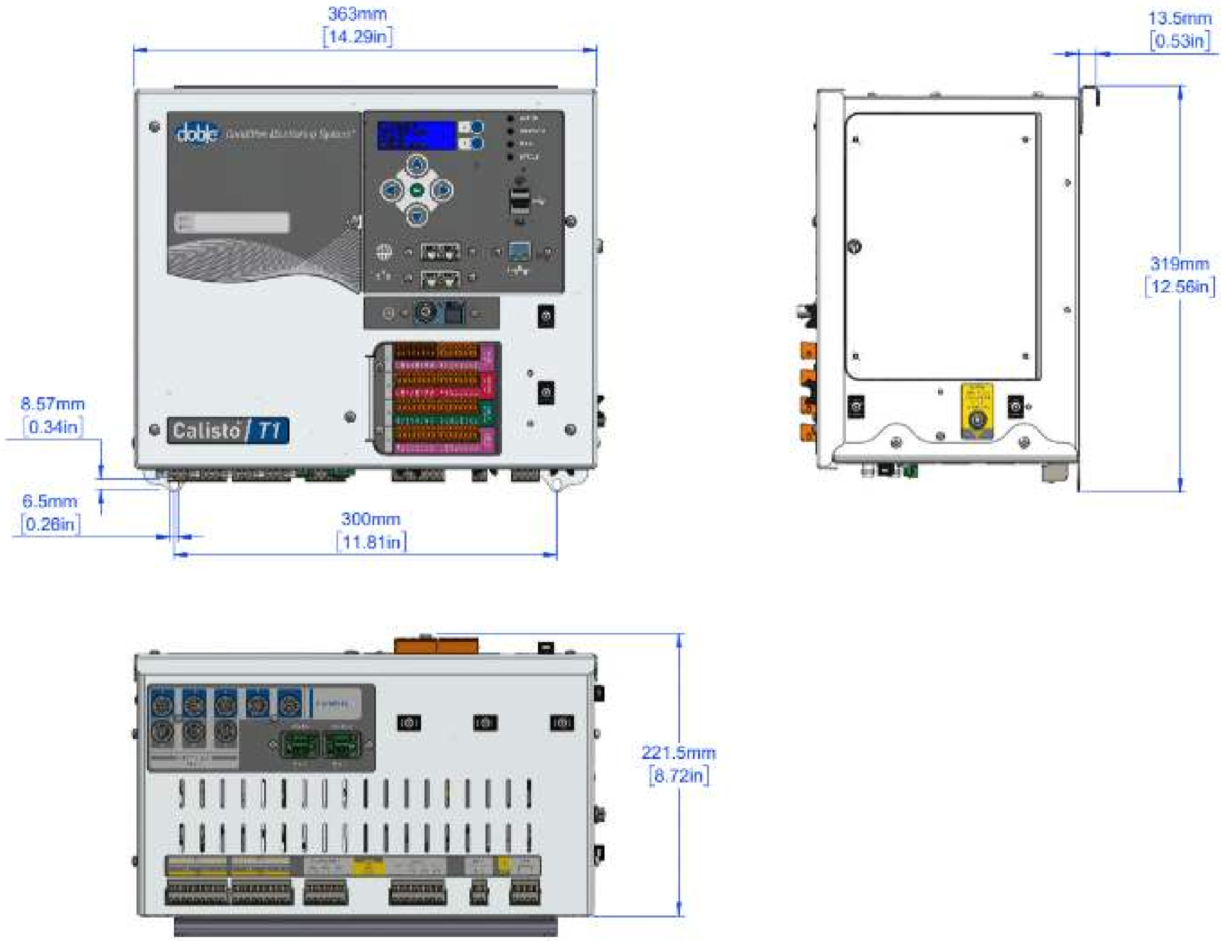
DPEN100 Enclosure Dimensions



Enclosures Details
Enclosure constructed from 316 Stainless Steel, powder coated
IP66 / NEMA 4X certified
IEC62208 compliant
CE Approved.

Mount fixings:-
Recommend quantity x 4 (four) of:-
M10 or 7/16 size screws
(fixings not supplied)

Calisto™ T1 Dimensions



D. PICOS Application

Along with the doblePRIME™ application, there is another application available in the system to help to troubleshoot internal monitors and quickly verify raw measurements. The PICOS application is a set of scripts that helps you to access the condition of the monitor itself and assists in the commissioning of the system. PICOS is not integrated into the Calisto web application; therefore, no data is exchanged between the two applications. The main application of PICOS is to:

- Troubleshoot internal or external monitors
- Test the front LED (Status Indicator) and supervisory relays
- Test the iO cards
- Set the date and time of the system
- Control doblePRIME™ application
- Purge the database
- Reboot the system

Accessing PICOS

To access PICOS open a web browser, type the IP address of LAN1 interface, and add "/picos" to the URL.

Example: If the unit has the default IP address – 192.168.1.234 – then type "192.168.1.234/picos" in the URL bar. A credential is required to access PICOS.

- Default user: doblePicos
- Password: doblePicos1!

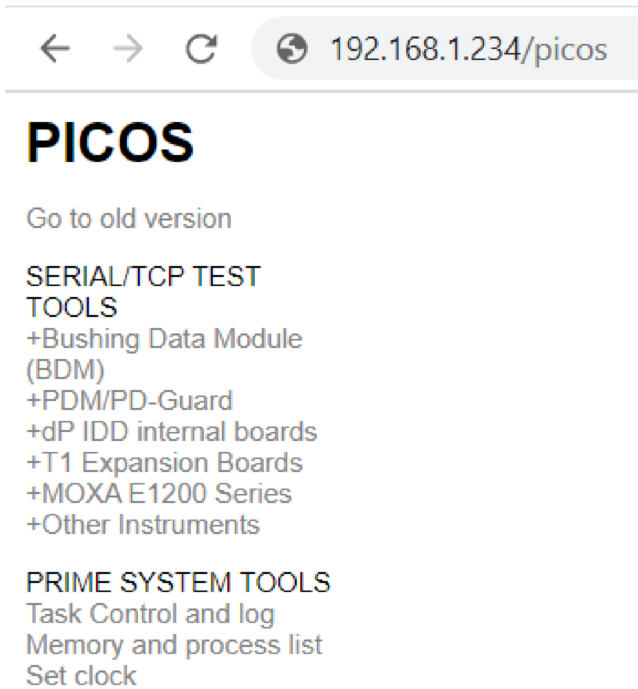


Figure 88 - PICOS Menu

Troubleshooting Internal Monitors

In the menu, there is a specific option for the internal monitors:

- Bushing Data Module (BDM)
- PDM/PD-Guard
- T1 Expansion Boards

The Bushing Monitor

1. Click **Bushing Data Module (BDM)** option to expand the menu.

> **Note:** Before using this tool, make sure SCT is stopped first; otherwise, you will experience connection issues to communicate with the bushing monitor. Refer to Control of the doblePRIME™ Application (page 126) in this appendix for more information.

2. Change the IP address in the field. This address, in the Calisto™ T1, is 192.168.10.35.

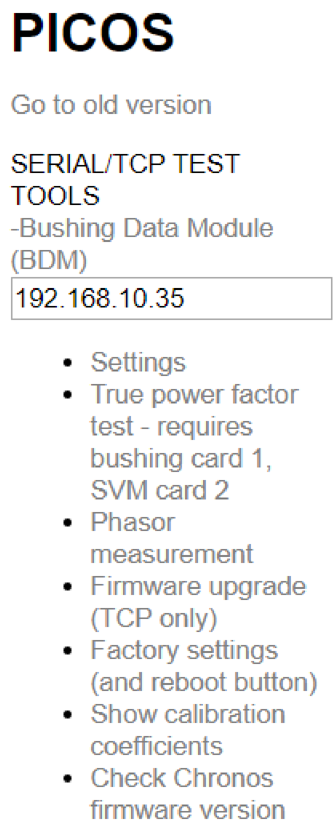


Figure 89 - PICOS Bushing Monitor Options

Bushing Monitor Settings

Option	Description
Settings	Return the settings of the Bushing Data Monitor. Do not change the parameters in the fields.
True Power factor test - requires bushing card 1, SVN card 2	The tool used to calibrate capacitance and power factor using the transformer and Instrument Transformer nameplate. See True Power Factor Calibration (page 128) for more information.
Phasor measurements	Return the magnitude and relative phase angles of the leakage current, sets 1 and 2, and voltage set 3. Use this tool to verify these measurements without having set up doblePRIME™ application during the commissioning.

Bushing Monitor Settings (continued)

Option	Description
Firmware upgrade (TCP only)	A tool to load firmware into the BDM. Requires a .bin file.
Factory settings (and reboot option)	The tool allows you to reboot the BDM monitor only. The main Calisto™ board won't be rebooted.
Show calibration coefficients	Calibration table of the bushing board and voltage board.
Check Chronos firmware version	Return the version of the GPS IRIG-B card.

The PD Monitor

Click **PDM/PD-Guard** to expand the menu.

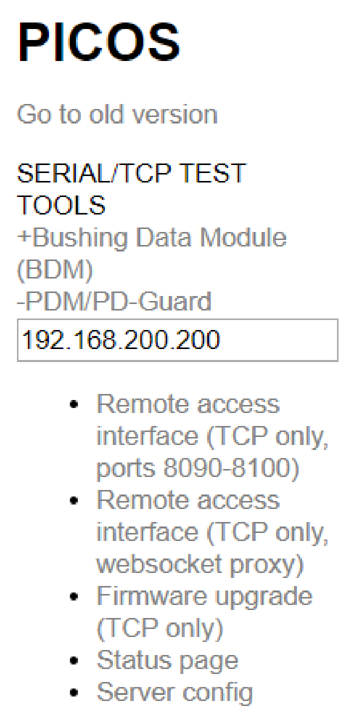


Figure 90 - PICOS PD Monitor Options

PD Monitor Settings

Option	Description
Remote access interface (TCP only, ports 8090-8100)	Remote access to the PDG interface to view spectral scan and configuration of the PDM board. Only works in an HTTP connection.
Remote access interface (TCP only, WebSocket proxy)	Remote access to the PDG interface to view spectral scan and configuration of the PDM board. Suitable when using HTTPS connection or in firewalled network.
Firmware upgrade (TCP only)	A tool to upgrade the PDM board. Require a .piz file
Status page	Show the status of the PDM and communication settings
Server Config	Show protocol enabled in the PDM

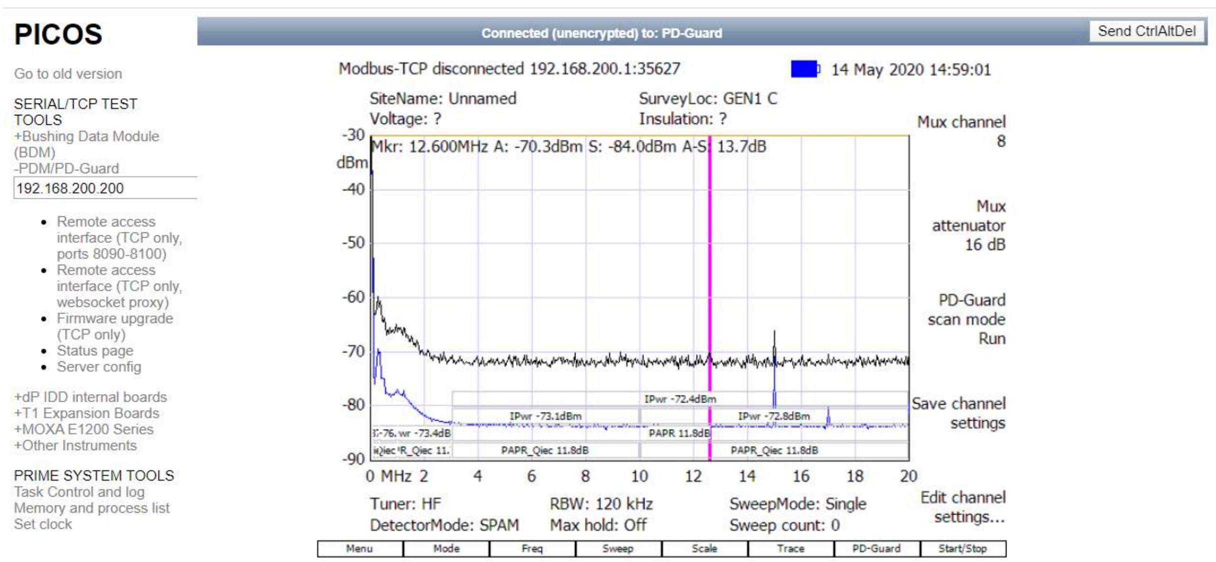


Figure 91 - Remote Accessing the PD Monitor

The Expansion Boards

Click **T1 Expansion Boards** to expand the menu.

> **Note:** Before using this tool, make sure SCT is stopped first; otherwise, you will experience connection issues to communicate with the boards. Refer to Control of the doblePRIME™ Application (page 126) in this appendix for more information.

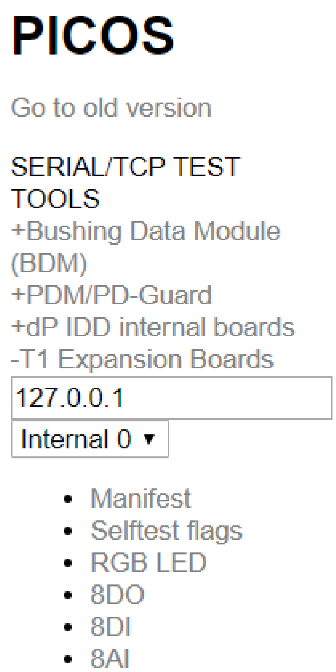


Figure 92 - Expansion Boards Options

Expansion Boards Settings

Option	Description
Manifest	Return the status of the boards
Selftest Flags	Return the flags of the board to verify anomalies
RGB LED	A tool to test the Status Indicator LEDs
8DO	Test the Digital Output card
8DI	Return the raw values of the digital card, 0 or 1
8AI	Return the raw values of the analog card

Viewing Raw Data from the iO Card

There are four slots which you can fit in the iO cards, numbered from 1 to 4. Those numbers on the left-hand side of the board are the indication of the slot position.

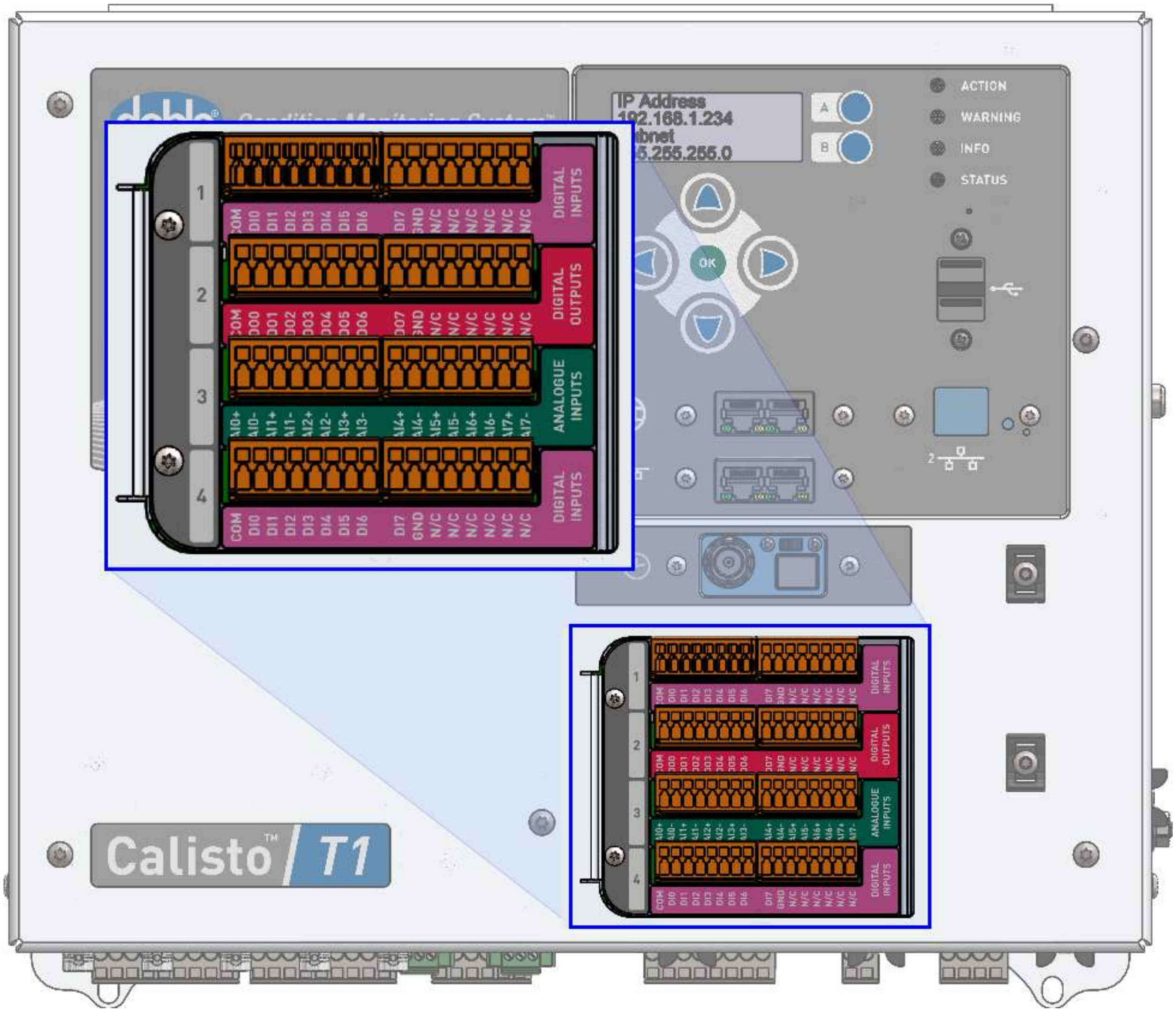


Figure 93 - Example of iO Cards Fitted

To view the raw value of a specific board, select the board position from the drop-down list under the field 127.0.0.1, and click **8DO/8DI/8AI**.

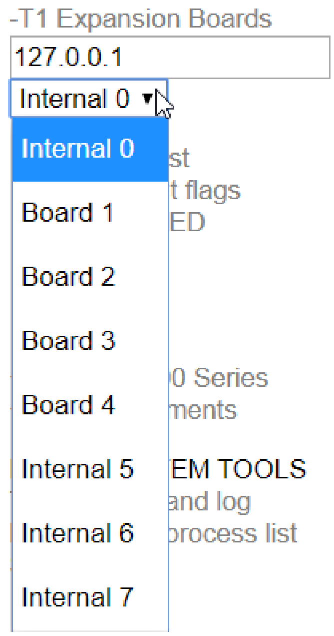


Figure 94 - Board Selection

For example, see the board configuration in Figure 93. If you want to view the raw measurement from digital input slot 2, select **8DI** under the **Board 2** drop-down list.

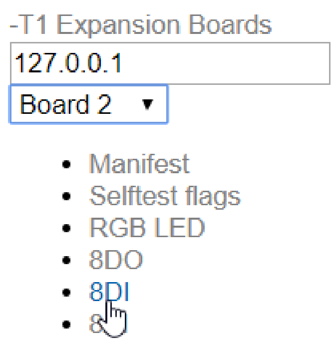


Figure 95 - Board Function Selection

The readings of the card are present on the focus panel.

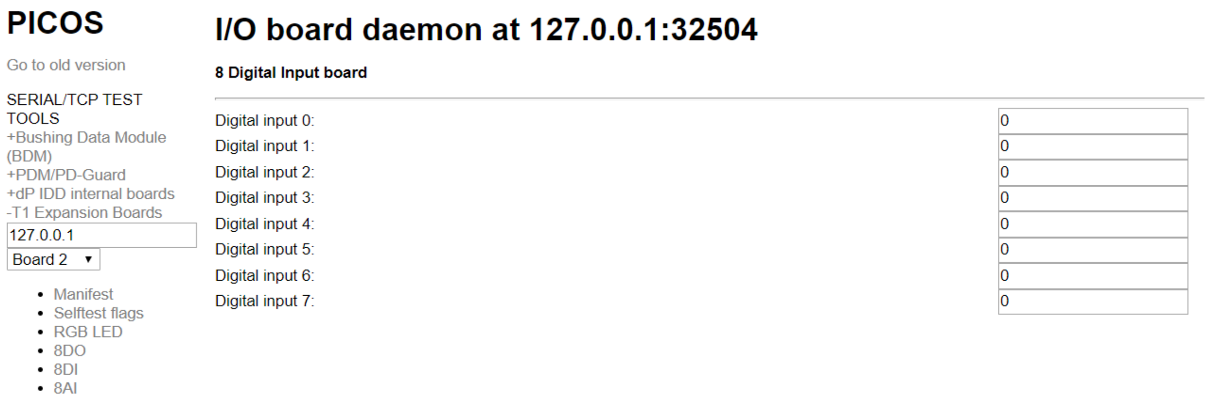


Figure 96 - Raw digital input example

Testing the Front LEDs (Status Indicator)

This tool allows to verify the current status of each LED and force a different status. Select **RGB LED** under the **Internal 0** drop-down list

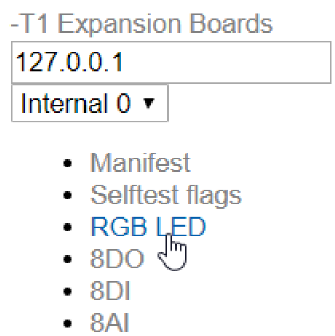


Figure 97 - Testing the front LEDs

LED control shows the current status of the LEDs. Look at the front LEDs on Calisto™ T1 to confirm the status in the software matches the LEDs indication.

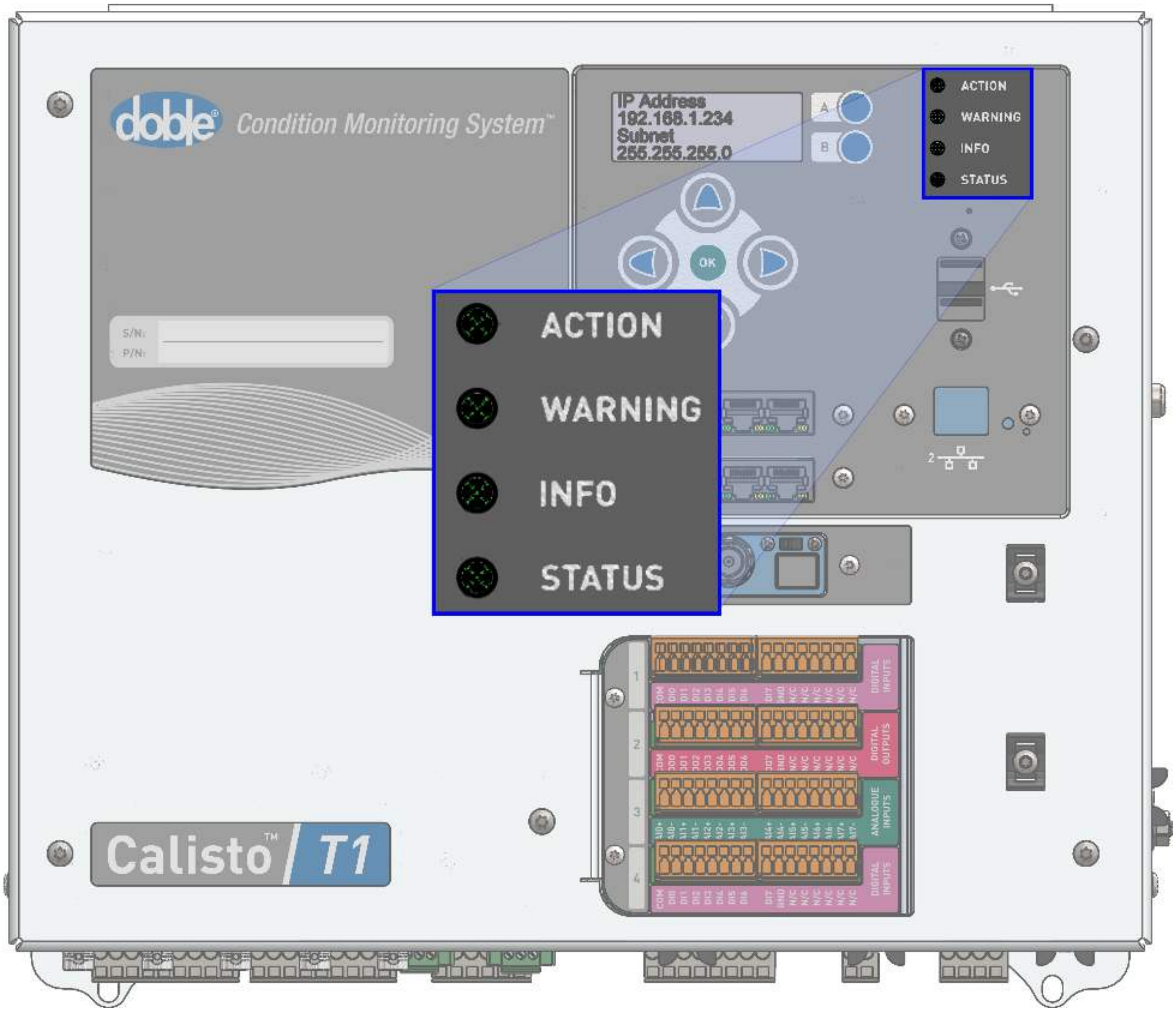


Figure 98 - Front LEDs on T1 and the Reset Pinhole

To change the LED status, click on the drop-down box on the right-hand side of the corresponding LED that you want to test, and toggle the status. Click **Write** to submit the changes.

Figure 99 - Software status and testing of the front LEDs

Set System Date and Time

Use this tool to set the time and date of the system. This clock is used by the Calisto™ T1 to timestamp the measurements and as a time reference to sync the clock of the BDM and PDM.

> **Note:** The correct way to set up time in the system is to use UTC as reference. Find the timezone in doblePRIME™ application to set up the timezone to show your current local time.

The current clock is presented on top of the focal panel. To set a new time and date in the fields and click **Set Clock** under PRIME SYSTEM TOOLS to submit the changes.

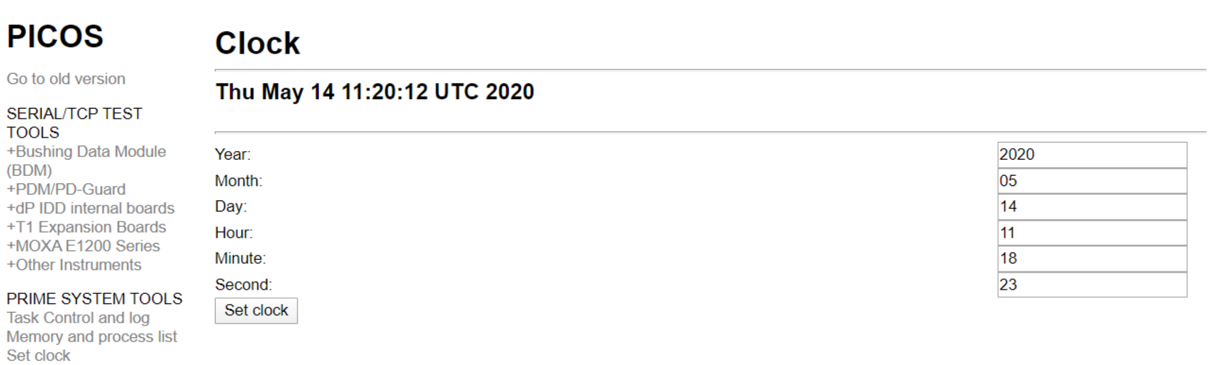


Figure 100 - Setting the time and date of mainboard - Prime Interface Gateway

Caution: After the new date and time are set, power cycle the unit so the internal BDM board can synchronize the clock with the main Calisto™ board. If the time between the two boards differs, the doblePRIME™ application will fail to save new data in the database.

Testing the Supervisory Relays

This tool allows you to verify the current status of each relay and force a different status. Although this option also shows the LEDs status (see Testing the front LEDs (page 122) in this appendix), this method of assessing the front Status Indicator does not apply to the Calisto™ T1, but to other Doble products, i.e., doblePRIME IDD and doblePRIME PDG.

Note: Before using this tool, make sure SCT is stopped first; otherwise, you will experience connection issues to communicate with the board. Refer to Control of the doblePRIME™ Application (page 126) in this appendix for more information.

Click **dP IDD internal boards** to expand the menu then click **dP IDD LED/relay IO**.

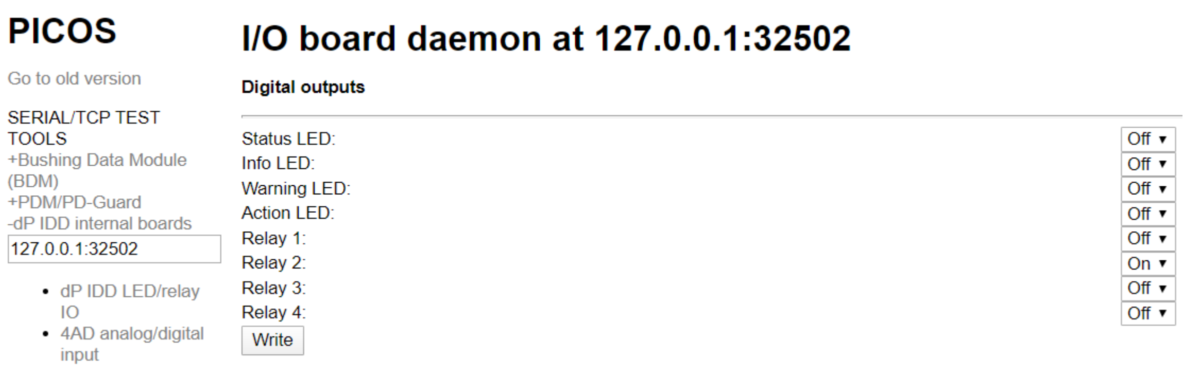


Figure 101 - Testing the relays

The Digital outputs show the current status of the relays. Verify the relays underneath the Calisto™ T1, or at the relays on the DIN rail inside the enclosure, to confirm the status in the software matches the relay status. Use a continuity tester to verify if the relays are open and closed.

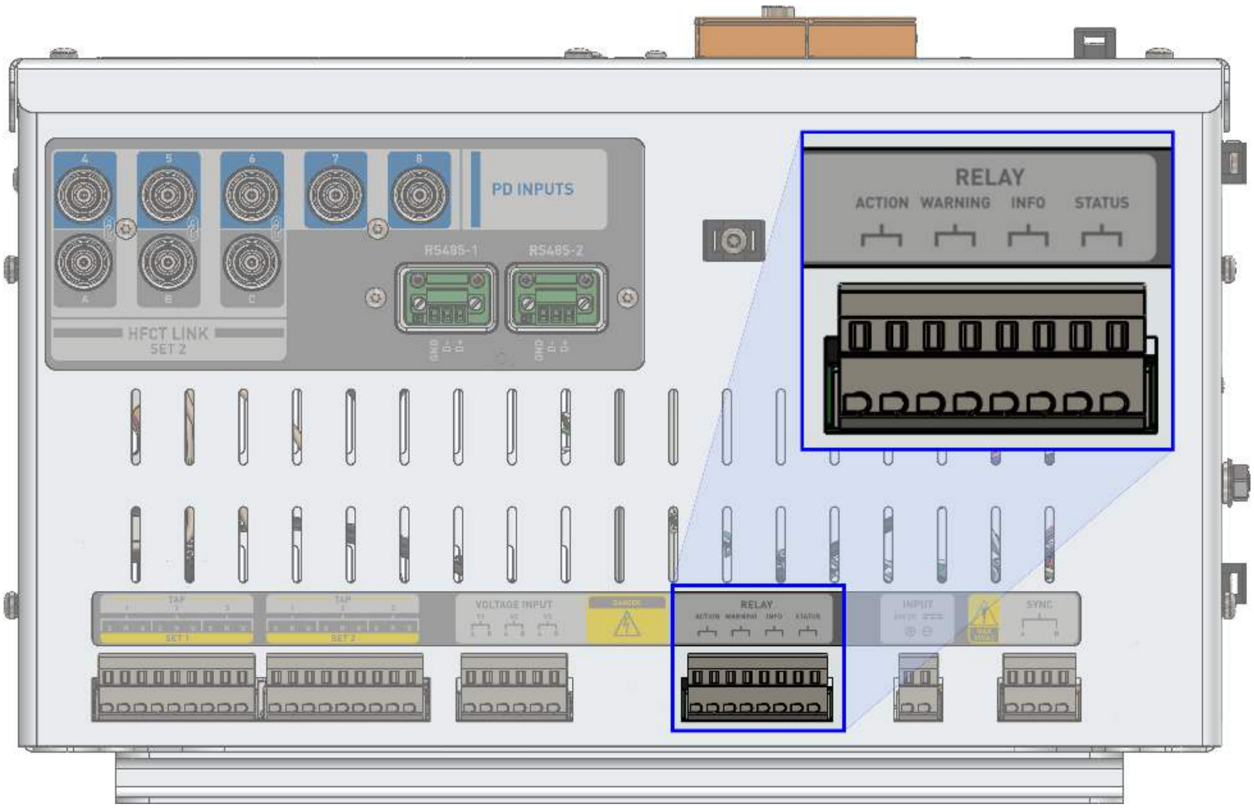


Figure 102 - Calisto™ T1 Relay Input

To change the relay status, click on the drop-down box on the right-hand side of the corresponding relay that you want to test, and toggle the status. Click **Write** to submit the changes.

Control of the doblePRIME™ Application

By using this PICOS tool, you have the means to:

- Execution of doblePRIME™ application
- Reinitialize database
- Reboot

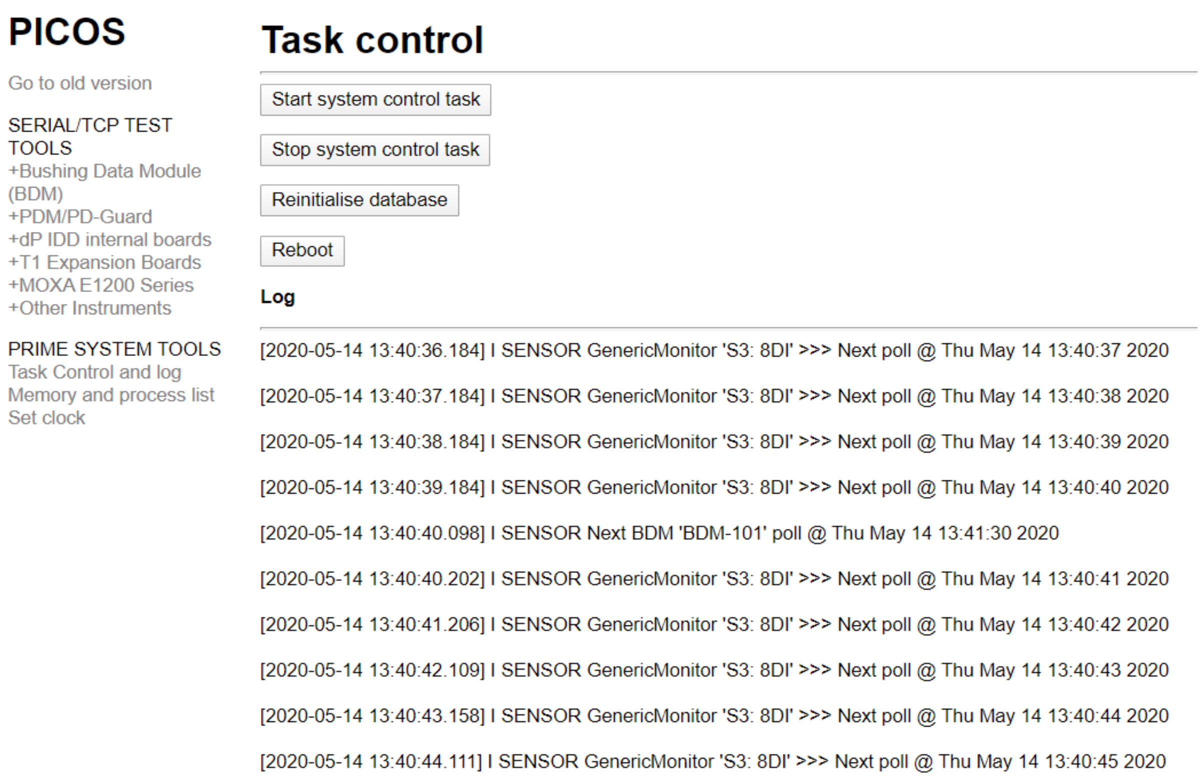


Figure 103 - Control doblePRIME™ application from Task Control

Task Control Options

Option	Description
Start/Stop system control task	Stopping doblePRIME™ application is required when troubleshooting the BDM, T1 expansion boards and testing the supervisory relays. During the time doblePRIME™ application is not running, data is not pulled from any monitor, and you cannot log into doblePRIME™ application.
Reinitialize database	Purge the configuration and database. This deletes all data in the device and frees up memory, and it is not reversible. Use this tool to start the configuration from scratch. This procedure requires a password. Use the password “crm114” to confirm the request.
Reboot	Reboot Prime Interface Gateway board only. The BDM and PDM board are not rebooted by this option. This procedure requires a password. Use the password “crm114” to confirm the request.
Log window	doblePRIME™ application output system messages on this box to help to troubleshoot the device.

E. True Power Factor Calibration

The True Power Factor method (TPF) is used by the Calisto™ T1 to determine the power factor of the bushings along with Relative Power Factor method. When TPF is enabled, the Calisto™ T1 monitors the bushing C1 leakage current and the reference voltage input from a potential device on the station bus. Using this method, the relative phase angle of each bushing C1 leakage current is compared to the bus voltage on that particular bushing. This method is also known as Tan Delta.

This section describes how to set up the monitor to find more accurate nameplate figures of the instrument transformer and transformer to calibrate the monitor when deriving TPF and capacitance. This method can be applied to bushings on the high voltage side, low voltage side and the tertiary side.

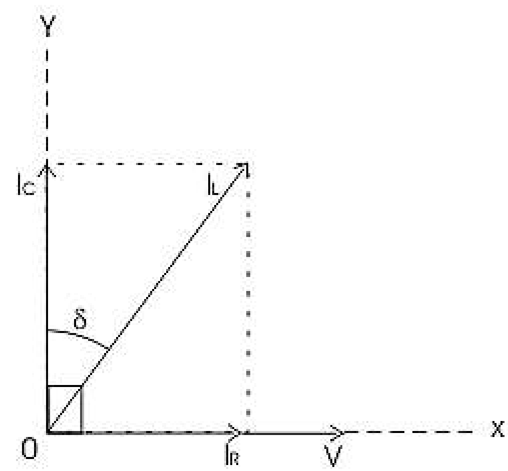


Figure 104 - Operation principle of TPF: Measuring the loss angle

Application Example

A hypothetical substation was created along with a couple of assets to demonstrate how to calibrate the monitor. In this substation, you will monitor the bushings at both sides to derive TPF. A set of instrument transformers are located at the high voltage side to measure the bus voltage. The element connections and bus voltages are described in the picture below.

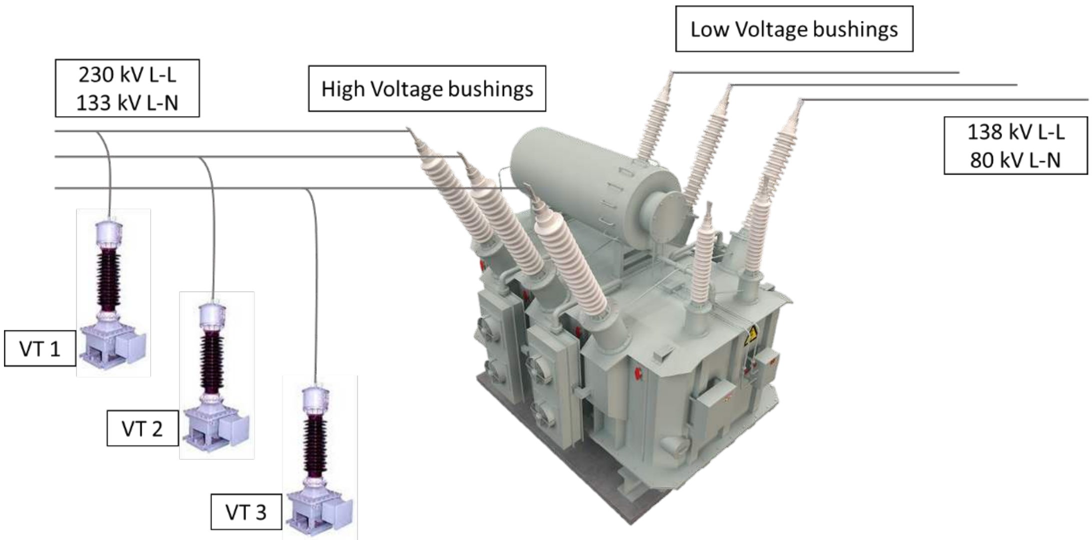


Figure 105 - Elements connected in the substation

The Calisto™ T1 is monitoring the high voltage bushings at SET 1 and the low voltage bushings at SET 2. The instrument transformers are connected to the voltage input.

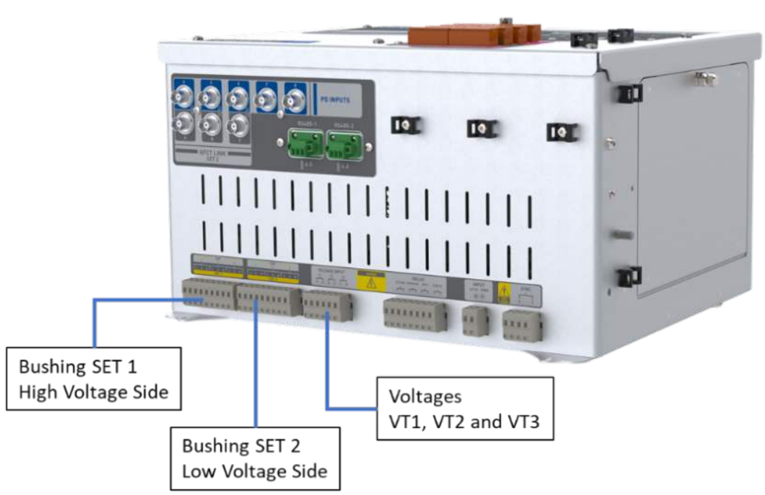


Figure 106 - Connection to the Calisto™ T1

Finding the Scale Factor and Phase Shift of the Instrument Transformers

Start by finding the ratio and phase angle error of the instrument transformers. The instrument transformers are directly associated with the high voltage bushings as they are on the same side; therefore, the system voltage on the high voltage bushings is known. Now that the leakage current and voltage are measured on the bushing, the Calisto™ T1 can calculate TPF.

Requirements for this step:

- Bushing nameplate or measured offline test of the high voltage bushings – capacitance and power factor
- Measured bushing leakage current at high voltage side
- Measured bus voltage on the high voltage bushing
- Instrument Transformer ratio and phase angle error

High Voltage Bushings nameplate:

- Capacitance = 250 pF
- Power Factor = 0.3 %

Instrument transformers nameplate:

- Voltage ratio = 133 kV L-N/110 V = 1209
- Phase angle error = 0°

For the sake of this example, we will assume the three bushings have identical capacitance and power factor. The same applies to the instrument transformer.

The PICOS application uses a different nomenclature for the voltage ratio, phase angle error and other measures.

PICOS Nomenclature is as follows:

- Voltage scale factor 1 - The ratio of the Instrument Transformer
- Phase shift 1 - Phase angle error of the Instrument Transformer
- Voltage scale factor 2 - The ratio of the transformer
- Phase shift 2 - Phase shift introduced by the connections in the transformer. Check the vector group
- Voltage - Instrument Transformer secondary output
- Scaled voltage 1 - Bus voltage on the bushings connected at SET 1 input
- Scaled voltage 2 - Bus voltage on the bushings connected at SET 2 input
- Current -Leakage current of the chosen SET

According to the PICOS nomenclature and the Instrument Transformer nameplate details, we have the following Instrument Transformer ratio and phase angle error:

	TAP 1	TAP 2	TAP 3
Scale Factor 1	1209	1209	1209
Phase Shift 1	0	0	0

Fine-Tuning the Scale Factor 1 and Phase Shift 1

The scale factor 1 and phase shift 1 from the nameplate is used as the starting point to fine-tune these figures to get a more accurate capacitance and power factor results. In particular, the more precise the phase shift, the better the result. A slightly imprecise phase shift can spoil the power factor measurement. The goal of the fine-tuning process is to get the same capacitance and power factor we find in the nameplate or from the offline test. The fine-tuned scale factor and phase shift calibrate the system to start monitoring the capacitance and power factor of the bushings.

Open the PICOS page (see Appendix PICOS Application (page 114)), and navigate to True Power Factor page, Figure 107. Click **Bushing Data Module** to expand the options then enter the IP address of the BDM into the field– 192.168.10.35. Click **True Power Factor test – requires bushing card 1, SVM card 2** to proceed.

Note: Before using this tool, make sure the Bushing monitor has the correct frequency set, and the status was changed to commissioned. It's crucial to have doblePRIME™ application talking to the BDM prior PICOS TPF diagnostics as it programs the BDM to read the signal in the correct frequency range. Next, go to the Task Control page and stop SCT so PICOS will not experience connection issues to communicate with the BDM while doblePRIME™ application is trying to do the same. Check the Appendix PICOS Application (page 114), subsection Control of Calisto, for more information.

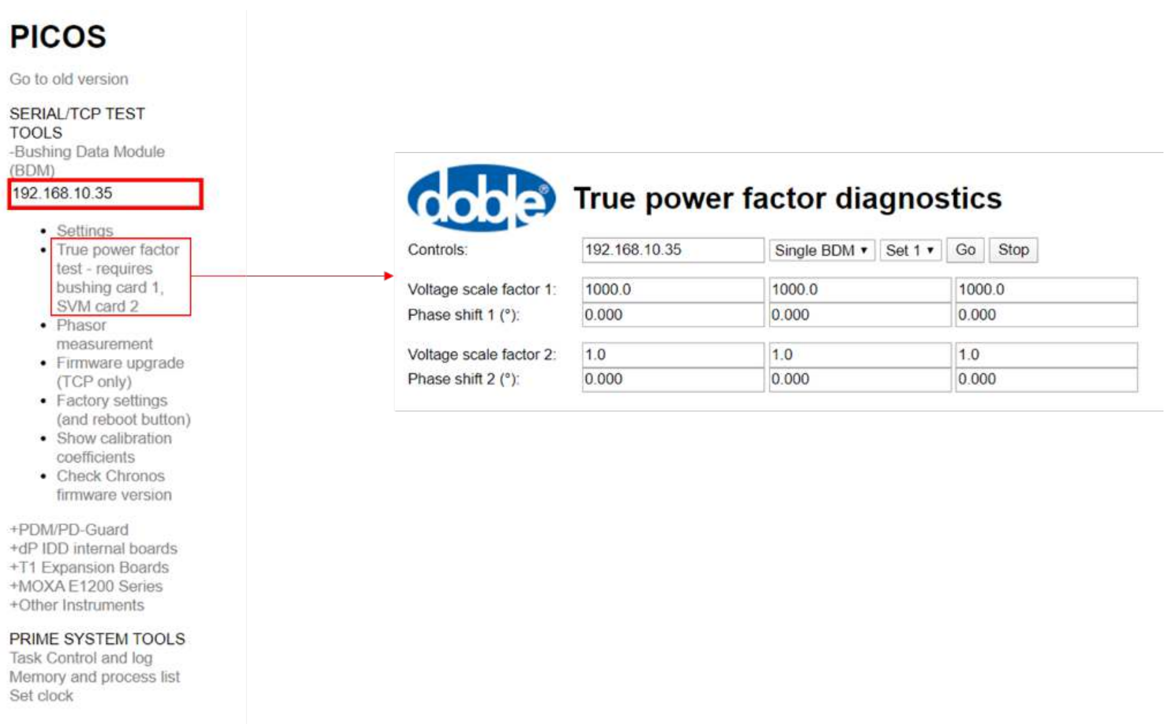


Figure 107 - PICOS TPF menu: change IP Address

Enter in the **Voltage scale factor 1** fields the VT ratio 1209, and in **Phase shift 1** fields enter the phase angle error 0 degrees. Click **Go** to start the acquisition. The TPF test reads the leakage current from SET 1, and the voltages then output the measurements and derived data.

After the data comes through, check the basic measurements the system is reading from the BDM: frequency, voltage and current. Voltage is the reading from the secondary of the VT and current is the leakage current from SET 1.

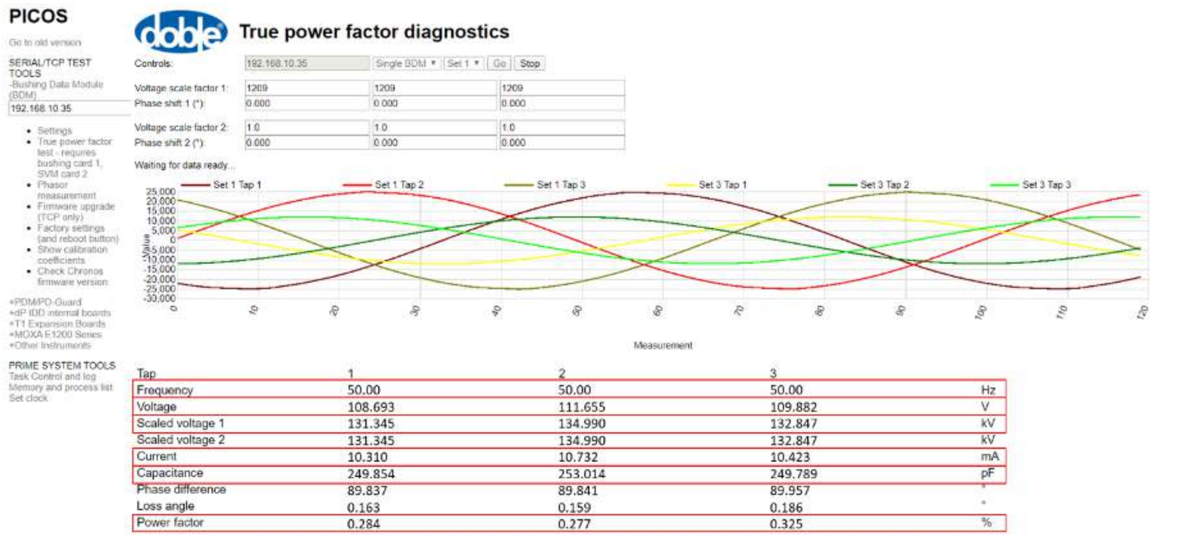


Figure 108 - Checking measurements on the table

Compare the measures with the reference. The measured values must be close to the reference. If the result is satisfactory, then you can proceed with the analysis.

	Reference	Measured Tap 1	Measured Tap 2	Measured Tap 3	Unit	Analysis
Frequency	50	50	50	50	Hz	OK
Voltage	110	108.693	111.655	109.882	V	OK
Scaled Voltage 1	133	131.345	134.99	132.847	kV	OK
Current	10.45	10.310	10.732	10.423	mA	OK

Now compare other data, the capacitance and power factor. The measured capacitance and power factor are not always even close to the target. Run an analysis to identify what needs to be improved.

	Target	Measured Tap 1	Measured Tap 2	Measured Tap 3	Unit	Analysis
Capacitance	250	249.854	253.014	249.789	pF	Capacitance Tap 2 can be improved
Power Factor	0.3	0.284	0.277	0.325	%	Need to improved power factor across all Taps

Take action to improve the figures by fine-tuning the scale factor 1 and phase shift 1. Slightly changing the scale factor 1, it causes its capacitance to change slightly. The same happens to the power factor. If you slightly change the phase shift, it causes its power factor to slightly change. Try to move the measured capacitance and power factor as close to the target as possible.

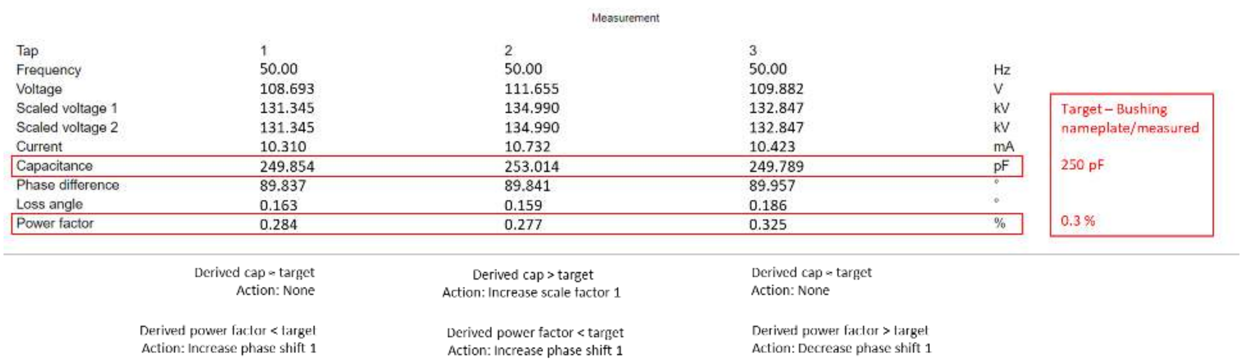


Figure 109 - Plan of action to improve the results

After following the plan advised, and tweaking the system, the new Scale Factor 1 and Phase Shift 1 figure is found. And as a result, the capacitance and power factor are much closer to the target.

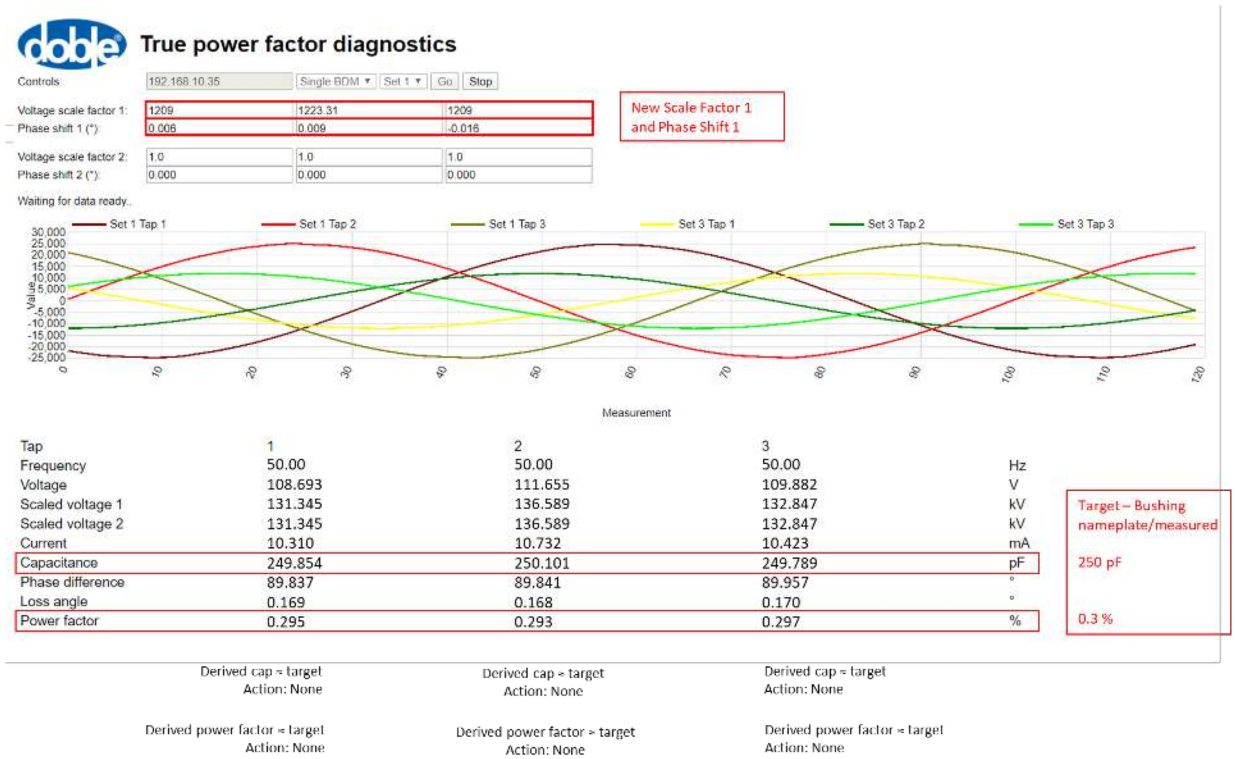


Figure 110 - New Scale Factor 1 and Phase Shift 1 after fine-tuning the system

The new scale factor 1 and phase shift 1 figures:

	TAP 1	TAP 2	TAP 3
Scale Factor 1	1209	1223.31	1209
Phase Shift 1	0.006	0.009	-0.016

Later, these new values must be entered in the bushing monitor instance, at voltage channels settings.

Finding the Scale Factor and Phase Shift of the Transformer

Now that the scale factor 1 and phase shift 1 of the instrument transformer was fine-tuned, we can work across the other end of the transformer to work out the power factor and capacitance of the low voltage bushings.

Requirements for this step:

- Bushing nameplate or measured offline test of the low voltage bushings – capacitance and power factor
- Measured bushing leakage current at low voltage side
- Measured bus voltage on the low voltage bushing

- Transformer ratio and phase angle error

Low Voltage Side Bushings nameplate indication:

- Capacitance = 210 pF
- Power Factor = 0.25 %

Transformers nameplate indication:

- Voltage ratio = 138 kV L-N / 230 kV L-N = 0.6
- Vector group = Dyn11 = 30°

Even though the instrument transformers are at the high voltage side, T1 can indirectly measure the bus voltage on the low voltage side if you take into consideration the ratio of the transformer.

Low Voltage side = (measured VT secondary voltage) x (ratio of the VT) x (ratio of the transformer)

Or using PICOS nomenclature

Scaled Voltage 2 = Voltage x (Scale Factor 1) x (Scale Factor 2)

Using this artifice, you can find the magnitude of low voltage phasors. However, these phasors are in phase with the high voltage phasors. Thus, to create the low voltage phasors, you have to introduce a phase shift, so the low voltage phasor leads or lags the high voltage phasors by as much as the vector group dictates.

Transformer ratio and phase shift according to the vector group:

According to PICOS nomenclature and the transformer nameplate details, we have:

	TAP 1	TAP 2	TAP 3
Scale Factor 1	0.6	0.6	0.6
Phase Shift 1	30	30	30

Fine-Tuning the Scale Factor 2 and Phase Shift 2

The vector group, in this case, is the Dyn11 which means the low voltage side leads the high voltage side by 30 degrees; therefore, the phase shift 2 starting point is 30 degrees. You already have the fine-tuned scale factor 1 and phase shift 1 found on the previous step, and it must not be changed. Use the scale factor 1 and phase shift 1 found in the last step.

	TAP 1	TAP 2	TAP 3	Need to Fine-tune?
Scale Factor 1	1209	1223.31	1209	NO
Phase Shift 1	0.006	0.009	-0.016	NO

Scale Factor 2	0.6	0.6	0.6	YES
Phase Shift 2	30	30	30	YES

Open PICOS True Power Factor Diagnostics page which you used to fine-tune the high voltage side and select the SET to where the low voltage bushings are wired. In this example, the low voltage bushings are wired to **SET 2**, see Figure 111.

The scale factor 1 and phase shift 1 fields already have the fine-tuned figures. Enter in the scale factor 2 fields the transformer ratio 0.6, and in the phase shift 2 fields enter the phase displacement of 30 degrees. Click **Go** to start the acquisition. The TPF test reads the leakage current from SET 2, and the voltages then output the measurements and derived data.

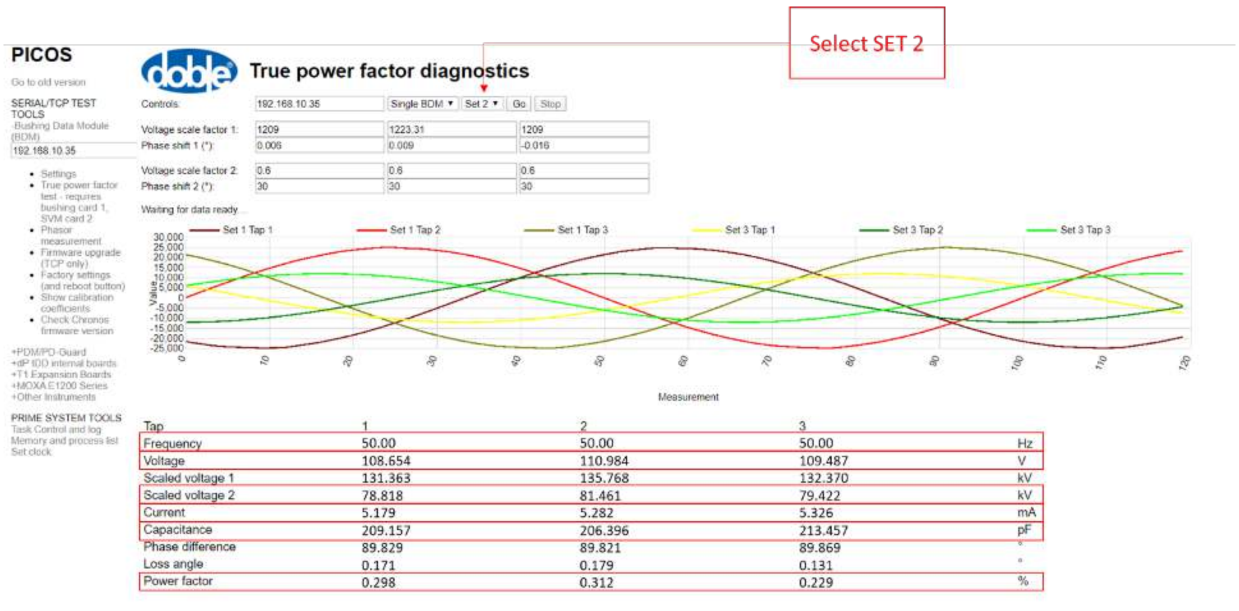


Figure 111 - Checking measurements on the table

Compare the measures with the reference. The measured values must be close to the reference. If the result is satisfactory, then you can proceed with the analysis.

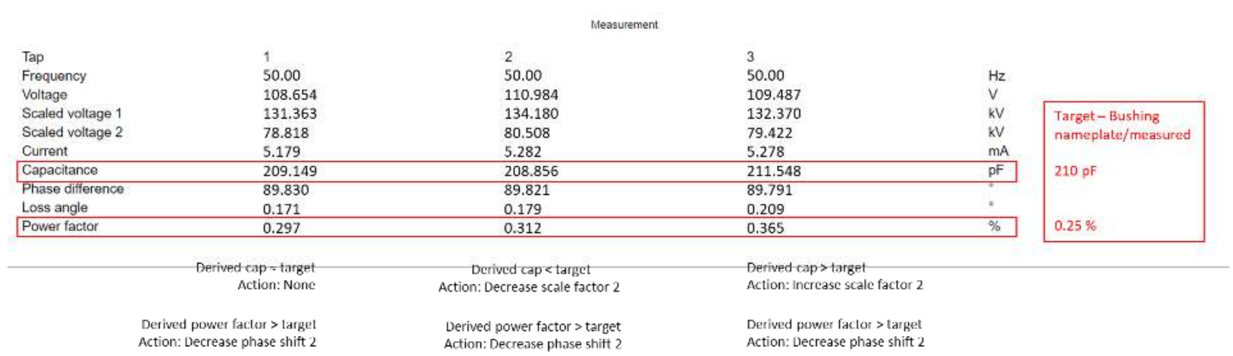
	Reference	Measured Tap 1	Measured Tap 2	Measured Tap 3	Unit	Analysis
Frequency	50	50	50	50	Hz	OK
Voltage	110	108.693	111.655	109.882	V	OK

Scaled Voltage 2	79.674	78.818	81.461	79.422	kV	OK
Current	5.256	5.179	5.312	5.326	mA	OK

Now we must compare other data, the capacitance and power factor. The measured capacitance and power factor are not always even close to the target. Run an analysis to identify what needs to be improved.

	Target	Measured Tap 1	Measured Tap 2	Measured Tap 3	Unit	Analysis
Capacitance	210	209.157	206.396	213.548	pF	Increase capacitance Tap 2 and decrease capacitance Tap 3
Power Factor	0.25	0.298	0.312	0.229	%	Need to improved power factor across all Taps

To improve the capacitance and power factor, you have to tweak the scale factor 2 and phase shift 2, but don't change the new scale factor 1 and phase shift 1 figures. Repeat the process you did to fine-tune the high voltage side. Slightly change the scale factor 2 and phase shift 2 to move the measured capacitance and power factor as close to the target as possible.


Measurement

Tap	1	2	3	
Frequency	50.00	50.00	50.00	Hz
Voltage	108.654	110.984	109.487	V
Scaled voltage 1	131.363	134.180	132.370	kV
Scaled voltage 2	78.818	80.508	79.422	kV
Current	5.179	5.282	5.278	mA
Capacitance	209.149	208.856	211.548	pF
Phase difference	89.830	89.821	89.791	°
Loss angle	0.171	0.179	0.209	°
Power factor	0.297	0.312	0.365	%

Figure 112 - Plan of action to improve the results

After following the plan advised, and tweaking the system, the new Scale Factor 2 and Phase Shift 2 figures are found. And as a result, the capacitance and power factor are much closer to the target.

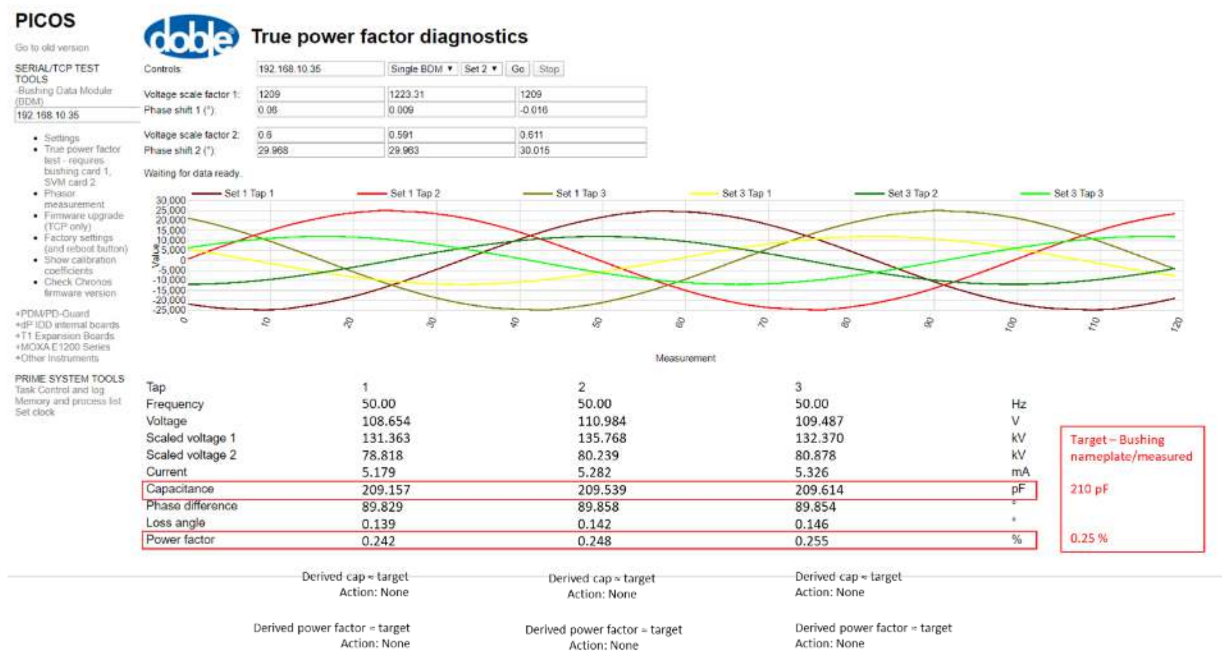


Figure 113 - New Scale Factor 1 and Phase Shift 1 after fine-tuning the system

Now you have a list of the new scale factors and phase shifts to calibrate the bushing monitor. These figures need to be entered in doblePRIME™ application.

	TAP 1	TAP 2	TAP 3
Scale Factor 1	1209	1223.31	1209
Phase Shift 1	0.006	0.009	-0.016
Scale Factor 2	0.6	0.591	0.611
Phase Shift 2	29.968	29.963	30.015

Where to Enter the New Figures

The new scale factor and phase shift found figures must be entered in the doblePRIME™ application. PICOS was used to find the figures, but PICOS and the doblePRIME™ application do not have a way to exchange any information, which means you have to enter the figures in the doblePRIME™ application manually.

> **Note:** After the TPF calibration is finished, run back doblePRIME™ application. Go to the Task Control page and click Start System Control Task to run the application. Refer to Control of the doblePRIME™ Application (page 126), for more information.

1. Log into doblePRIME™ application to edit the Bushing Monitor Instance to configure the bushings.
2. Click the gear icon on the top-right of the title bar then click **Monitors**.

   The Monitors tab opens in the feature panel. The bushing monitor is accessible on the list.
3. To edit the bushing monitor, click the appropriate **Channels** icon.
4. Enter the scale factor 1 and phase shift 1 in the Voltage Channels fields.

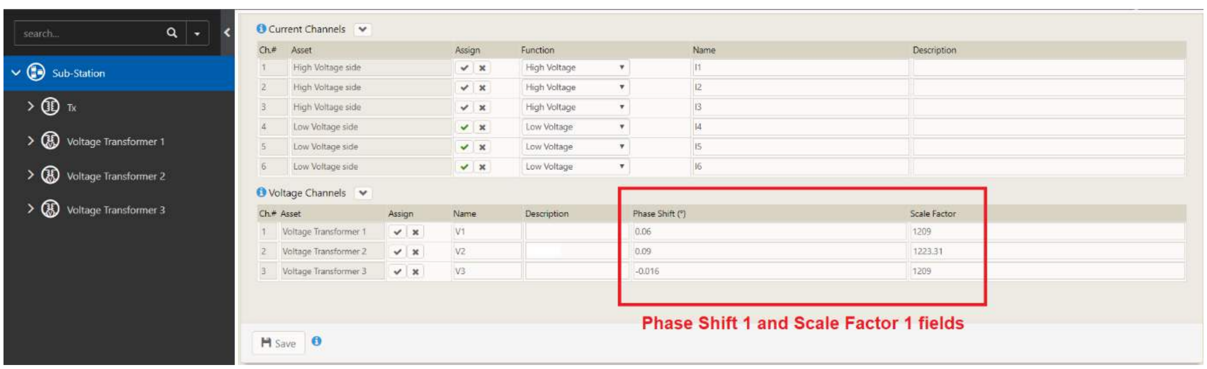


Figure 114 - Enter the scale factor 1 and phase shift 1 in the bushing monitor instance

5. Click **Save** in the panel footer to save the current settings.
6. Open the Asset Configuration tab.
7. Click the gear icon on the top-right of the title bar then click on **Asset Configuration**.
8. On the Asset Tree, drill down the transformer asset unit until the bushings related to scale factor 2 and phase shift 2 are exposed. In this case, it is the **Low Voltage side bushing set**.
9. Click on the bushing channel you want to enter the bushing nameplate and edit the configurations. The menu to edit the bushing appears in the Asset Configuration page. Click **True Power Factor** to show the options.

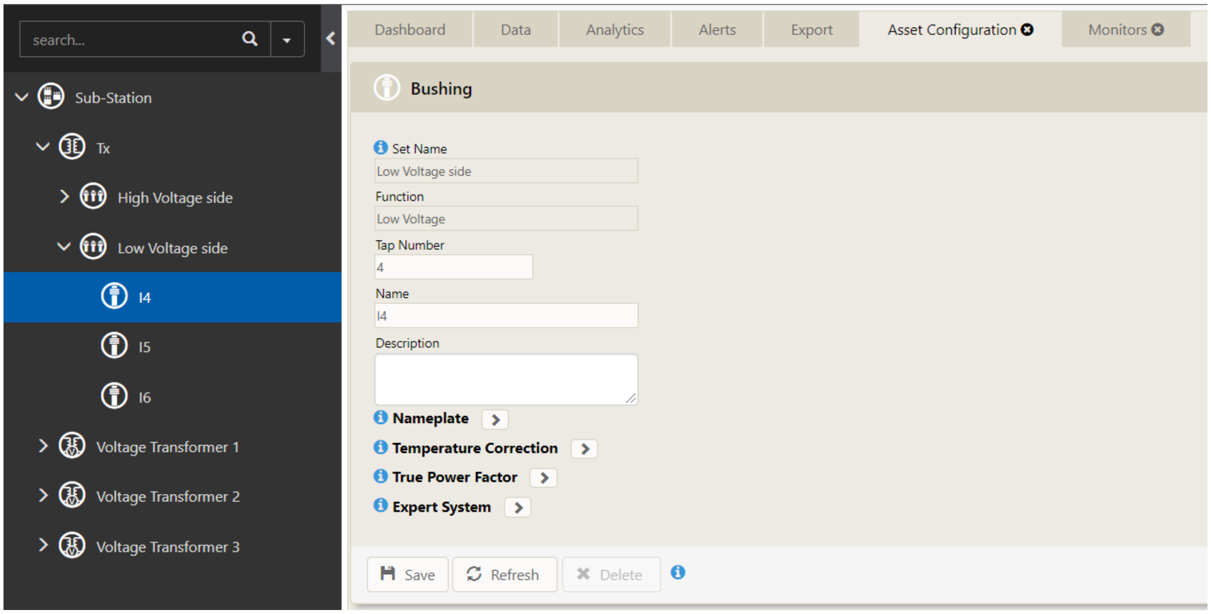


Figure 115 - Enter phase shift 2 and scale factor 2 in the bushing True Power factor option

Confirm that TPF option is enabled. Enter the scale factor 2 and phase shift 2 in the fields. Also, make sure the voltage transformer was assigned to the appropriate bushing. Click **Save** in the panel footer to save the current settings.

Repeat the process on the other two bushings to enter the scale factor 2 and phase shift 2 figures to the corresponding bushing channel.

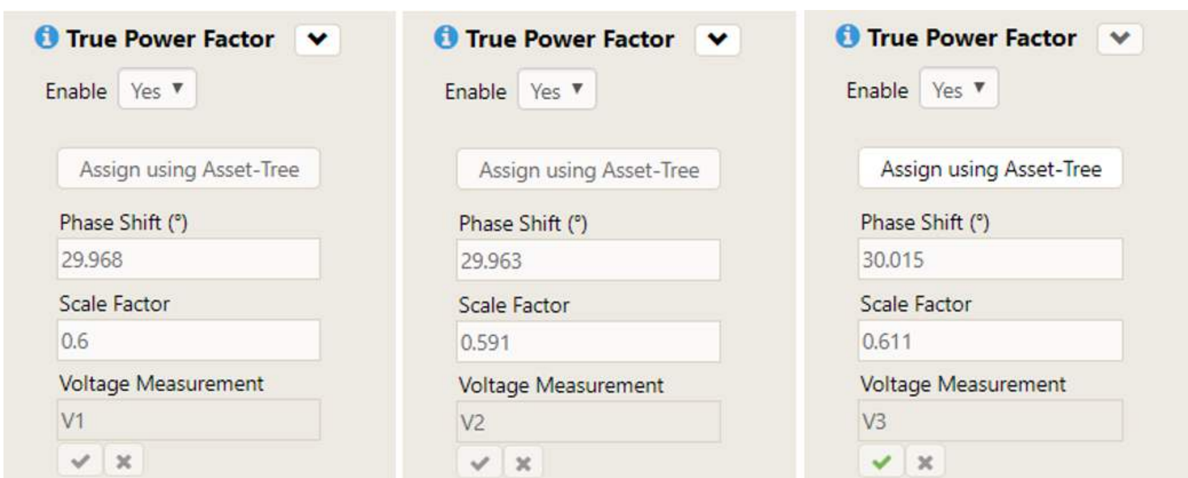


Figure 116 - Scale factor 2 and phase shift 2 entered on the three bushings

After all parameters are entered in the software, the doblePRIME™ application takes a couple of minutes to acknowledge the changes and restart itself to take the new settings. After the self-restart, it shows the measurements on the Dashboard. At first, the Dashboard tabwill just show leakage current, but 24 hours later the daily capacitance and daily power factor will be shown. To view the instantaneous capacitance and power factor go to Data tab and select a bushing channel in the asset tree to view instantaneous capacitance and power factor of that specific bushing.

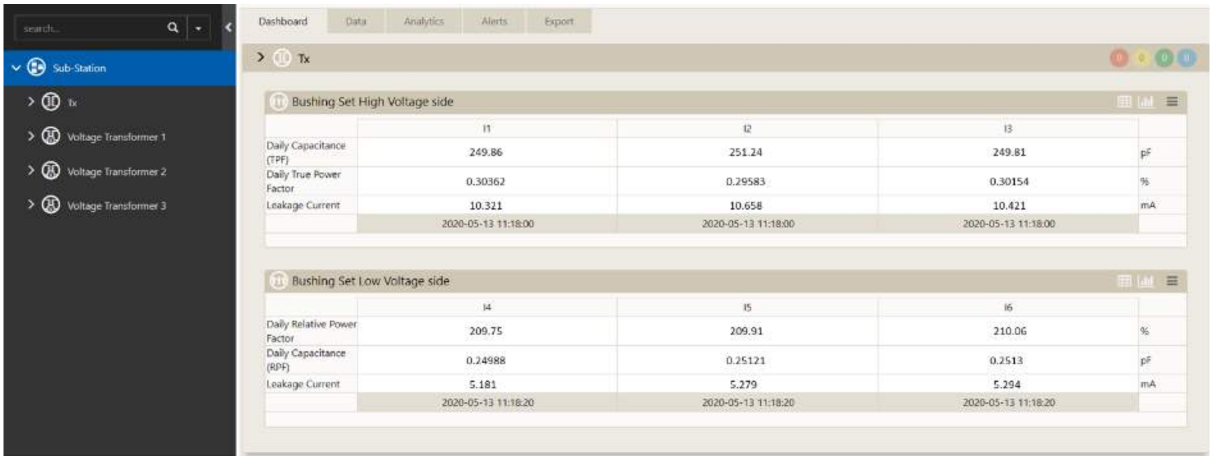


Figure 117 - TPF results on the Dashboard after 24 hours

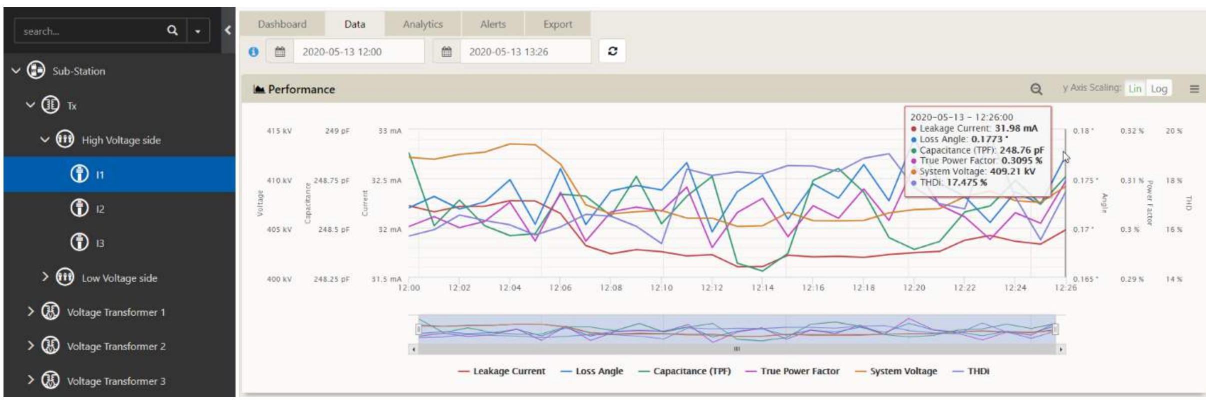


Figure 118 - Instantaneous TPF in Data chart