



DOBLE CONDITION MONITORING

Calisto T1

CONDITION MONITORING SYSTEM



FCC CLASS A NOTE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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Preface

Who Should Read this Guide

This guide is intended for two sets of Calisto T1 users:

- Doble customers
- Doble technical support employees

It is assumed that all readers are familiar with professional standards and safety practices.

Document Conventions

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. Also used for text displayed in the user interface, such as an error message or prompt. Examples:

Click **Close**.

Go to the **Sources** tab.

- **Monospace**— Any text you must type in is shown in this typeface:

Example: Type in 1500 ms.

Notes, Cautions, and Warnings

This document uses notes, cautions, and warnings to provide specialized information and to alert you to potential safety hazards, 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.

Legal

Refer to "LEGAL NOTICE" on page 106 for Doble's complete legal statements.

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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 (BDM-102 or BDM-101 models) 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.
- The Expansion Card Inputs are data recorders that accept current, voltage, temperature, and digital 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 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 Calisto DGA monitors
- Networked to any doblePRIME condition monitoring module
- Networked to a third-party supervisor (e.g. SCADA system with Modbus, DNP3 LAN, or IEC61850 (optional) protocols)

2. Hardware Reference

This section describes the components of the Calisto T1.

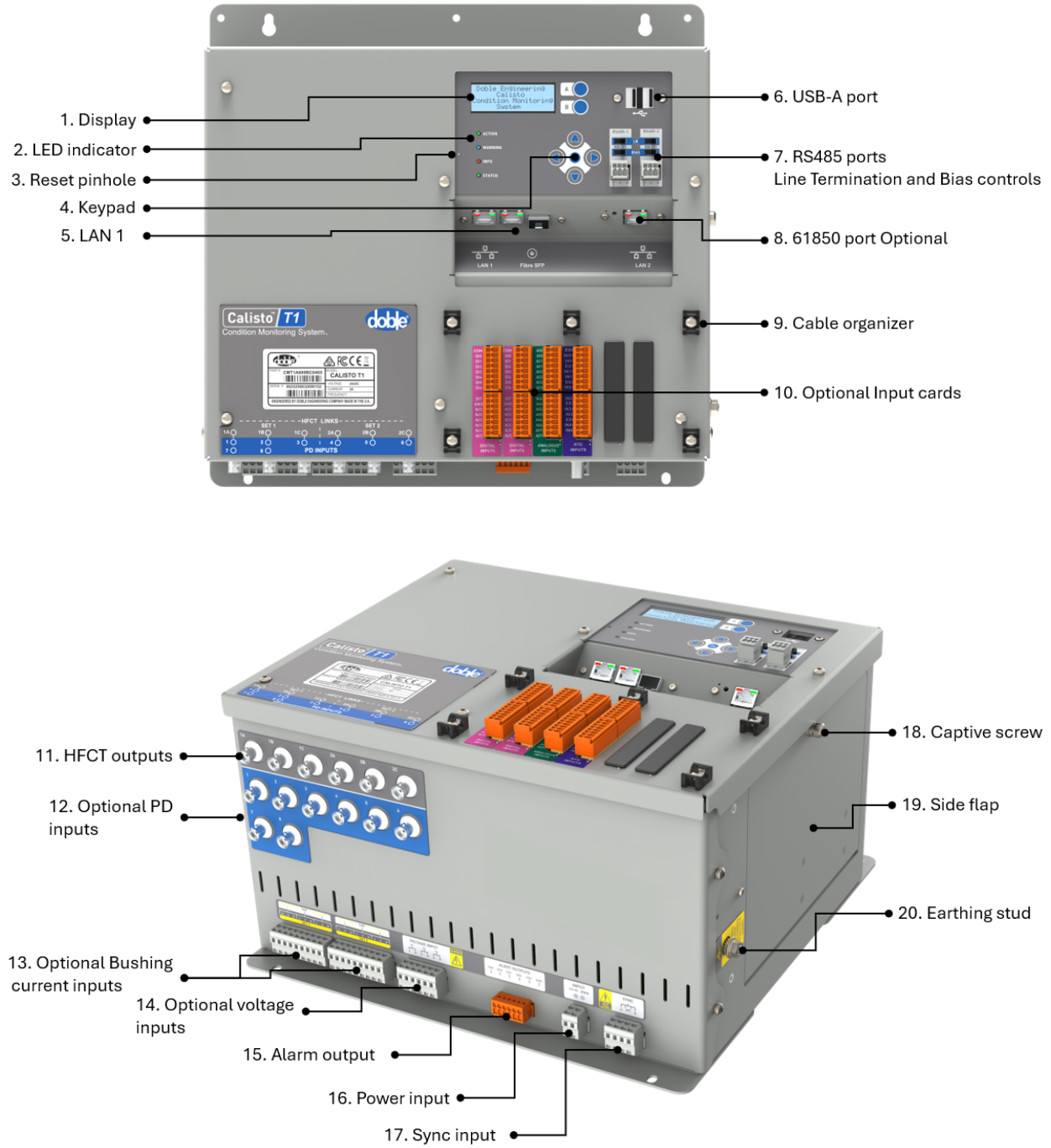


Figure 1 - Calisto T1 Components

Callout	Component	Description
1	Display	Shows IP of all interfaces and latest measurements
2	LED indicator	Indicates the highest current system alert
3	Reset pinhole	Resets IP to default addresses
4	Keypad	LCD navigation control
5	LAN 1	Dual Ethernet and SFP slot
6	USB interface	Allows firmware to be updated via flash drive
7	RS485 ports	Allows communication with other monitors and SCADA systems
8	Optional IEC61850 port	Optional port for IEC61850 communication
9	Cable organizer	Keeps your cables together and attached to the profile
10	Optional Expansion cards	Expand inputs using the 8AI, 8DI and 5TI cards. Up to 4 expansion cards are supported
11	HFCT outputs	Set 1 and Set 2 HFCT outputs
12	Optional PD inputs	Eight PD inputs for all monitoring purposes. PD1 required
13	Optional bushing current inputs	Set 1 and set 2 bushing inputs. Six current inputs from the bushing sensors. BDM-102 or BDM-101 required
14	Optional voltage inputs	Three voltage Inputs from Instrument Transformers (PT/VT). BDM-101 required
15	Alarm outputs	Four digital outputs for system alerts
16	Power Input	24V DC power input @ 2A
17	Sync input	Voltage input from a sync transformer for PRPD measurements

Callout	Component	Description
18	Captive screw	Unscrew it to remove the side flap
19	Side flap	Remove side flap to access PRIME CPU
20	Earthing stud	Protective earthing connection

3. Getting Started

This chapter describes the wiring of power, safety ground, sensors inside the enclosure, and how to connect to a network and interpret alarm indications. Calisto T1 is installed in an IP66 enclosure to safeguard the monitor against environmental factors.

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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.



Caution: The enclosure where T1 is mounted only accepts AC mains. Do not wire DC power to the enclosure.



Figure 2 - Power Supply Input



Warning: Do not remove the cable that connects the earth stud to the grounding bar in the enclosure.



Figure 3 - Earth Stud

Inputs and Outputs on Calisto T1

Depending on the application, sensors can be connected to the bushing current inputs, voltage inputs, sync input, Partial Discharge inputs, and card inputs. The characteristics of each of these connections are described in the following sections.

Bushing Current Inputs

SET 1 and SET 2 current inputs (Bushing Monitor BDM-102 or BDM-101 required) accept signals from Bushing Tap Adapters (BTA) to monitor leakage current and derive power

factor and capacitance. Each SET can monitor up to three bushings. An internal High Frequency Current Transformer (HFCT) card is connected internally to each SET to allow PD signals to be decoupled from the leakage current.

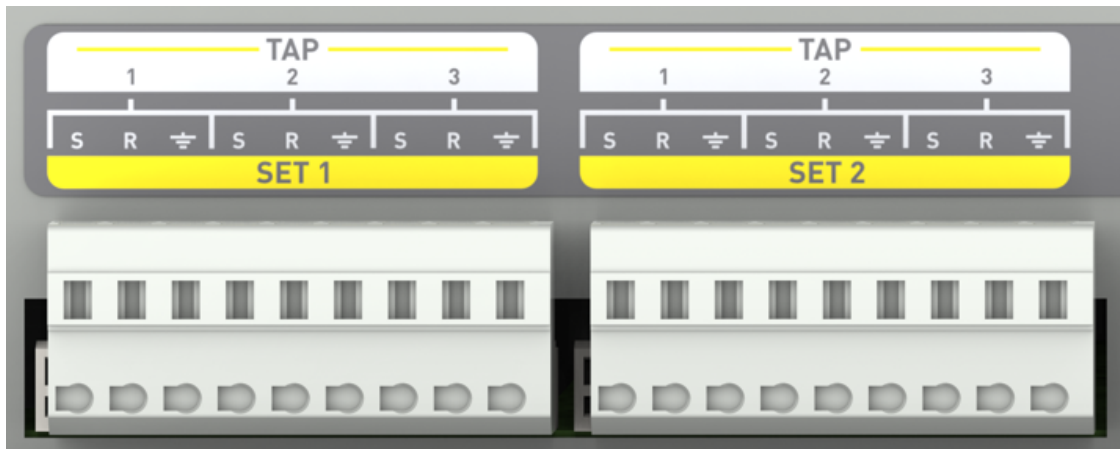


Figure 4 - Bushing SET 1 and SET 2 Inputs



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 wirings 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 "[Wiring the Bushing Sensor Cables to the Shorting Blocks](#)" on page 28. Only cables provided by Doble shall be used.

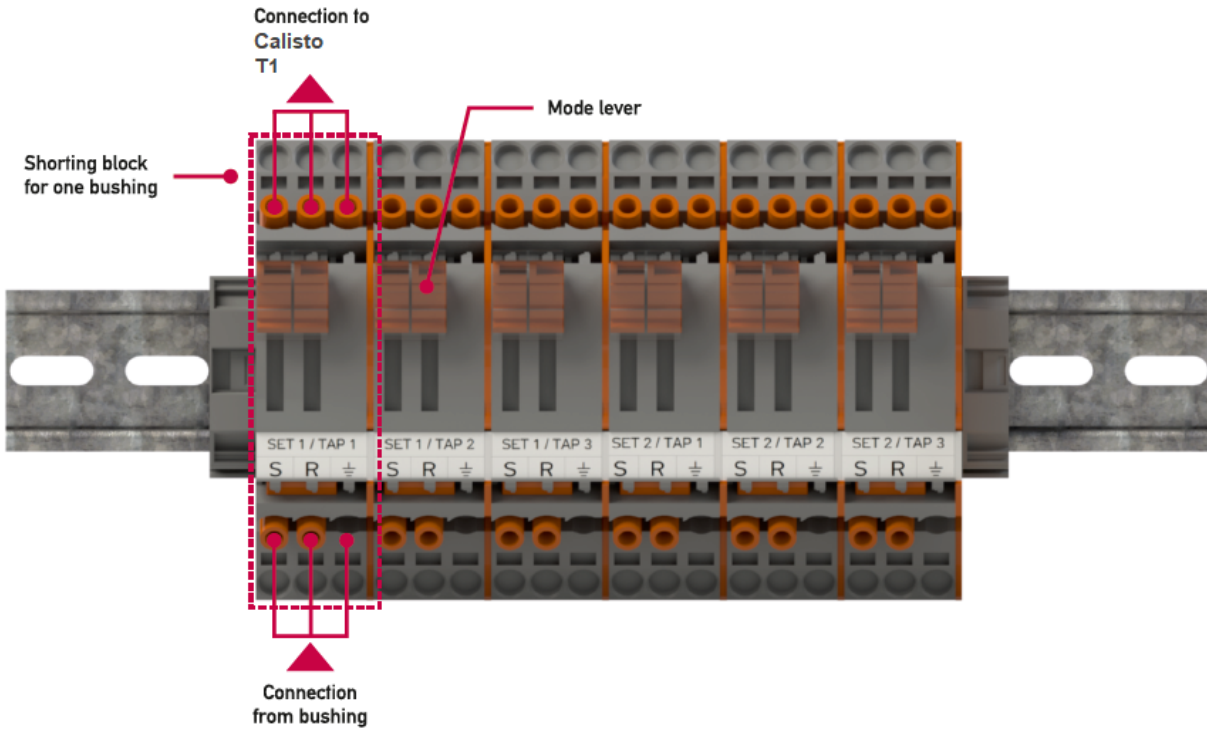


Figure 5 - Shorting Blocks in Service Position

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.

For further information about the Shorting Block consult "[Wiring the Bushing Sensor Cables to the Shorting Blocks](#)" on page 28.

Voltage Inputs

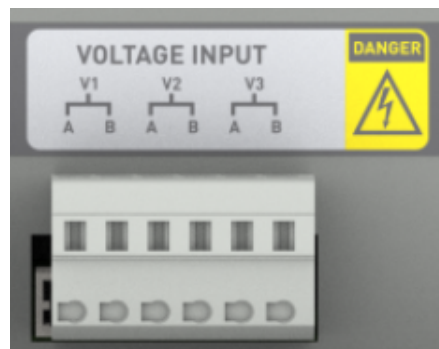


Figure 6 - Voltage Input

Voltage inputs V1, V2 and V3 (Bushing Monitor BDM-101 required) accept signals from instrument transformers (PT or VT), 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.

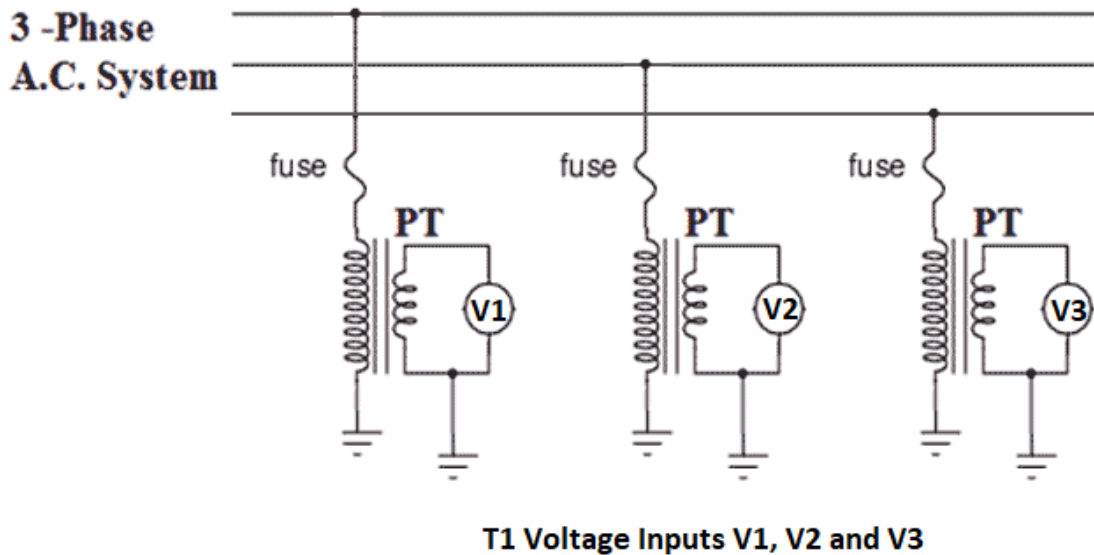


Figure 7 - Instrument transformers monitoring the system voltage



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.

Sync Input

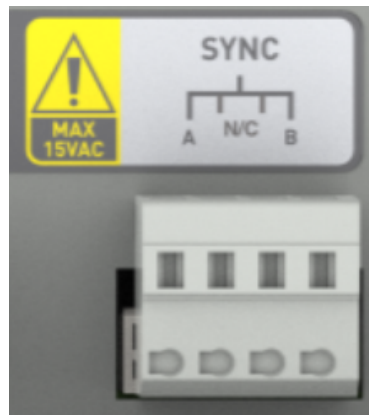


Figure 8 - Transformer Sync Input

The 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 Phase Resolved Partial Discharge data.

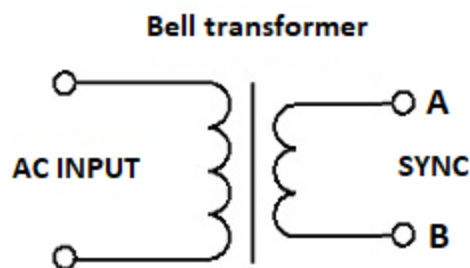


Figure 9 - Sync Transformer Detail

Partial Discharge Inputs and HFCT Outputs

The PD sensor connections are by means of 50 Ohms cable with BNC termination. There are eight multiplexed channels available to monitor Partial Discharge and all eight channels are available for general use [Figure 10](#) and [Figure 11](#).

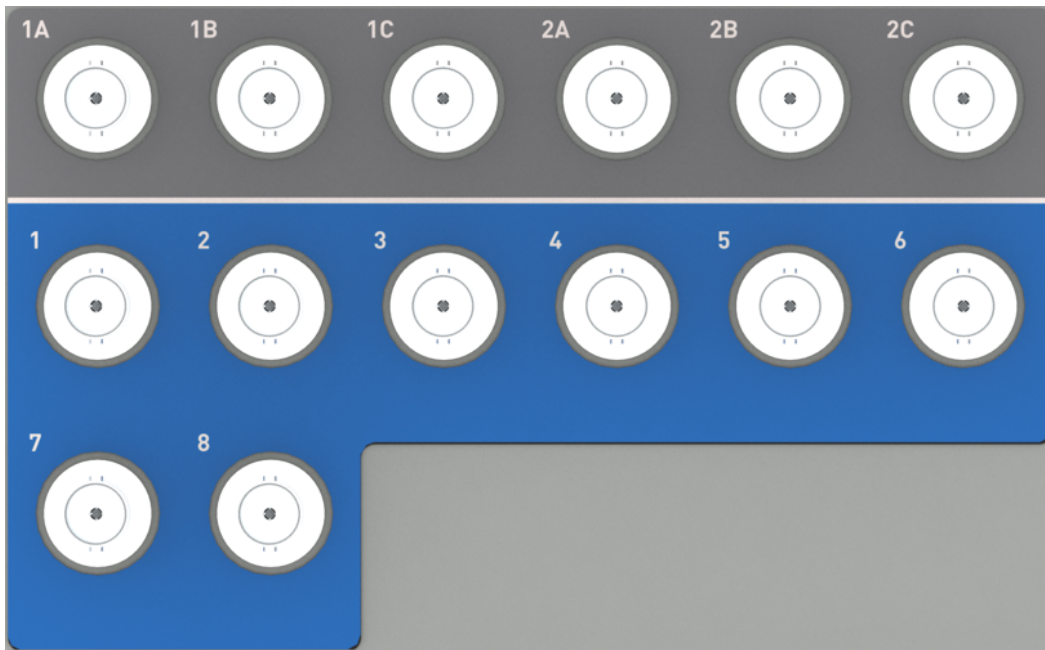


Figure 10 - Eight PD Inputs and six HFCT Outputs

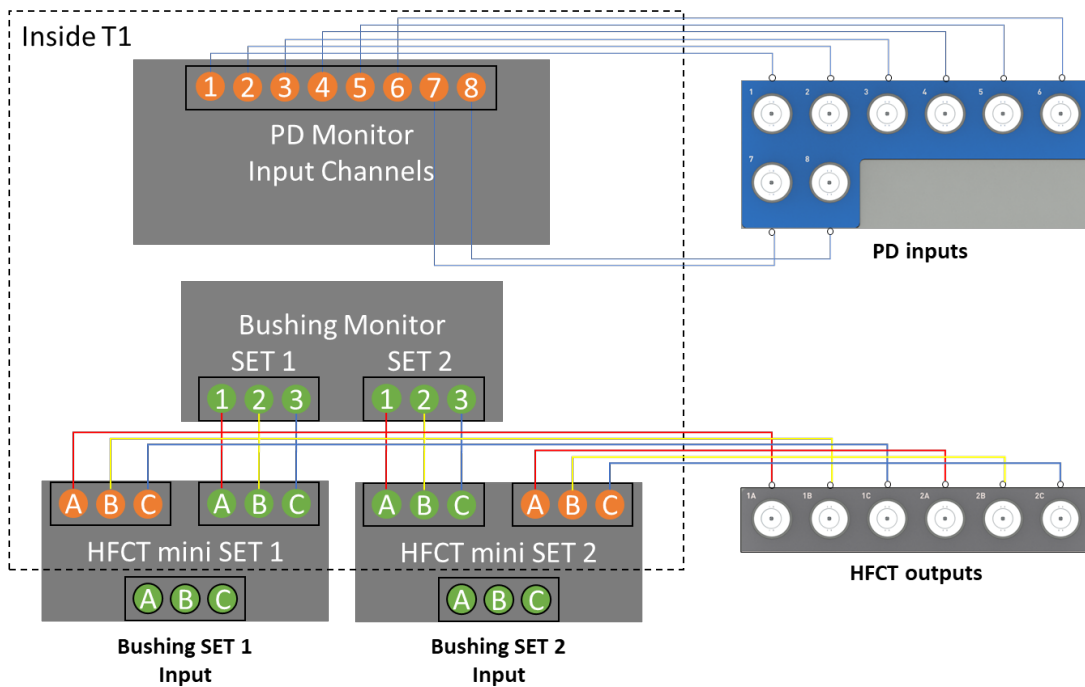


Figure 11 - PD Channels internal connection

To monitor PD from SET 1 or SET 2, connect the HFCT output to the corresponding PD inputs (channels 1–6). Use the BNC-BNC link cables – provided with the monitor - to connect the channels as indicated in the table below:

Table 1 - HFCT Links Connection

HFCT Link Output	PD Input
Set 1A	1
Set 1B	2
Set 1C	3
Set 2A	4
Set 2B	5
Set 2C	6

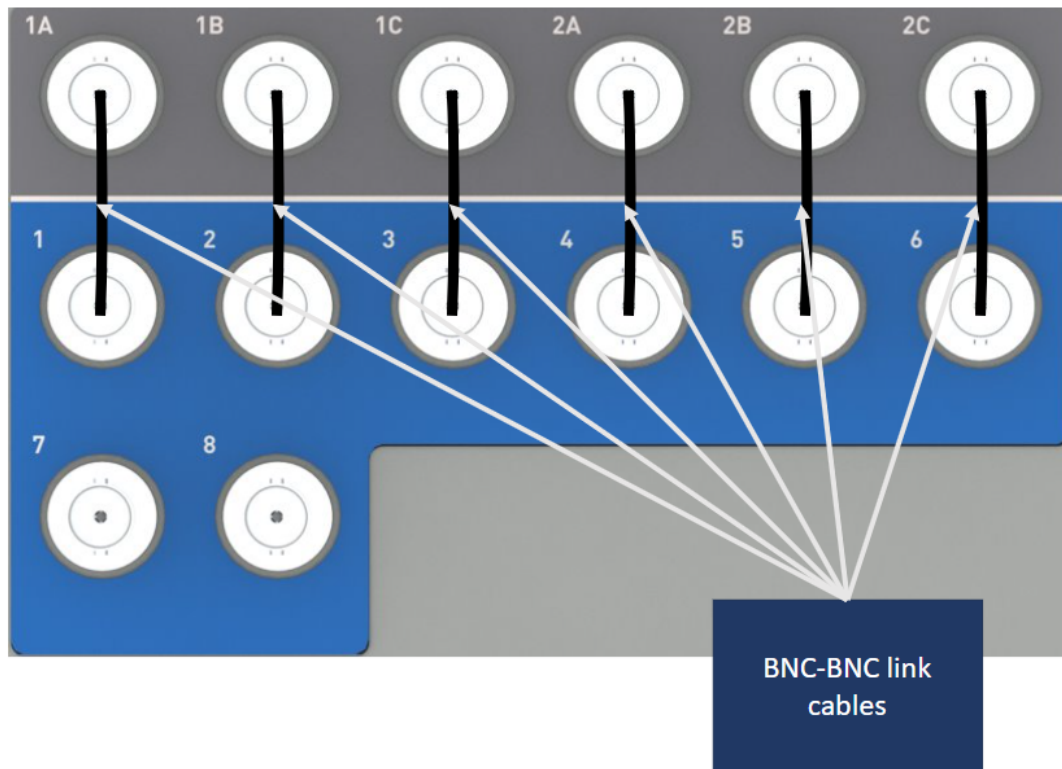


Figure 12 - Linking the HFCT Set 1 and 2 outputs to the PD inputs

When the coax jumpers are present, the PD monitor can detect PD using channels 1-2-3-4-5-6 (Figure 12). If the links are not present, the channels can be connected to other sensors, e.g., drain valve probe, LDWS-T and others (Figure 13).

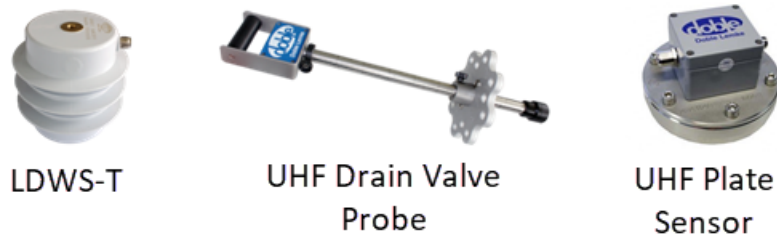


Figure 13 - Example of PD Sensors

Expansion Cards

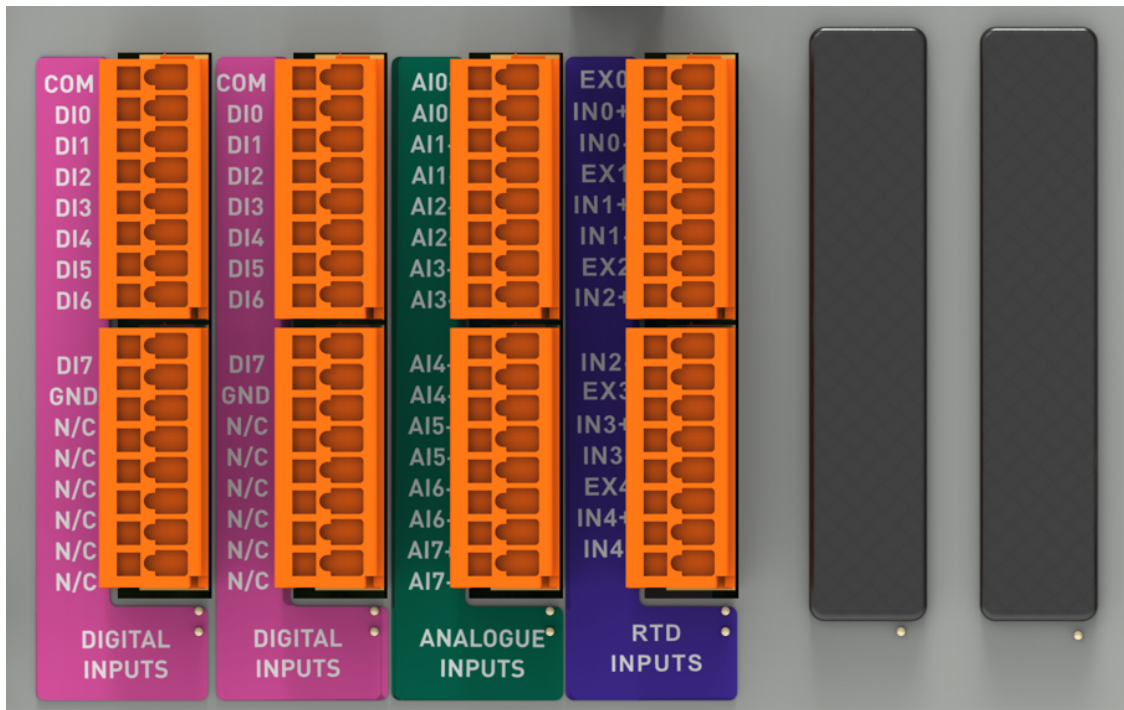


Figure 14 - Input Cards

The inputs cards accept different types of signals: current, voltage, temperatures, and digital inputs. There are six slots available for expansion, and up to four cards 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.

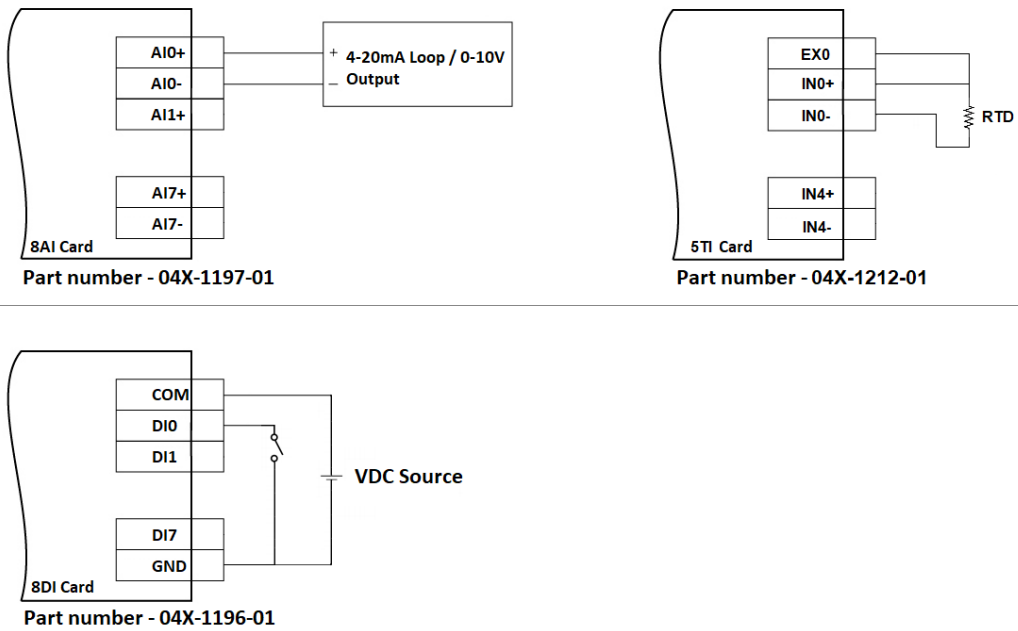


Figure 15 - Expansion Card

Alarm Outputs

The alarm outputs are digital signals and reflect the PRIME software's alert status (D0-status, D1-info, D2-warning, and D3-action).

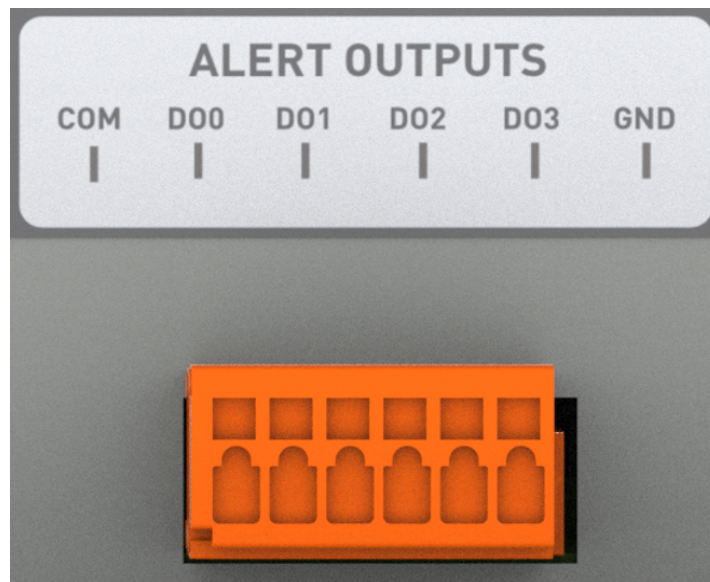


Figure 16 - Digital Outputs

These digital signals are wired to terminal strip supervisory relays for connection to the control room or LED tower (optional accessory).

RELAY:

OPERATION in NORMAL condition:

INFO/WARNING/ACTION - Normally OPEN

STATUS - Normally Closed

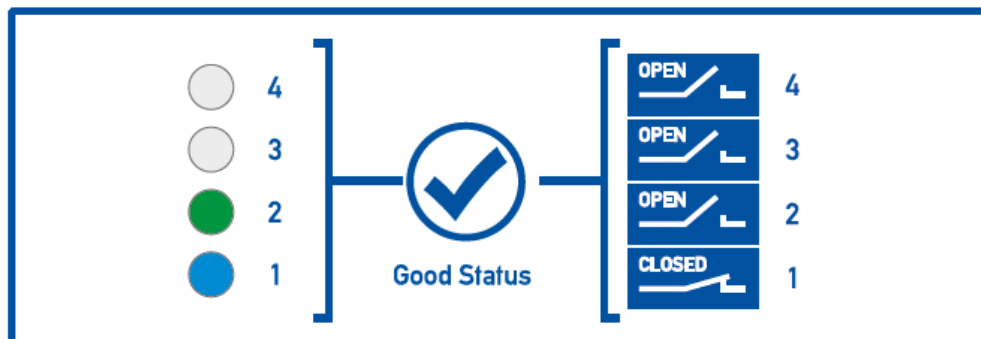
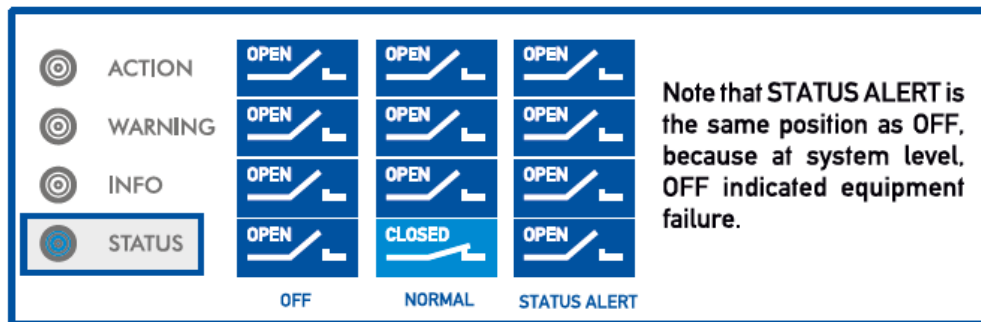
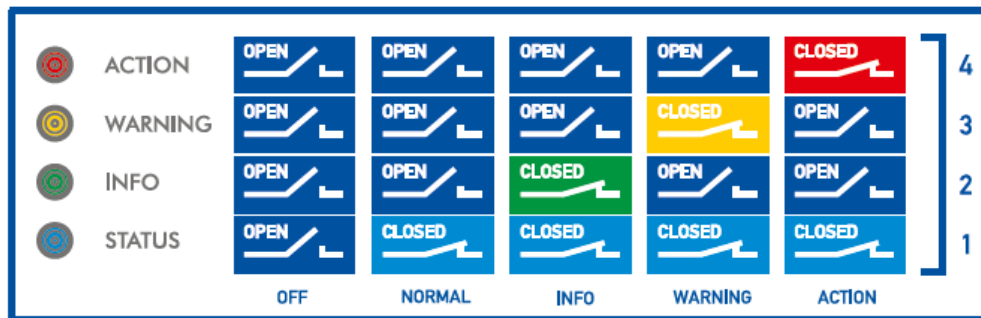


Figure 17 - Alarm outputs

Note: Alarm outputs are driven by alerts only. They are not configurable on PRIME software.

Network Connection

There are three different types of ports to allow computers, third party systems, and monitors to be connected to the Calisto T1.

- Ethernet LAN 1
- Serial Ports
- Ethernet LAN 2

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, IP address, and the IEC61850 protocol points and settings.

Ethernet - LAN 1

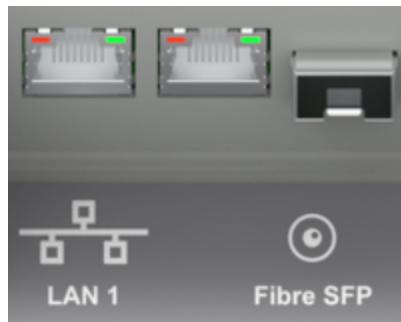


Figure 18 - LAN 1 Ethernet and SFP slot

The Ethernet switch ports allow receiving and sending data to multiple devices at once or daisy-chained to extend the network range.

The SFP slot is designed to accommodate SFP transceivers (optional) that convert electrical signals to optical signals for fiber optic connections. The SFP module plugs into the SFP slot, allowing the network device to connect to different types of cables (fiber optic or copper) and support various data rates and transmission distances.



Note: SFP adapters are not included and must be sourced by the customer.



Note: On PRIME UI, any port of LAN 1, copper and fiber, is controlled by Ethernet Interface eth1.

Ethernet Interface

Details	Name	Interface	Description
	eth0	Internal	Network 1
	eth1	Internal	Network 2
	eth2	Internal	Network 3

Network Settings

IP Address:

IP Address: Subnet Mask: Default Gateway:

DNS Servers

NTP Servers

Server Name	
0.debian.pool.ntp.org	<input type="button" value="✘"/>
1.debian.pool.ntp.org	<input type="button" value="✘"/>
2.debian.pool.ntp.org	<input type="button" value="✘"/>
3.debian.pool.ntp.org	<input type="button" value="✘"/>
192.168.0.5	<input type="button" value="✘"/>

Figure 19 - Ethernet interface settings

These ports provide the following services:

- HTTP/HTTPS access to the PRIME web interface
- MODBUS TCP master and slave
- DNP3 LAN master and outstation
- NTP – Time synchronization
- Diagnostics
- MySQL – Sources

Serial Ports

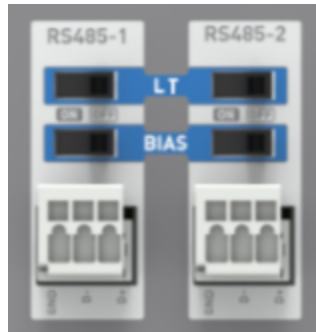


Figure 20 - Figure 20 Serial Ports

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

There are two control switches for each RS485 port. One enables the 120 Ohms Line Termination (LT) and the other switch enables the Line Bias resistors (BIAS).

Ethernet - LAN 2



Figure 21 - Figure 21 IEC61850 Port

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

All other services (e.g., PRIME web UI, Modbus, DNP3) are not support via LAN 2 port.

Status Indicator and the IP Reset Pinhole

The front panel shows the current alert level of the assets being monitored. Below the LED indicators are located the reset pinhole. The reset pinhole allows you to restore the default LAN 1 IP address of the unit when the IP is forgotten.



Figure 22 - Indicator LEDs and Reset Pinhole

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

Table 2 - 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.

1. Insert and hold a paperclip or similar in the pinhole. The LEDs will go out then light up in sequence from 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 - eth1 - will fall back to the default address – 192.168.1.234 – and will wait for connection.

4. Enclosure and ancillaries

The Calisto T1, and ancillaries, comes into the enclosure DPEN101 T (see "Dimensions" on page 113).

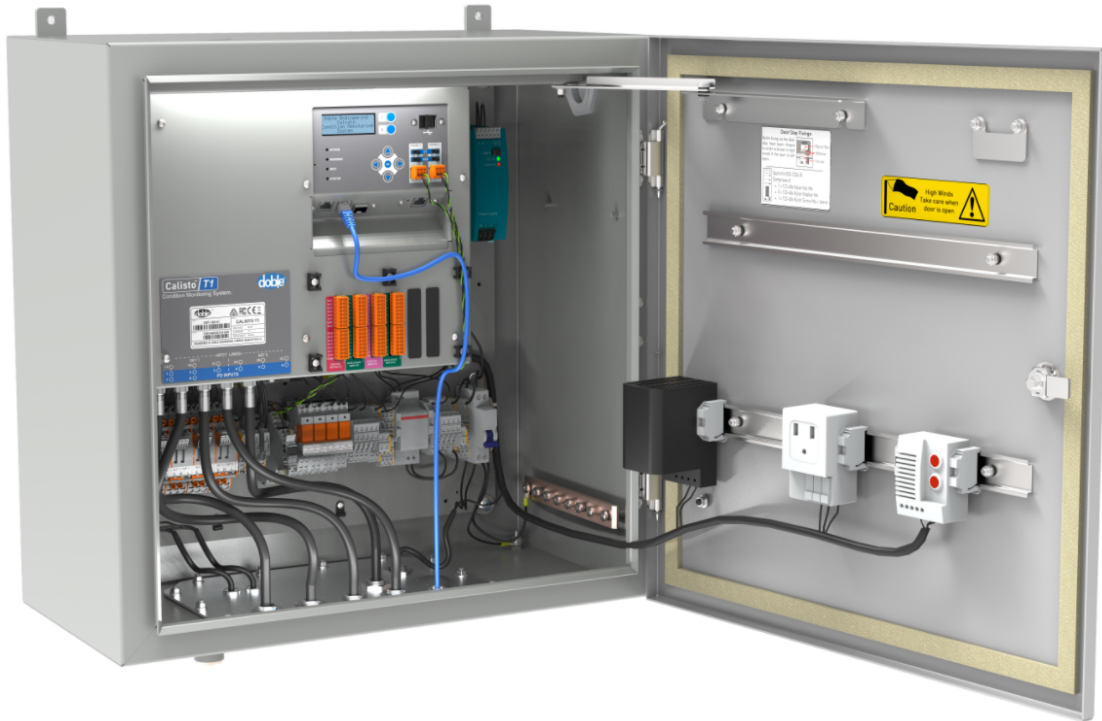


Figure 25 - DPEN101 T Enclosure populated

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Sync transformer	37
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Elements of the enclosure

Removable aluminum gland plate and grounding lug.

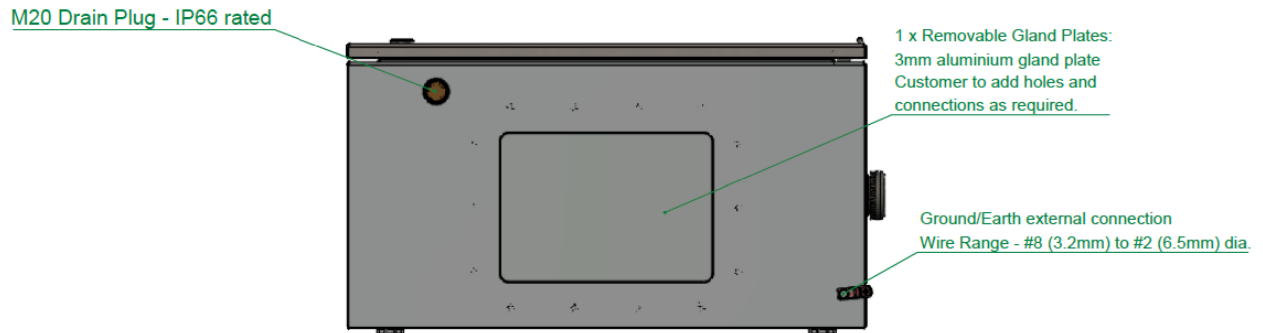


Figure 26 - Bottom view of enclosure

DPEN101 T accessories

Power supply, located at top right. The Hygrostat, heater and socket are mounted on the door. The magnet fixing light bar is located on the ceiling of the enclosure and the fan is located at bottom-left of the enclosure.

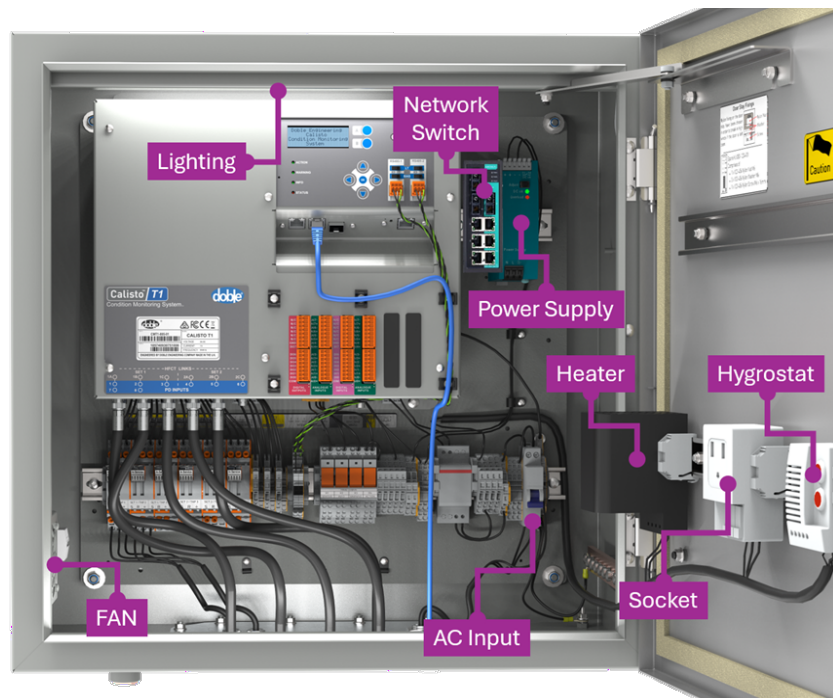


Figure 27 - Enclosure ancillaries

Power Supply

The enclosure's DC-powered components are supplied by the 24VDC Puls power supply - Doble universal power adapter (PN 401-0597).

Power Supply specifications:

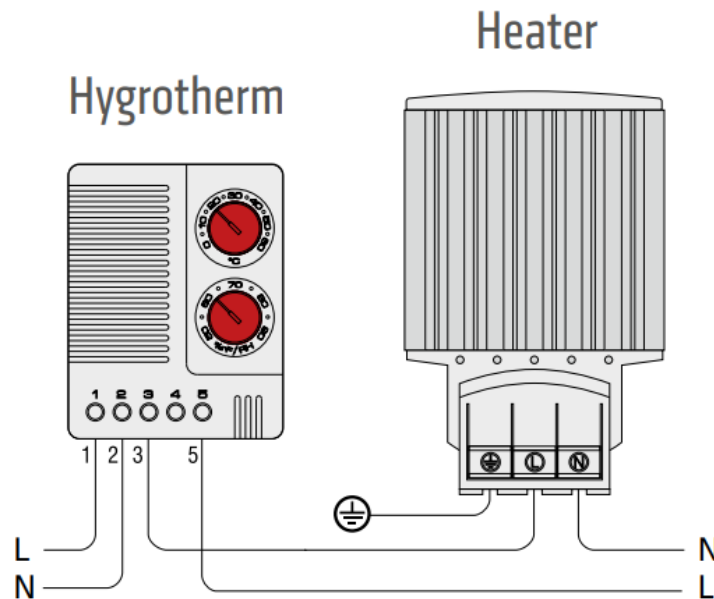
- AC 100-240V Wide-range Input
- Output voltage DC 24V
- Output current 5 – 4.5A continuous
- Output power 120W continuous

The power supply is wired to the AC terminals in the terminal strip inside the enclosure. The enclosure must be wired to 100/240VAC to operate properly.

Climate control

The electronic hygrotherm senses the ambient temperature and relative humidity in the enclosure with electric/electronic components and turns on a heater at either set point, helping prevent the formation of condensation in the enclosure.

The CS 060 is a touch-safe heater for use in enclosures with heating capacity of 100W. The design of the heater utilizes natural convection which results in a circulating current of warm air.

**Figure 28 - Climate control**

Network switch

The 9-port unmanaged Ethernet switches (optional) are designed for harsh industrial environments, such as the hazardous locations defined by the Class 1 Div. 2 and ATEX Zone 2 standards.

Moxa EDS-309-3M-ST-T specifications:

Input Current	0.26 A @ 24 VDC
10/100BaseT(X) Ports (RJ45 connector)	6 Auto negotiation speed Full/Half duplex mode Auto MDI/MDI-X connection
100BaseFX Ports (multi-mode ST connector)	3

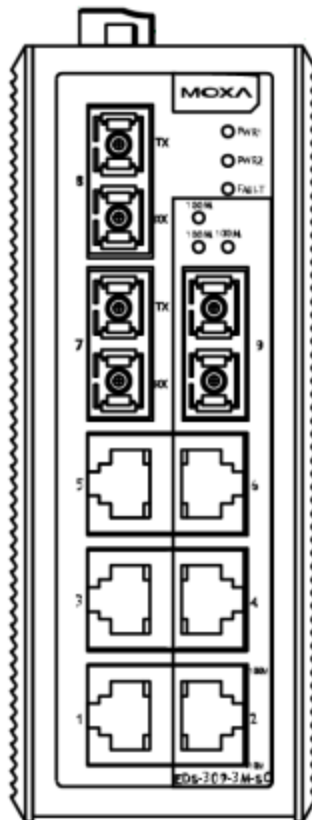


Figure 29 - Climate control

Terminal strip elements

All terminal blocks are cage clamp style designed for solid, stranded or fine-stranded conductors. To connect a conductor in the connection opening, insert a flat blade screwdriver - tip size of 2.5 x 0.4mm – straight into the corresponding rectangular opening.

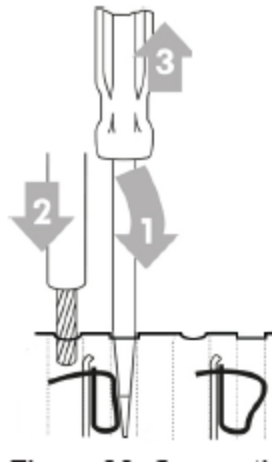


Figure 30 - Connecting a Conductor to a CAGE CLAMP

The terminal blocks on Calisto T1, except for the Expansion Input cards, are wired to the terminal strip located at the bottom of the enclosure. The terminal strip is the interface between the field and terminals on Calisto T1.

For detailed information of internal wiring in the enclosure consult drawing reference 051-02-04-07 Rev D.

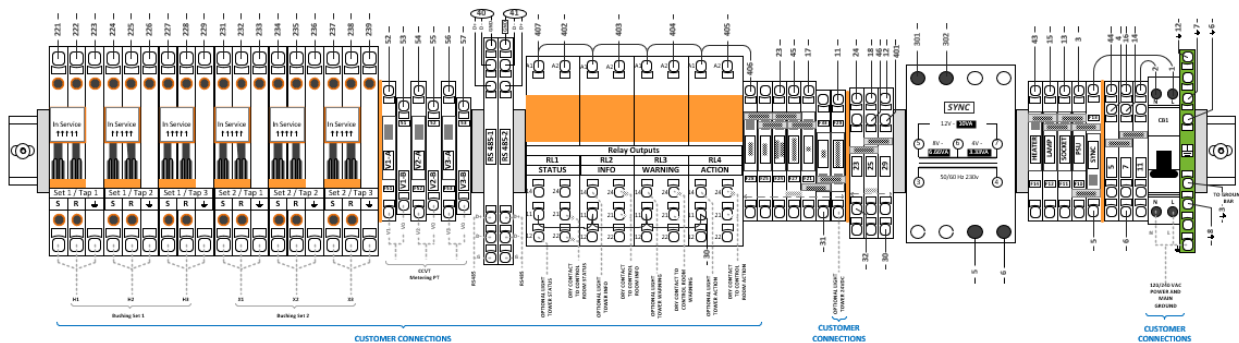


Figure 31 - Terminal strip

Shorting block terminals

Connections from bushing sensors must run through the shorting blocks for safety reasons. A lever on the shorting block is used to change the operation of the shorting block, either Service or Maintenance mode.

In Service mode it allows the leakage current from the bushing to go straight into the input Set then return to the transformer ground. In this process the leakage current is measured by the Bushing Monitor (BDM-102 or BDM-101 monitor required) thus power factor and capacitance measurements can be derived from it.

If the Calisto T1 needs maintenance, where it must be removed from its enclosure, the shorting block must be put in Maintenance mode. In Maintenance Mode the leakage current is short-circuited in the shorting block causing it to return safely to the transformer ground.

Up to 6 bushings can be wired to the terminal blocks and each terminal block will take Signal, Return and Shield wires.

There isn't a specific order in which the bushing set (i.e., high voltage side or low voltage side) needs to be wired to Set 1 and Set 2. For example, the high voltage side can be wired to Set1 and low voltage side to Set 2, and vice versa.

The top of the shorting blocks is wired to Set 1 and Set 2 terminals on Calisto T1. All bushing sensors must be connected to the bottom of the shorting block, see image below.

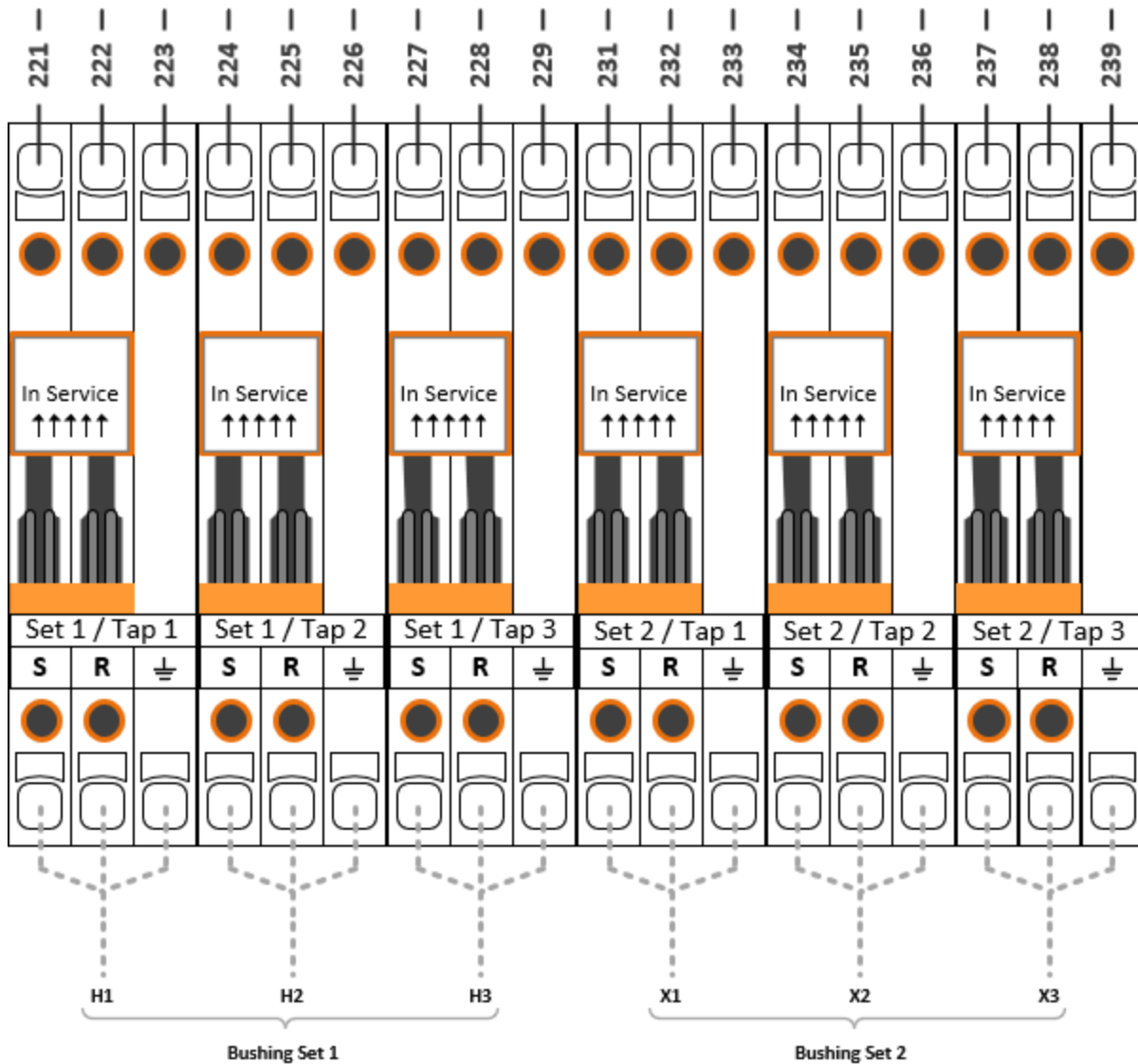


Figure 32 - Terminal strip

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 SET 1 and SET 2 current inputs.

Wiring to the shorting block

Help with wiring the bushing sensor to the shorting block.

Note:

When not wired to T1, short red wires to black wires using shorting bars and open disconnects.

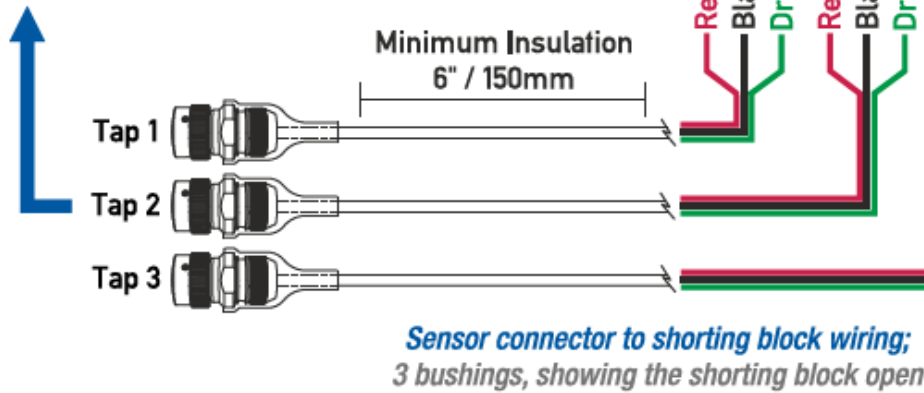
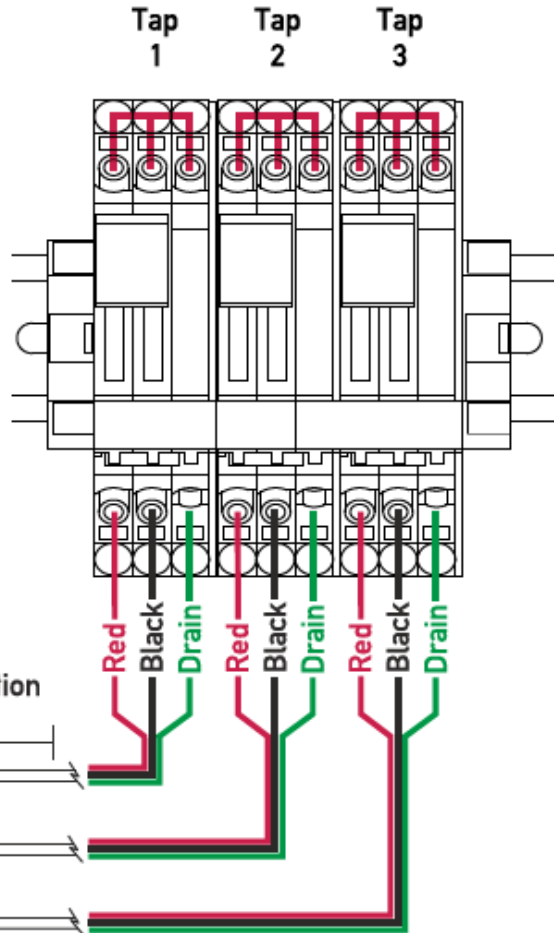
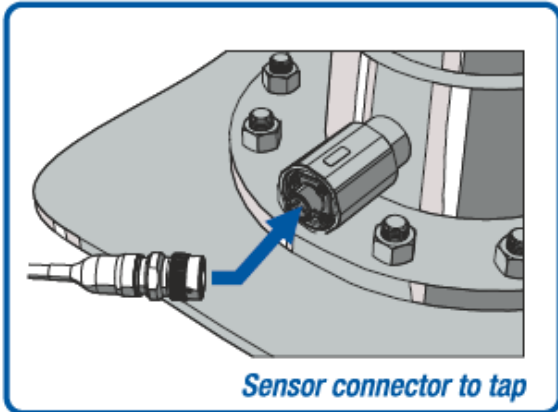


Figure 33 - Wiring the Bushing Sensor to Shorting Blocks

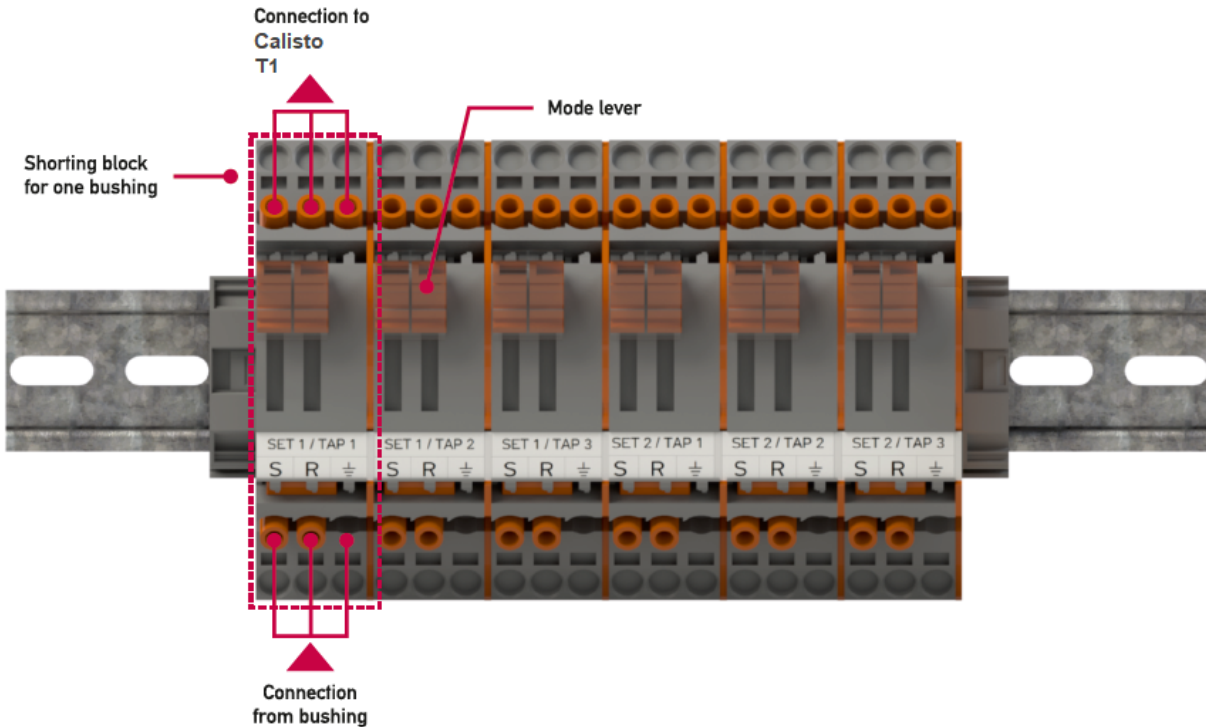


Figure 34 - Shorting Block Segments

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.

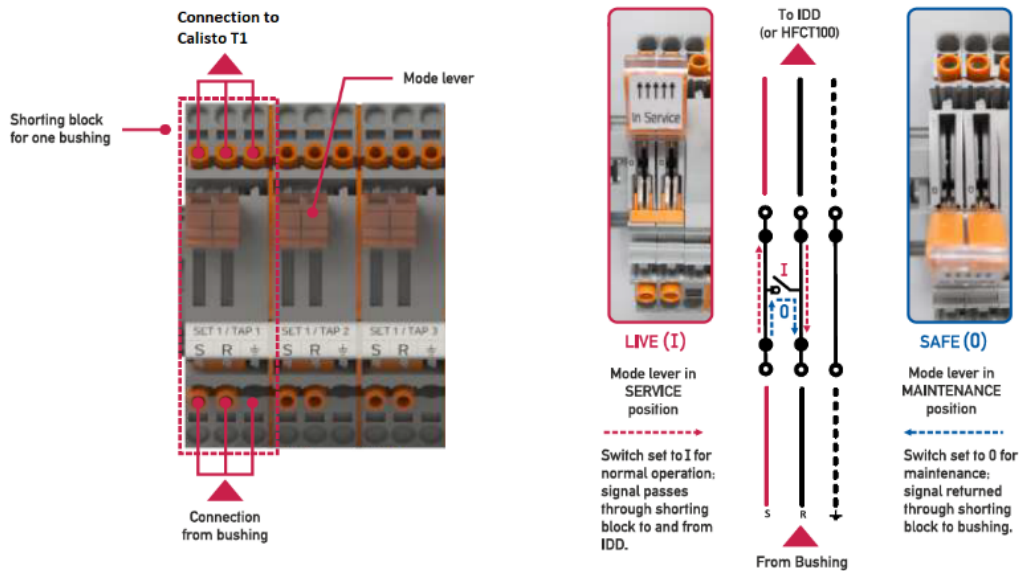


Figure 35 - Wiring and Operating the Shorting Blocks



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.

Test Points and Terminations

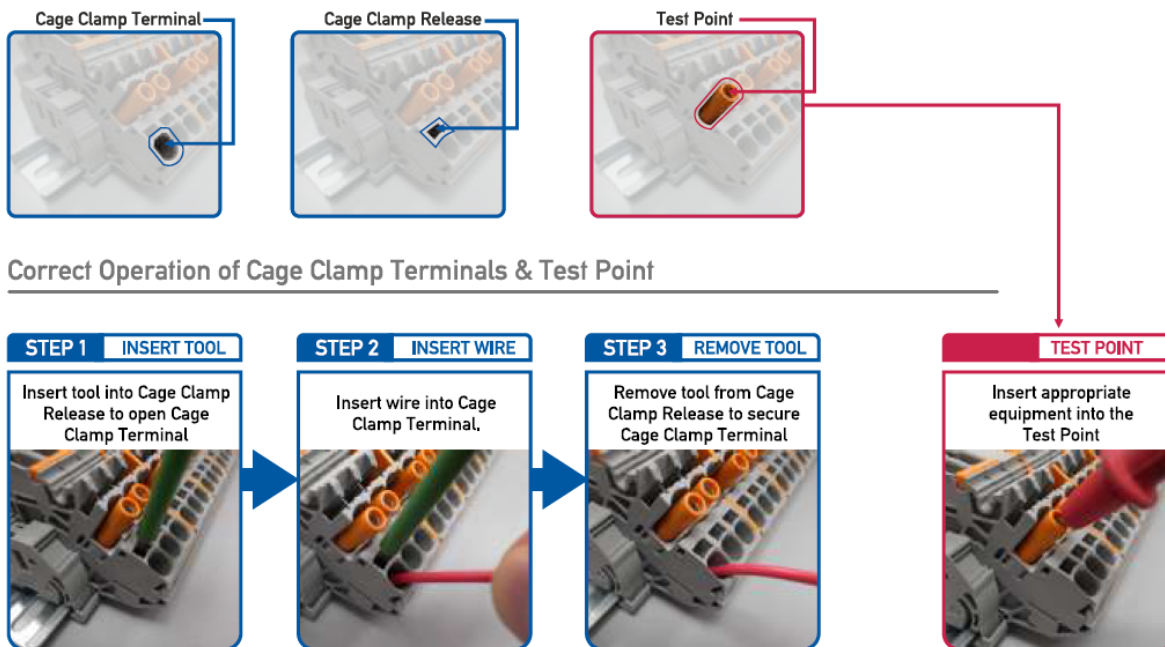


Figure 36 - Wiring to the Shorting Block and Test Point Location

Voltage Terminals

Connections from Potential Transformers or Voltage Transformers must run through the voltage terminals indicated in the image below. The terminals allow disconnection and protection to the system. Each phase is protected by a fused terminal – 315mA.

The voltage signal from PTs or VTs are necessary for True Power Factor measurement and the bushing Monitor BDM-101 (optional) is required.

The top of the voltage terminals is wired to Voltage Terminal on Calisto T1. All voltage signals from PTs/CTs must be connected at the bottom of the terminal, see image below.

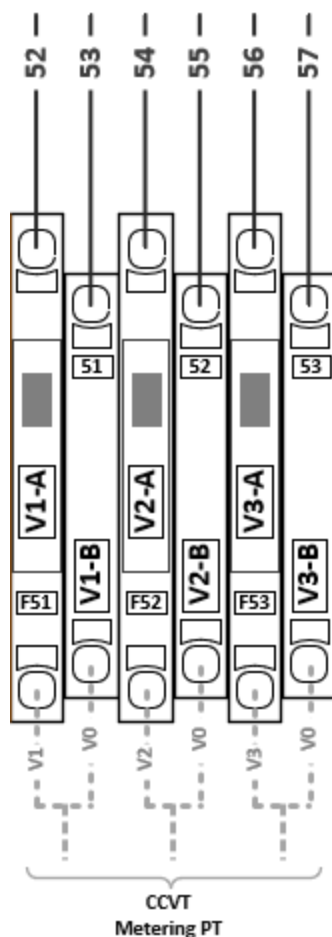


Figure 37 - Voltage terminal

RS485 terminals

There are 2 three-level terminals for RS485 communication, one for each port. The RS485 is a 2-wire communication and requires: Data+, Data- and ground signal.

The top of the RS485 terminals is wired to RS485 terminals on Calisto T1. The communication cable must be wired at the bottom of the terminal, see image below.

Additional control, line biasing and line termination, are located on the RS485 terminal on the front face of Calisto T1.

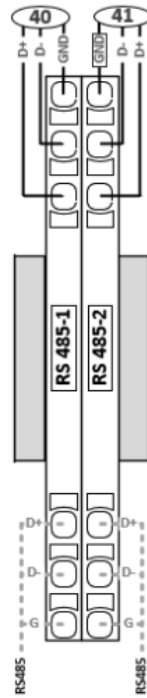


Figure 38 - RS485 terminals

Supervisory relays

The Supervisory relays are controlled by the Alert Outputs (Digital Outputs) on Calisto T1. The relay contacts provide a significant better current and voltage rating compared to the digital outputs.

Wire the alerts to the control room or Light Tower (optional accessory) as illustrated in the image below. The coil of the relay terminals is wired to Alert Outputs on Calisto T1 and to F28 terminal. The alerts to the external world must be wired at the bottom of the terminal.

A jumper bar is used to connect all terminals A1 of the coil. Another jumper bar connects all terminals 11 (GND) for the Light Tower connection.

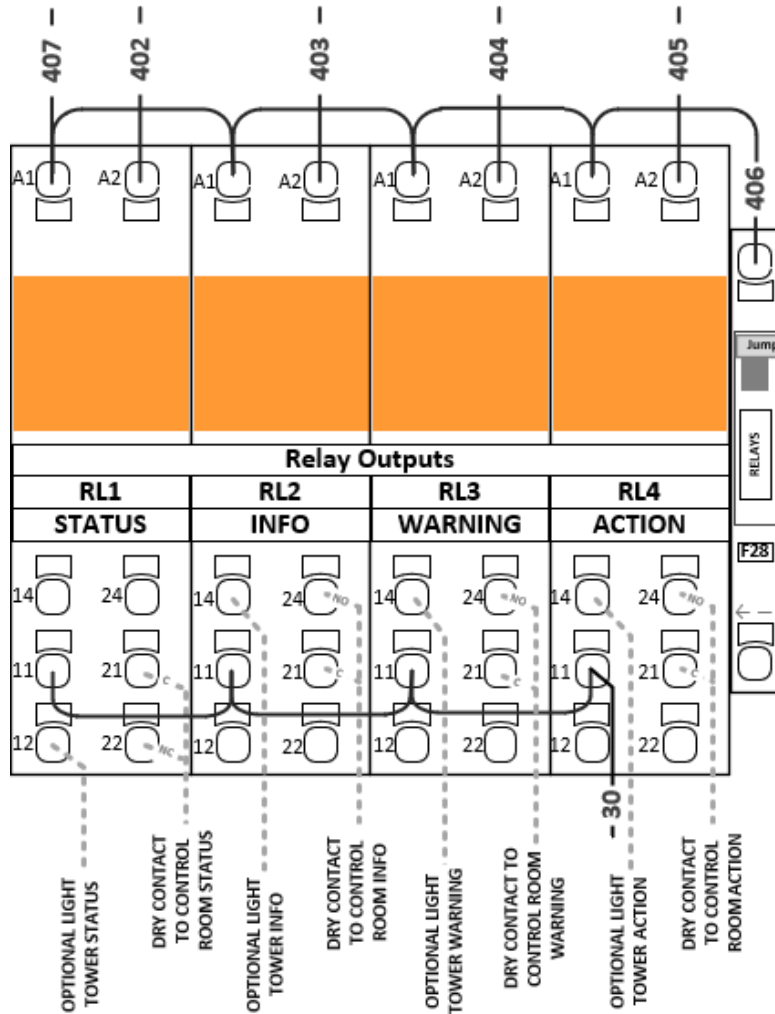


Figure 39 - Status relays

DC terminals

All 24VDC terminals feeding power to the elements inside of the cabinet are represented below. Each element is protected by a fused terminal – 3.15A.

Fuse ID	Wire pair	Element
F28	406-401	Supervisory relays
F25	-	Spare terminal

F24	23-24	Network switch (optional)
F27	45-46	Hygrostat control
F21	17-18	Calisto T1
F33	31-32	Fan
F29	-	Light Tower (optional)

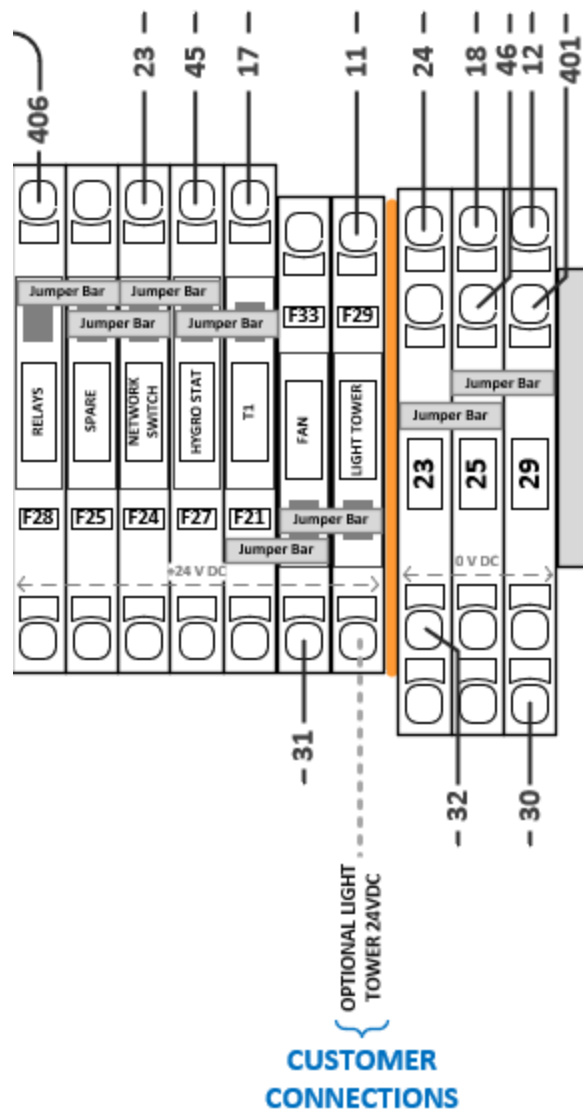


Figure 40 - DC terminals

Sync transformer

Phase Resolved Partial Discharge is a tool that allows us to analyze the fault with respect to the phase of the applied voltage. The sync transformer is responsible for outputting a small AC voltage signal that is connected to the sync input of Calisto T1.

The sync transformer takes the same AC input that feeds power to the cabinet and steps down the voltage to around 8VAC.

Whether the PD-Guard monitor is part of T1 build or not, the sync transformer is always present and mounted on the DIN rail.

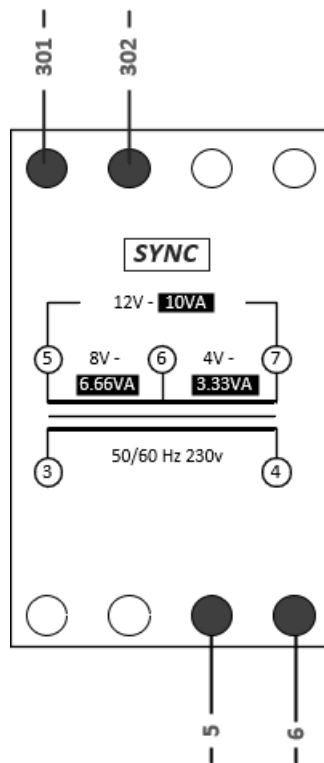


Figure 41 - Sync transformer

AC terminals and grounding

All AC terminals (120/240VAC) for feeding power to the elements inside of the cabinet are represented below. Each element is protected by a fused terminal – 3.15A.

Connection to the mains (AC input only) is via a MCB located at the right-hand side of the terminal strip.

The grounding terminal is connected to the grounding bar in the cabinet which in turn is connected to the grounding lug outside the cabinet.

Fuse ID	Wire pair	Element
F14	43-44	Heater
F12	15-16	Lamp
F11	13-14-7	Socket
F10	3-4-8	PSU
F13	5-6	Sync

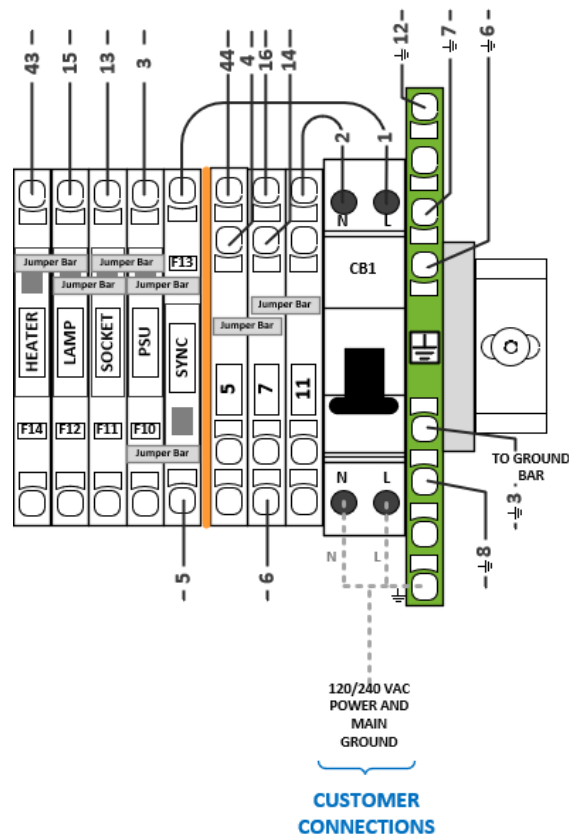


Figure 42 - AC terminals

Warning: Connect only 120/240VAC to circuit breaker CB1 to power the enclosure. Connecting DC power might damage the Sync transformer and other AC-dependent components.

5. Installation

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Planning the Calisto T1 Installation

The Calisto T1 can be used to monitor bushings on either three-phase or three single-phase transformers. In both cases, the concept of bushing sets applies. A bushing set consists of 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.

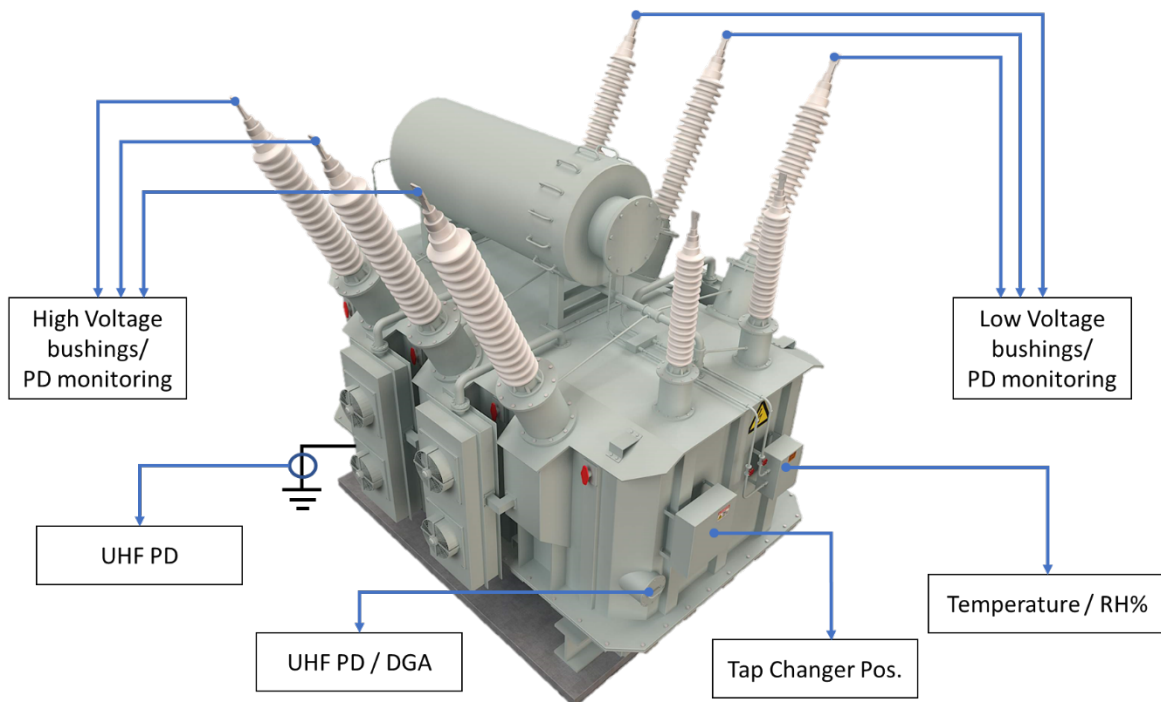


Figure 43 - Online monitoring

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 the monitor can be installed from the transformer is determined by the sensor with the worst maximum distance associated.

Table 3 - Sensor Cable Lengths

Application	Sensor	Maximum Distance
Bushing Sensor	Bushing Tap Adapter	60 m
PD HF Sensor	HFCT	50 m
	HFCT Clamp	
	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 "[Dimensions](#)" on page 113 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.

6. User Interface

The PRIME web interface has a web browser configuration and visualization utility.

Perform the following steps to access the web interface.

1. Connect your PC to Port LAN 1 on the front panel of Calisto T1 using an Ethernet cable. Assign an appropriate IP address and netmask to your PC's Ethernet adapter, 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.

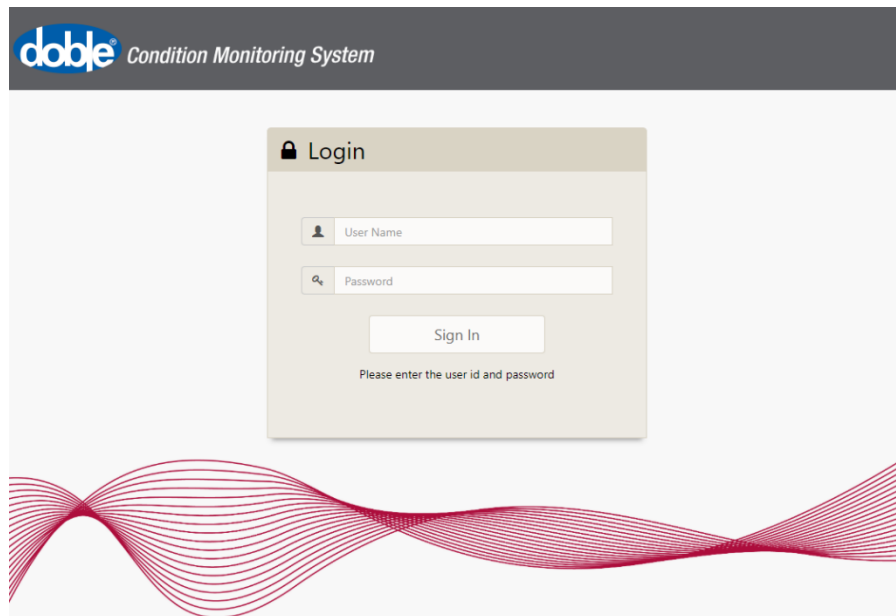


Figure 44 - PRIME Web Interface Login Screen

For more information about setting up the PC network adapter to connect to Calisto T1, please refer to the Calisto T1 QuickStart Guide (PN 75A-0321-01).

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. Check `doblePRIME 3.2 User Guide (PN: TP-DP-UG Rev T)` for more details of other accounts available.

The PRIME web interface 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.

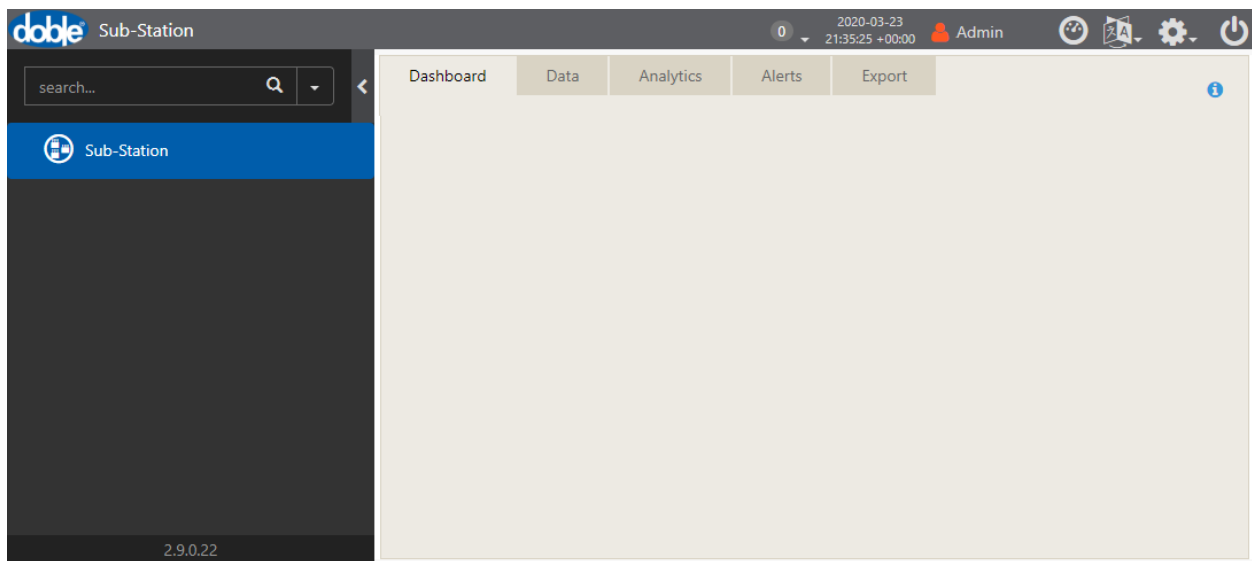


Figure 45 - Calisto Web Interface: Main Page

Refer to the Prime 3.2 User Guide (TP-DP-UG Rev T) for more information about the web interface and other tools available in DoblePRIME application.

7. Configuration of monitors

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In the real world, the asset you want to monitor has sensors mounted on and they are 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.

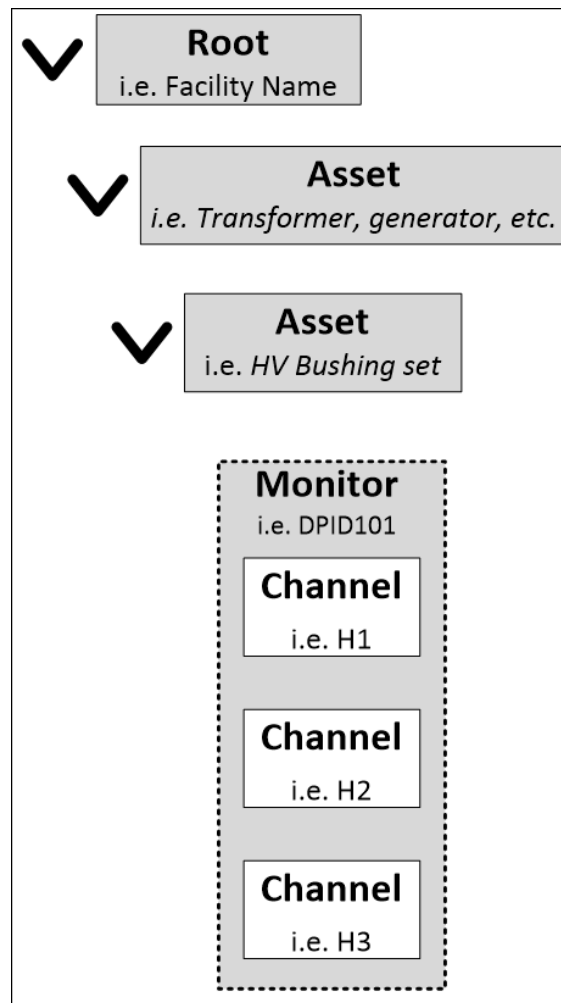


Figure 46 - Entities on PRIME Application

Creating an Asset

The asset is an entity that “owns” the channels as if it represents where the sensors are physically mounted on. The Monitor needs an asset to attach their channel to it so data can be recorded by PRIME. Create as many assets as required to attach to the monitor’s channels.

Perform the following steps to add an asset.

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

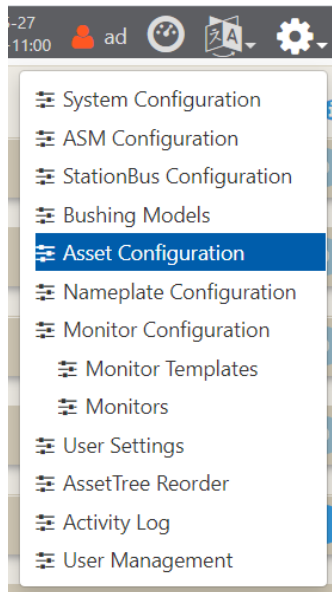


Figure 47 - Asset Configuration Setting

The Asset Configuration tab will open in the feature panel.

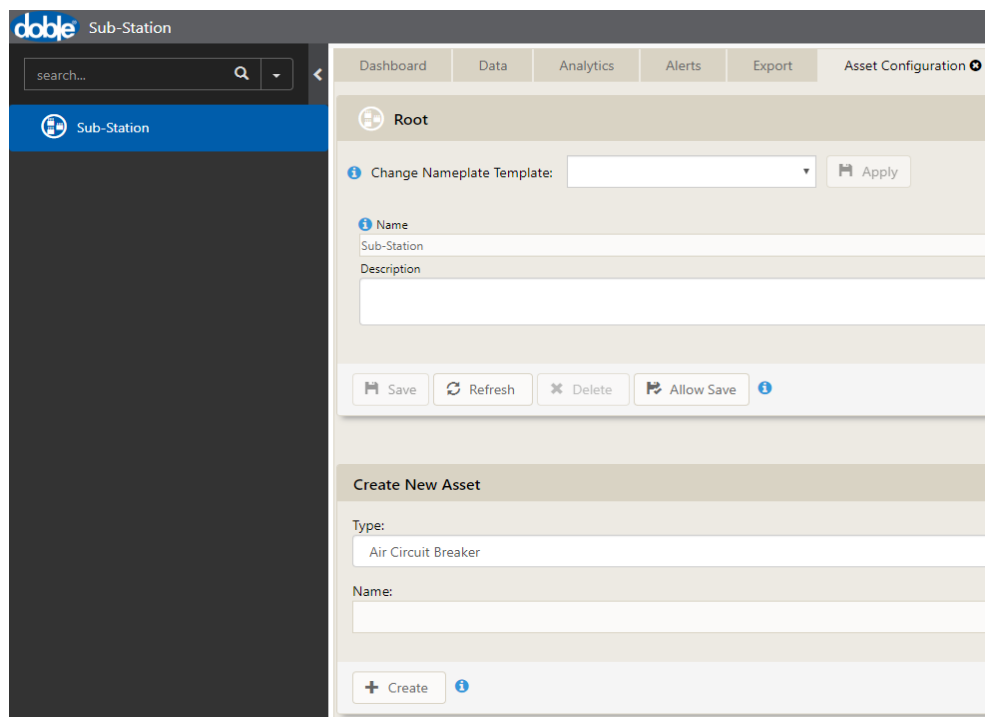
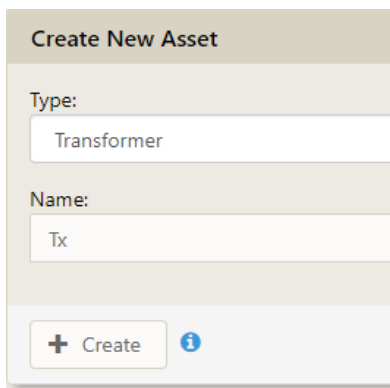


Figure 48 - Asset Configuration Tab

3. Enter a name in the Name field of the Root section. The root name may be defined as required but is generally used to describe the location of the monitoring system (e.g., Substation 1, Powerplant West).
4. Click the **Type** drop-down list in the Create New Asset section and select the asset type that you want to create. The following assets are available:
 - 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
5. Enter the name of the asset you are creating in the Name field of the Create New Asset section.



The screenshot shows a 'Create New Asset' form with the following fields and controls:

- Type:** A dropdown menu with 'Transformer' selected.
- Name:** A text input field containing 'Tx'.
- Buttons:** A '+ Create' button and an information icon (i) are located at the bottom of the form.

Figure 49 - Create New Asset

- Click **Create**. An asset created notification will appear at the top-right of the window and the asset will appear in the asset tree.

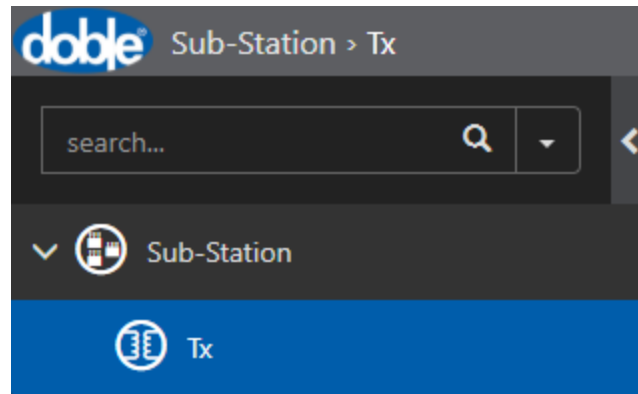


Figure 50 - Recently Created Asset in Asset Tree

Creating a Bushing Set

Bushing set is a special asset entity to represent the bushings on the transformer. A set is a group of three bushings which could be a representation of the high voltage, low voltage or tertiary bushings of the transformer. The bushing set must be deployed under the transformer asset to show its relationship with it.

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

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

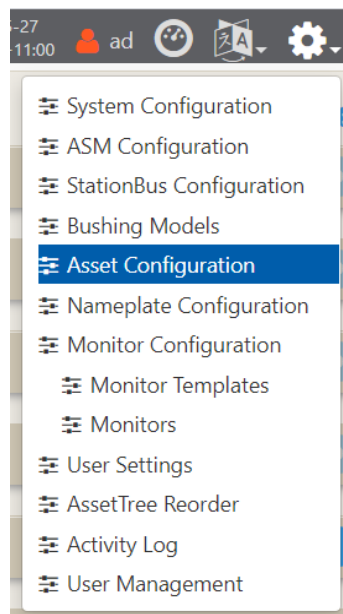


Figure 51 - Asset Configuration Setting

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.

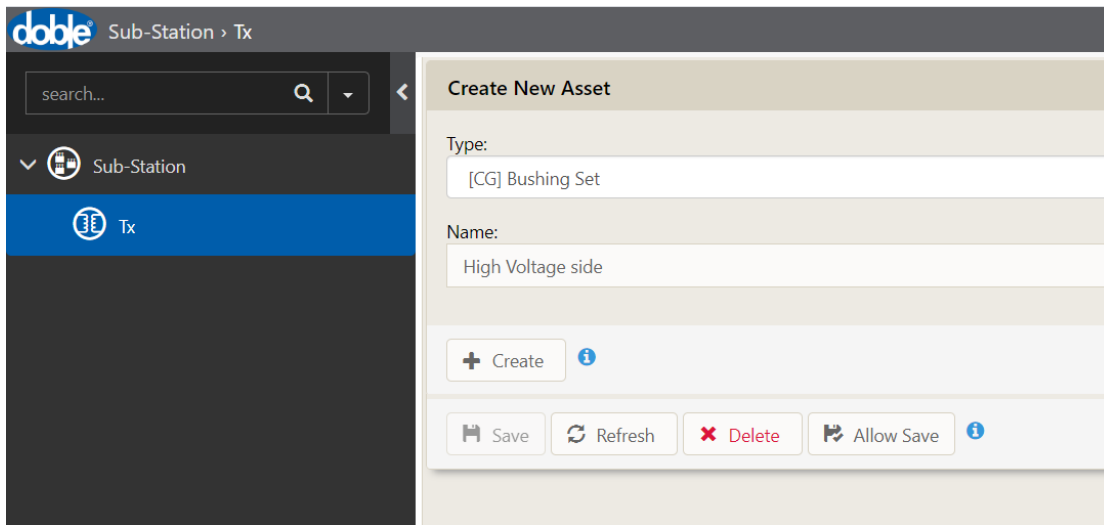


Figure 52 - Create New Asset: Bushing Set

6. Click **Create**.

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

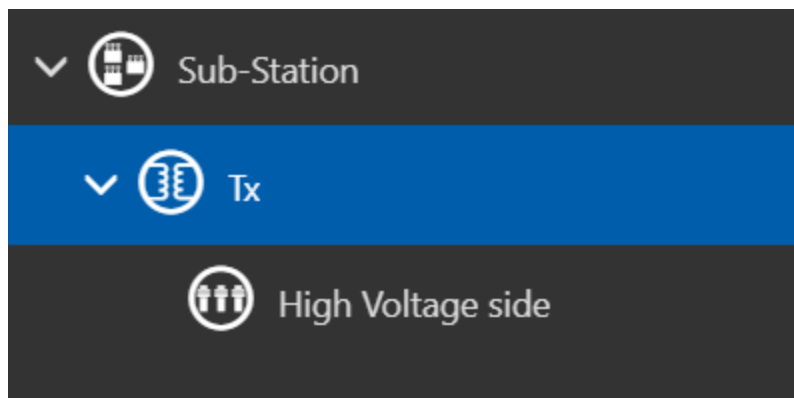


Figure 53 - Bushing Set in Asset Tree

Bushing Monitor Configuration

This section describes how to set up the bushing monitor (optional) 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](#)" on page 53 applies when TPF is to be used.

Bushing Monitor Settings

The bushing monitor instance is the entity representing the Doble IDD monitor (BDM-102 or BDM-101) 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, that are connected to bushing TAP adapters and instrument transformers. When the asset is assigned to the channel, it records the channel measurements on PRIME database.

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**.

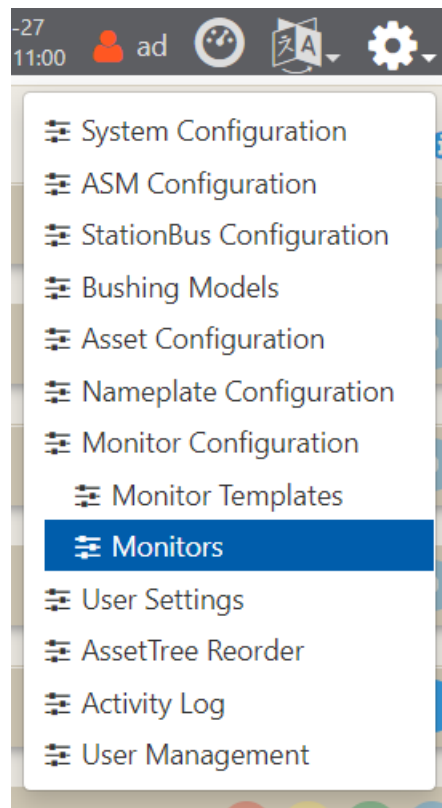


Figure 54 - Settings: Monitor

3. Click **Channels** for the BDM--101 or BDM-102 Monitor to open its settings.

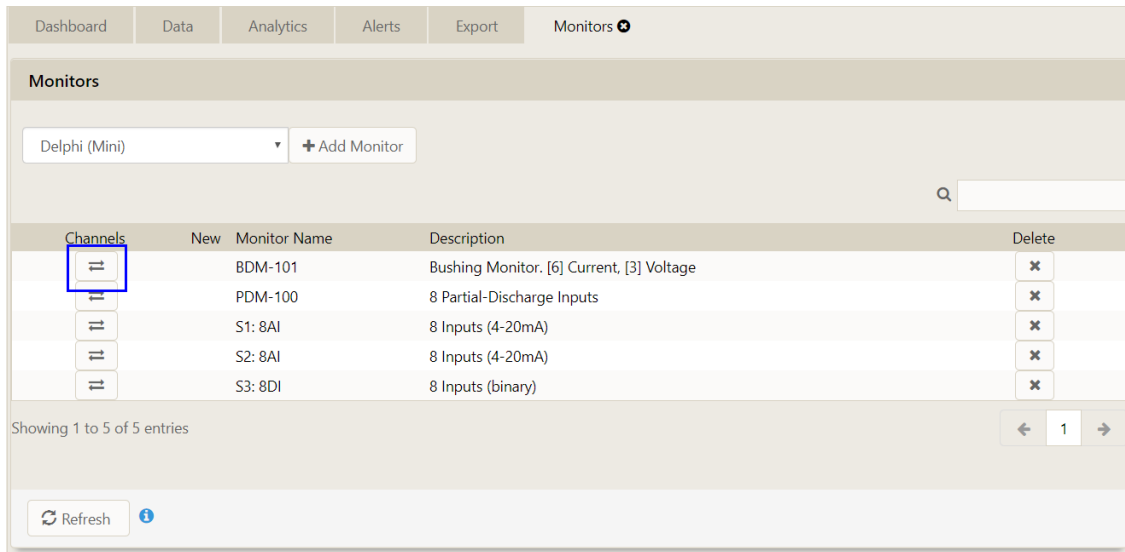


Figure 55 - Monitors: Open Settings

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

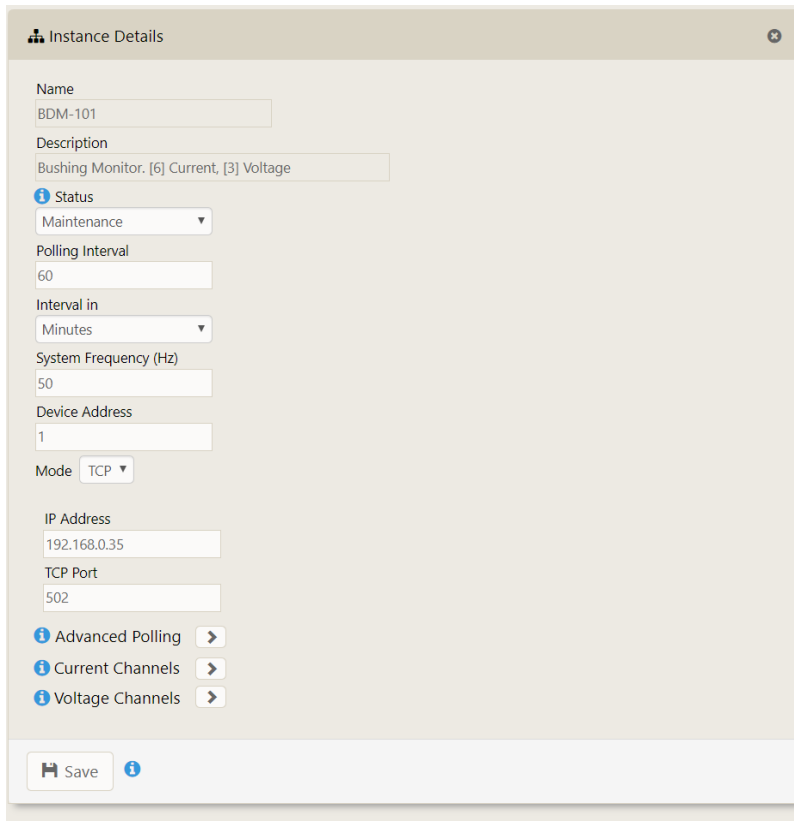


Figure 56 - Bushing Monitor Communication Settings

The following table lists the bushing monitor parameters.

Table 4 - 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 Bushing Monitor
Interval in	Select Interval in minutes and hours. Don't set to a polling interval faster than 1 minute. For permanent monitoring set the polling interval 15 minutes or greater
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 can be assigned to one bushing set entity. Channels 4-5-6, which is bushing SET 2 input, can be assigned to a second bushing set entity.

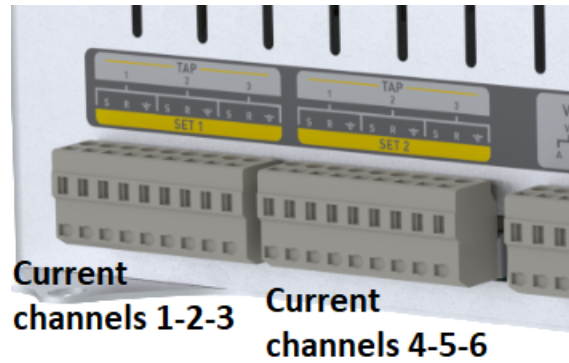


Figure 57 - Calisto T1: Current Channels

Perform the following steps to assign the bushing set to the current channels. Create a bushing set for SET 1, or SET 1 and SET 2, if they have not been created yet. Locate the bushing set created, then click on it to select. The bushing set is nested under the transformer asset in the asset tree.

1. In the bushing monitor settings, click the Current Channels chevron to expand the options
2. 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.

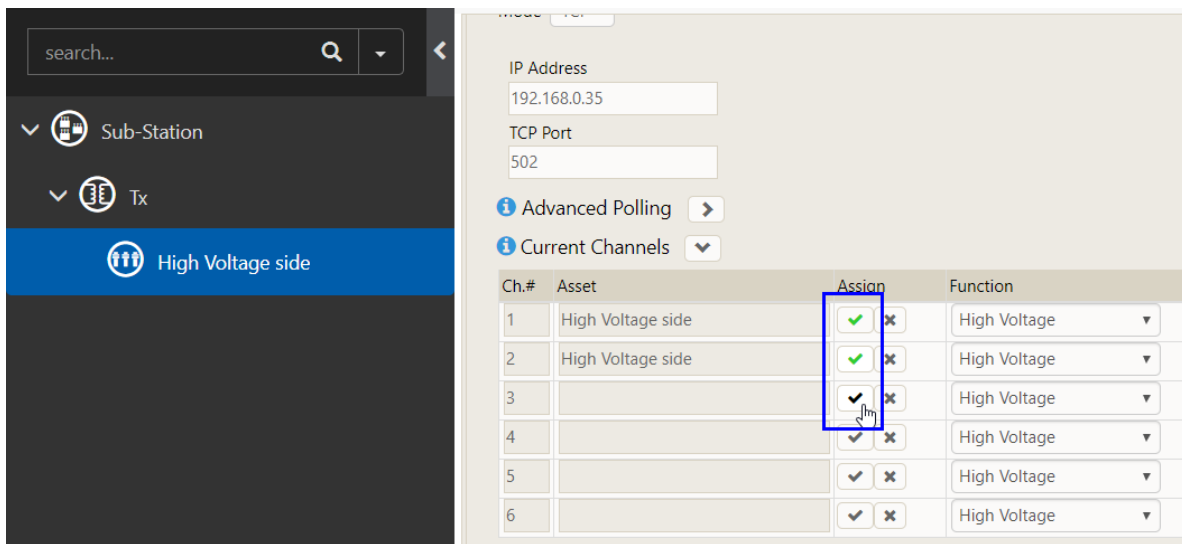


Figure 58 - Figure 58 Assign Check Mark

3. Select High Voltage, Low Voltage, Tertiary Voltage, or Neutral from the Function drop-down. The Neutral selection will only process the leakage current.
4. Assign the remaining channels to the appropriate bushing set.
5. 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 input channels in the Bushing Monitor Instance. For this functionality you need to have BDM-101 model fitted on Calisto T1 and have the BDM-101 monitor on the list.

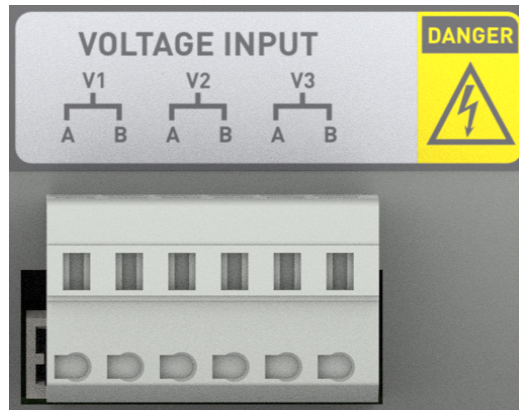


Figure 59 - Calisto T1: Voltage Channels 1-2-3

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

Create three voltage transformer assets, if they have not been created yet.

Locate the first voltage transformer in the asset tree, then click on it to select.

1. In the monitor settings, click the Voltage Channels chevron to expand the options.
2. Click the **Assign** check mark next to voltage channels. The name of the voltage transformer is copied into the Asset field, and the check mark will change to green.

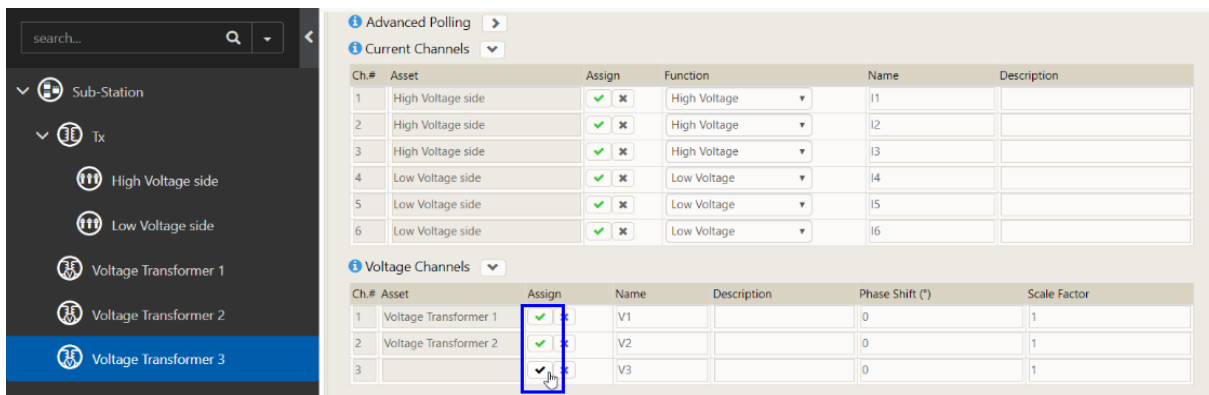


Figure 60 - Assign Check Mark

- Each voltage transformer is assigned to an individual input channel. Continue until all voltage transformer assets are assigned to the appropriate input channel.
- 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 must be tweaked to calibrate so the bushing monitor, so it can derive precise capacitance and power factor results. Refer to True Power Factor Calibration (page 1) for more information.

Status should only be changed to Commissioned after the bushing nameplate is entered. Please consult "[Configuring the Bushing Asset](#)" below 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.

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

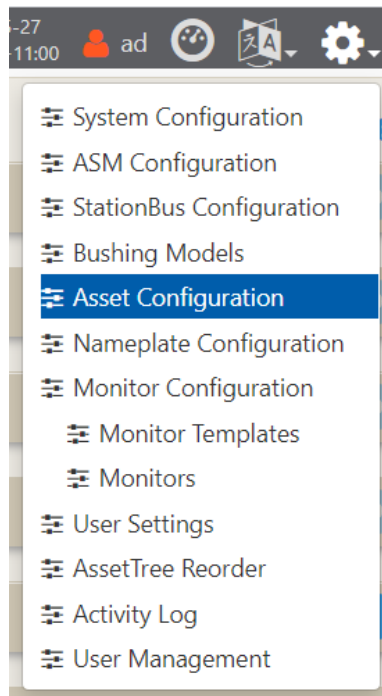


Figure 61 - Settings: Asset Configuration

3. In the asset tree, drill down the transformer asset until the bushing entities are exposed. These entities, with an orange circle with 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.

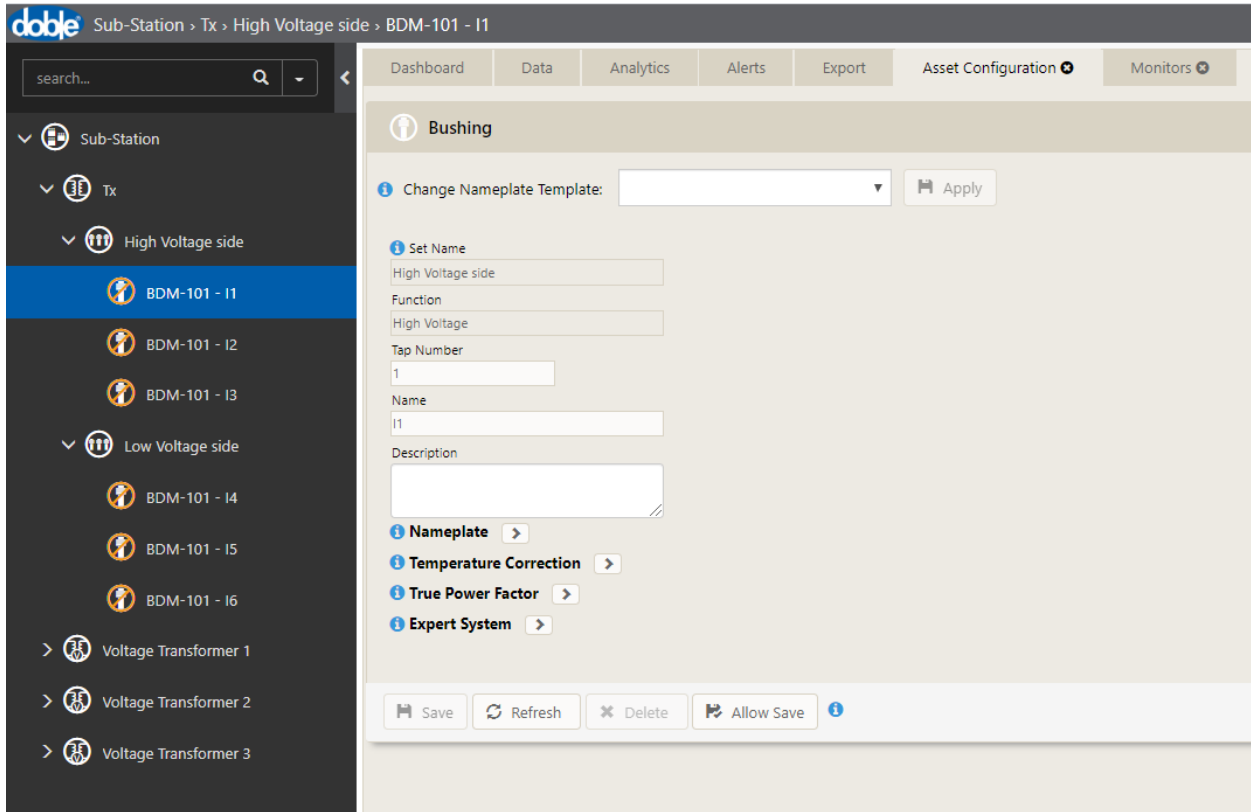


Figure 62 - Bushing Settings

Bushing options:

Function	Descriptions
Set Name	Name of the asset the current channels belong to.
Function	Functions available: High Voltage, Low Voltage, Tertiary, and Neutral
Tap Number	Bushing tap this channel is linked to

Function	Descriptions
Name	Name of the channel in the user interface
Description	Additional description
Nameplate	Bushing nameplate data, system voltage, bushing model, and bushing tap details
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 (BDM-101 required). 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 required information of the bushing and system voltage:

Function	Description
Capacitance pF – Nameplate / measured	Capacitance pF - Enter the capacitance from bushing nameplate or latest offline test. If only Nameplate or Measured value is known enter same figure in both fields
PF %	Enter the Power Factor from bushing nameplate or latest offline

Function	Description
Nameplate / measured	test. If only Nameplate or Measured value is known enter same figure in both fields
System Voltage	Voltage level which the bushings are connected to
System Voltage Reference	System voltage reference. Line to Line or Line to Ground
Manufacturer	Optional information
Model	Optional information
Serial Number	Optional information
Year of Manufacturer	Optional information
Installation Date	Optional information
BTT Model	Optional information
BTT Serial Number	Optional information
BTT Model	Optional information
Installation Date	Optional information

Nameplate ▼

Units	Nameplate	Measured
Cap. (pF)	0	0
PF%	0	0

System Voltage (kV)

System Voltage Reference
Line to Line ▼

Manufacturer
ABB ▼

Model
C ▼

Serial Number

Year Of Manufacture

Installation Date

Bushing Sensor Type (A / T) ▼

BTT Model

BTT Serial Number

BTA Model

Installation Date

Figure 63 - 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 input or 5TI card or from other monitors. To enable the temperature correction option, select Point or Average from the Mode drop-down.

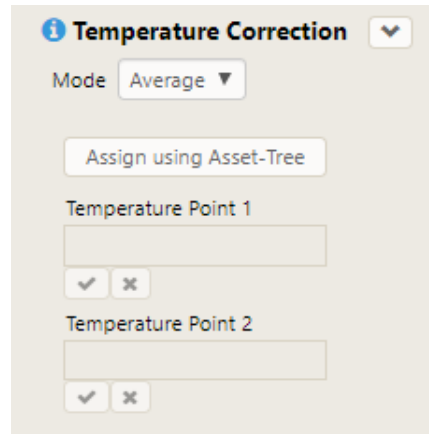


Figure 64 - Temperature Correction: Modes

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 drop-down menu and select Mode 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 box to assign the channel to the Temperature Point 1.
5. If Average mode was selected, pick a second temperature channel in the asset tree, and assign to Temperature Point 2.

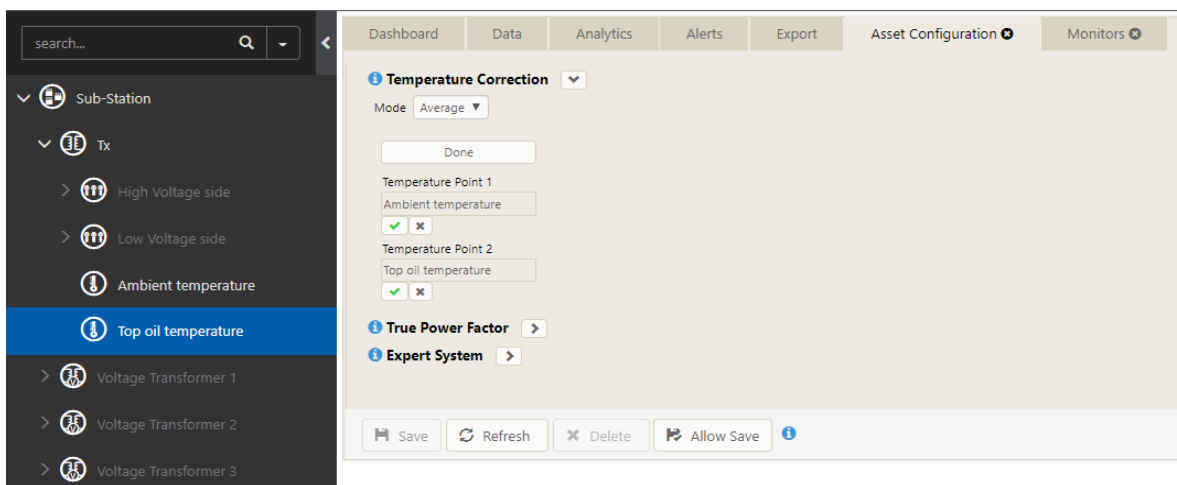


Figure 65 - Temperature Correction Options

True Power Factor Options

When the voltage transformers are present at the station, wired up to the Calisto T1, and True Power Factor is required, then you will need to enable it from the Enable drop-down. If True Power Factor is not enabled, then only Relative Power Factor will be derived. The phase shift and scale factor figures may depend on the transformer's nameplate and connection. For more information about phase shift and scale factor configuration, refer to "[True Power Factor Calibration](#)" on page 130.

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

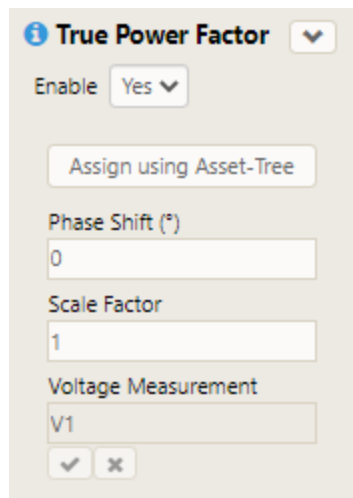
The image shows a configuration window titled "True Power Factor" with a dropdown arrow. Below the title, there is an "Enable" dropdown menu set to "Yes". A button labeled "Assign using Asset-Tree" is positioned below the enable menu. Underneath, there are three input fields: "Phase Shift (°)" with the value "0", "Scale Factor" with the value "1", and "Voltage Measurement" with the value "V1". At the bottom of the window, there are two small icons: a checkmark and an 'x'.

Figure 66 - True Power Factor enabled

Perform the following steps to enable and set up TPF.

1. Click the drop-down menu and select **Enable 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 box to assign the channel to the voltage field.

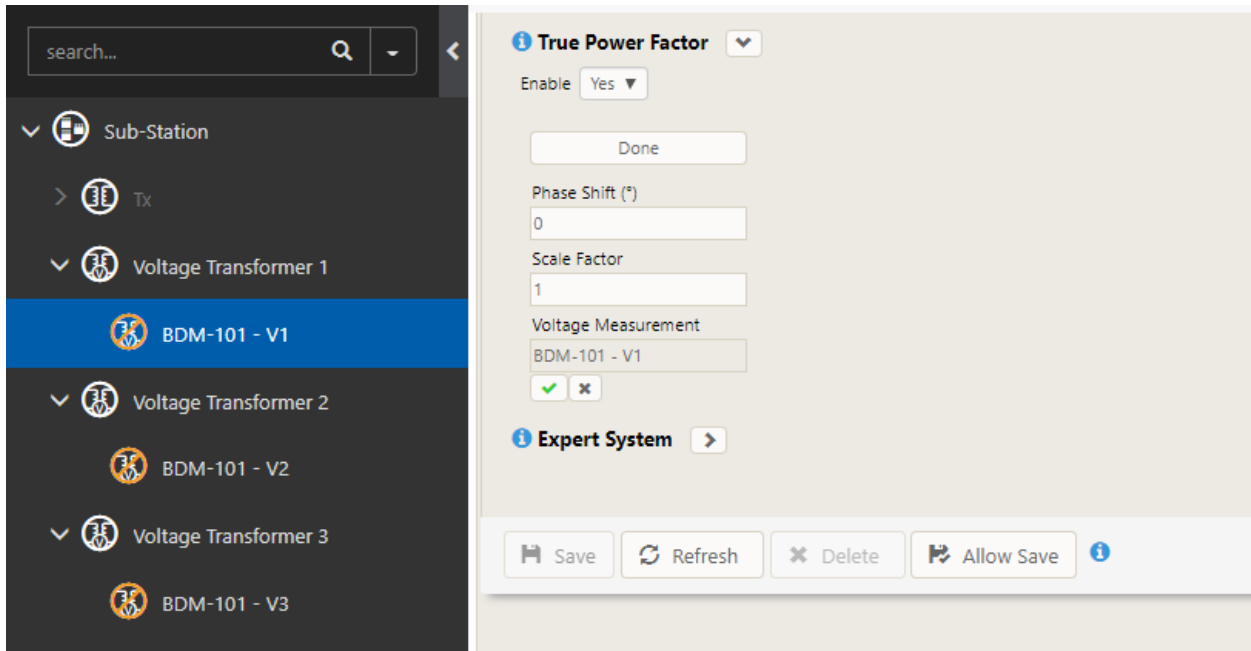


Figure 67 - Assigning a voltage channel

Expert System

Click **Expert System** to view the alerts thresholds for the bushing monitor. 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.

The Expert System is exclusive to the Bushing Monitor and its threshold will not apply to other monitors, e.g., PD or DGA monitors.

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 68 - Expert System

Saving the Settings

At the panel footer 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.

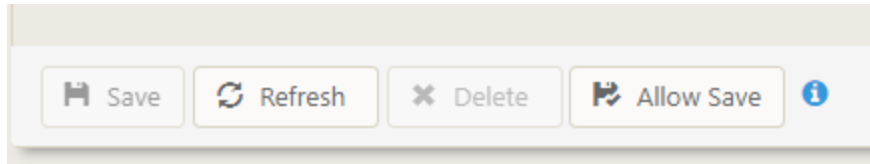


Figure 69 - Allow Save

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 70 - 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 up to commissioned mode. Data logged by the monitor cannot be deleted or altered in the database.

Table 5 - 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 1)

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

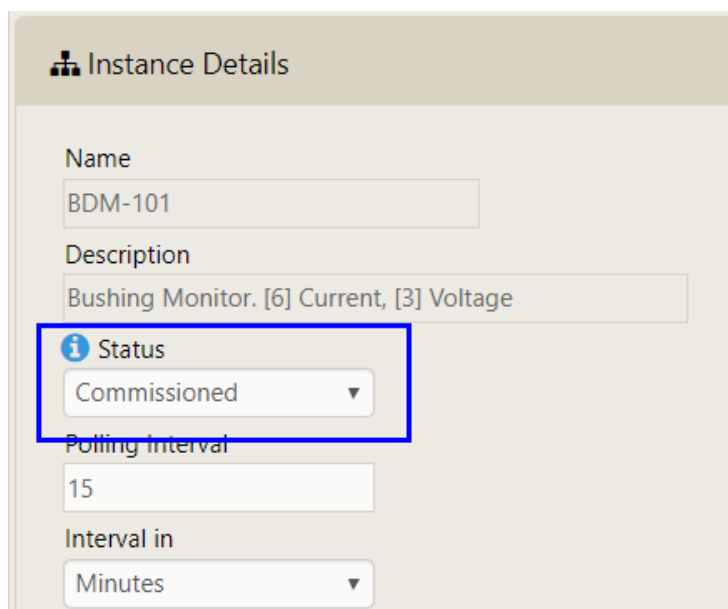


Figure 71 - Bushing Monitor Status

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 on the Dashboard page. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

	I1	I2	I3	
Daily Capacitance (TPF)	248.71	248.39	248.83	pF
Daily True Power Factor	0.3049	0.29626	0.28348	%
Leakage Current	31.754	31.701	31.732	mA
	2020-04-20 15:03:00	2020-04-20 15:03:00	2020-04-20 15:03:00	

Figure 72 - 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 described.

The PD monitor can be accessed via PICOS where it's possible to run manual scans and view spectrum/phase resolved/time resolved charts using Sparklet interface. For further information about accessing the PD monitor see "[PICOS Application](#)" on page 115. And for further information on how to use Sparklet refer to Sparklet User Guide.

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 on the user interface.

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**.

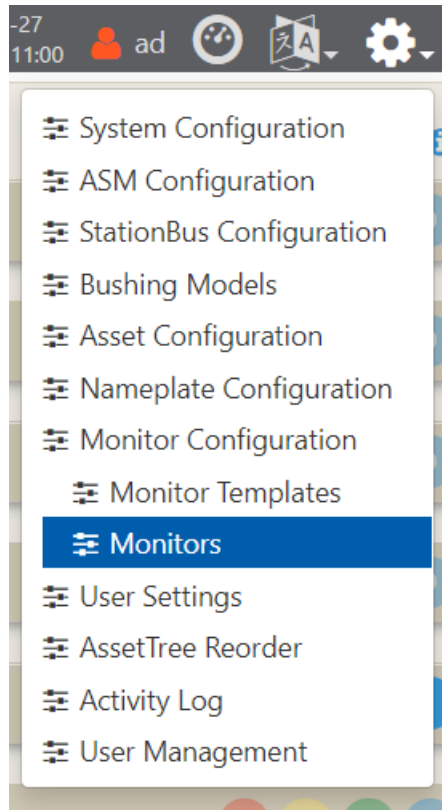


Figure 73 - Settings: Monitors

The Monitors tab will open in the feature panel.

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

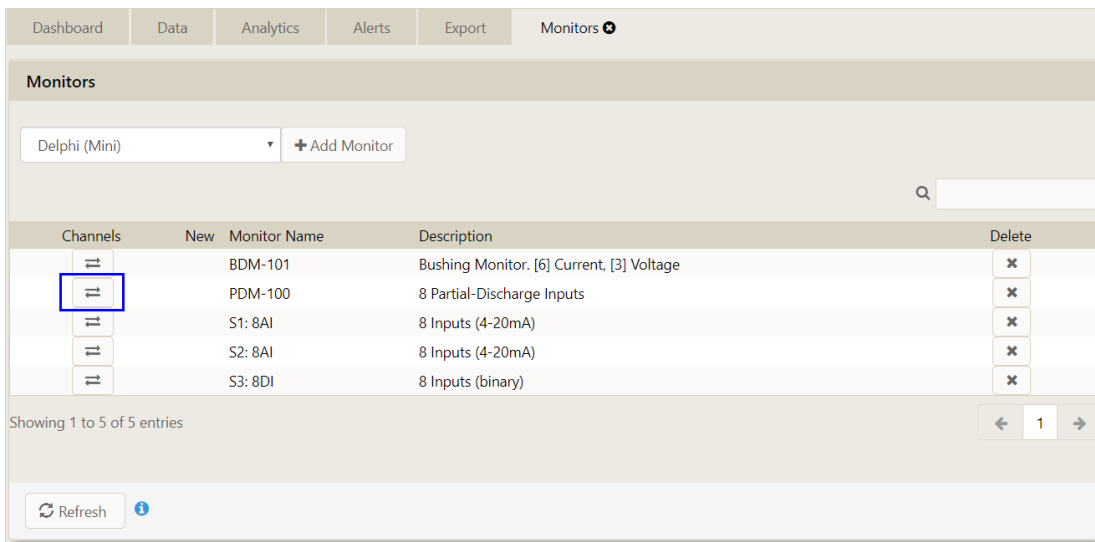


Figure 74 - Monitors: Open Settings

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

Instance Details

Name: PDM-100

Description: 8 Partial-Discharge Inputs

Native Alerts: ON

Status: Maintenance

Polling Interval: 60

Interval in: Minutes

Device Address: 1

Mode: TCP

IP Address: 0.0.0.0

TCP Port: 502

Advanced Polling: >

PD Channels: ▾

Ch#	Asset	Assign	Name	Description	Reference Level	Sensor	Model	Serial Number
1		✓ ✕	PD1		Auto	Unknown		
2		✓ ✕	PD2		Auto	Unknown		
3		✓ ✕	PD3		Auto	Unknown		
4		✓ ✕	PD4		Auto	Unknown		
5		✓ ✕	PD5		Auto	Unknown		
6		✓ ✕	PD6		Auto	Unknown		
7		✓ ✕	PD7		Auto	Unknown		
8		✓ ✕	PD8		Auto	Unknown		

Save ⓘ

Figure 75 - 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 on SET 1 so it can be monitored using PD channels 1-2-3. The output of HFCT SET 1 is brought out to the BCN connectors: 1A-1B-1C. Therefore, to monitor PD on Set 1 use the BNC-BNC link cables (provided with Calisto T1) to connect:

- HFCT output 1A to PD Input 1
- HFCT output 1B to PD Input 2
- HFCT output 1C to PD Input 3

If there is no need to monitor PD on SET 1, you can connect any PD sensor to PD inputs 1-2-3.

Likewise, the signals from SET 2 (current channels 4-5-6) are internally connected to the second HFCT inside the unit. The output from HFCT SET 2 is brought out to the BNC connectors: 2A-2B-2C. Therefore, to monitor PD on Set 2 use the BNC-BNC link cables (provided with Calisto T1) to connect:

- HFCT output 2A to PD Input 4

- HFCT output 2B to PD Input 5
- HFCT output 2C to PD Input 6

If there is no need to monitor PD on SET 2, you can connect any PD sensor to PD inputs 4-5-6.

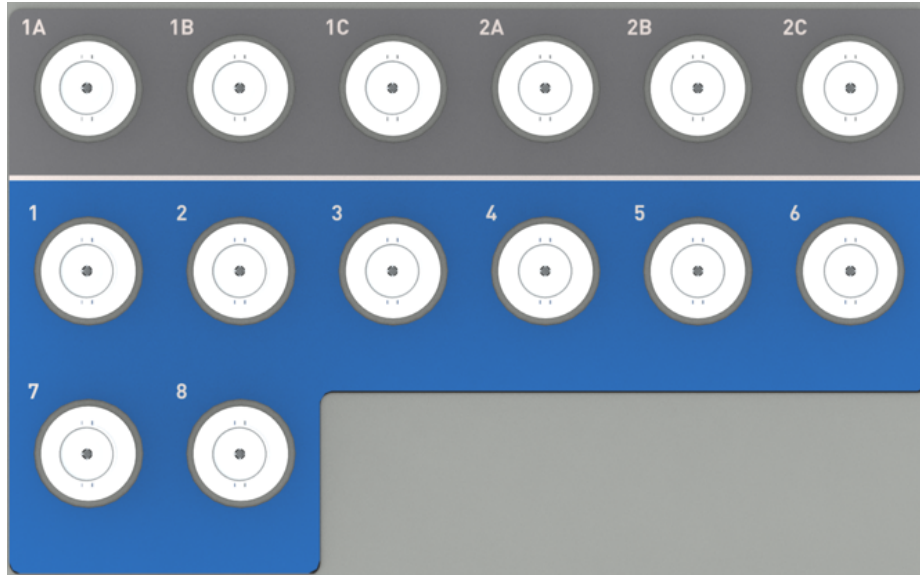


Figure 76 - Calisto T1: HFCT outputs and PD Inputs



Figure 77 - Calisto T1: SET 1 and SET 2 Inputs

Assigning the Partial Discharge Monitor to Bushing SET 1

Perform the following steps to monitor PD from 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. Set **Reference Level** to Auto.

5. Select the HFCT mini sensor from the **Sensor** drop-down.
6. Click **Save** in the panel footer.

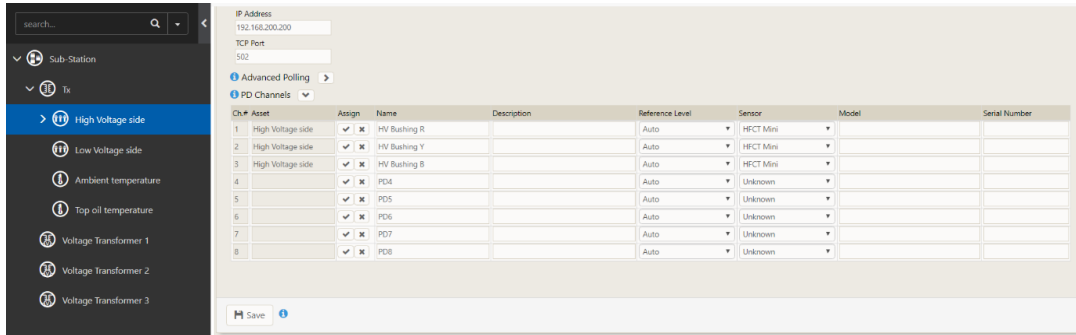


Figure 78 - PD Channels SET 1 configuration example

When there is no need to monitor bushing SET 1, you can use channels 1-2-3 to monitor PD signals from different sensors. Plug the sensor to PD input 1 or 2 or 3 then select the asset from the asset tree which best represents the location of the sensor and appropriate sensor preset.

Assigning the Partial Discharge Monitor to Bushing SET 2

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

1. In the web interface, 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. 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 mini sensor from the Sensor drop-down.
6. Click **Save** in the panel footer.

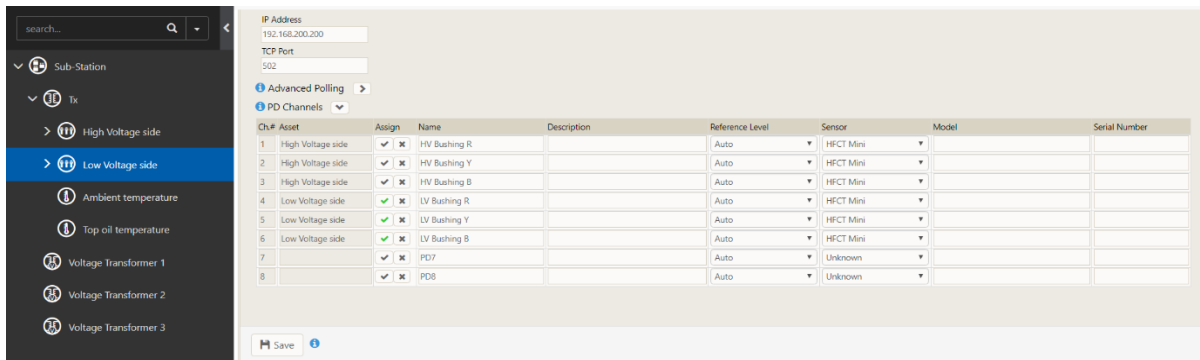


Figure 79 - PD Channels SET 1 and SET 2 configuration example



Note: Use the BNC-BNC cable links to connect outputs 2A-2B-2C 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 from different sensors. Plug the sensor to PD input 4 or 5 or 6 then select the asset from the asset tree which best represents the location of the sensor and appropriate sensor preset.

Assigning the Partial Discharge Monitor to Channels 7 and 8

These channels are for general use. They can be used with any type of PD sensor.

Perform the following steps to monitor channels 7 or 8.

1. Plug the sensors in to 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 / HFCT Clamp	HFCT 300
PDDC-17	PDDC 17
PDDC-24	PDDC 24
UHF Drain Valve	DN50/80
UHF Plate	DN50/80
TEV	TEV

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

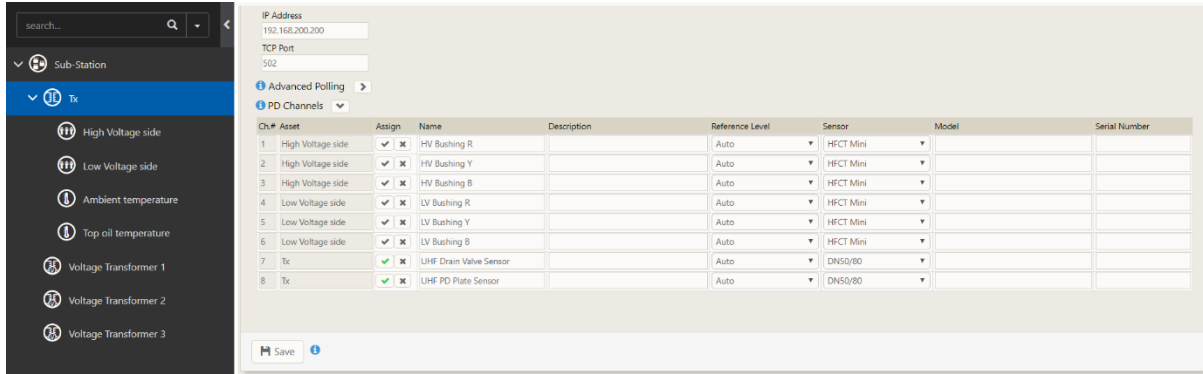


Figure 80 - Figure 80 PD Channels example

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 recorded by the monitor cannot be deleted or altered in the database.

Table 6 - Partial Discharge Monitor Settings

Monitor Field	Description
Name	PD monitor name
Native Alerts	Alerts are no longer generated on the PD monitor. They have to be configured using the ASM tool on PRIME
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 interval in minutes and hours
Device Address	Do not change this setting. Default address 1

Monitor Field	Description
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	Attention. The first firmware version of the PD monitor uses port 5020 for communication with PRIME. From firmware 1.00 onwards the PD monitor supports both ports 5020 and 502 for communication with PRIME.

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

The screenshot shows the 'Instance Details' configuration page for a PD monitor. The fields are as follows:

- Name: PDM-100
- Description: 8 Partial-Discharge Inputs
- Native Alerts: ON
- Status: Commissioned (highlighted with a blue box)
- Polling Interval: 60
- Interval in: Minutes

Figure 81 - 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 on the Dashboard page. 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 Expansion Card Monitors

This section describes how to configure the expansion cards to record analog and digital data. Feeding data from expansion cards onto PRIME adds some context regarding the operation of the asset and help to investigate issues that may arise.

Expansion Card Monitor overview

The Expansion Card instances - i.e., 8AI ,8DI and 5TI - are the entities in the software representing the Expansion Card monitors inside the Calisto T1.

There are three different Expansion card instances available:

- 8AI - 8 Analog Input Channels. For more information see 8AI Settings (page "8AI Monitor Settings" below)
- 8DI - 8 Digital Input Channels. For more information see 8DI Settings (page "8DI Monitor Settings" on page 78)
- 5TI - 5 Thermocouple Input Channels. For more information see 5TI Settings (page

There are four slots on the front panel of the Calisto T1 where the Expansion Cards can be plugged in. When a card is inserted in the slot, PRIME 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 Expansion Card upgrade and replacement see "Hardware Expansion" on page 99

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 on PRIME software representing the physical inputs of the card, that can be 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 user interface.

Assigning the Asset to the 8AI Monitor Channel

There are eight Analog Input 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**.

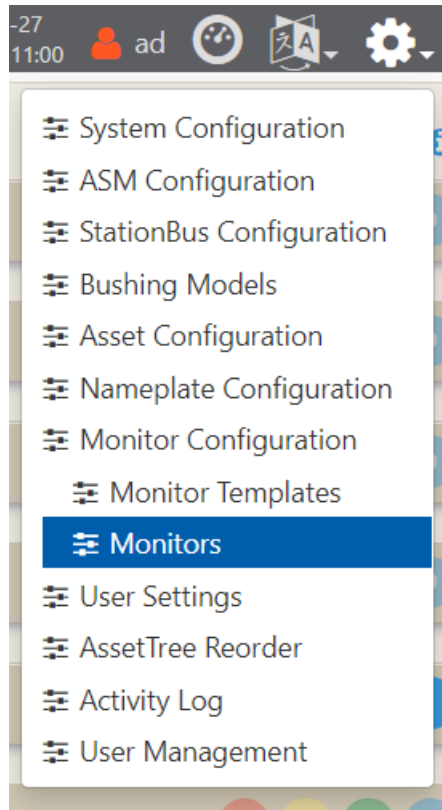


Figure 82 - Settings: Monitor

3. Click Channels icon for the appropriate 8AI Monitor to open its settings.

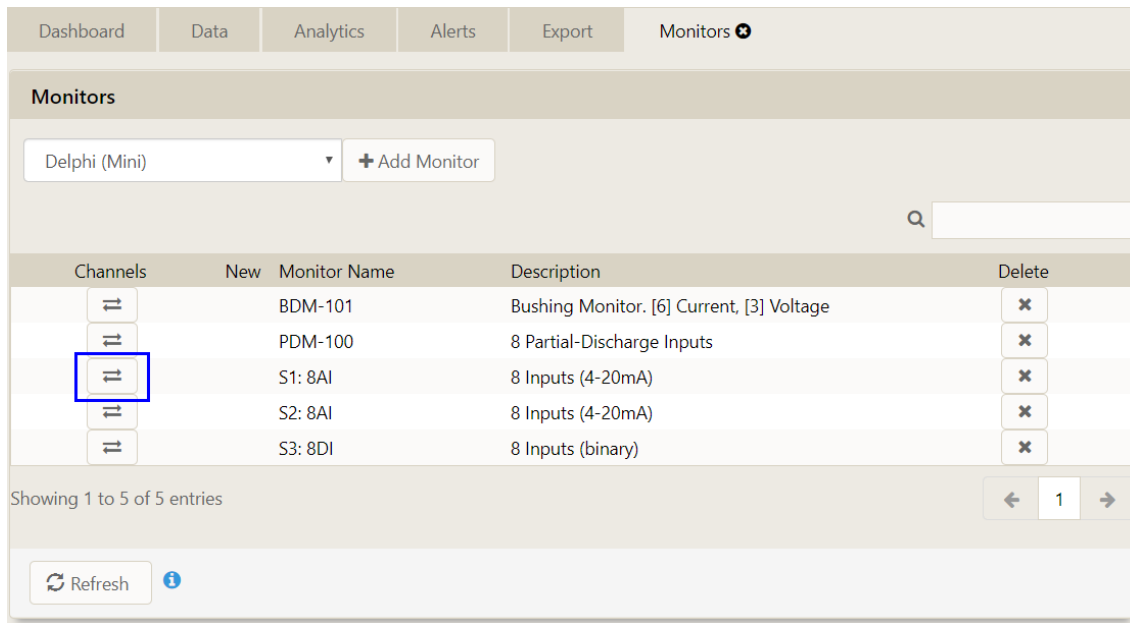


Figure 83 - Open Monitor Settings

- Select an asset in the Asset tree; it will be highlighted in blue. In the Monitor Instance Details, click Assign check mark next to channels which you want to associate to the asset.

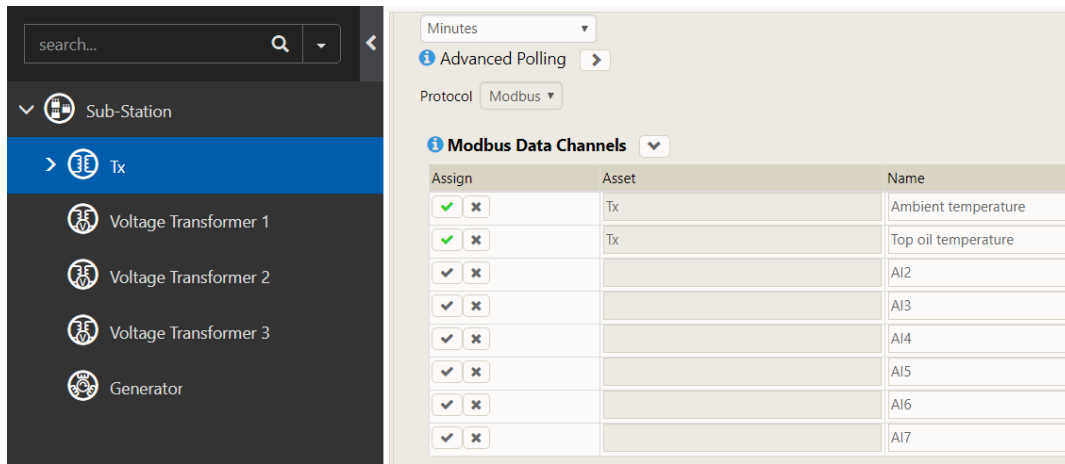


Figure 84 - 8AI Options

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

- 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 into PRIME in raw format. Scaling is required to convert raw measurement to an appropriate engineering value and apply the measurement unit. The scaling and unit of measurement can be configured on each channel.

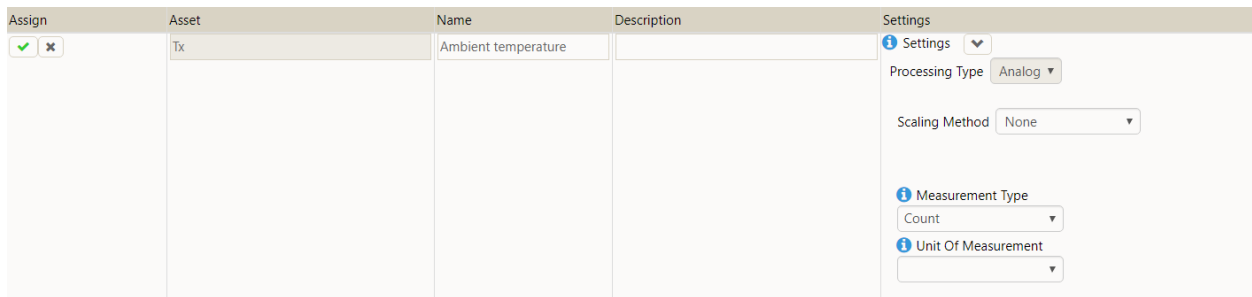


Figure 85 - Analog Channel Settings

General Settings

Table 7 - 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

The screenshot shows a 'Settings' dialog box with the following configuration:

- Settings** (dropdown menu)
- Processing Type**: Analog (dropdown menu)
- Scaling Method**: $y=mx+c$ (dropdown menu)
- Multiply**: 0 (text input field)
- Divide**: 0 (text input field)
- Offset**: 0 (text input field)
- Measurement Type**: Count (dropdown menu)
- Unit Of Measurement**: (empty dropdown menu)

Figure 86 - Scaling Method: Slope-Intercept Parameters

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

Suppose you want to integrate a current transducer to T1, and upon reviewing the transducer’s specifications, you come across the following information:

Transducer Input	0-1600 A AC
Transducer Output	4-20 mA DC

On the T1 device, the 8AI module converts the analog input signal to counts, providing the raw digitalized measurement internally to PRIME. The PRIME application receives these raw measurements, or counts, and then applies the appropriate scale to convert the data into engineering units.

4AD Input range	4-20 mA
4AD Output range	4000-20000 counts

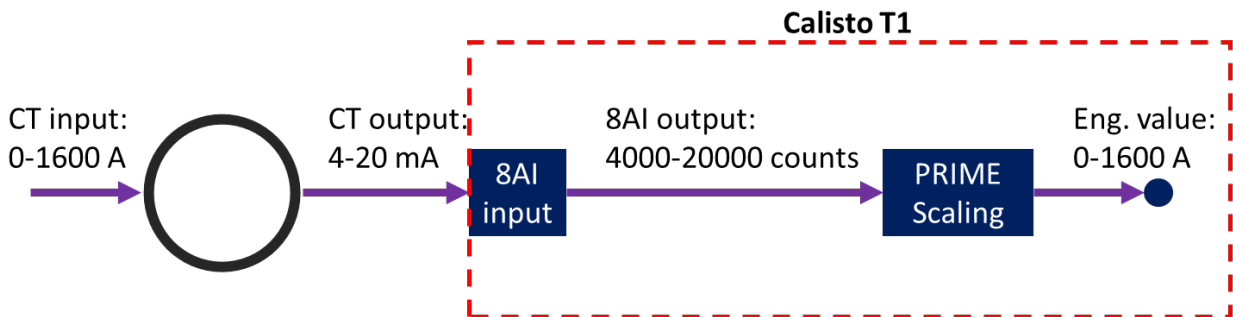


Figure 87 - Visual representation of the data conversion chain

Should you want to plot it on a chart, assume that the x-axis is represented by the 8AI output and y-axis by the transducer input current. Alternatively, we can view the data in table format.

x-axis raw measurement	y-axis Current
4000 counts	0 A
20000 counts	1600 A

The next step is to calculate the slope:

$$(y - y_0) = m(x - x_0)$$

$$m = \frac{(y - y_0)}{(x - x_0)}$$

$$m = \frac{(1600 - 0)}{(20000 - 4000)} = \frac{1600}{16000} = \frac{1}{10} = 0.1$$

Back to the equation, find the slope-intercept form:

$$(y - 0) = 0.1(x - 4000)$$

$$y = 0.1x - 400$$

As stated previously:

$$m = \frac{\text{Multiply}}{\text{Divide}} \text{ and } c = \text{offset}$$

Therefore:

Multiply = 1, Divide=10 and c = -400

$$m = \frac{1}{10} = 0.1 \text{ and } c = -400$$

You can also represent those figures as:

$$m = \frac{10}{100} = 0.1 \text{ and } c = -400$$

Table 8 - 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
				or		
				10	100	-400



Note: The minimum value for Divide is 1. Also, do not enter decimals in the Multiply, Divide and Offset fields. Decimals are ignored.

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.

Table 9 - 8AI Monitor Settings

Monitor Fields	Description
Name	Slot position and name of the card.
Description	Number and type of inputs.
Status	<p>Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required.</p> <p>Commissioned status causes the monitor to collect data if the communication settings are correct.</p> <p>Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.</p>
Polling Interval	Interval at which Calisto T1 receives data from the 8AI card. The minimum interval is 1 minute
Interval in	Select Interval in seconds, minutes.

To save the change click **Save** in the panel footer. Allow the CalistoT1 web 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 at the Dashboard page. 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 on PRIME software representing the physical inputs of the card, that can be connected to switches (e.g., circuit breaker state, alarms). When the asset is assigned to the channel, it owns and displays the channel measurements on the user interface.

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**.

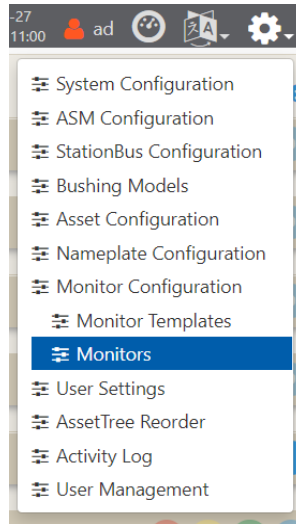


Figure 88 - Settings: Monitor

3. Click Channels icon for the appropriate Monitor to open its settings.

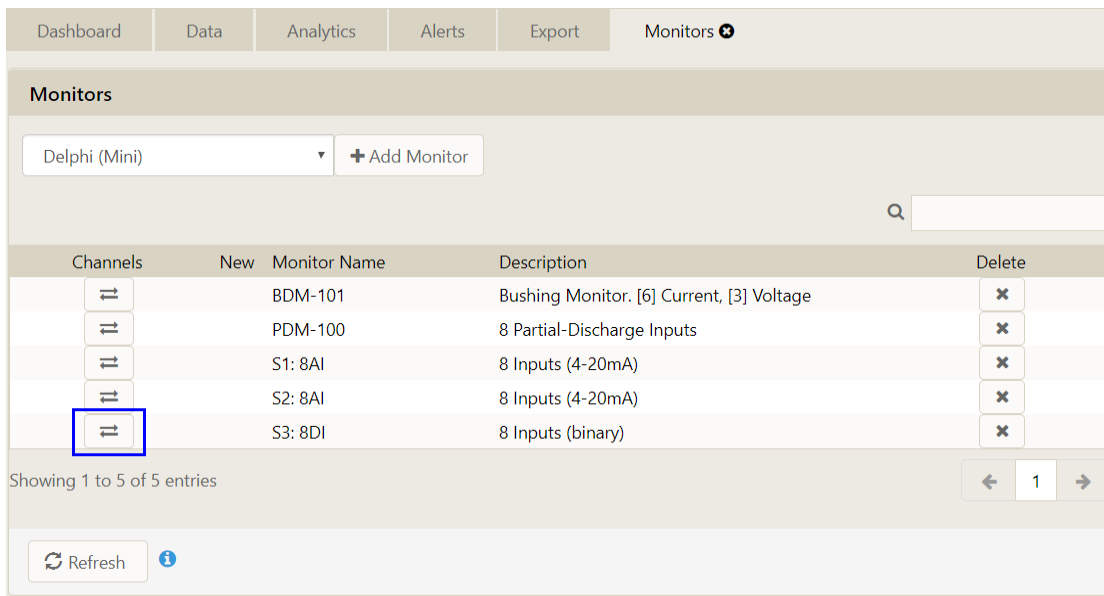


Figure 89 - Open 8DI Monitor Settings

4. Select an asset in the Asset tree; it will be highlighted in blue. In the Monitor Instance Detail, click Assign check mark next to channels which you want to associate to the asset.

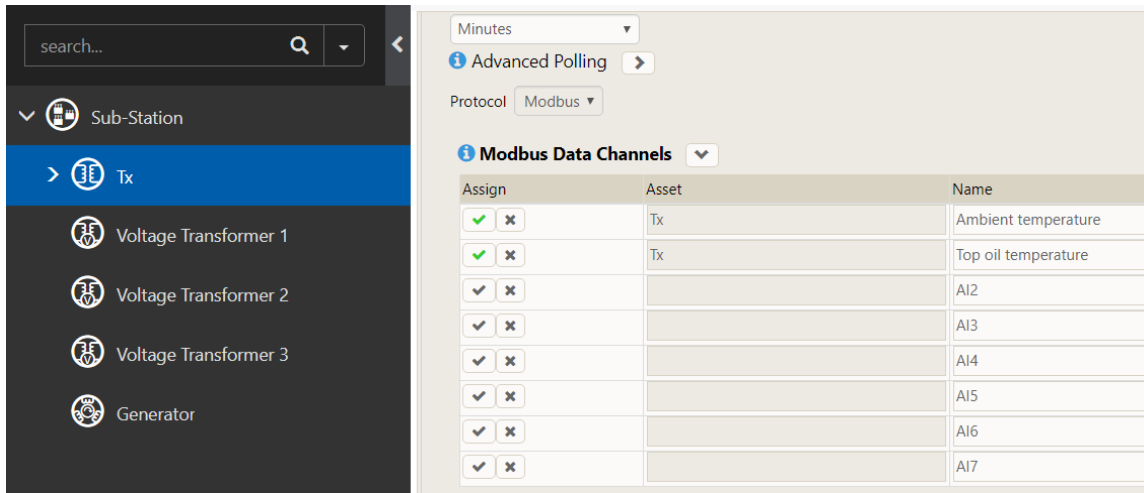


Figure 90 - 8DI Options

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 into PRIME in raw format. Select the appropriate processing type label to 0 or 1 states.

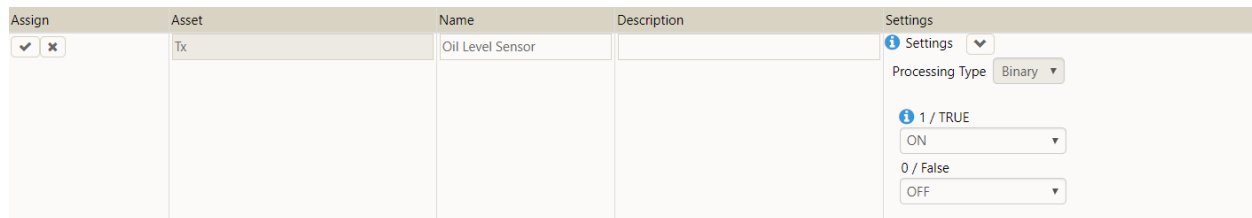


Figure 91 - Digital Channel Settings

General Settings

Table 10 - 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

Setting	Description
	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

Table 11 - 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.
Polling Interval	Interval at which the Calisto T1 receives data from the 8DI card. The minimum interval is 1 minute
Interval in	Select Interval in seconds and minutes.

To save the change click **Save** in the panel footer. Allow the PRIME 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 at the Dashboard page. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

5TI Monitor Settings

On the 5TI monitor page you can edit the communications settings and assign the asset created to the channels. The channels are entities on PRIME software representing the physical inputs of the card, that can be connected to PT100 sensor. The channels assigned to the asset are "owned" by the asset so data can be presented on the user interface.

Assigning the Asset to the 5TI Monitor Channel

There are five Temperature Input 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**.

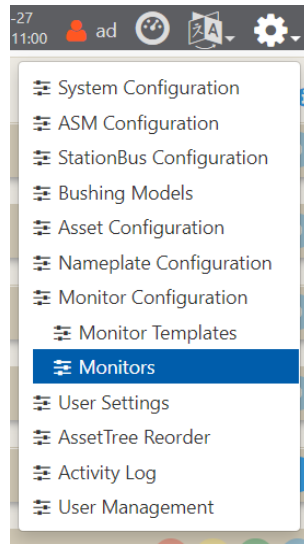


Figure 92 - Settings: Monitor

3. Click Channels icon for the appropriate 5TI Monitor to open its settings.

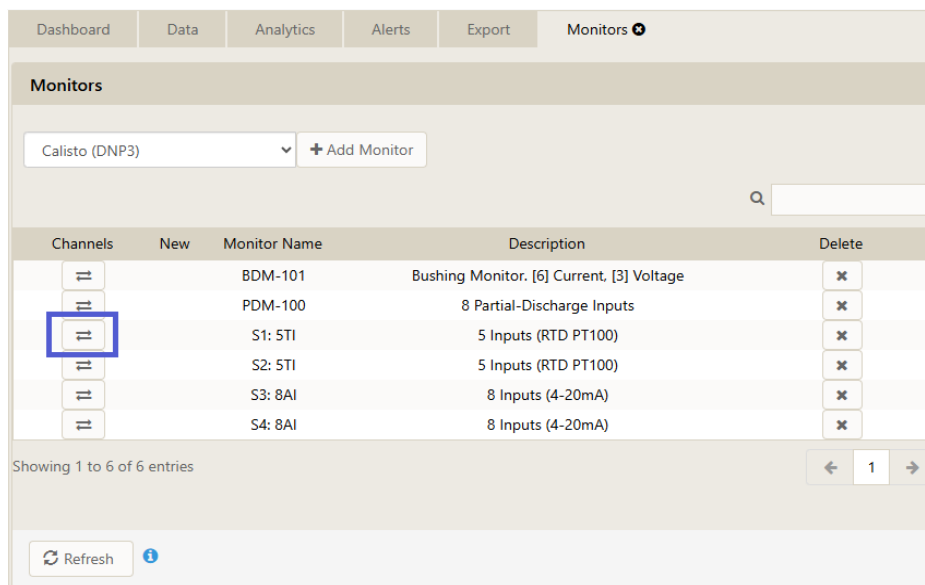


Figure 93 - Open Monitor Settings

- Select an asset in the Asset tree; it will be highlighted in blue. In the Monitor Instance Details, click Assign check mark next to channels which you want to associate to the asset. The name of the asset is copied into the Asset field, and the tick box will change color to green.

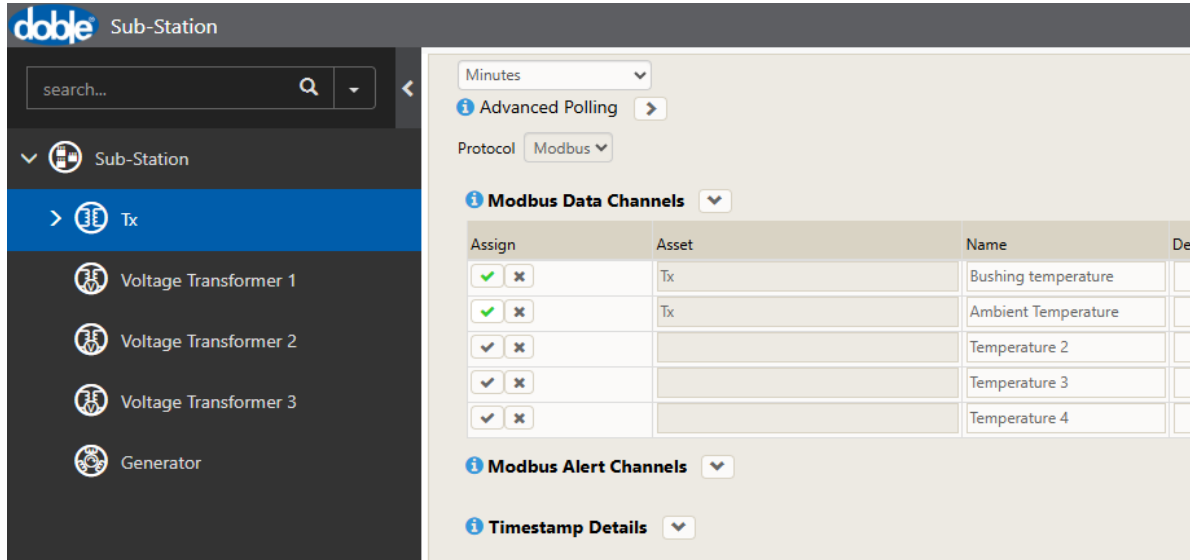


Figure 94 - 5TI Options

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

Channel Settings

Readings from the 5TI card comes into PRIME already scaled, therefore do not change the scaling factors – multiply, divide and offset.

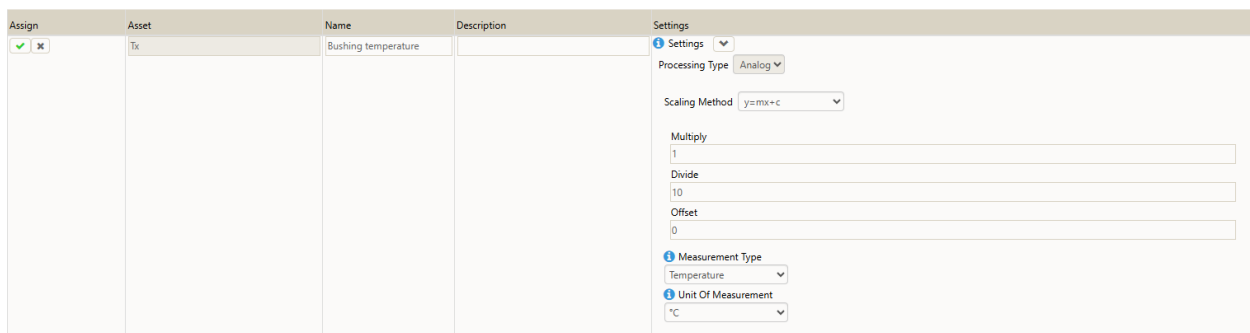


Figure 95 - Temperature Channel scaling

Commissioning the 5TI Monitor

Table 12 - 5TI Monitor Settings

Monitor Field	Description
Name	Slot position and name of the card.
Description	Number and type of inputs.
Status	<p>Maintenance status causes the monitor to stop collecting data. It should be used when the monitor is temporarily not required.</p> <p>Commissioned status causes the monitor to collect data if the communication settings are correct.</p> <p>Decommissioned status causes the monitor to stop collecting data. It should be used when the monitor is no longer required.</p>
Polling Interval	Interval at which the Calisto T1 receives data from the 8DI card. The minimum interval is 1 minute.
Interval in	Select Interval in seconds and minutes.

To save the change click **Save** in the panel footer. Allow the PRIME 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 at the Dashboard page. Refresh the web browser page according to the polling rate and latest measured timestamp to see new data in the Dashboard tab.

8. Network Configuration

This section describes how to configure the network settings using the PRIME interface.

Configuring the Ethernet Interfaces	85
Network Settings	87
Firewall Settings	88
Configuring the Serial Ports	89
Comms settings – Modbus and DNP3 protocol address settings	90
Configuring the LAN 2 Port	91

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**.

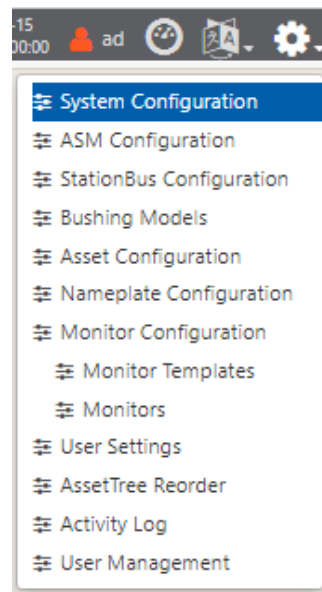


Figure 96 - Settings: System Configuration

3. In the System Configuration tab, click **Ethernet Interface**. There are three network interfaces available.

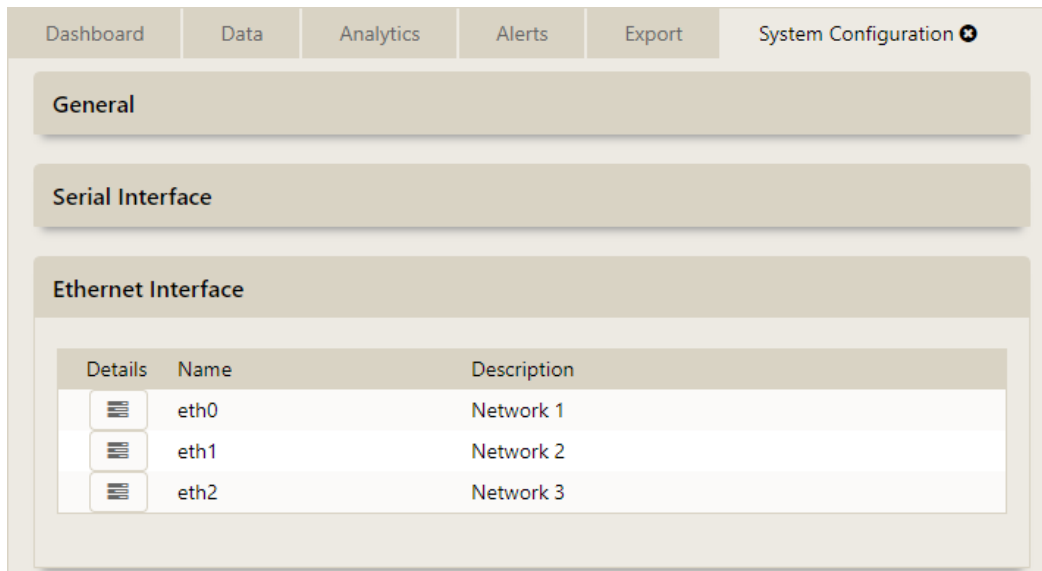


Figure 97 - System Configuration: Ethernet Interface



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, when built into Calisto T1. Changing the IP address of those interfaces will disrupt 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 (dual Ethernet port and SFP), is the only interface that you should edit when the IP of Calisto T1 must be changed.

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

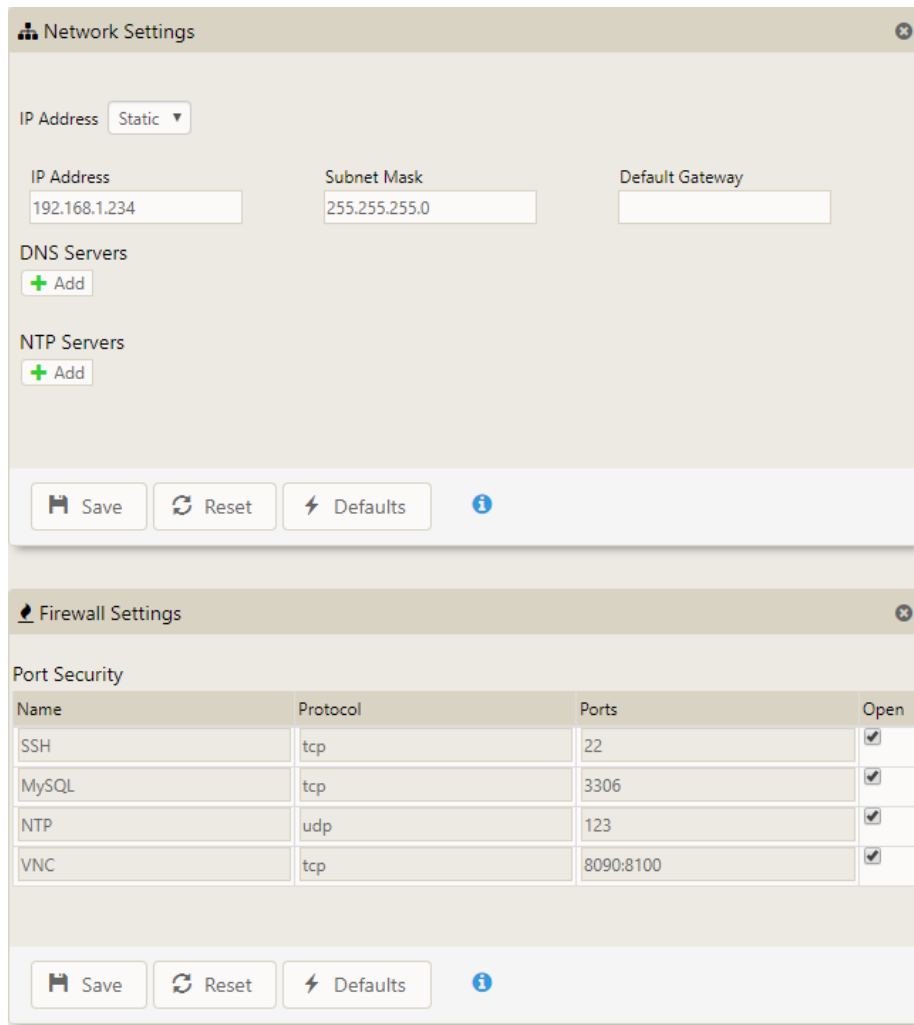


Figure 98 - LAN 1 (eth1) Network and Firewall Settings

Network Settings

The network settings are described in the following table.

Table 13 - 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	Enter the IP address in this field when Static mode is selected.

Option	Description
(field)	
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.

Table 14 - Firewall Settings

Port Name	Description
SSH	Maintenance port. The Doble engineer can use a terminal 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	Legacy protocol to VNC the old PD monitor. Not applicable to the new PD monitor

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 (Master mode) or supervisory systems (Slave/Outstation mode) using the RS485 interfaces. Each port can be configured individually and operate using any mode required.

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. Click **Serial Interface** in the System Configuration tab in the feature panel.

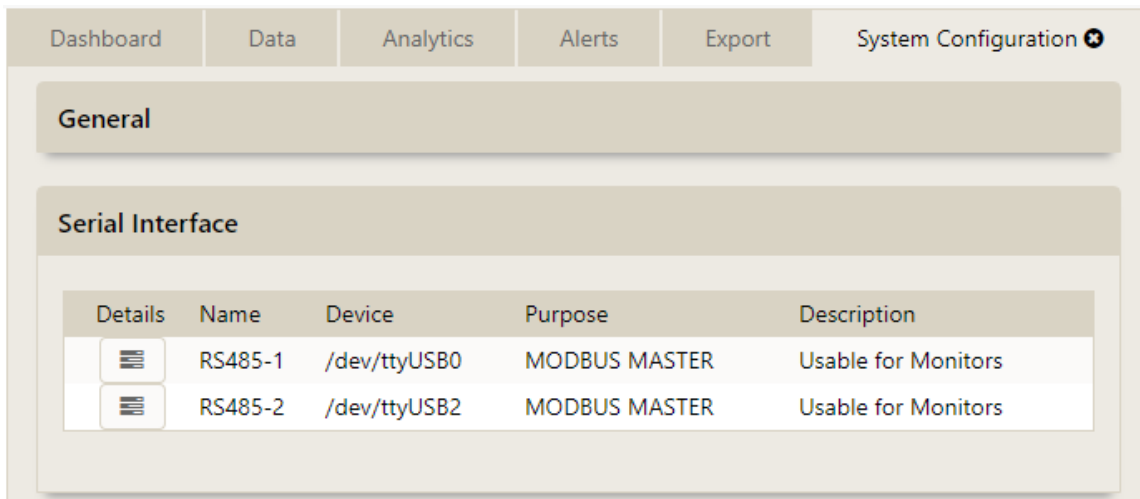


Figure 99 - Serial Interfaces - Example

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

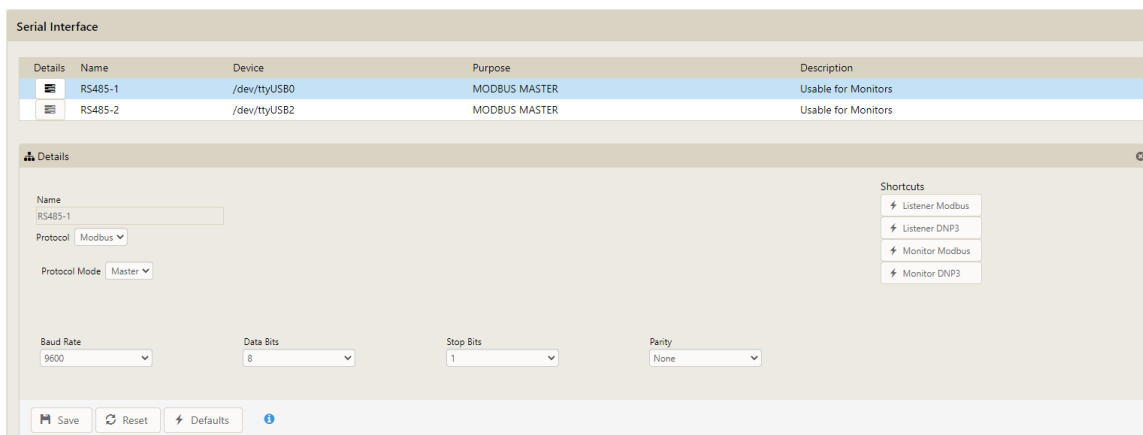


Figure 100 - Serial Interface Configuration Options

5. Select the communication protocol which will be bound to this port.

6. Select the appropriate protocol mode. 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 mode. Listener set up the serial port in Slave mode whereas Monitor set up the port in Master mode.
9. Make the appropriate configuration changes and click **Save**.

Comms settings – Modbus and DNP3 protocol address settings

Edit the Modbus and DNP3 addresses as required.

1. Click the settings icon at the top-right of the title bar.
2. Click **System Configuration**.
3. Click **Comms Settings** in the System Configuration tab in the feature panel.

Comms Settings

DNP3 Master Address
1

DNP3 Outstation Address
2

Modbus TCP Unit Identifier
1

Save Reset Defaults i

Figure 101 - Comms settings

Options:

- **DNP3 Master Address:** Global address valid for both serial and TCP connections and Monitor and StationBus
 - **DNP3 Outstation Address:** Valid for TCP connection only and StationBus. On serial connection, the outstation address can be set in the serial interface.
 - **Modbus TCP Unit Identifier:** Server address for TCP connection and StationBus. On serial connection, the Modbus slave address can be set in the serial interface.
4. Click **Reset** to reset the changes to the previous saved settings.
 5. Click **Default** to reset the changes back to factory settings.
 6. Make any necessary changes and click **Save**.

Refer to "[Configuring the Serial Ports](#)" on page 89 for more information on setting up the DNP3 outstation address and Modbus server 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 application note - Doble_ICOS_App-Note_Kalki_221_Integration_and_testing_Rev3.

9. Operation

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

Overview

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

- PRIME Interface Gateway - PIG
- Bushing Data Monitor - BDM
- Partial Discharge Monitor - PDM
- Expansion card monitors – 8AI / 8DI / 5TI

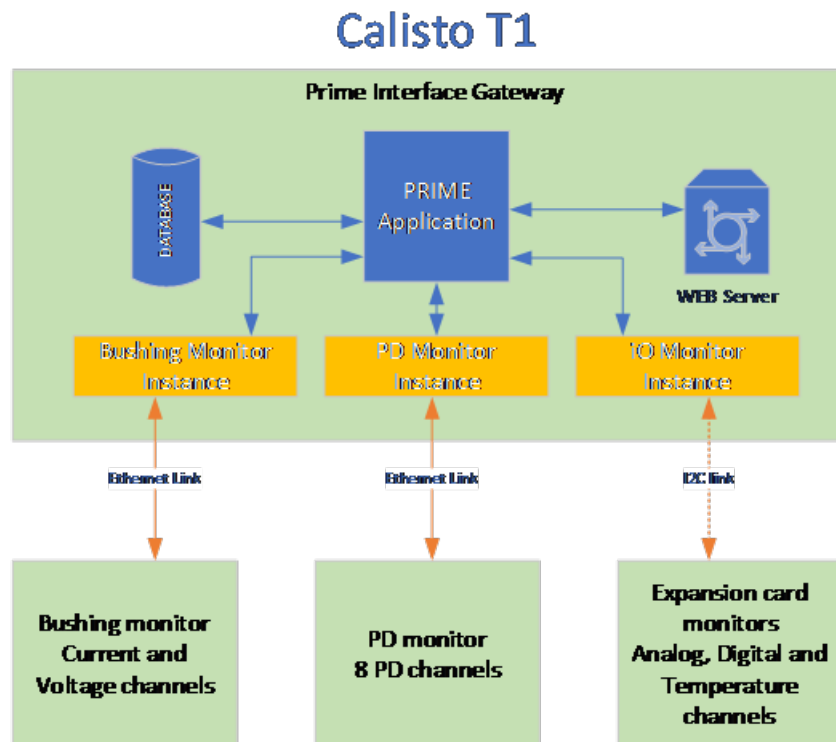


Figure 102 - Calisto T1: Internal Communication Architecture

System Overview

The PRIME Interface Gateway is the central board responsible for running key services, including the DoblePRIME application, web server, database management, and communication with both internal and external monitors. Measurements from the monitors are collected using a polling method. The DoblePRIME application polls each monitor at a user-defined rate. When a monitor responds, the data is saved to the database, making it available for user access.

Bushing Data Monitor (BDM)

The Bushing Data Monitor measures leakage current, voltage, and phase angles to calculate capacitance, power factor, and harmonics for each bushing. This process is computationally intensive, requiring the BDM's CPU to handle thousands of data points. While the CPU is busy processing, it does not respond to requests from the DoblePRIME application.

Once processing is complete, the results are stored in a buffer and made available through MODBUS registers. The DoblePRIME application retrieves this data at the next polling cycle. Each new data set overwrites the previous one in the buffer.

Partial Discharge Monitor (PDM)

The Partial Discharge Monitor sequentially scans its channels using a multiplexed system. In VHF mode, scanning all eight channels takes about 8 minutes; in EMI mode, it takes about 40 minutes. As each channel scan completes, its results are made immediately available over Modbus.

Expansion Card Monitors

The Expansion Card Monitors acquire analog and digital signals. This process is simpler than the data acquisition performed by the Bushing and Partial Discharge Monitors. The acquired data is stored internally in raw format via Modbus, awaiting retrieval by the PRIME application.

Results and data representation

The DoblePRIME application pulls data from all connected monitors, saves it to the database, and presents it to users through the PRIME web interface. The Dashboard tab displays an overview of asset health for a selected location (e.g., a substation) along with any active alerts. Additional tools are available for viewing charts, trend analysis, and data tables.

Additional Bushing Monitor Data

Beyond capacitance and power factor, the Bushing Monitor provides the following additional measurements:

- Loss Angle
- System Voltage
- Phase Angle (normalized to zero)
- Total Harmonic Distortion (THD) of leakage current
- Current and Voltage Phasors

The monitor also offers two types of power factor measurements:

- Relative Power Factor (RPF):
 - Does not require a voltage reference.
 - Calculated by comparing the phase angles of the three leakage currents.
 - RPF is always calculated by default.
- True Power Factor (TPF):
 - Requires a voltage reference input from instrument transformers.
 - The phase angle difference of each bushing's currents is compared to its corresponding bus voltage.
 - TPF is disabled by default. Before enabling, verify that the required voltage input is connected.

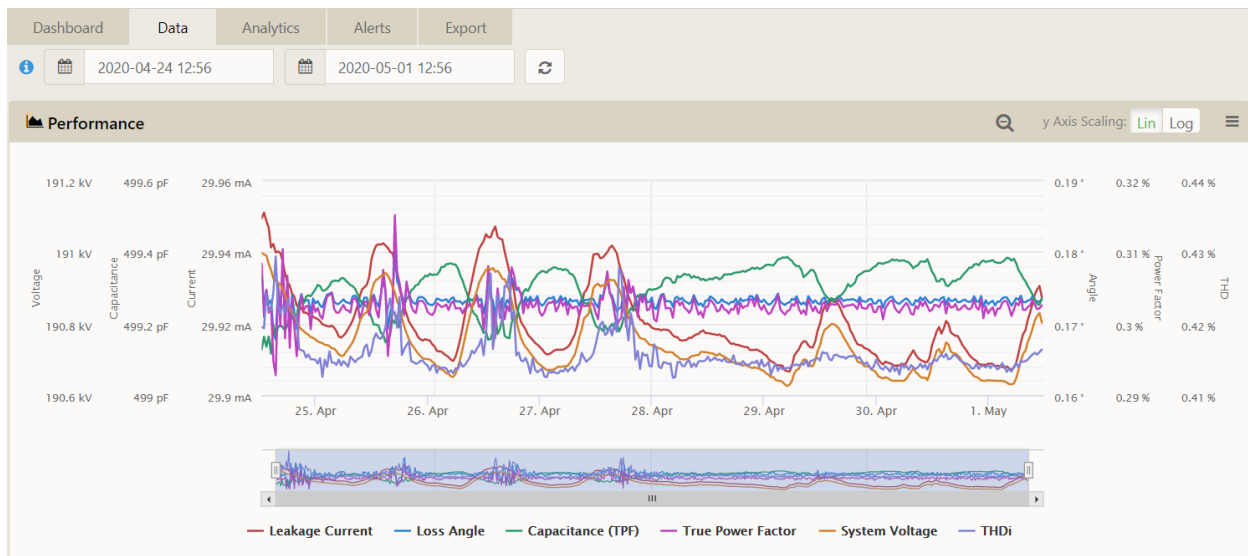


Figure 103 - Bushing Monitor Measurements

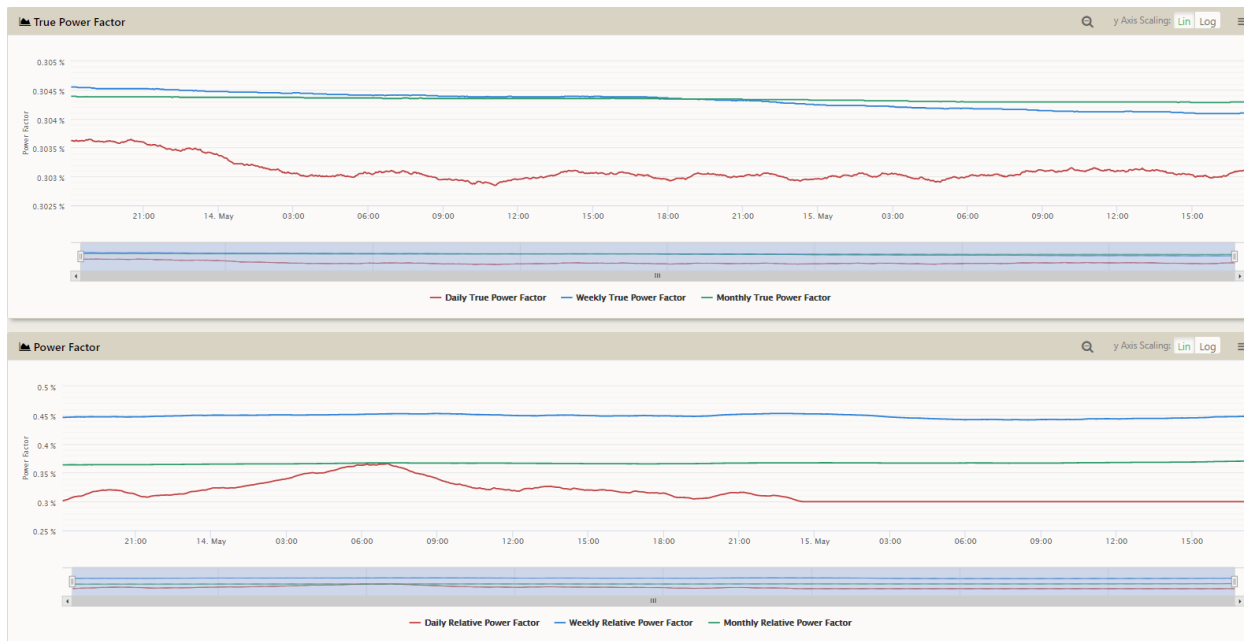


Figure 104 - TPF and RPF Trending in the Same Period

Partial Discharge Results

The Partial Discharge (PD) Monitor presents its results using a proprietary metric developed by Doble. This metric helps detect and quantify the energy of PD signals and is designed to be easily understood, even by less experienced users.

The results of a spectral scan are displayed as two key statistical values for each frequency band:

- **IPwr (Integrated Power):** Indicates the total energy within the band based on statistical analysis.
- **PAPR (Peak-to-Average Power Ratio):** Highlights the presence of partial discharge activity by showing the ratio between the peak and average power levels in the band.

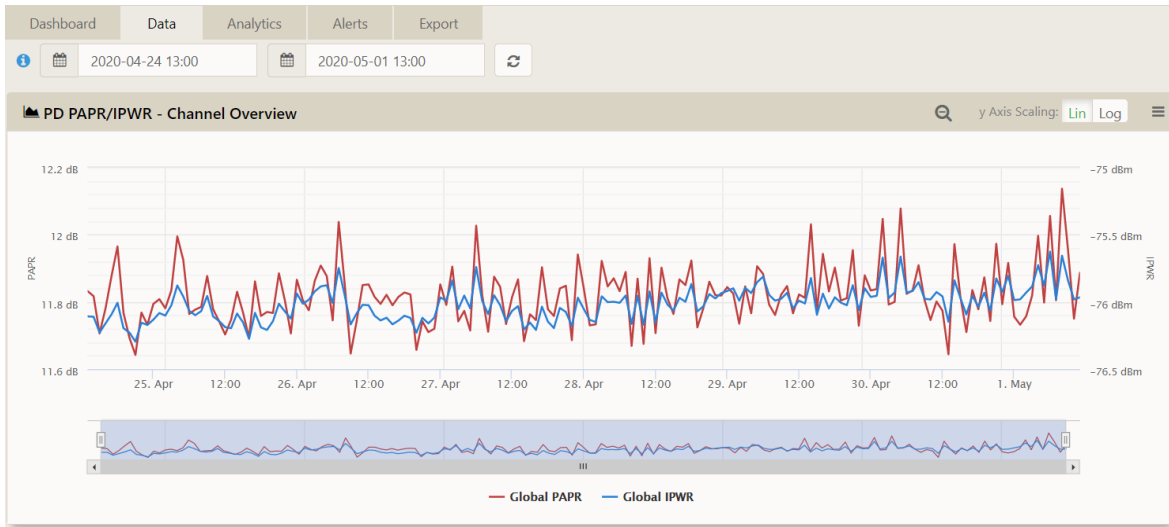


Figure 105 - PD Monitor Measurements

Expansion Card Data Scaling

Raw data from the Expansion Card Monitors does not immediately reflect meaningful measurements. Each value must be scaled according to a factor and assigned a unit of measurement based on the connected transducer’s specifications.

For example:

- Analog data from the card might report 4000 counts for 4mA and 20000 counts for 20mA.
- The correct scaling factor and measurement limits are provided in the transducer’s datasheet, and these values need to be applied to the monitor instance to convert the raw data into usable values.

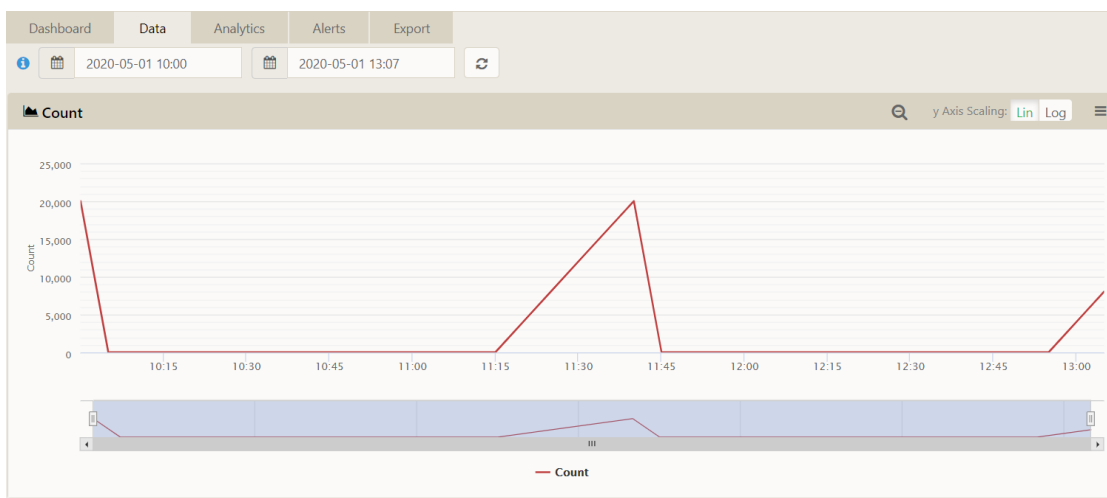


Figure 106 - 8AI Monitor Measurements

Alerts and notifications

An Alert Status is generated when a channel's value crosses user-defined threshold levels. There are three alert levels:

- Information
- Warning
- Action

The system uses a “highest alert wins” logic to determine the overall status, meaning the most critical individual alert takes precedence. The alert status is shown via:

- Front panel LEDs
- Alert outputs

Detailed alerts can be viewed and acknowledged in the PRIME application. The Alerts tab shows both active and acknowledged alerts, organized by asset and channel.

Level	Asset	Channel	Time	Alert	Ack Message	Time Sent	Ack
Information	TX	[HV]	2020-05-01 14:11:00	The bushing set is offline (low leakage current).		Not Sent	ACK...
Warning	TX	[HV] I1	2020-05-01 14:14:00	The measured bushing current is not in the same range as the expected current estimated from the nameplate values.		Not Sent	ACK...
Warning	TX	[HV] I2	2020-05-01 14:14:00	The measured bushing current is not in the same range as the expected current estimated from the nameplate values.		Not Sent	ACK...
Warning	TX	[HV] I3	2020-05-01 14:14:00	The measured bushing current is not in the same range as the expected current estimated from the nameplate values.		Not Sent	ACK...

Figure 107 - Alerts Tab

Bushing Alerts in Calisto DoblePRIME

The Calisto DoblePRIME application uses a specialized alert system for bushing monitors. It leverages an embedded Expert System to compare offline and online data and trigger alerts accordingly.

Partial Discharge Monitor Alerts

By default, PD alerts are not generated within the Partial Discharge Monitor. Use the ASM tool to create customized alert thresholds for each PD channel.

Custom Alert Creation

For Partial Discharge Monitors, Expansion Cards, and other monitors, all user-defined alerts must be created using the Alert State Machine (ASM) tool.

Simply select the desired channel and configure the appropriate alert levels and conditions.

For detailed instructions on viewing results, managing alerts, and configuring the ASM tool, please refer to the DoblePRIME 3.2 User Guide.

10. Hardware Expansion

Expansion Cards

This section describes how to install the Expansion 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.

The 8AI Jumper Configuration 99

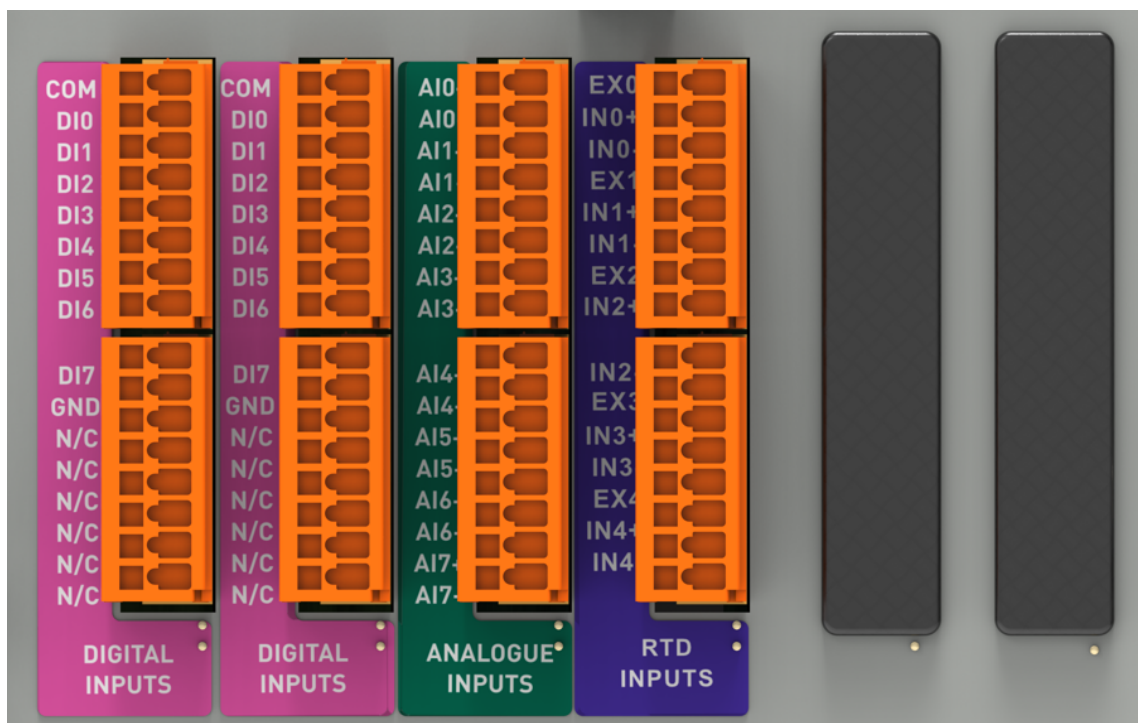


Figure 108 - Expansion Cards

Perform the following steps to add or remove expansion cards.

1. Power off the Calisto T1.
2. Remove the connection blocks from the expansion cards.
3. Undo the screws on the front panel of Calisto T1 then remove the front panel.
4. Insert or remove the card 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.

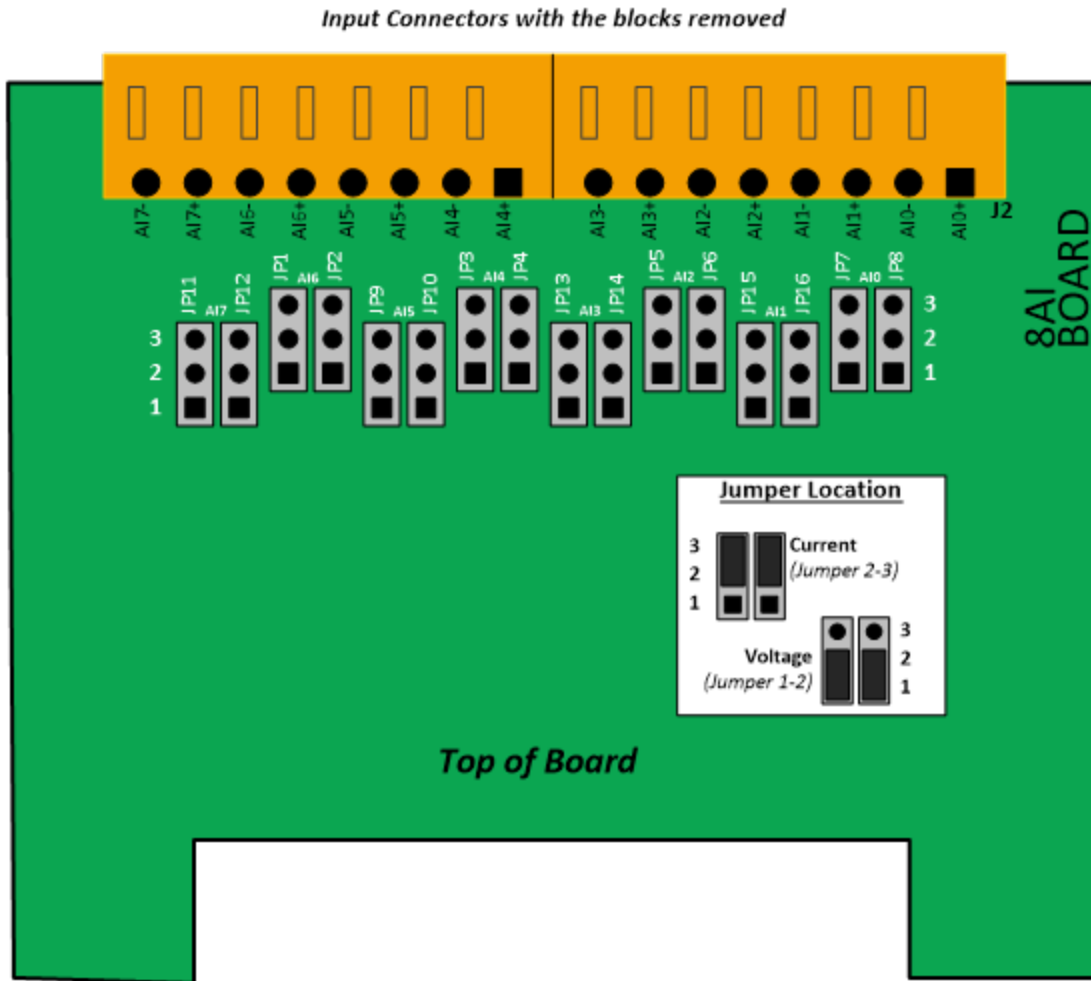


Figure 109 - 8AI Card Jumper Configuration

Table 15 - 8AI Jumper Configuration

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

AI Channels	AI Jumper Set	Current Mode	Voltage Mode
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 on the list.

The other cards, 8DI and 5TI, do not have jumper configuration.

11. Wiring Sensors to the Expansion Cards

This section describes how to wire sensors to Expansion Cards.

Wiring Sensors to Expansion Cards	102
Analog Input Wiring – 8AI Card	102
Digital Input Wiring – 8DI Card	103
DI Wet Contact (NPN Sensor)	103
DI Wet Contact (PNP Sensor)	104
Temperature Input Wiring – 5TI Card	104

Wiring Sensors to Expansion Cards

The following wiring guide explains how to wire the three different types of sensor to the input 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 "8AI Card Jumper Configuration" on page 100

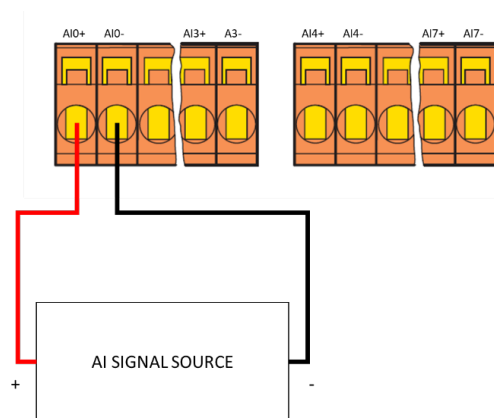


Figure 110 - Wiring a 4-20mA/0-10V Sensor to the 8AI Input

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 lower voltage threshold level to indicate the channel is in low-state. Max DC Power Source: 30 VDC.

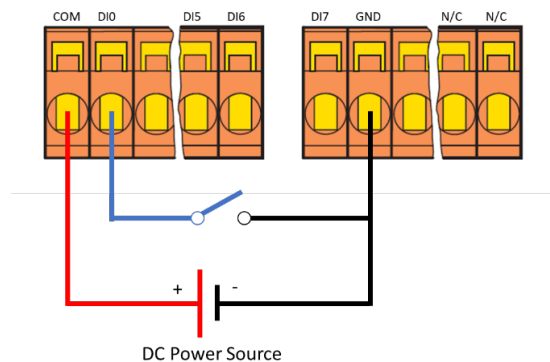


Figure 111 - Wiring a Digital Input, Dry Contact Sensor

DI Wet Contact (NPN Sensor)

Operation mode:

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

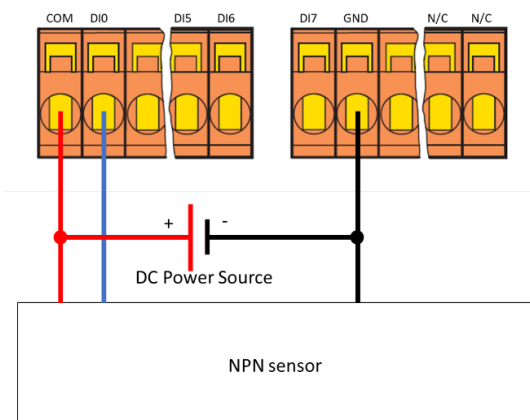


Figure 112 - Wiring a Digital Input, Wet Contact NPN Sensor

DI Wet Contact (PNP Sensor)

Operation mode:

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

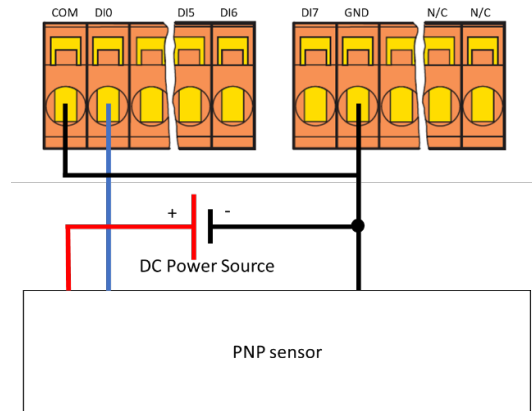


Figure 113 - Wiring a Digital Input, Wet Contact PNP Sensor

Temperature Input Wiring – 5TI Card

How to wire RTD PT100 sensor to the terminal block.

2-Wire RTD:

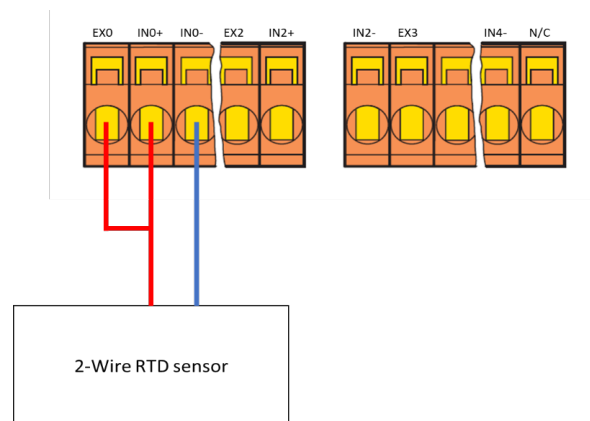


Figure 114 - 2-wire RTD

3-Wire RTD:

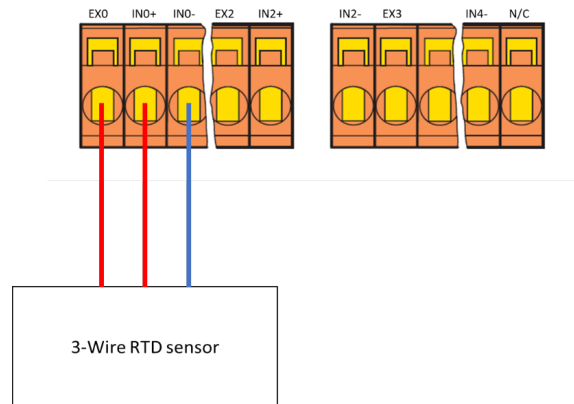


Figure 115 - 3-wire RTD

4-Wire RTD:

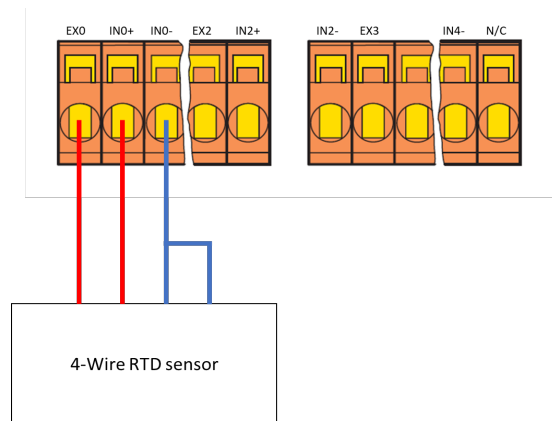


Figure 116 - 4-wire RTD

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

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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.

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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.

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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

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)	
SFP port	
Alert LED (Status, Info, Warning, Action)	
Digital Outputs (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
<i>TEMPERATURE*</i>	

Operating temperature	-20°C to +50°C
Extended temperature	-40°C to +60°C
Storage temperature	-20°C to +70°C
MECHANICAL DATA	
Height	298.5mm / 11.75 in
Width	363mm / 14.29 in
Depth	206mm / 8.11 in
Weight	51kg / 113 lbs
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

DATA ACQUISITION	
HF Tuner	9 kHz to 56 Mhz
VHF Tuner	56 MHz to 2 GHz
Sync Input	DC to 500 KHz
Detector Modes	Spectrum analysis (Peak, Average, Quasi-Peak), Time resolved (zero span), Phase resolved, Acoustic
Tuner Sensitivity	1 uV
Number of input channels	8 channels (multiplexed)

Number of Sync inputs	1
-----------------------	---

Bushing Monitor Specifications

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%

Expansion card Specifications

DATA ACQUISITION	
Connector	Push-in termination
8AI	8 channel analog inputs, 4-20 mA or 0-10V. Jumper selectable
5TI	5 channel inputs, 2/3-wire connection PT100
8DI	8 channel digital inputs, dry or wet contact

C. Dimensions

Calisto T1 Dimensions

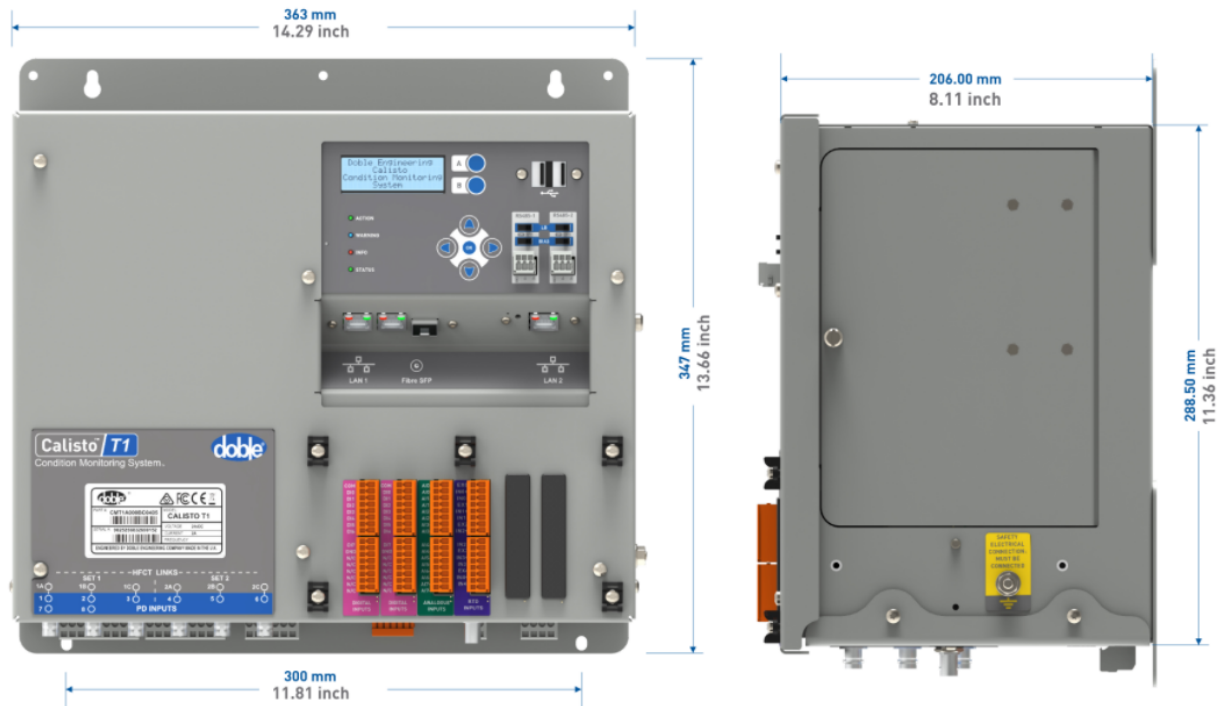


Figure 117 - T1 base dimensions

DPEN101 T Enclosure Dimensions

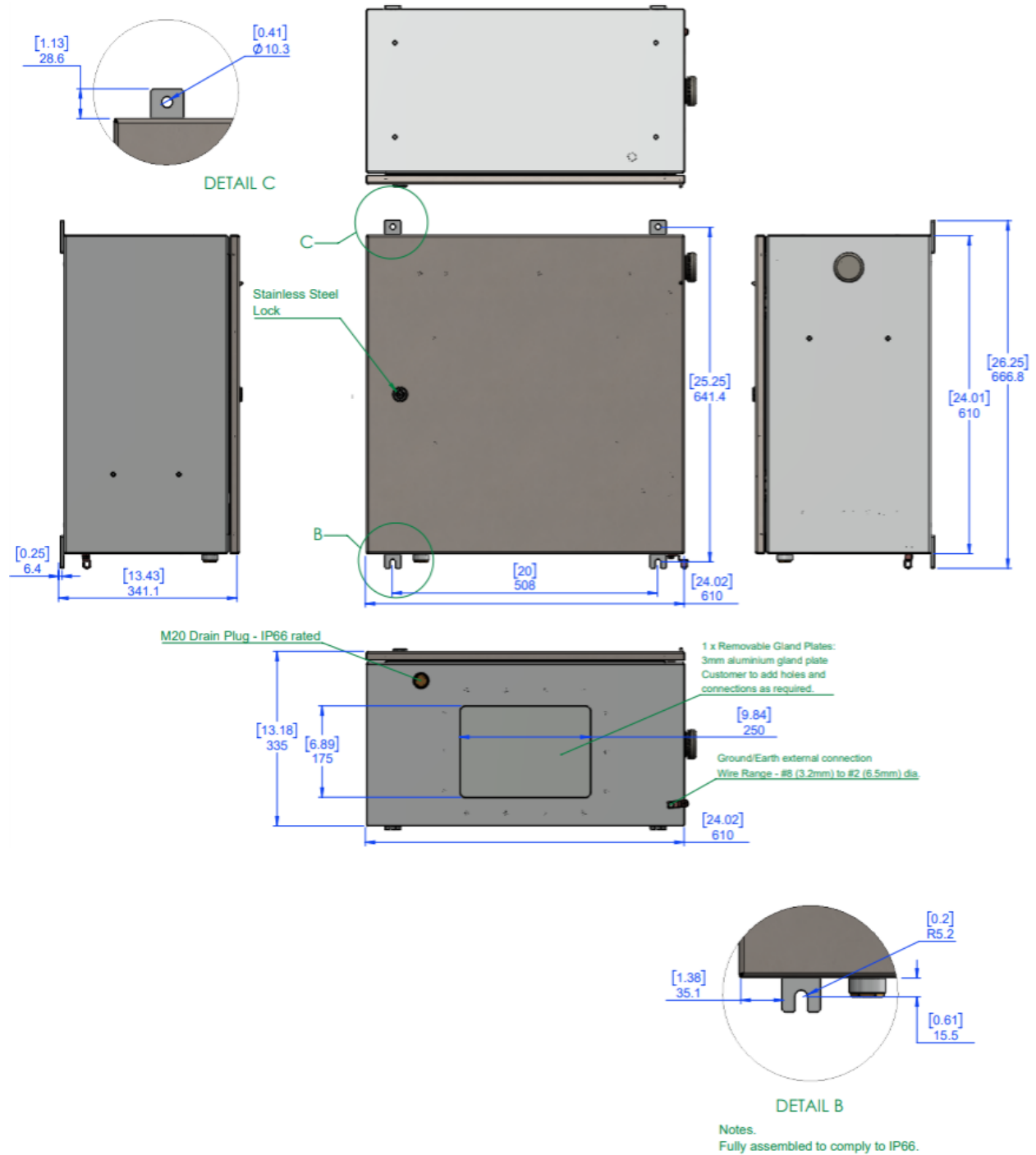


Figure 118 - Enclosure dimensions

D. PICOS Application

Along with the DoblePRIME application, there is another application in the system to help troubleshoot internal monitors and quickly take 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 PRIME application; therefore, no data is exchanged or shared between the two applications.

The main application of PICOS is to:

- Troubleshoot internal or external monitors
- Test the front LED (Status Indicator) and Alert outputs
- Test the Expansion cards
- Set the date and time of the system
- Control PRIME 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 “https://192.168.1.234/picos” in the URL bar. A credential is required to access PICOS.

- Default user: doblePicos
- Password: doblePicos1!

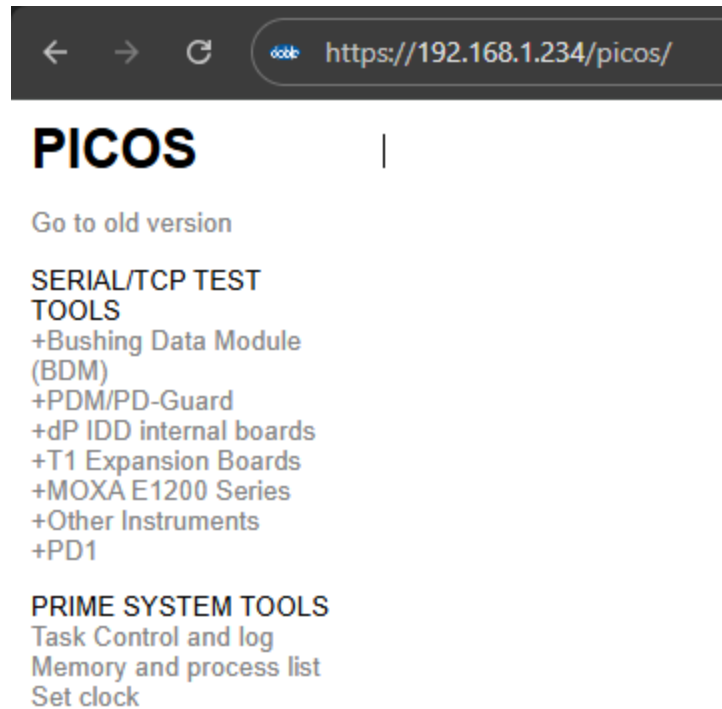


Figure 119 - PICOS Menu

Troubleshooting internal monitors

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

- Bushing Data Module (BDM)
- PDM/PD-Guard (deprecated, see new PD Monitor PD1)
- T1 Expansion Boards
- PD1 (Spark PD Monitor)

The Bushing Monitor (BDM)

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. Check the subsection Control of DoblePRIME application in this appendix.

First step, change the IP address in the field. This address, in Calisto T1, is 192.168.10.35.

PICOS

[Go to old version](#)

SERIAL/TCP TEST TOOLS

-Bushing Data Module (BDM)

192.168.10.35

- Settings
- True power factor test - requires bushing card 1, SVM card 2
- Phasor measurement
- Firmware upgrade (TCP only)
- Factory settings (and reboot button)
- Show calibration coefficients
- Check Chronos firmware version

Figure 120 - PICOS Bushing Monitor Options

Table 16 - 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	This tool is used to calibrate capacitance and power factor using the transformer and Instrument Transformer nameplate. See True Power Factor Calibration (page 1) 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 DoblePRIME application set up during the commissioning.
Firmware	A tool to load firmware onto the BDM. Requires a .bin file.

Option	Description
upgrade (TCP only)	
Factory settings (and reboot option)	The tool allows you to reboot the BDM monitor only. The PRIME 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 (PD1)

The link PDM/PD-Guard is deprecated and is not applicable to access the new PD-Guard web page. Please refer to PD1 link, located below Other Instruments, to open the PD module web page.

PICOS

[Go to old version](#)

SERIAL/TCP TEST

TOOLS

+Bushing Data Module (BDM)

-PDM/PD-Guard

192.168.200.200

- Remote access interface (TCP only, ports 8090-8100)
- Remote access interface (TCP only, websocket proxy)
- Firmware upgrade (TCP only)
- Status page
- Server config

Figure 121 - Old PD Monitor links (deprecated)

To access the new PD monitor web interface, click on PD1 link.

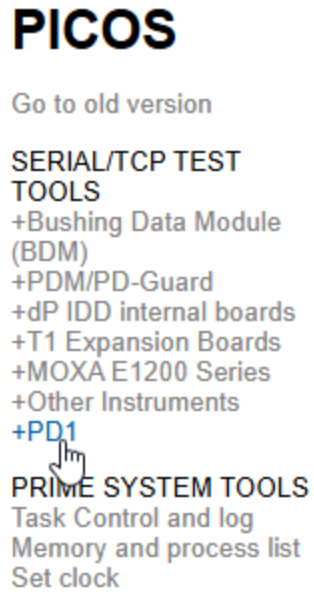


Figure 122 - New link to the PD monitor web interface

The IP address of the PD module is already entered in the field, don't change this address then click on PD1 web UI.

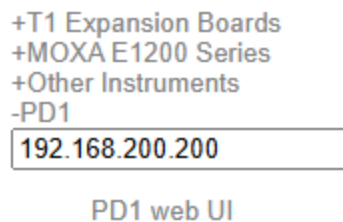


Figure 123 - IP address of the PD monitor

The web page of the PD monitor is open in the main frame. For further information about the PD monitor UI please refer to the Sparklet User Guide.

PICOS

Go to old version

SERIAL/TCP TEST TOOLS

- +Bushing Data Module (BDM)
- +PDM/PD-Guard
- +dP IDD internal boards
- +T1 Expansion Boards
- +MOXA E1200 Series
- +Other Instruments
- +P31

192.168.200.200

PD1 web UI

PRIME SYSTEM TOOLS

- Task Control and log
- Memory and process list
- Set clock

Welcome to Spark

Identifying Name on Device

User Name

Enter Device Remote Access Password

Password

Remember this user name on this browser

Login

Figure 124 - Sparklet web UI

The Expansion Boards

Click **T1 Expansion Boards** 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 boards. "Control of DoblePRIME application" on page 127.

PICOS

[Go to old version](#)

SERIAL/TCP TEST

TOOLS

+Bushing Data Module
(BDM)

+PDM/PD-Guard

+dP IDD internal boards

-T1 Expansion Boards

- Manifest
- Selftest flags
- RGB LED
- 8DO
- 8DI
- 8AI

Figure 125 - Expansion Boards Options

Table 17 - 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 (not support on PRIME)
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 Expansion Card

There are four slots which you can fit in the expansion card. The slot numbering starts from the left to the right. Only four cards are addressable and automatically recognized by PRIME application.

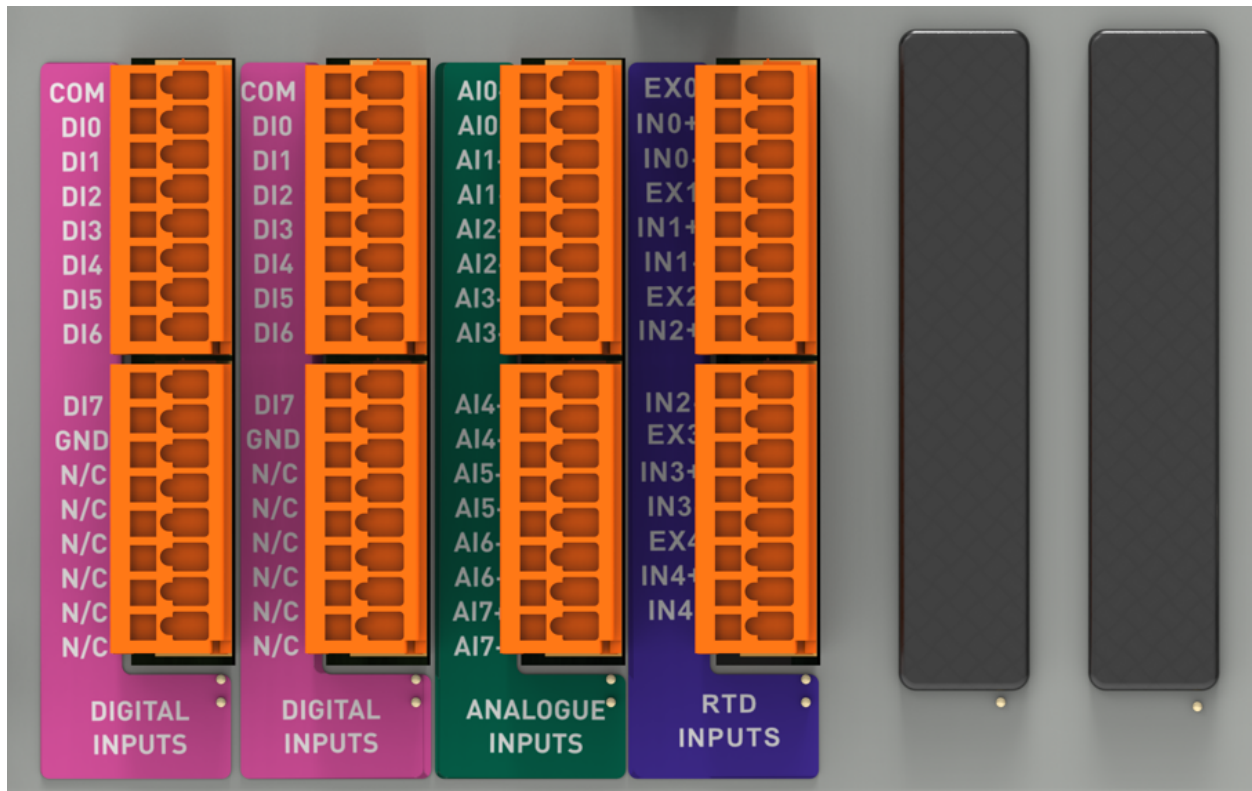


Figure 126 - Example of iO Cards fitted

To view the raw value of a specific board, select from the drop-down menu, under the field 127.0.0.1, the board position before clicking on 8DI or 8AI option.

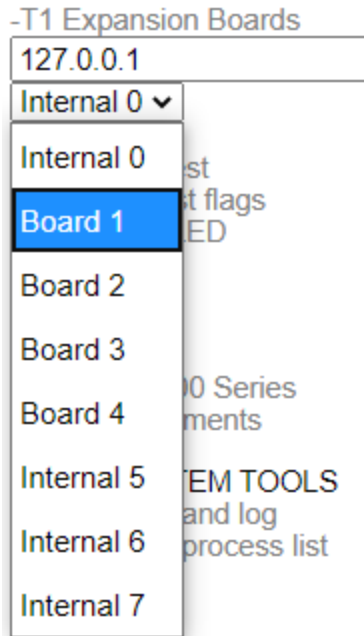


Figure 127 - Board Selection

For example, see the board configuration in [Figure 100](#). If you want to view the raw measurement from Digital Input slot 2, select in the drop-down menu Board 2 then click the 8DI option.

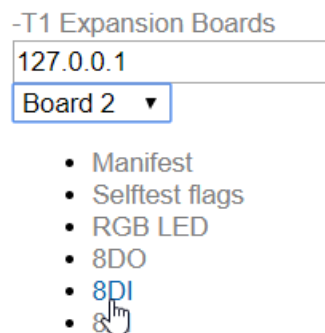


Figure 128 - Board Function Selection

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

PICOS

Go to old version

SERIAL/TCP TEST TOOLS

+Bushing Data Module (BDM)

+PDM/PD-Guard

+dP IDD internal boards

-T1 Expansion Boards

127.0.0.1

Board 2 ▾

- Manifest
- Selftest flags
- RGB LED
- 8DO
- 8DI
- 8AI

I/O board daemon at 127.0.0.1:32504

8 Digital Input board

Digital input 0:
 Digital input 1:
 Digital input 2:
 Digital input 3:
 Digital input 4:
 Digital input 5:
 Digital input 6:
 Digital input 7:

0
0
0
0
0
0
0
0

Figure 129 - Raw digital input example

Testing the Front LEDs (Status Indicator)

This tool allows the verification of the current status of each LED and forces a different status. Before clicking on the RGB LED option, make sure the Internal 0 instrument is selected.

-T1 Expansion Boards

127.0.0.1

Internal 0 ▾

- Manifest
- Selftest flags
- **RGB LED**
- 8DO
- 8DI
- 8AI

Figure 130 - 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.

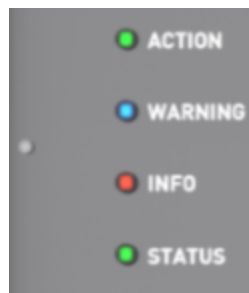


Figure 131 - Front LED on T1 and the reset pinhole

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.

PICOS

Go to old version

SERIAL/TCP TEST

TOOLS

+Bushing Data Module

(BDM)

+PDM/PD-Guard

+dP IDD internal boards

-T1 Expansion Boards

127.0.0.1

Internal 0 ▾

- Manifest
- Selftest flags
- RGB LED
- 8DO
- 8DI
- 8AI

+MOXA E1200 Series

+Other Instruments

PRIME SYSTEM TOOLS

Task Control and log

Memory and process list

Set clock

I/O board daemon at 127.0.0.1:32502

LED control

Status LED:

On ▾

Info LED:

On ▾

Warning LED:

Off ▾

Action LED:

Off ▾

Write

Reset button status

Reset button:

Not pressed ▾

Reset button defeat:

Button runs reset script ▾

Write

Lamp test mode

Lamp test mode:

Normal ▾

Write

Figure 132 - 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 PRIME application to timestamp the measurements. Also, this clock, it is the time reference to sync the clock of the BDM and PDM monitors.



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.

Click **Set Clock** under PRIME SYSTEM TOOLS. 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** to submit the changes.

PICOS

[Go to old version](#)

SERIAL/TCP TEST TOOLS

- +Bushing Data Module (BDM)
- +PDM/PD-Guard
- +dP IDD internal boards
- +T1 Expansion Boards
- +MOXA E1200 Series
- +Other Instruments

PRIME SYSTEM TOOLS

- Task Control and log
- Memory and process list
- Set clock

Clock

Thu May 14 11:20:12 UTC 2020

Year:	2020
Month:	05
Day:	14
Hour:	11
Minute:	18
Second:	23

Figure 133 - Setting the time and date of mainboard - PRIME CPU



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 PRIME CPU. If the time between the two boards differs, the DoblePRIME application will fail to save new data in the database.

Testing the Alert Outputs

This tool allows you to verify the status of each Alert output and force a different status. Although this option also shows the LEDs status (see [Testing the front LEDs](#) (page "Testing the front LEDs" on page 124) 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. Check the Control of DoblePRIME application (page "[Control of DoblePRIME application](#)" on the next page) in this appendix.

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

PICOS

Go to old version

SERIAL/TCP TEST
 TOOLS
 +Bushing Data Module (BDM)
 +PDM/PD-Guard
 -dP IDD internal boards

- dP IDD LED/relay IO
- 4AD analog/digital input

I/O board daemon at 127.0.0.1:32502

Digital outputs

Status LED:	<input type="button" value="Off ▼"/>
Info LED:	<input type="button" value="Off ▼"/>
Warning LED:	<input type="button" value="Off ▼"/>
Action LED:	<input type="button" value="Off ▼"/>
Relay 1:	<input type="button" value="Off ▼"/>
Relay 2:	<input type="button" value="On ▼"/>
Relay 3:	<input type="button" value="Off ▼"/>
Relay 4:	<input type="button" value="Off ▼"/>

Figure 134 - Testing the relays

The Digital outputs show the current status of the alerts. Verify the digital outputs underneath the Calisto T1, or at the supervisory relays on the DIN rail, to confirm the status in the software matches the output status. Use a continuity tester to verify if the relays open and close when the status on PICOS is changed.

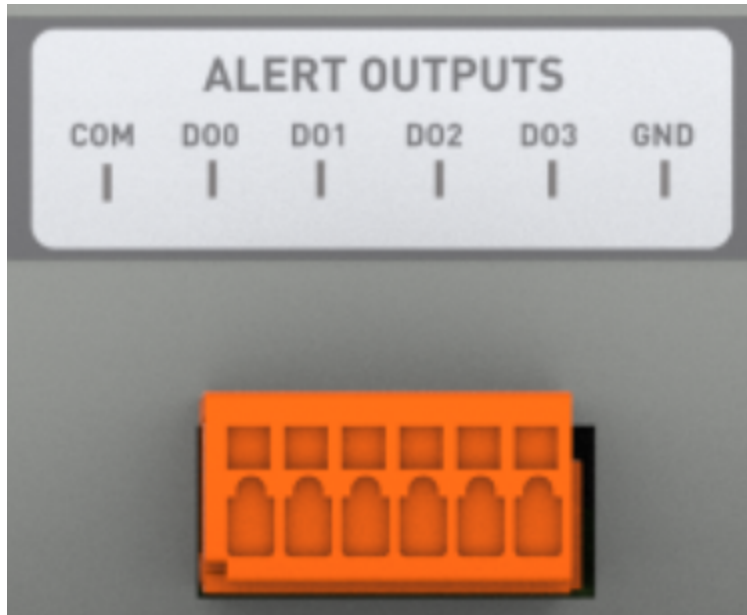


Figure 135 - Calisto T1 Relay Input

To change the output 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 DoblePRIME application

Using this tool on PICOS you have the means to:

- Execution of DoblePRIME application
- Reinitialize database
- Reboot

PICOS

Go to old version

SERIAL/TCP TEST TOOLS

- +Bushing Data Module (BDM)
- +PDM/PD-Guard
- +dP IDD internal boards
- +T1 Expansion Boards
- +MOXA E1200 Series
- +Other Instruments

PRIME SYSTEM TOOLS
Task Control and log
Memory and process list
Set clock

Task control

Start system control task

Stop system control task

Reinitialise database

Reboot

Log

```
[2020-05-14 13:40:36.184] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:37 2020
[2020-05-14 13:40:37.184] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:38 2020
[2020-05-14 13:40:38.184] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:39 2020
[2020-05-14 13:40:39.184] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:40 2020
[2020-05-14 13:40:40.098] I SENSOR Next BDM 'BDM-101' poll @ Thu May 14 13:41:30 2020
[2020-05-14 13:40:40.202] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:41 2020
[2020-05-14 13:40:41.206] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:42 2020
[2020-05-14 13:40:42.109] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:43 2020
[2020-05-14 13:40:43.158] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:44 2020
[2020-05-14 13:40:44.111] I SENSOR GenericMonitor 'S3: 8DI' >>> Next poll @ Thu May 14 13:40:45 2020
```

Figure 136 - Control DoblePRIME application from Task Control

Table 18 - 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 Alert outputs/supervisory relays. During the time DoblePRIME application is not running, data is not pulled from any monitor, and you cannot log into DoblePRIME application.
Reinitialise database	Purge the configuration and database. This script deletes all data in the device and frees up memory, and the operation 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.

Option	Description
Reboot	Reboot PRIME Interface Gateway board only. The BDM and PDM boards are not rebooted by this option. This script requires a password. Use the password "crm114" to confirm the request.
Log window	PRIME 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.

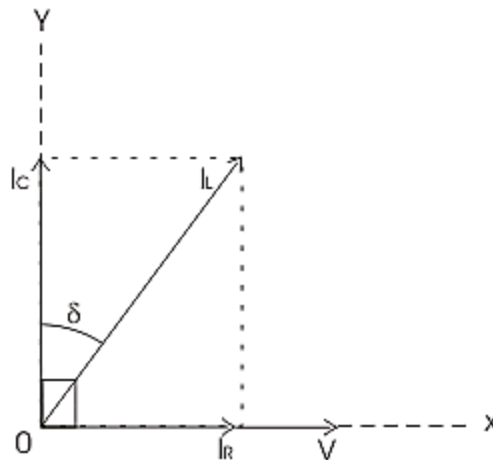


Figure 137 - Operation principle of TPF: Measuring the loss angle

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 (BDM-101 required). 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.

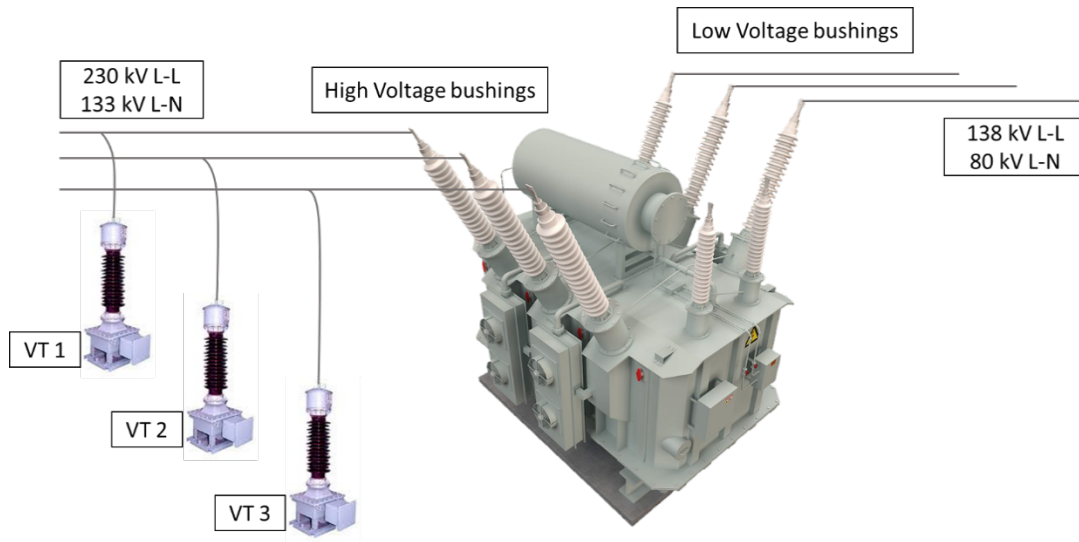


Figure 138 - Elements connected in the substation

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

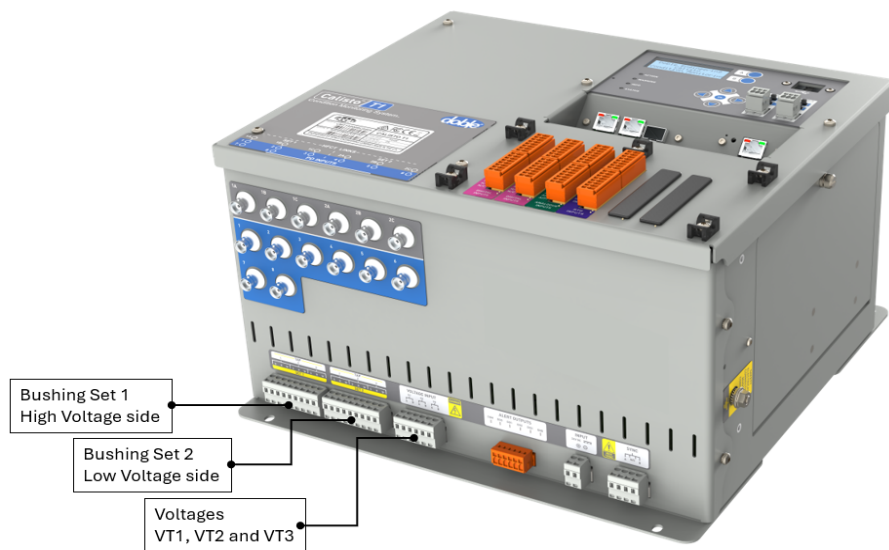


Figure 139 - Connection to the Calisto T1

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 on 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.

- 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 are 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 "[PICOS Application](#)" on page 115), and navigate to True Power Factor page, [Figure 114](#). Click **Bushing Data Module** to expand the options then enter the IP address of the BDM in 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. "[PICOS Application](#)" on page 115 for more information.

PICOS

Go to old version

SERIAL/TCP TEST TOOLS

- Bushing Data Module (BDM)
- 192.168.10.35
- Settings
 - True power factor test - requires bushing card 1, SVM card 2
 - Phasor measurement
 - Firmware upgrade (TCP only)
 - Factory settings (and reboot button)
 - Show calibration coefficients
 - Check Chronos firmware version
- +PDM/PD-Guard
- +dP IDD internal boards
- +T1 Expansion Boards
- +MOXA E1200 Series
- +Other Instruments

PRIME SYSTEM TOOLS

- Task Control and log
- Memory and process list
- Set clock

doble True power factor diagnostics

Controls: 192.168.10.35 (Single BDM) Set 1 Go Stop

Voltage scale factor 1:	1000.0	1000.0	1000.0
Phase shift 1 (°):	0.000	0.000	0.000
Voltage scale factor 2:	1.0	1.0	1.0
Phase shift 2 (°):	0.000	0.000	0.000

Figure 140 - 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.

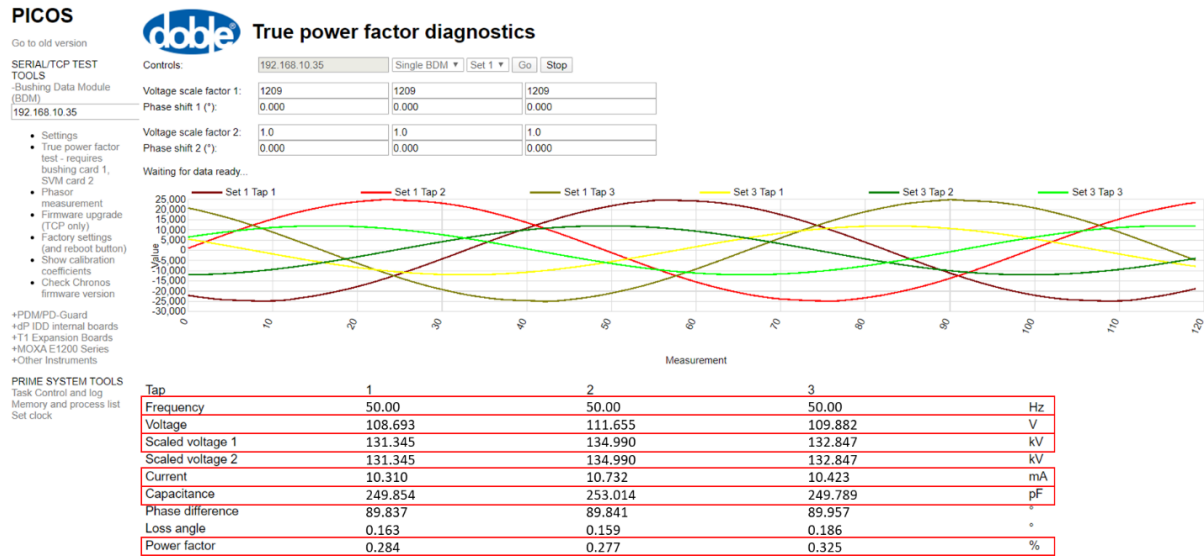


Figure 141 - Checking measurements on the table

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.

Tap	Measurement			Unit	
	1	2	3		
Frequency	50.00	50.00	50.00	Hz	
Voltage	108.693	111.655	109.882	V	
Scaled voltage 1	131.345	134.990	132.847	kV	
Scaled voltage 2	131.345	134.990	132.847	kV	
Current	10.310	10.732	10.423	mA	
Capacitance	249.854	253.014	249.789	pF	Target – Bushing nameplate/measured 250 pF
Phase difference	89.837	89.841	89.957	°	
Loss angle	0.163	0.159	0.186	°	
Power factor	0.284	0.277	0.325	%	0.3 %

Derived cap = target Action: None	Derived cap > target Action: Increase scale factor 1	Derived cap = target Action: None
Derived power factor < target Action: Increase phase shift 1	Derived power factor < target Action: Increase phase shift 1	Derived power factor > target Action: Decrease phase shift 1

Figure 142 - 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.

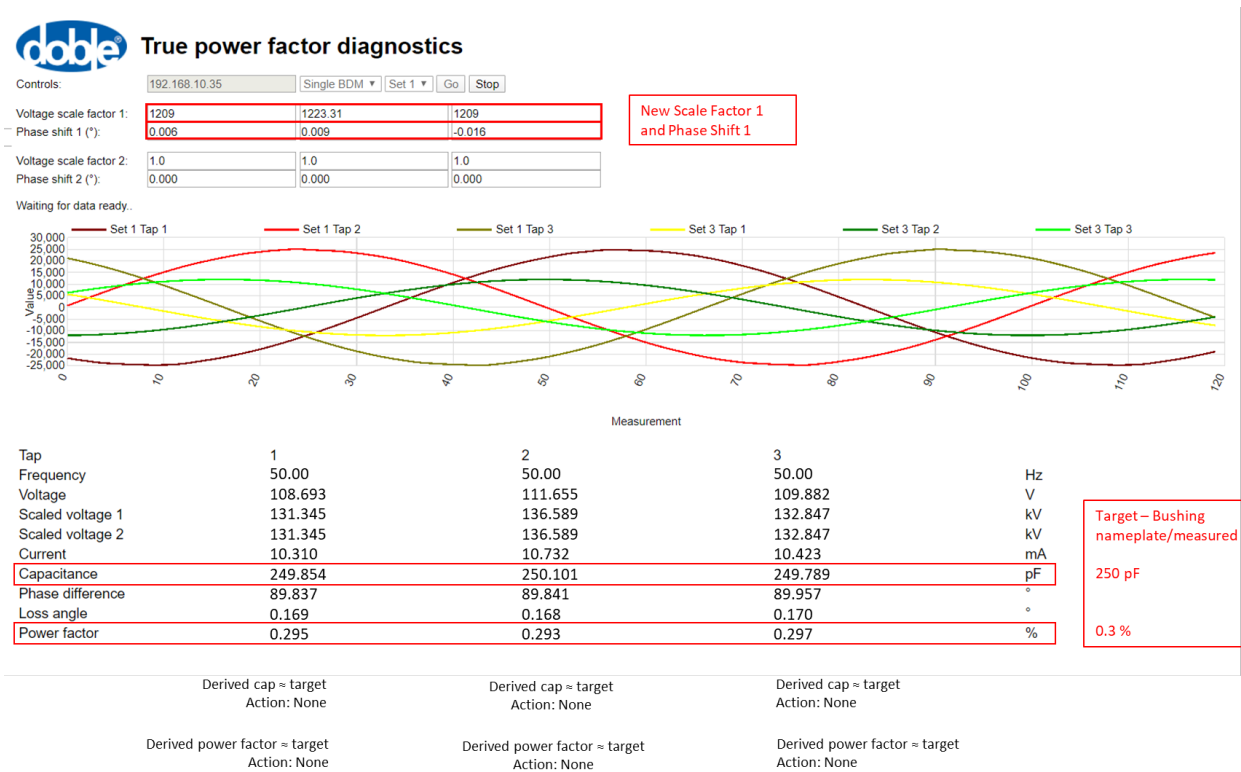


Figure 143 - New Scale Factor 1 and Phase Shift 1 after fine-tuning the system

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 on 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 phasors on the low voltage side. 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 118](#).

The scale factor 1 and phase shift 1 fields already have 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 shift 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.

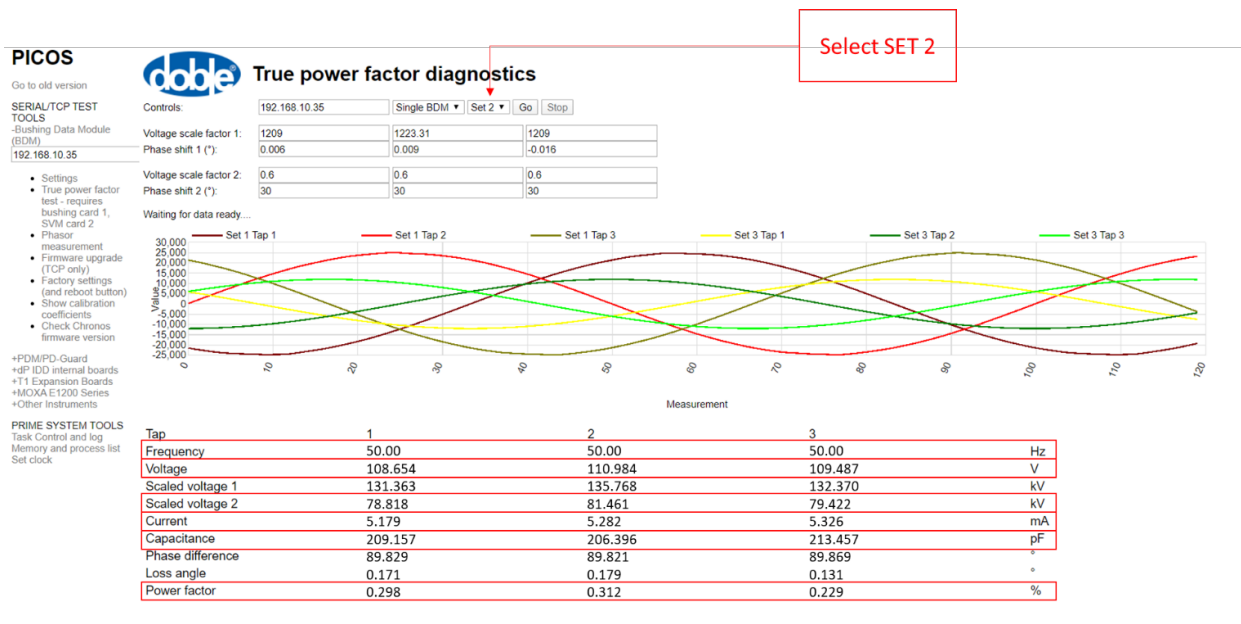


Figure 144 - Checking measurements on the table

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 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	%

Target – Bushing nameplate/measured

210 pF

0.25 %

Derived cap = target Action: None	Derived cap < target Action: Decrease scale factor 2	Derived cap > target Action: Increase scale factor 2
Derived power factor > target Action: Decrease phase shift 2	Derived power factor > target Action: Decrease phase shift 2	Derived power factor > target Action: Decrease phase shift 2

Figure 145 - 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.

PICOS

Go to old version

SERIAL/TCP TEST TOOLS

Bushing Data Module (BDM)

192.168.10.35

- Settings
- True power factor test - requires bushing card 1, SVM card 2
- Phasor measurement
- Firmware upgrade (TCP only)
- Factory settings (and reboot button)
- Show calibration coefficients
- Check Chronos firmware version

+PDM/PP-Guard
+IP-IDD internal boards
+T1 Expansion Boards
+MOXA E1200 Series
+Other Instruments

PRIME SYSTEM TOOLS

Task Control and log
Memory and process list
Set clock

True power factor diagnostics

Controls: 192.168.10.35 | Single BDM | Set 2 | Go | Stop

Voltage scale factor 1:	1209	1223.31	1209
Phase shift 1 (*):	0.06	0.009	-0.016
Voltage scale factor 2:	0.6	0.591	0.611
Phase shift 2 (*):	29.968	29.963	30.015

Waiting for data ready...

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	135.768	132.370	kV
Scaled voltage 2	78.818	80.239	80.878	kV
Current	5.179	5.282	5.326	mA
Capacitance	209.157	209.539	209.614	pF
Phase difference	89.829	89.858	89.854	°
Loss angle	0.139	0.142	0.146	°
Power factor	0.242	0.248	0.255	%

Target – Bushing nameplate/measured

210 pF

0.25 %

Derived cap = target Action: None	Derived cap = target Action: None	Derived cap = target Action: None
Derived power factor = target Action: None	Derived power factor = target Action: None	Derived power factor = target Action: None

Figure 146 - 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 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. Check "[PICOS Application](#)" on page 115, subsection Control of Calisto, for more information.

Log into DoblePRIME application to edit the Bushing Monitor Instance to configure the Bushings

Go to the Gear icon on the top-right of the title bar then click **Monitors**.

The Monitors tab pops up in the feature panel. The bushing monitor is accessible on the list. To edit the bushing monitor, click the appropriate Channels icon.

Enter the scale factor 1 and phase shift 1 in the Voltage Channels fields.

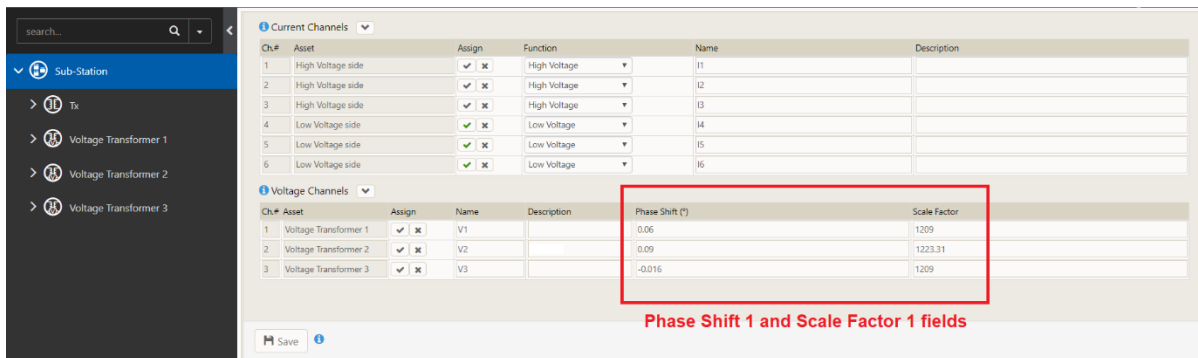


Figure 147 - Enter the scale factor 1 and phase shift 1 in the bushing monitor instance

Click **Save** in the panel footer to save the current settings.

Now open the Asset Configuration tab. Go to the Gear icon on the top-right of the title bar then click **Asset Configuration**.

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.

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.

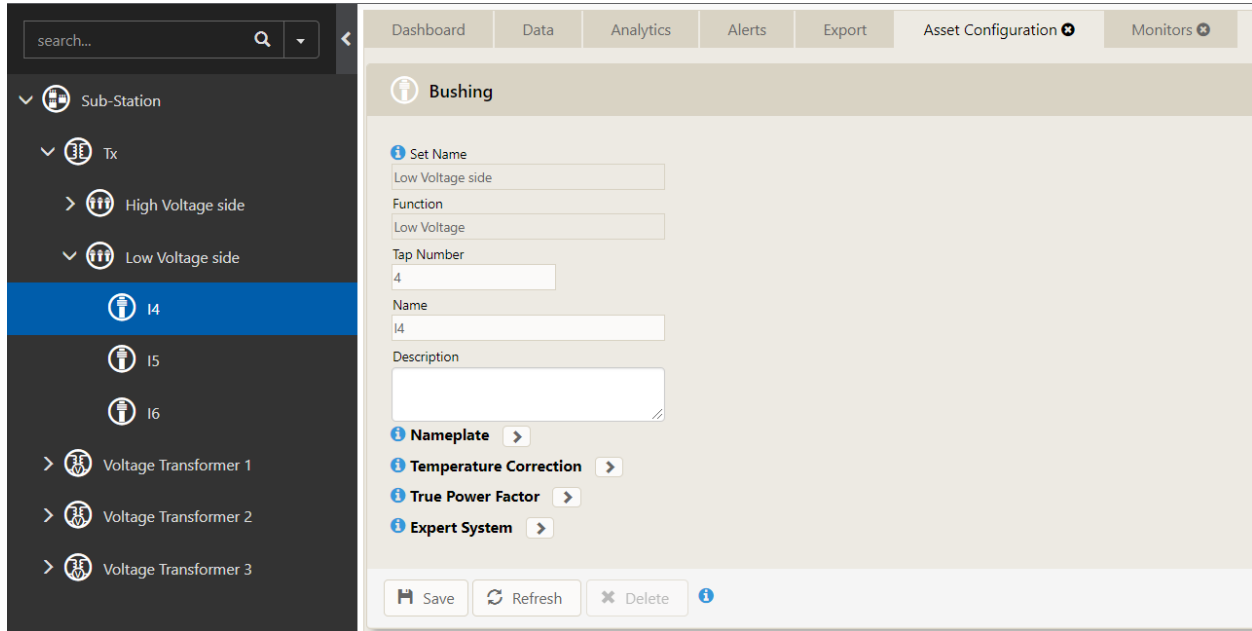


Figure 148 - Enter phase shift 2 and scale factor 2 in the bushing True Power factor option

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.

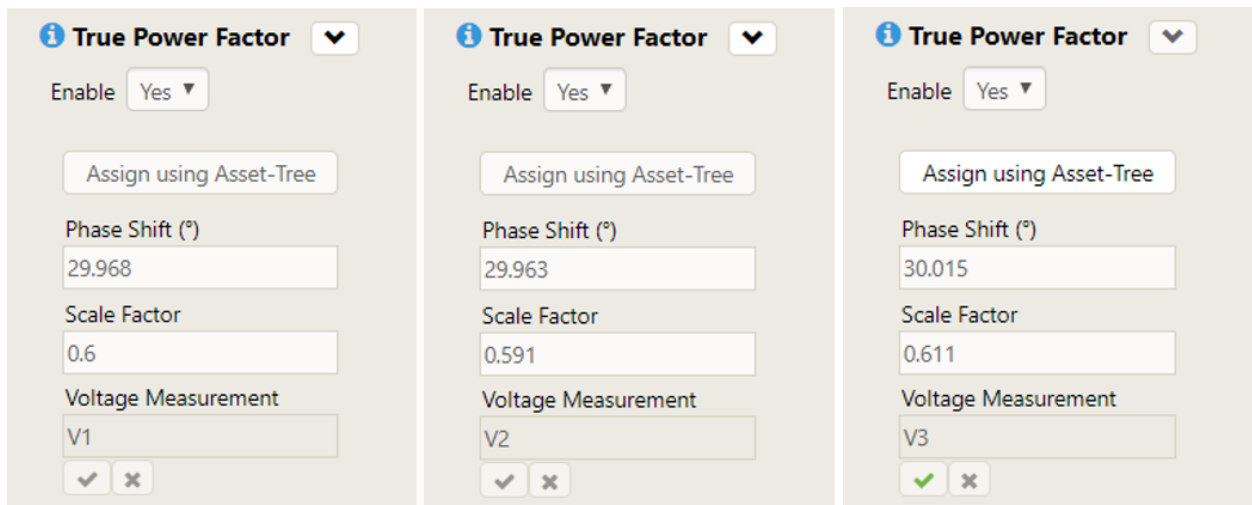


Figure 149 - Scale factor 2 and phase shift 2 entered on the three bushings

After all parameters are entered into 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, in the Dashboard tab, you see just leakage current, but 24 hours later, daily capacitance and daily power factor show up. 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.

Bushing Set High Voltage side				
	11	12	13	
Daily Capacitance (TPF)	249.86	251.24	249.81	pF
Daily True Power Factor	0.30362	0.29583	0.30154	%
Leakage Current	10.321	10.658	10.421	mA
	2020-05-13 11:18:00	2020-05-13 11:18:00	2020-05-13 11:18:00	

Bushing Set Low Voltage side				
	14	15	16	
Daily Relative Power Factor	209.75	209.91	210.06	%
Daily Capacitance (RPF)	0.24988	0.25121	0.2513	pF
Leakage Current	5.181	5.279	5.294	mA
	2020-05-13 11:18:20	2020-05-13 11:18:20	2020-05-13 11:18:20	

Figure 150 - TPF results on the Dashboard after 24 hours

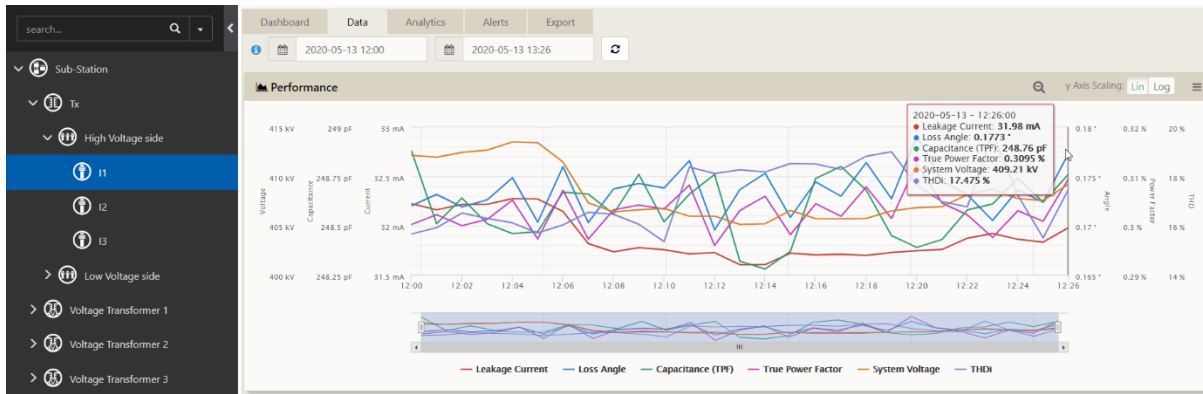


Figure 151 - Instantaneous TPF in Data chart

F. Using the HMI

The 20x4 characters display located on the front panel allow you to view the latest measurements and unacknowledged alerts without using a PC to connect to Calisto T1. Also, it allows you to view the IP address of the two ethernet interfaces.

Keypad layout

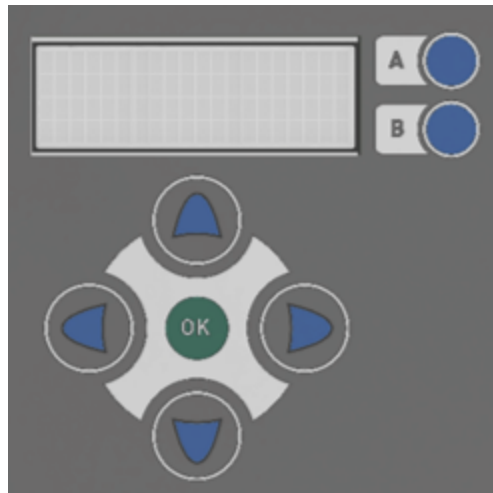


Figure 152 - Display and keypad

Key functions:

- Use the keypad to navigate through the menus.
- The Up and Down keys are used to scroll through the menu and sub-menus.
- The Left key is used to return to the menu selection.
- To access a menu option, or change an attribute, press OK.
- To save changes press A
- The B and Right keys have no function assigned to it.

Menu layout

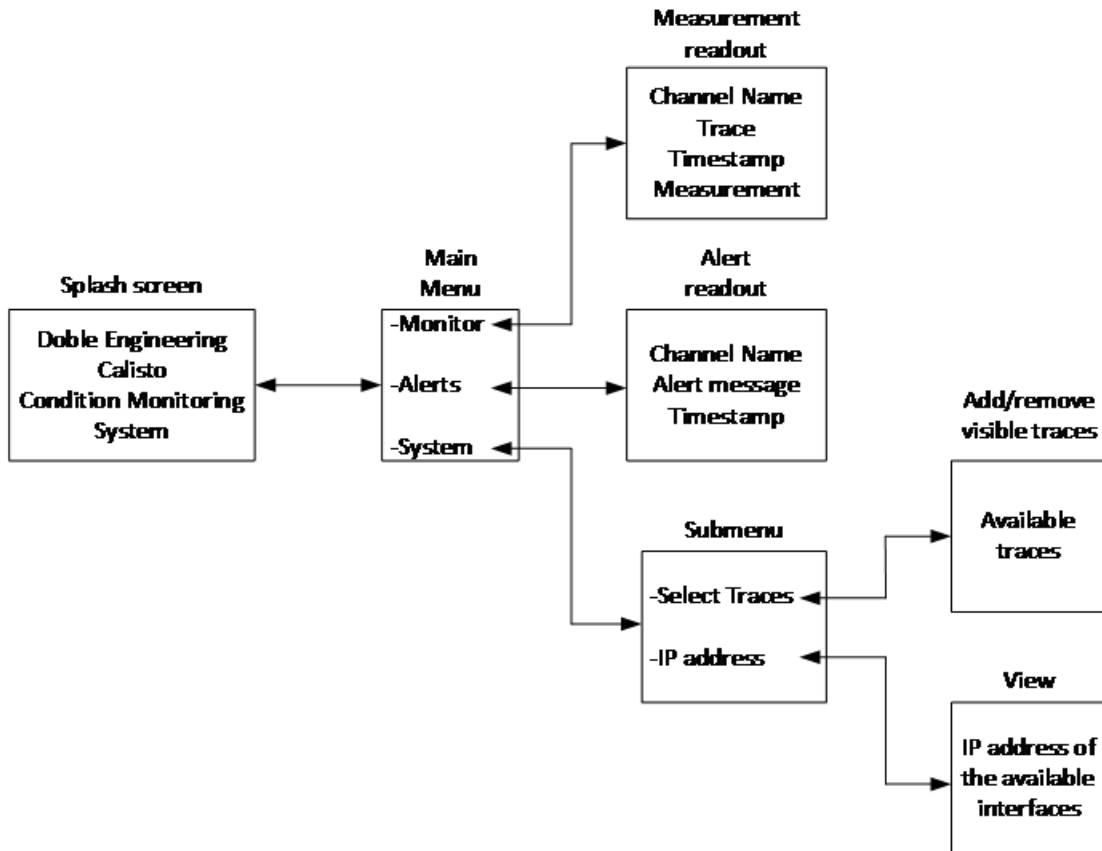


Figure 153 - HMI Menu Structure

When the display is initiated, it will show the splash screen, that is, just a page showing the name of the device. Press any key to view the main menu. You can return to the splash screen any time from the Main menu, just press Left key to return.

- To view latest measurements, position the cursor on Monitor then press OK. Use Up and Down to scroll through the latest measurements. To return, press the Left key.
- To view unacknowledged alerts, position the cursor on Alerts then press OK. Use Up and Down to scroll through the alerts. To return press the Left Key
- To view System submenu, position the cursor on System then press OK. Use Up and Down to scroll through the submenu. To return press the Left Key.
- In the submenu, to view or edit traces, position the cursor on Select Traces then press OK. Use Up and Down to scroll through the traces. To return press the Left Key. To toggle the view attribute +/-, position the cursor on the trace of interest then press OK. To save the changes press A. To return press the Left Key.
- In the submenu, to view the IP addresses, position the cursor on IP address then press OK. To return press the Left Key.

Monitor Page

The Monitor shows the latest measurements taken by PRIME application. The script will fetch new measurement data from PRIME database every second and update the measurement on the display.

If the trace that you want to see is not in the list, go to Select Traces paged and check if the corresponding trace attribute is set to viewable (+).

Alerts Page

The Alerts show the unacknowledged alerts registered by PRIME application. The script will fetch new alerts every time you enter the Alerts page. Alerts cannot be acknowledged via this interface, only via web browser.

Select Traces Page

Traces are entities that correspond to a measurement type, i.e., temperature, leakage current, PAPR, Power factor, and are shown on Monitor page. The list of traces shown on the Traces menu will depend on your PRIME configuration. The HMI script reads all the measurements available in the database to extract a list of traces. Thus, the more variety of measurement types you have, the longer that list will be.

- To avoid overloading the Monitor list with all possible traces, the script sets an attribute to each possible trace as viewable (+) or not viewable (-) preceding the name of each trace. In that way, the Monitor page will only show traces that precedes with a viewable attribute (+) and hide traces with (-) attribute.
- Should you want to toggle the view attribute of a trace, position the select cursor > on the trace of interest then press OK.
- After you finish changing the view attributes, press A to save the changes. Wait for the script to update the list of measurements.
- If you accidentally press Left and leave the page, you can return to Traces page and save the changes previously made. The attribute changes will not be lost by leaving the menu, but they will not take effect until you save them.
- After the changes are made and saved, return to the Monitor page to view the new list of measurements.



Note: The unit must be power cycled after the configuration is finished or changed on PRIME web interface so the HMI script can read the new structure while the system boots up.



Note: Changes of the trace attributes are saved to volatile memory. If the system is power cycled, the changes made by the user will be lost.

G. Maintenance

For maintenance instructions, please refer to the Calisto T1 maintenance guide. The maintenance guide will provide instructions for replacing the RTC battery of the unit.