TD-002
Rev. 08

synaptec

Product manual

Distributed Electrical Sensing Interrogator

DES Interrogator version: 3.0

Firmware version: 3.17.1

Contents

1. Introduction 2
1.1 Chapter overview 2
1.2 Foreword 2
1.3 Product scope 3
1.4 Summary of features and functions 3
1.5 Compliance 3
1.6 Functional overview 3
2. Safety instructions 5
2.1 Chapter overview 5
2.2 Health and safety 5
2.3 Symbols 5
2.4 Safety instructions 6
6
3. Product overview 7
3.1 Overview 7
3.2 Product purposes and use cases 7
3.3 Hardware architecture 7
3.4 Mechanical implementation 7
4. Connections and interfaces 8
4.1 Chapter overview 8
4.2 Front panel interfaces 8
4.3 Rear panel interfaces 10
5. Installation and commissioning 13
5.1 Chapter overview 13
5.2 Competencies 13
5.3 Tools 13
5.4 Handling 14
5.5 Mechanical installation 14
5.6 Cables and connectors 16
5.7 Installation Checklist 16
5.8 Commissioning 16
6. Front panel HMI operation 18
6.1 Chapter overview 18
6.2 HMI operation during system boot 18
6.3 General HMI operation and user interaction 19
7. System and protection configuration 20
7.1 Chapter overview 20
7.2 System configuration 20
7.3 Protection configuration 21
8. Config tool 25
8.1 Chapter overview 25
8.2 Accessing the config tool 25
8.3 Monitoring and configuring Interrogator systems 29
9. Technical Data 39
9.1 Chapter overview 39
9.2 Mechanical specifications 39
9.3 Environmental conditions 39
9.4 Regulatory compliance 40

1. Introduction

1.1 Chapter overview

This chapter provides some general information about the technical manual and an introduction to the Distributed Electrical Sensing (DES) Interrogator platform.

This chapter contains the following sections:

- Chapter overview
- Foreword
- Product scope
- Features and functions
- Compliance
- Functional overview

1.2 Foreword

This technical manual provides a functional and technical description of Synaptec's DES Interrogator, as well as a comprehensive set of instructions for using the device. The level at which this manual is written assumes that you are already familiar with power systems instrumentation and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product.

We have attempted to make this manual as accurate, comprehensive, and user-friendly as possible. However, we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors or opportunities for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product.

We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

All feedback should be sent to us via support@synapt.ec.

1.2.1 Target audience

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment and fibre optics.

1.2.2 Nomenclature

Due to the technical nature of this manual, many special terms, abbreviations, and acronyms are used throughout. Some of these terms are well-known industry-specific terms, while others may be special product-specific terms used by Synaptec. The first instance of any acronym or term used in a particular chapter is explained.

British English is used throughout this manual. The term 'earth' used throughout this manual is the direct equivalent of the North American term 'ground'.

1.3 Product scope

The Interrogator is the core component of all Synaptec sensor network installations. The device is responsible for performing centralised, light-speed interrogation of every sensor in the deployed array. Modular and scalable, the Interrogator fully supports any mix of Synaptec's electrical and mechanical sensors and is capable of both serving measurements or triggers to legacy IEDs (e.g. protection relays) and performing real-time analysis on the leveraged measurements to evaluate the performance and condition of power networks.

The Interrogator simultaneously monitors up to 30 sensors over 60 km of standard single-mode optical fibre, processing and streaming synchronised waveform data in real-time with industry-leading latency and detail.

The Interrogator hardware is identical for most applications (with some customisation possible for specific applications). Configuration of the device is necessary to tailor the device operation to specific applications, e.g. serving of Sampled Value (SV) data to a Process Bus or Auto-Reclose (AR) blocking on mixed circuits.

1.4 Summary of features and functions

1.4.1 Measurement functions

Function	Description
Synchronised waveform measurements	Synchronised waveform measurement of all sensors in the optical network
Communications protocols	IEC 61850-9-2 "LE" IEC 61869-9 IEC 61850-8-1 (GOOSE)
Supported sampling rates	4 kHz 4.8 kHz 14.4 kHz
Ethernet interface	SFP (user selectable interface type)
Time synchronisation	Precision Time Protocol (PTP) 1 pulse per second (1PPS) optical input and output Network Time Protocol (NTP)

1.4.2 Protection and control functions

Function	Description
Multi-zone differential and overcurrent protection	Define up to 10 discrete protection zones using any combination of sensors
Mixed Circuit Protection (MCP)	Protection for mixed-conductor circuits to reliably differentiate between faults on underground cable and overhead line sections, and generates a signal to block or allow AR Up to 6x normally-open (NO) dry contacts available (shared with watchdog function)
Watchdog contacts	Up to 6x normally-open (NO) dry contacts available (shared with protection trips)

1.4.3 Synthesis®

Additional visualisation and analysis functions are enabled by using the Interrogator with Synaptec's Synthesis® software.

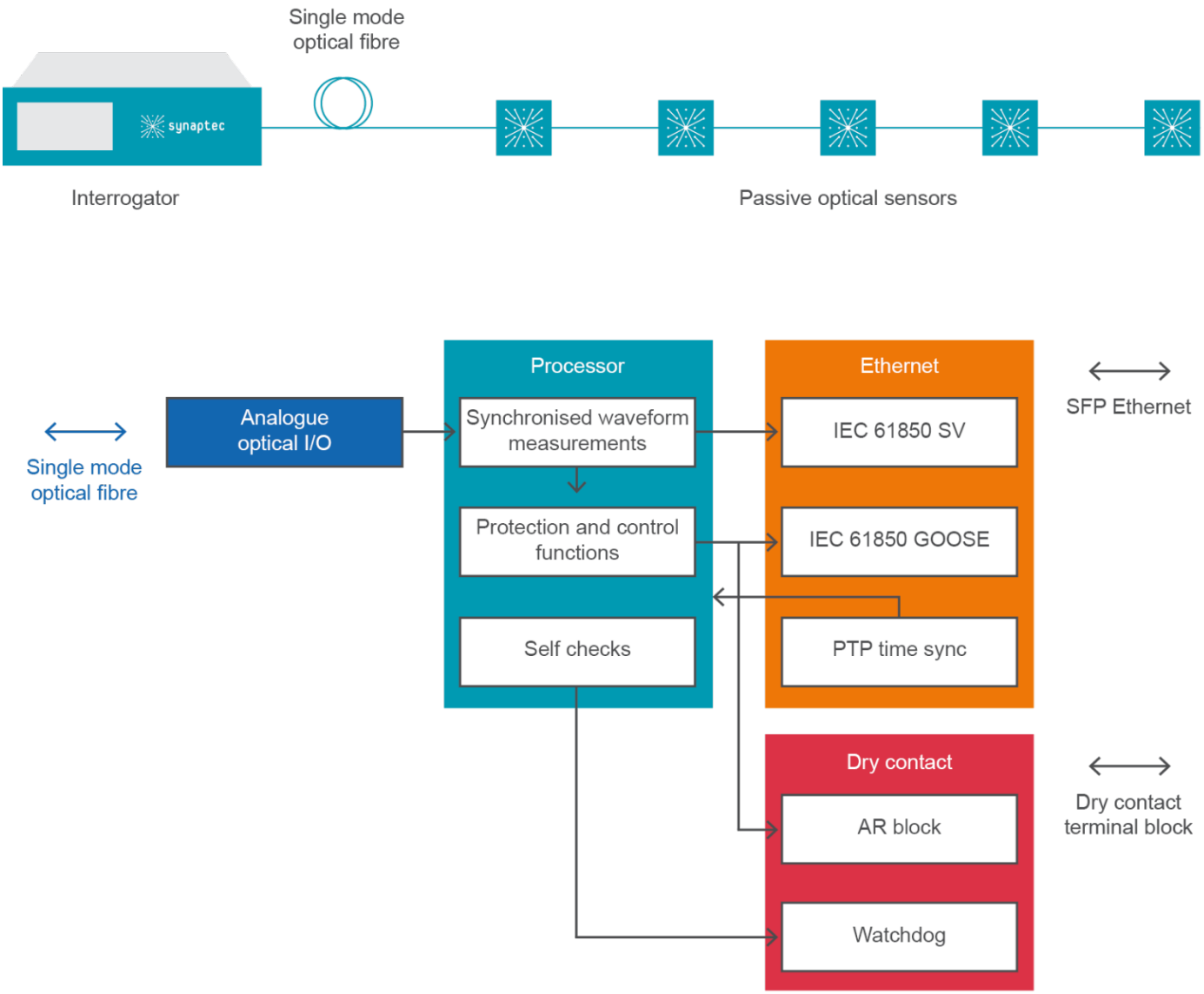
1.5 Compliance

The device has undergone a range of extensive testing and certification processes to ensure and prove compatibility with the target markets. A detailed description of these criteria can be found in Chapter 9.

1.6 Functional overview

A schematic and simplified block diagram of the Interrogator functionality is provided below.

Figure 1.1


Single mode
optical fibre
synaptec
Interrogator
Passive optical sensors
Processor
Analogue
optical I/O
Synchronised waveform
measurements
Protection and control
functions
Self checks
Ethernet
IEC 61850 SV
IEC 61850 GOOSE
PTP time sync
SFP Ethernet
Single mode
optical fibre
Dry contact
AR block
Watchdog
Dry contact
terminal block

2. Safety instructions

2.1 Chapter overview

This chapter provides information about safe handling and use of the equipment. The equipment must be properly installed and handled in order to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with the information in this chapter before unpacking, installing, commissioning, or servicing the equipment.

This chapter contains the following sections:

- Chapter overview
- Health and safety
- Symbols
- Safety instructions

2.2 Health and safety

Personnel installing or using this equipment must be familiar with the contents of this chapter.

When electrical equipment is in operation, dangerous voltages may be present in certain parts of the equipment. When the equipment is active, laser light is broadcast down the connected single-mode fibre. Improper use of the equipment and failure to observe warning notices will endanger personnel.

Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who are:

- Familiar with the installation, commissioning and operation of the equipment and the system to which it is being connected
- Familiar with accepted safety engineering practises and are authorised to energise and de-energise equipment in the correct manner
- Trained in the care and use of safety apparatus in accordance with safety engineering practises
- Trained in emergency procedures (first aid).

This manual provides instructions for installing, commissioning, and operating the equipment. It cannot, however, cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorisation. Please contact Synaptec and request the necessary information.

2.3 Symbols

This manual employs the following symbols. These may also be found labelled on parts of the equipment.

CAUTION: Refer to equipment documentation. Failure to do so could result in damage to the equipment.

WARNING: Risk of electric shock.

WARNING: Risk of damage to eyesight.

2.4 Safety instructions

2.4.1 Handling

Caution

Care should be taken when handling the Interrogator system due to its size, weight, and sharp corners.

Two-person handling is recommended. Please ensure that the system is not subjected to excessive vibrations or shocks during transportation or installation.

2.4.2 Hot surfaces

Caution

Areas of the rear of the system, particularly the fan exhaust and heatsink, are intended to become warm and should not be touched while the system is in operation. When the system is switched off, allow time for the rear surfaces to cool before handling.

2.4.3 Laser safety

Warning

Laser radiation can cause damage to eyes and skin and all safety precautions and instructions in this user manual must be followed to mitigate these risks.

The system operates using high-power 1550 nm near-IR laser technology which, by design, is constrained to optical fibres. The laser is a Class 3B product.

Laser output is provided via SC/APC connectors on the rear panel which incorporate a shutter to avoid stray laser light exiting when the external fibre is disconnected. At 1550 nm, the emitted light is invisible to human eyes. Under no circumstances should the user look directly into the SC/APC connector or attempt to open the shutter mechanism manually.

The system should not be switched on until all fibre optic connections to the equipment have been made. If any fibre connections are required to be disconnected, the equipment should first be switched off.

2.4.4 High voltages

Warning

The system is capable of operating from a supply voltage of up to 264 VAC and 370 VDC, connected to input terminals on the rear panel. When installing and servicing the system, extreme care should be taken to protect against shock.

Installation, service, and repair of the system, including opening the top cover, must only be performed by trained and authorised personnel. The input power supply must be switched off and the system isolated before opening the top cover.

3. Product overview

3.1 Overview

This chapter provides information about the product's purpose and design. This chapter contains the following sections:

- Chapter overview
- Product purpose and use cases
- Hardware architecture
- Mechanical implementation

3.2 Product purposes and use cases

The Interrogator is the core component of all Synaptec sensor network installations, and is versatile as a solution for many industry applications. It natively supports communication with digital and conventional electromechanical protection equipment. It is designed to be digital-ready, streaming live data in industry standard formats including IEC 61850 Sampled Values and GOOSE, and supporting custom data formats upon request. All measurements are time-synchronised, accurately time-stamped to within a microsecond, and published at rates of up to 14.4 kHz, enabling the system to support a combination of protection, control, and condition monitoring applications.

The uniquely powerful and flexible nature of the Interrogator makes Synaptec's systems ideal for long- range, multi-point protection, automation and control applications that demand high quality, speed, and flexibility of measurements. Streaming data from the DES Interrogator may be integrated with Synaptec's Synthesis® visualisation and analytics platform to provide live system condition visualisation, configurable alarms, performance insights, and decision support for asset managers.

3.3 Hardware architecture

The main components of the Interrogator are as follows:

- The housing, consisting of a front panel and connections at the rear
- Fibre optic components for illumination of and receiving of signals from an array of passive fibre optic sensors
- A processor module consisting of the main Central Processing Unit (CPU), memory, and an interface to the front panel Human-Machine Interface (HMI)
- Data output and communications via Small Form-factor Pluggable (SFP) array

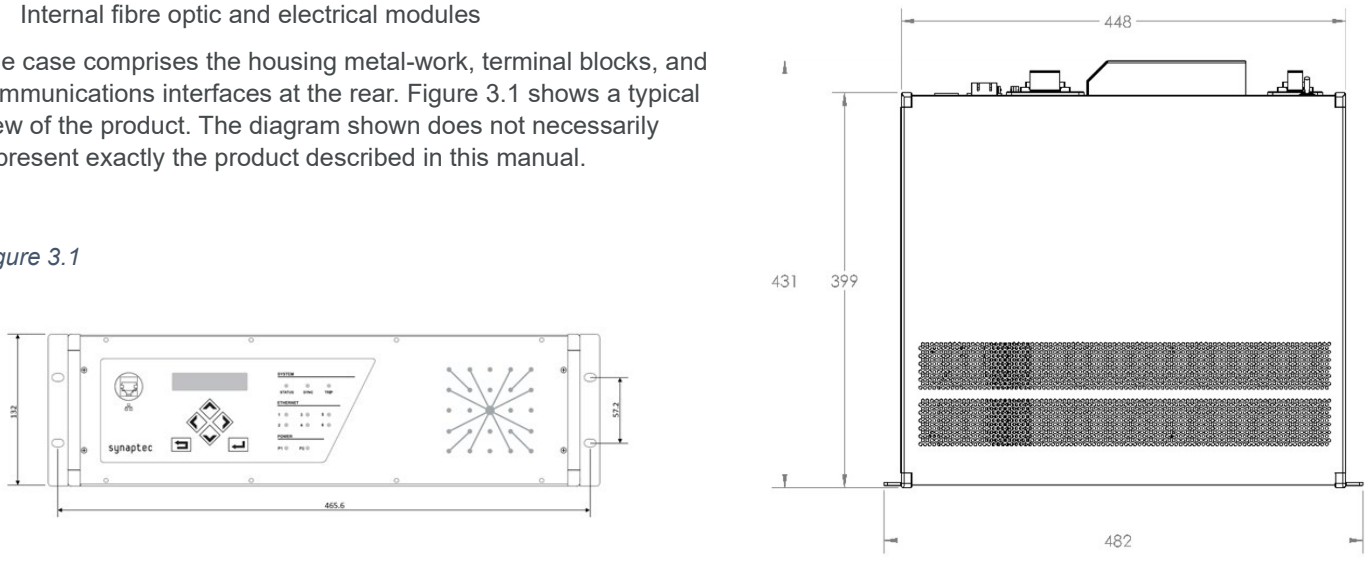
3.4 Mechanical implementation

The hardware consists of the following main parts:

- Case and terminals
- Front and rear panels
- Upper panel with ventilation grille
- Internal fibre optic and electrical modules

The case comprises the housing metal-work, terminal blocks, and communications interfaces at the rear. Figure 3.1 shows a typical view of the product. The diagram shown does not necessarily represent exactly the product described in this manual.

Figure 3.1



4. Connections and interfaces

4.1 Chapter overview

This chapter provides information about the product's purpose and design.

This chapter contains the following sections:

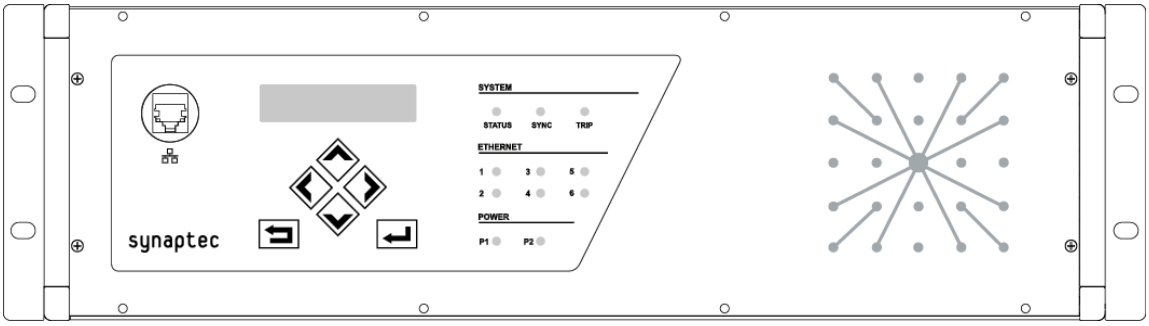
- Chapter overview
- Front panel interfaces
- Rear panel interfaces

4.2 Front panel interfaces

4.2.1 Front panel

Figure 4.1 shows the front panel of a typical Interrogator unit.

Figure 4.1



The front panel houses the following interfaces:

- HMI panel with LCD display
- Keypad
- RJ45 Ethernet port
- Fixed-function LEDs

Front membrane panel

The front membrane panel of a typical Interrogator unit is shown in Figure 4.2, with numbered items specified in Table 4.1 on the following page.

LCD Display and keypad

The keypad provides access to device functionality using a range of menu options. The information is displayed on the LCD. The LCD is a high-resolution display with 16 characters by 2 lines and a controllable back light.

Ethernet port

The Ethernet port is situated on the front panel and is used to communicate with a locally connected PC. It is used for configuration and commissioning of the device.

This port is intended for temporary connection during testing, installation, and commissioning. It is not intended to be used for permanent communications.

Figure 4.2

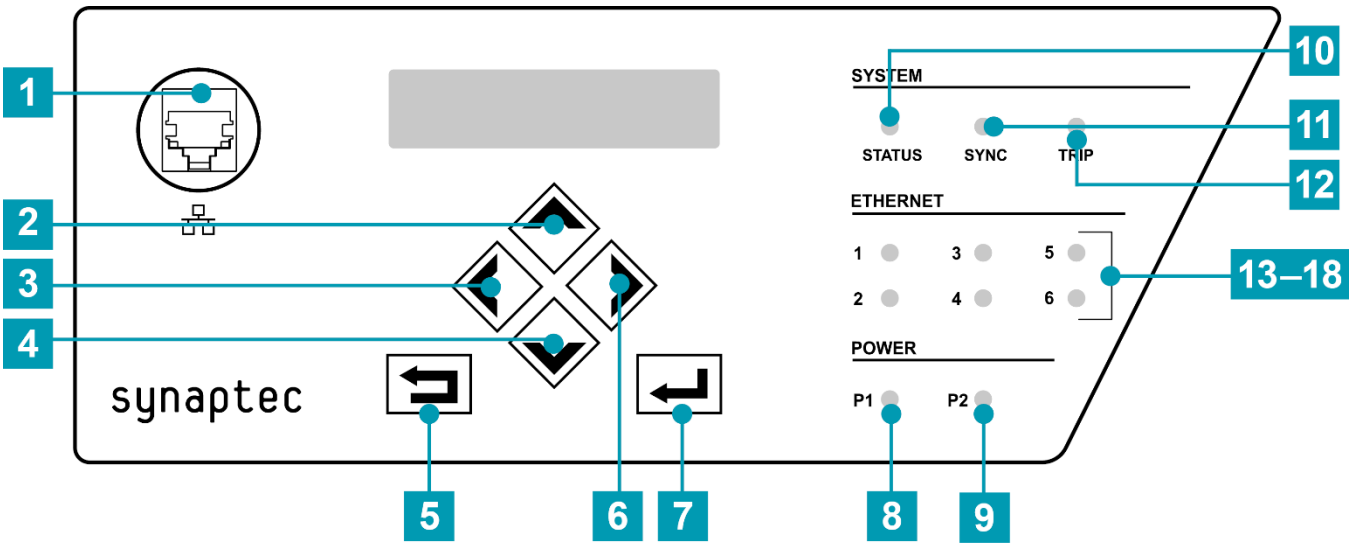


Table 4.1: Front membrane panel items.

Item	Description	Function	Specifications
1	Ethernet Port	1 Gbps Ethernet	RJ45, 10/100/1000BASE-T IEEE 802.3 compliant
2	Menu navigation button	Up	
3	Menu navigation button	Left	
4	Menu navigation button	Down	
5	Menu navigation button	Back	
6	Menu navigation button	Right	
7	Menu navigation button	Reset protection or back	
8	Indicator LED	Power P1 - Indicates unit is powered on (with redundant PSU 1) / indicate PSU 1 failure	Active: Green Not connected: LED off
9	Indicator LED	Power P2 - Indicates unit is powered on (with redundant PSU 2) / indicates PSU 2 failure	Active: Green Not connected: LED off
10	Indicator LED	Status - Indicates system has started up correctly and is in normal state / indicates malfunction or measurement flag raised	System healthy: Green System error: Amber System off or booting: LED off
11	Indicator LED	Sync - Indicates PTP time synchronisation has been established	Sync heathy: Green No sync: LED off
12	Indicator LED	Trip - Indicates tripping of protection system (if deployed)	Trip: Red No trip: LED off
13	Indicator LED	Ethernet 1 - Indicates Ethernet 1 interface connected	Interface connected: Green No connection: LED off
14	Indicator LED	Ethernet 2 - Indicates Ethernet 2 interface connected	Interface connected: Green No connection: LED off
15	Indicator LED	Ethernet 3 - Indicates Ethernet 3 interface connected	Interface connected: Green No connection: LED off
16	Indicator LED	Ethernet 4 - Indicates Ethernet 4 interface connected	Interface connected: Green No connection: LED off
17	Indicator LED	Ethernet 5 - Indicates Ethernet 5 interface connected	Interface connected: Green No connection: LED off
18	Indicator LED	Ethernet 6 - Indicates Ethernet 6 interface connected	Interface connected: Green No connection: LED off

Fixed-function LEDs

Eleven fixed-function LEDs are present on the front panel, grouped under the following headings:

System:

- STATUS LED switches green when the Interrogator is operating normally, after successful initialisation, and amber when an alarm or malfunction condition is encountered. It is reset to green when this condition is cleared, and normal operation has resumed.
- SYNC LED switches green when the Interrogator has acquired an external PTP time synchronisation signal and turns off when in free-running mode. The LED does not illuminate when a 1PPS source is connected.
- TRIP LED switches red when the Interrogator issues a trip or AR block signal. The LED and trip state are latched until manually reset. Conditions for the trip may be configured or the function disabled via the config tool.

Ethernet:

- LEDs 1-6 switch ON (green) to indicate on which SFP Ethernet ports communications are active. At present, this feature is not implemented.

Power:

- LEDs P1 and/or P2 switch ON (green) to indicate which of the dual redundant power supplies are currently active.

4.3 Rear panel interfaces

4.3.1 Rear panel

The rear panel of a typical Interrogator unit is shown in Figure 4.3, with numbered items specified in Table 4.2.

Figure 4.3

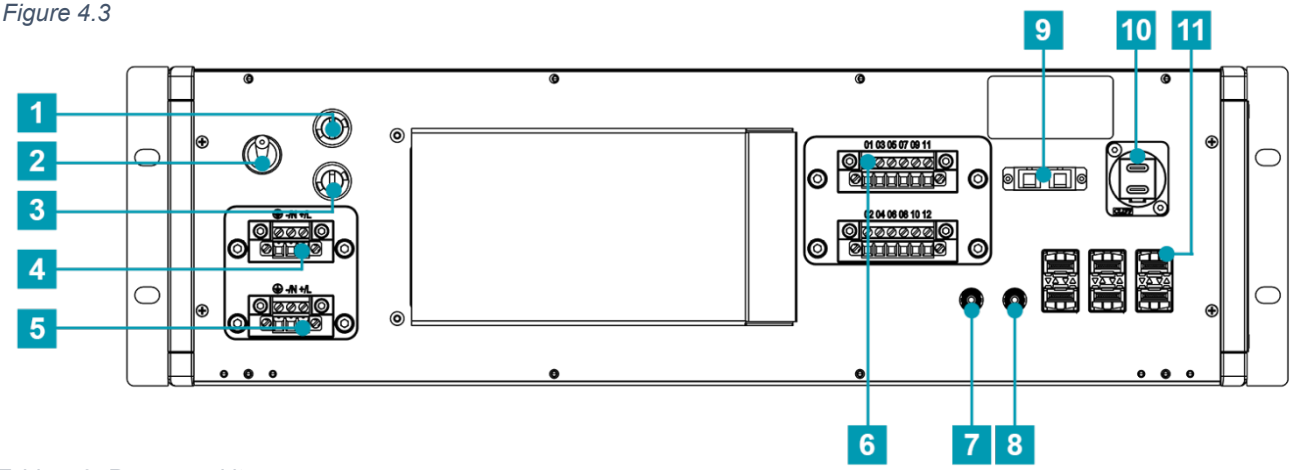


Table 4.2: Rear panel items.

Item	Description	Function	Specifications
1	Power Supply Fuse 1	Fuse for power module 1	8 A, fast, 250 V, 1.5 kA breaking
2	Power Supply Switch	4-pole switch to control the power input	
3	Power Supply Fuse 2	Fuse for power module 2	8 A, fast, 250 V, 1.5 kA breaking
4	Power Supply Terminals 2	Connection point for power supply to module 2	Power Module UL, CSA, CE certified Input Range Single phase, 85 to 264 VAC, 80 to 370 VDC AC Frequency 50/60 Hz (47 to 450 Hz)
5	Power Supply Terminals 1	Connection point for power supply to module 1	Power Module UL, CSA, CE certified Input Range Single phase, 85 to 264 VAC, 80 to 370 VDC AC Frequency 50/60 Hz (47 to 450 Hz)

Table 4.2 (continued)

Item	Description	Function	Specifications
6	Relay Interface	NO relay contacts	Relay 2 kV coil to contact and contact to contact 2 kV isolation to case 8 A, 250 VAC resistive capacity
7	Optical Timing Interface (1PPS Output)	LED output, fibre interface	-7 dBm max output at 820 nm, ST fibre compatible
8	Optical Timing Interface (1PPS Input)	Photodiode input, fibre interface	-7 dBm max input, ST fibre compatible
9	Optical Measurement Interface	Fibre ports for measurements, laser output	SC/APC duplex fibre port, shuttered
10	Engineering Interface	USB interfaces for test and development	USB compliant interfaces
11	Network Interfaces	SFP module cages for Ethernet interfaces	Dependent on module fitted

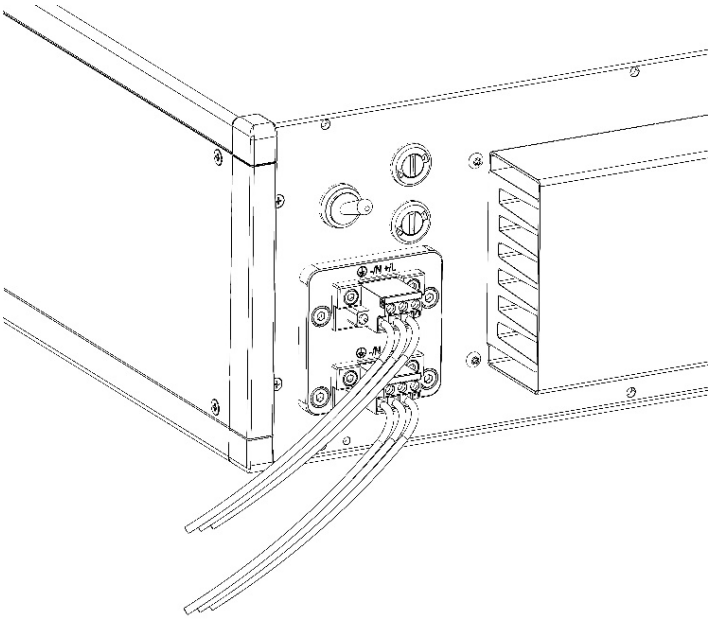
The rear panel houses the following interfaces:

- Power supply terminals and power switch
- Relay interface
- Optical measurement interface
- Optical timing interfaces (PPS)
- Network interfaces

Power supply terminals

Dual redundant power supplies are available inside the Interrogator chassis. Two independent terminal blocks are provided on the rear panel for additional redundancy, labelled appropriately for connection of external AC or DC supplies. Should a single supply be available externally, this should be wired up to both terminal blocks in parallel. Should two supplies be available, these may be wired up separately to each terminal block. Power supply wiring should be terminated in suitable insulated ferrules with 12mm pin length for a safe connection. The recommended torque used in the terminal block is between 0.5Nm and 0.6Nm.

Figure 4.4



Relay interface

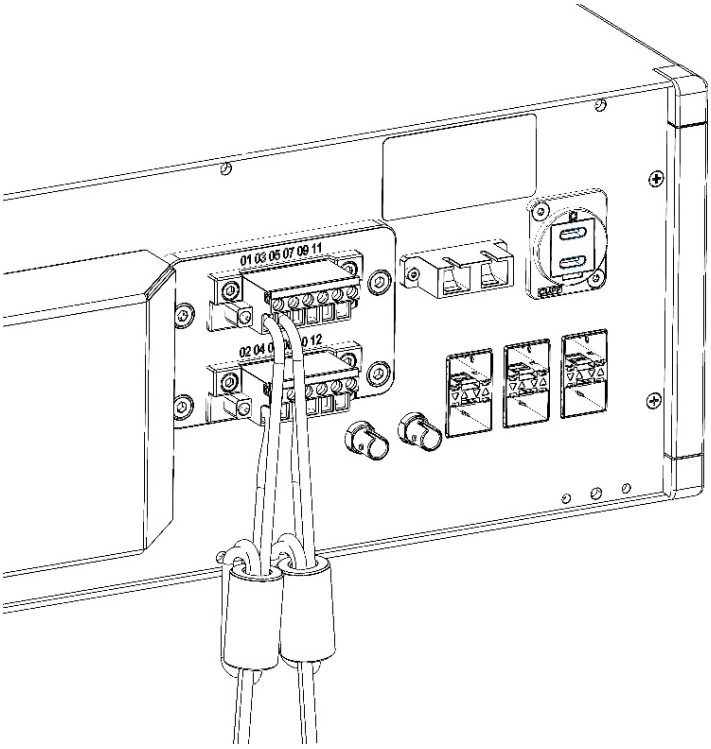
The relay interface provides dry contacts for communicating information such as trips or device health to external devices. The outputs use normally-open (NO) operation, as follows:

- For trips and similar outputs, the output relay will be open to indicate “no event” and closed to indicate “event is present/active”.
- For watchdog outputs, the “open” state will mean that the system is unhealthy or unpowered, and will be driven to the “closed” state when the system is healthy.

The function of each output is fully configurable, including combining multiple control signals, depending on customer requirements. However, some combinations are not possible to be combined in the same dry contact, such as the watchdog and a trip output.

Wiring for connection to an external device (e.g. watchdog device or protection relay) should be terminated in suitable insulated ferrules with 12mm pin length for a safe connection. The recommended torque used in the terminal block is between 0.5Nm and 0.6Nm. Connections to the relay terminals may be made from the top or bottom to best suit cable routing. The individual pairs of relay cables must be installed with a Wurth 74270053 ferrite bead with wires looped around per the diagram in Figure 4.5.

Figure 4.5



Optical measurement interface

The Interrogator is designed for monitoring of Synaptec’s passive optical sensors via standard single-mode optical fibre. At the Interrogator, connection to the external optical sensor network should be made via an appropriate single-mode fibre optic patch cable terminated in an SC/APC connector.

PPS time synchronisation ports

The Interrogator may be time-synchronised via either IEEE 1588 Precision Time Protocol (PTP) or 1 Pulse-Per- Second (1PPS). In the case of 1PPS synchronisation, two ST fibre ports are present as a 1PPS input, and an output to re-broadcast the 1PPS signal (e.g. to synchronise another Interrogator).

Ethernet communication ports

Six multi-purpose SFP module cages are provided for interface with external devices. Each port supports 1 Gbps connection speed. Optical SFP modules and Ethernet cables are recommended.

5. Installation and commissioning

5.1 Chapter overview

This chapter provides a generic guide for installation and commissioning of the DES Interrogator. The DES Interrogator will always be supplied as part of a wider Synaptec DES system, and therefore installation should be completed with reference not only to this document, but to the DES Installation Manual[1] and to the installation manuals for other products in the same sensor network. Guidance on verification and troubleshooting is provided Guidance on verification is provided, and an accompanying checklist document[1] should be completed to guide and evidence successful installation.

This chapter contains the following sections:

- Chapter overview
- Competencies
- Tools
- Handling
- Mechanical installation
- Cables and connectors
- Commissioning
- Troubleshooting

5.2 Competencies

Installation of the DES Interrogator requires no specialist competencies that are unfamiliar to installation of measurement, protection, or telecoms hardware in the power sector.

All mechanical and electrical installation works should be carried out by qualified installers. Typical skills required for mechanical and electrical installation works will include:

- Mechanical mounting in a standard 19” rack, including installation of additional support(s) where necessary for structural security of the hardware
- Wiring of AC or DC power supplies and binary terminals
- Installation of SFP Ethernet ports and Ethernet cables
- Installation of optical fibre patch cables
- Safe and secure routing of electrical, comms and fibre optic cabling

All fibre optic work should be carried out by qualified fibre optic engineers. Synaptec systems use only single-mode fibre. Typical skills required for fibre optic works during DES Interrogator installation will include:

- Fibre end and connector inspection and cleaning
- Use of single-mode, angle-polished fibre connectors
- Fibre optic routing and the use of splice boxes and/or patch panels
- Optical time-domain reflectometry (OTDR) and loss measurements

For additional competencies related to the wider DES system installation, refer to TD-13 DES Installation Manual.

5.3 Tools

For the purposes of installation, it is presumed that the installer has access to the following tools:

- Tools necessary for mounting equipment into a standard 19” rack
- Tools necessary for stripping and crimping wiring for connection to power supply and binary terminals

[1] TD-13 DES Installation Manual

- Fibre optic inspection equipment

5.4 Handling

Synaptec's products are of robust construction but require careful handling and treatment until installation is complete. This section discusses requirements for receiving and unpacking the goods, as well as associated considerations regarding product care and user safety.

5.4.1 Receipt

On receipt, confirm the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor and notify Synaptec promptly.

If the product is not intended for immediate installation, repack it in its original delivery packaging.

5.4.2 Unpacking

When unpacking and installing the product, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packaging or lost. Do not discard any technical documentation. These should accompany the product to its installation destination and be stored in a dedicated safe location.

The site should be well-lit to aid inspection, and should be clean, dry, and reasonably free from dust and excessive vibration. This particularly applies where installation is being carried out at the same time as construction work.

5.4.3 Storage

If the product is not intended for immediate installation, store it in a place free from dust and moisture in its original packaging.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations of high humidity. The device can be stored between -25 °C to +70 °C (see technical specifications).

Caution

Before lifting or moving the equipment you should be familiar with the Safety Instructions chapter of this manual.

5.5 Mechanical installation

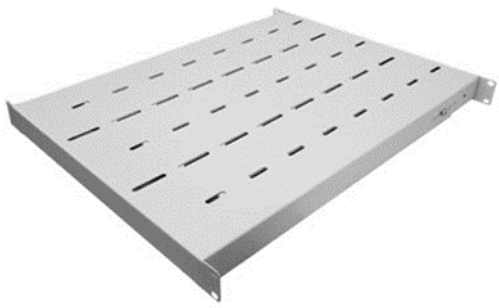
The product is dispatched either individually or as part of a rack assembly. The product is ultimately designed to be compatible with a 19" (483 mm) rack with 3U height.

5.5.1 Rack mounting

The Interrogator device occupies a rack height of 3U (three rack units). However, a space of ½ - 1U must be provided above the Interrogator to allow for adequate ventilation.

Installation in the rack will vary depending on the rack design. To ensure long-term, reliable operation, it is required that the device is located on a shelf system with minimum static load-bearing capacity of 15 kg, fixed at both the front and rear of the cabinet. An example of a suitable shelf is shown in the image below:

Figure 5.1



The Interrogator must be secured at the front of the rack using the four standard rack mounting bolt positions. Bolts compatible with the rack system must be used (generally M6), and must be of sufficient length to pass through the Interrogator flange, shelf flange, rack upright, and cage nut. The four bolts should be tightened to the torque specified by the rack manufacturer.

Installation of the Interrogator and rear panel brackets for connection to the shelf are shown in Figure 5.2 and Figure 5.3. The following instructions refer to the numbered items in Figure 5.3.

At the rear, the Interrogator should be secured to the installed shelf using the two mounting brackets (**3**) suppled. Install the two brackets to the rear of the Interrogator using the supplied M2.5 x 20 screws (**6**) and washers (**7**) and tighten to a torque of 1.0 Nm.

When the Interrogator is installed and seated correctly on the shelf, use the supplied M6 x 25 screws (**1**), washers (**2,4**) and nylon-insert nuts (**5**) to attach the two brackets to the shelf. The screws should be tightened to a torque of 8 Nm.

Depending on the shelf design, it may be necessary to drill suitable locating holes in the shelf to enable retention of the brackets.

Caution

Sufficient space should be left above the upper panel to ensure air flow to the ventilation grille. It is recommended that minimum ½U of rack space is left open above the Interrogator for this purpose.

Figure 5.3

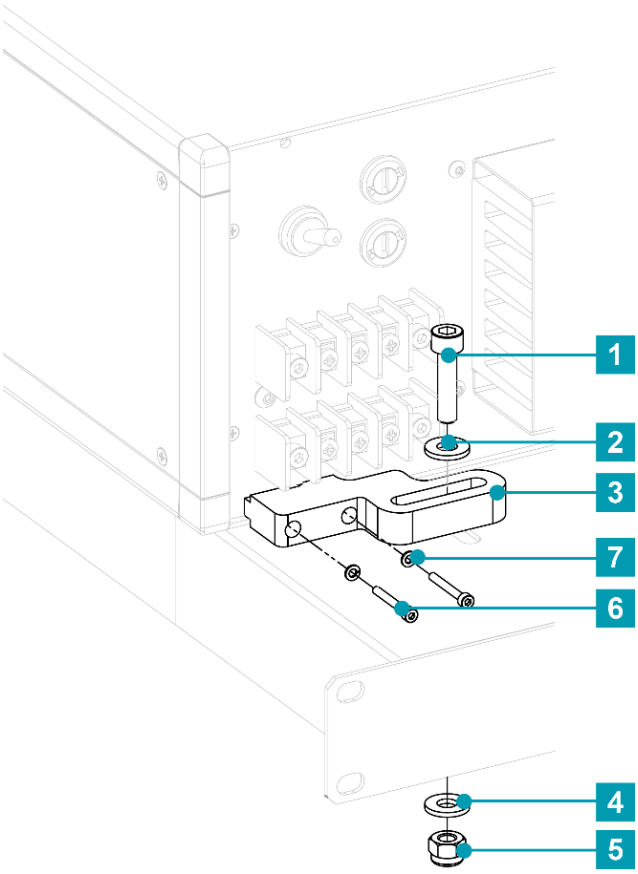
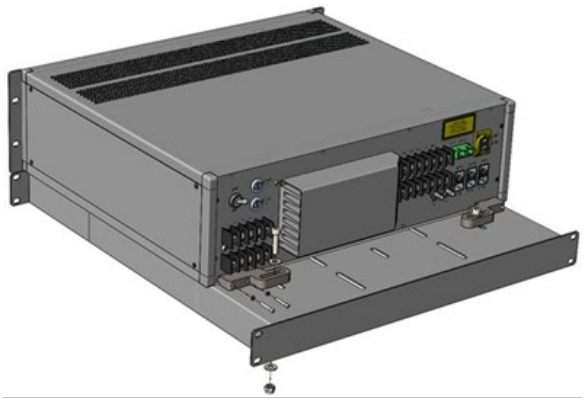
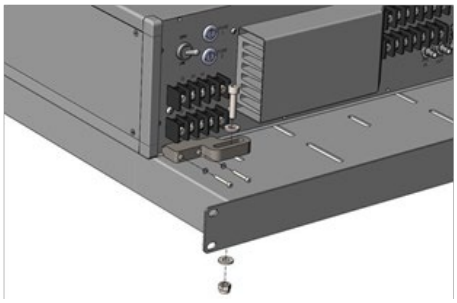


Figure 5.2





5.6 Cables and connectors

5.6.1 Electrical connections

Appropriately rated cables should be used for all electrical connections. These should be chosen by the installer with reference to the power supply ratings provided in Table 4.2.

5.6.2 Fibre optic connections

The optical measurement interface should be connected to the sensor network using telecoms standard OS2 single-mode fibre patch cables, terminated in an SC/APC connector.

If PPS time synchronisation is being used, the optical timing interface should be connected to the time source using telecoms standard multi-mode fibre patch cables, terminated in an ST connector.

5.6.3 Data communications connections

The Interrogator is supplied with six small form-factor pluggable (SFP) network connections on the rear panel. A suitable SFP transceiver should be chosen by the installer for interface between the Interrogator and any external network or devices. Optical interfaces are recommended. If using copper (RJ45) Ethernet cables, then shielded cables should be used.

USB-based Ethernet adapters can be unreliable, so these should not be used with the Interrogator.

5.7 Installation Checklist

The accompanying document TD-013 DES Interrogator Installation Checklist should be filled out to evidence correct installation of the hardware. This document should be supplied to Synaptec along with any supporting evidence for countersign by Synaptec to approve the completed installation.

5.8 Commissioning

5.8.1 General guidelines

Synaptec's Interrogator performs self-checks during start-up and will raise an alarm in the unlikely event of a failure.

To commission the devices, the commissioning engineer is not required to test every function. It is only necessary to verify that the hardware is functioning correctly and that the application-specific software settings have been applied. Synaptec engineers will be able to confirm settings and system functionality should this be required at the commissioning stage.

Commissioning will typically follow installation of a series of Synaptec passive optical sensors and connection of the single-mode fibre network to the Interrogator during its installation. Commissioning is then required to confirm that the system is operating as designed and within agreed limits.

Caution

Before carrying out any work on the equipment you should be familiar with the Safety Instructions chapter of this manual.

Warning

Do not disassemble the device during commissioning.

Warning

If a fibre optic connection is made to the optical measurement interface on the rear panel of the unit, do not power the system on until all fibre connections are safely made.

Commissioning activities may vary depending on the application and user policy. This chapter covers only the minimum commissioning requirements necessary to confirm operation of the Interrogator. Further commissioning activities shall be agreed with Synaptec during project specification.

5.8.2 Commissioning equipment

At a minimum, the following equipment is required:

- Hardware or software packet inspection tool
  (e.g. Wireshark network packet analyser, https://www.wireshark.org) installed on a laptop
- Ethernet cable (shielded)
- Label maker
- Optical time-domain reflectometer (OTDR)
- Fibre end cleaner
- Fibre optic test kit (source and optical power meter)

5.8.3 Visual inspection

Carefully examine the Interrogator to check that no physical damage has occurred since installation.

Ensure that the case earthing connections at the rear panel power supply terminals are used to connect the unit to a local equipment earth.

5.8.4 External wiring

Caution

Check that any external wiring is correct according to the installation scheme agreed with Synaptec.

Electrical connections to external equipment (power supplies, dry contacts) are the responsibility of the installer.

5.8.5 Power supply

The Interrogator can be operated from a DC or AC supply. The incoming voltage must be within the operating ranges stated in the device specifications.

It is recommended that a Universal Power Supply (UPS) or similar auxiliary source is used as the power source. It is also recommended that the Interrogator is powered off for at least 10 seconds whenever reboots are required.

Caution

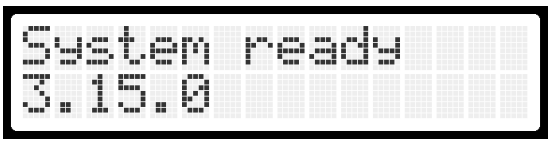
Only energise the Interrogator if the auxiliary supply is within the specified operating ranges.

Warning

The Interrogator outputs near-IR laser light. Do not energise the Interrogator if open fibre optic connections are present in the optical sensor network. Ensure all connections are made before energising the device.

5.8.6 Power-on self-test (POST)

On energisation of the Interrogator, the device will run a series of self-checks to ensure it is operating correctly. If completed successfully, the front panel LCD screen will indicate ‘System Ready’ per the example below:



Should any issues arise during the POST process, an alarm will be raised by the system which can be investigated using the config tool (see Chapter 8). If this cannot be resolved, Synaptec engineers should be contacted for assistance.

5.8.7 Fibre optic connections

With the system energised and POST passed, the Interrogator will perform further checks to determine whether all optical sensors in the specified network can be detected via the connected single-mode fibre. Should there be any issues, an alarm will be raised by the system.

This type of problem is typically a result of improper or faulty fibre connections external to the Interrogator in the sensor array. An OTDR device should be used to examine the sensor array from the point of connection to the Interrogator and identify any locations of high optical losses. The telecoms contractor responsible for fibre connections should then repair any affected fibres or connections until the Interrogator alarm is resolved. It may also be required to clean the connectors of any fibre patch cables using a fibre end cleaner.

Following verification of the fibre network, it should be ensured that all fibres used for the system are labelled adjacent to the Interrogator with their use or allocation as appropriate.

5.8.8 Sampled Value output

The Interrogator is typically configured to output measured values from the sensor array in IEC 61850 Sampled Value (SV) format over Ethernet via the network interfaces on the rear panel. Following successful installation, visual checks, POST, and confirmation of fibre optic connections, the presence of the SV stream(s) on the network can be verified using a hardware or software packet inspection tool. For example, Wireshark (https://www.wireshark.org/) can be installed on a suitable computer connected to the SV Ethernet network interface (or connected via a network switch).

6. Front panel HMI operation

6.1 Chapter overview

This chapter provides information about front panel HMI operation.

This chapter contains the following sections:

- Chapter overview
- HMI operation during system boot
- General user operation

6.2 HMI operation during system boot

This section explains the operation of the user-facing aspects of the Interrogator front panel HMI.

6.2.1 Boot process and system health checks

After completing the installation and commissioning process (see Chapter 5), the Interrogator can be powered. The POST process will begin, which will check the internal subsystems, the configuration of the Interrogator, and the connected sensor array.

During this process, the front panel LCD will display the “Loading...” message. After the POST process completes, the LCD will display the “System ready” message, along with the installed firmware version. If a critical POST issue is detected, then the “POST failed” message is displayed and Synaptec support should be contacted. This sequence is summarised in Figure 6.1. The POST process typically takes 2-3 minutes to complete. Note that if the sensor array is misconfigured, such as due to the sensor optical fibre not being connected, the POST process will take longer to complete due to the system checking additional range in the available spectrum.

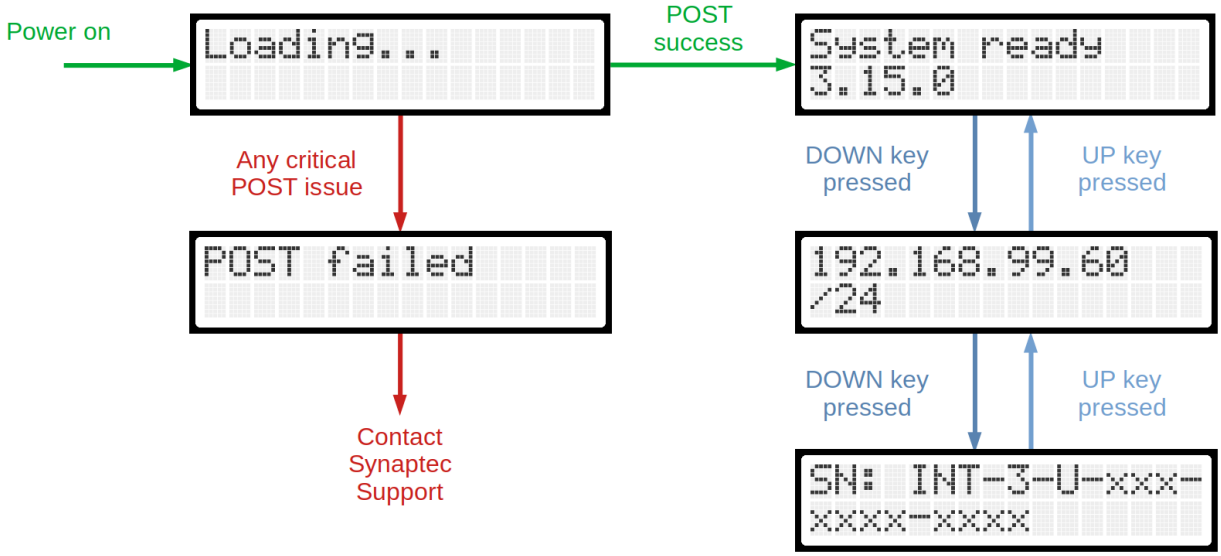
6.2.2 Front panel indicators

LEDs for the appropriate subsystems in use, such as rear Ethernet ports and PTP time synchronisation, will be illuminated (see Chapter 4 for the full description of the front panel indicators).

6.2.3 Trip reset

The “back” key (see Section 4.2) is used to manually reset any latched trips.

Figure 6.1: LCD message flow chart.



6.3 General HMI operation and user interaction

6.3.1 System information

Once the Interrogator has completed the start-up process, the up and down arrow buttons can be used to navigate between the available screens, as illustrated in Figure 6.1. These display important system information:

- The Interrogator firmware version, e.g. “3.15.0”.
- The front panel Ethernet port IP address and subnet, e.g. an IP address of 192.168.99.60 with a subnet of 24 (equivalent to a subnet mask of 255.255.255.0).
- The Interrogator’s serial number (SN), e.g. INT-3-U-xxx-xxxx-xxxx.

6.3.2 Trips and other events

Special events, such as protection trips and CT failure alarms, will be displayed on the LCD screen. Only the most recent event will be shown and will remain latched until manually cleared. The event can be cleared by pressing the “back” button to return to the normal screen.

Examples of these event messages are:

- Figure 6.2: protection trip, for the differential protection (PDIF) function configured for zone 2 (i.e. it is the second configured protection instance). This was a three-phase fault, as shown by “Phs:ABC”.
- Figure 6.3: CT failure alarm, which indicates that the CT supervision feature has detected an open- or short-circuited CT secondary connection. The function estimates the affected phase (B, in this example) and the affected zone end (end 1 in this example). This information identifies the location of the affected CT (although this is not possible in every scenario). See Section 7.3.6 for more details on the CT supervision feature.

Figure 6.2: LCD message for a protection trip.

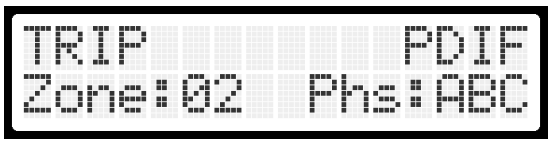
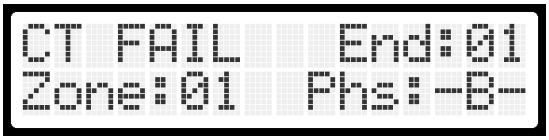


Figure 6.3: LCD message for a CT failure alarm.



6.3.3 Front panel Ethernet port

The front panel Ethernet port is used for accessing the Interrogator config tool, see Chapter 8 for details.

7. System and protection configuration

7.1 Chapter overview

This chapter provides information about operation of the product and configuration of protection applications.

This chapter contains the following sections:

- Chapter overview
- Software configuration
- Protection configuration

7.2 System configuration

This section describes system-wide Interrogator configuration parameters.

7.2.1 Core system settings and operation

At present, system settings are configured by Synaptec at the factory. Table 7.1 describes the available settings. At present, systems configured for 50 Hz nominal frequency will use 4 kHz measurement sampling, and 60 Hz nominal frequency will use 4.8 kHz sampling.

Table 7.1: System settings.

Setting	Possible values
HMI language	EN, FR, DE, IT, RO
Nominal system frequency	50 Hz or 60 Hz

7.2.2 Network interface settings

At present, network interfaces are configured by Synaptec at the factory, and will be tailored for each application's requirements. For example, this may include PTP time synchronisation, SV output streams, and GOOSE trip commands. Six gigabit network interfaces are available, supporting both optical and electrical SFPs, allowing a high level of flexibility and customisability for real-time applications.

7.2.3 Time synchronisation

The time synchronisation mode can be changed while the Interrogator is running, using the config tool (see Section 8.3.2).

1PPS input and output

See Section 4.3.1 for details.

Precision Time Protocol (PTP)

When PTP is synchronised to a suitable external clock, the *refrTm* field within SV packets will be set to the present second. Used along with the *smpCnt* value, allows the precise global timestamp to be extracted for each measurement sample without requiring a separate time reference in the device subscribing to the SV stream.

Free-running mode

When no PTP or 1PPS input is available or configured to provide an absolute time reference, the system uses a free-running mode for synchronising measurement acquisition. An internal 1PPS signal is generated to control measurement sampling

and Sampled Value output. All measurements from the Interrogator use this common clock source and maintain relative synchronisation, so that the measurement data can still be used for protection applications where time synchronisation is critical.

Network Time Protocol (NTP)

NTP can be enabled to synchronise the main system clock with a suitable NTP server. This is used for timestamping internal log messages. Note that NTP is not used for synchronising sensor measurements – a suitable PTP or 1PPS source is required for synchronising measurement acquisition.

Once enabled, NTP may take 5-10 minutes to synchronise. This is normal because the local system clock is gradually aligned with the reference clock.

7.2.4 Sampled Value operation

After the system boots successfully, it will automatically begin transmitting Sampled Value (SV) data streams for all configured sensors. Each data sample includes a quality flag, with a 1-bit field which represents the validity of the sample. If a sensor's optical power drops below a set threshold, the sensor will be flagged as invalid. For an invalid sensor to recover and be marked as valid again, its optical power must increase to and remain above the threshold for at least 40 seconds.

7.2.5 IEC 61850 configuration

Information relating to the IEC 61850 data model definition, SV/GOOSE services, and related parameters will be provided in an IED Capability Description (ICD) file. This will enable interoperability and distributed functionality with other IEC 61850 devices.

Synaptec will provide an ICD file, where required, for use in system installation and commissioning.

7.2.6 Software updates

At present, only Synaptec-qualified engineers can perform Interrogator software updates.

7.2.7 Watchdog functionality

The Interrogator has an advanced internal watchdog system which continuously monitors the health of the device. If an internal issue occurs which results in incorrect operation or degraded performance of the Interrogator, a dry contact output can be configured to change to the “unhealthy” state to notify other devices.

The watchdog caters for the following potential failure modes:

- One or more sensors are not visible in the optical spectrum e.g. due to damage or disconnection of the sensor optical fibre.
- Failure to initialise the optical system.
- Internal inter-processor communications failure.
- Detection of excessive optical saturation.
- Failure of a major sub-system, such as the optical light source.
- CPU execution halts or freezes for any reason (monitored separately by a dedicated hardware system).

7.3 Protection configuration

At present, all protection settings are configured by Synaptec at the factory, and correct system operation will normally be demonstrated during a Factory Acceptance Test (FAT) with the customer.

The Interrogator supports configuring up to **10 independent protection zones**. Each zone can be assigned to use either a current differential or overcurrent function. Current sensors can be assigned to any zone (including multiple zones, if required). The protection settings for each zone are separate.

Following installation and commissioning, protection settings can be modified using the config tool (see Chapter 8). All minimum and maximum values are described in **per-unit (pu)** in this section, relative to the configured nominal primary current. The config tool performs the conversion so that current values are presented and set in **amps relative to the primary side of the CT**.

7.3.1 Current differential protection overview

The Interrogator can enable multi-zone current differential protection applications. This includes Mixed Circuit Protection (MCP) for mixed-conductor circuits, line current differential, busbar protection, and distribution feeder protection. Two-ended

differential schemes are the common case, but the function can also be configured to support multi-ended zones. The protection operates independently on a per-phase basis. For MCP applications, a “trip” is equivalent to an AR block command i.e. for indicating that a fault occurred on a cable section.

The processing chain calculates high-fidelity current phasors from waveform samples at the full sensor sampling rate (typically 4 or 4.8 kHz). The phasor calculation is designed to be highly resilient to disturbances such as noise, harmonics, DC component, phase-steps, and off-nominal frequency. The performance is also tuned to enable fast measurement response and therefore to ensure sub-cycle tripping for low-impedance faults.

Due to the nature of interrogating remote CTs outside the substation fence at the speed of light, potentially over long distances, Synaptec’s line current differential protection solutions can operate significantly faster than conventional approaches which rely upon communications networks, which can add delay and jitter. Another advantage is that all measurements performed by each Interrogator are inherently synchronised to a common time reference, so current differential protection can be executed without requiring external time synchronisation (or can operate continuously even if the time synchronisation source for the Interrogator is lost).

7.3.2 Current differential protection settings

The current differential protection scheme uses a dual-slope characteristic as illustrated in Figure 7.1. The protection settings will be defined in collaboration with the customer and the specific application requirements.

Figure 7.1: Current differential protection characteristic.

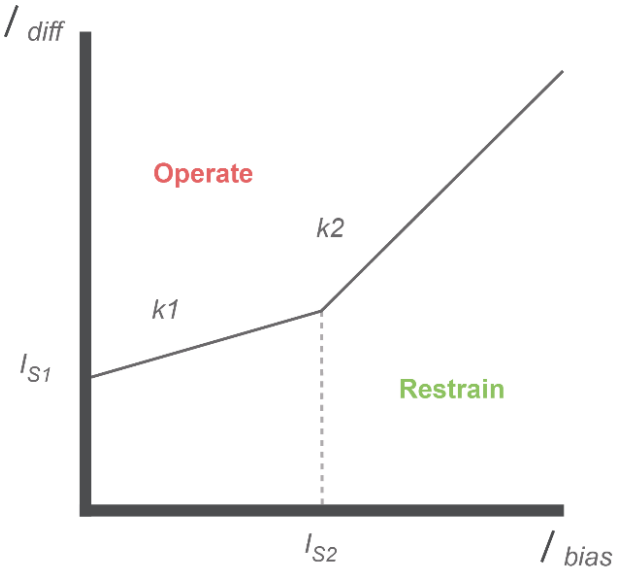


Table 7.2 describes the settings available for current differential protection functions. Note that setting ***k1 = k2*** creates a single slope characteristic, if desired.

Table 7.2: Differential protection settings.

Setting	Description	Minimum value	Maximum value
I_{S1}	Minimum operating/ pickup current	0 pu	10 pu
I_{S2}	Bias slope breakpoint threshold	0 pu	10 pu
k1	Gradient of first slope	0	2
k2	Gradient of second slope	0	2
Confirmation time	Time required for continuous trip state before actual trip is issued	0.0 s	2.0 s
Output latch time	Time duration for latching dry contact outputs in the “trip” state following a trip (assuming the fault is subsequently cleared by protection)	0.0 s	10.0 s

Idiff is calculated as the **vector sum** of the input current phasors. It should equal 0 A in a perfect, non-fault scenario (although there are sources of error which make it non-zero).

Ibias is the bias (or restraining or spill) current, and is the **sum of the magnitudes** of the current input phasors, divided by 2. This is used to make the protection less sensitive during high currents, which may be due to CT saturation or external ("through") faults. The divisor of 2 is used regardless of the number of ends in the protection zone.

Operate means that a genuine fault has been detected inside the protected zone. In MCP applications, AR should be blocked.

Restrain means that the measurements are from non-fault conditions, or from an external fault. In MCP applications, AR should not be blocked.

Protection trip outputs

Trip outputs are assigned to a normally-open (NO) dry contact outputs (see Chapter 4 for details). Dry contact trip outputs are typically configured to latch for at least 1 second from fault detection (although this is configurable). If a fault condition is no longer present after the configured latch time, the dry contact output will revert to its inactive state.

As described in Section 6.3, the front panel HMI will display trip information until manually reset or another event occurs.

Trip outputs and other information can also be published using fast-responding IEC 61850-8-1 GOOSE messaging. This configuration is presently performed by Synaptec engineers.

7.3.3 Overcurrent protection overview

The Interrogator implements a definite-time (DT) overcurrent protection function. The protection function will trip after the current threshold is exceeded for a configurable time duration.

The inputs for each configured overcurrent zone can be either a single-phase current sensor or three-phase current sensors.

7.3.4 Overcurrent protection settings

Table 7.3 describes the settings available for overcurrent protection functions.

Table 7.3: Overcurrent protection settings.

Setting	Description	Minimum value	Maximum value
I_k	Current threshold for tripping	0 pu	10 pu
Confirmation time	Time required for continuous trip state before actual trip is issued	0.0 s	2.0 s
Output latch time	Time duration for latching dry contact outputs in the "trip" state following a trip (assuming the fault is subsequently cleared by protection)	0.0 s	10.0 s

7.3.5 CT polarity

During system commissioning, Synaptec engineers can reverse the polarity of individual CTs within the Interrogator system software, to correct for improperly installed CTs.

7.3.6 CT supervision

Each configured differential protection zone can optionally enable a CT supervision function. This checks for scenarios where the CT secondary connections are unexpectedly open-circuited or short-circuited, where measurements from the CT will be close to 0 A. Open-circuit CT secondaries are particularly hazardous due to the possibility of a high voltage being developed at the terminals, so the CT supervision feature helps to mitigate this issue.

CT supervision is only applicable to differential protection zones with three-phase CTs monitored at each end. The feature is achieved using only the sensors that are part of the differential protection zone, so no additional CTs or VTs are required.

The config tool can be used to highlight the problematic CT on the protection settings page – the system attempts to identify the affect phase and zone end (although this is not possible in every scenario).

The CT supervision approach is summarised as follows:

1. A “standing differential alarm” is established. This operates independently of the main differential function. It is implemented as a definite-time overcurrent element based on the differential current (Idiff) signals which are already calculated. The standing differential alarm is calculated per-phase. It can be set to be relatively sensitive, so that small levels of differential current will activate it. The threshold should be set above the capacitive charging current of the cable, if applicable.
2. The standing differential alarm should have a relatively long confirmation time, such as 1-2 seconds. Furthermore, as there is a risk of an intermittent connection and arcing at the CT contacts, there could be bursts of current rather than continuous 0 A measured in the affected phase (and therefore the Idiff value may dip below the activation threshold). Therefore, an integrative overcurrent approach is used so that overcurrent is accumulated up to the threshold, and there is a time delay (5 seconds) before the accumulated overcurrent is reset to zero.
3. Once the standing differential alarm operates, the CT failure alarm will be raised and latched. The trip (or AR block/allow) signal from the main protection will be overridden to a pre-defined default value. This choice will depend on the customer’s policy, or the length of the cable involved (for short cable sections, defaulting to allowing AR may be acceptable while the CT failure is investigated).
4. To provide phase selection, the affected phase is implicitly known from the per-phase Idiff signal which generated the CT failure alarm.
5. The set of CTs which contains the failed CT (i.e. which end of the protection zone which has the failed CT) is obtained through analysis of the positive and negative sequences of the differential current.
6. A manual reset from the Interrogator front panel HMI or the config tool is required to clear the latched CT failure alarm.

The following operational factors should be considered when enabling CT supervision:

- CT supervision is not guaranteed to detect CT failures under all circumstances. Similarly, the choice of protection settings will have an impact on the effectiveness of the CT supervision feature – there are scenarios where the protection will always trip before the CT supervision has time to operate and raise the CT failure alarm.
- The system is designed to cater for AR block/reclose applications and does not attempt to perform reliable sub-cycle detection of CT failures.
- Although it is very unlikely, it is possible that an external fault could coincide with the occurrence of a CT failure. In this scenario, a large differential current may be experienced, which is very likely to result in a trip/AR block before the CT failure alarm can be raised. This will mean that the entire circuit will likely be tripped by the primary protection, and AR will be locked out. However, it is assumed that blocking AR is the safest response, as at least one CT is compromised. This edge case can only be addressed with a much more complicated sub-cycle approach which can detect CT failure before the main differential function trips.
- By design, through use of the per-phase differential current to initiate the CT Failure Alarm, the system cannot identify if CTs at both or all ends of a zone fail. It is assumed that this scenario is very unlikely in practice. It may occur during commissioning or maintenance, but there will be other obvious indications that the system is not installed correctly, or test switches are in the wrong position (i.e., no phase currents will be measured at all in the affected CTs).
- The CT supervision approach is not expected to operate until there is sufficient load current to create a large enough differential current.
- If there are multiple CT failures on different phases, the solution correctly identifies both affected phases independently. If multiple CT failures occur at different ends, then the behaviour of the CT location indicator is undefined (however this is a very unlikely scenario).
- The approach based on current differential can detect failure of a single CT within a parallel CT combination, resulting in halving of the fault current in that phase. If the differential current is above the detection threshold (i.e., the load current is high enough), then parallel CTs will not pose a significant problem for CT supervision.
- It is necessary to reset the main differential protection function while the CT failure alarm is present. All three phases are reset (and provide the default output) if the CT failure alarm is raised on any phase, within a configured protection zone.

7.3.7 CT supervision settings

Table 7.4 describes the settings available for CT supervision.

Table 7.4: CT supervision settings.

Setting	Description	Minimum value	Maximum value
Standing differential threshold	Minimum differential current to detect CT failures	0.01	10.0
Default auto-reclose/trip state	Determines the default state of the trip output if CT supervision detects a CT failure (i.e. to force AR block or to allow AR)	n/a	n/a
Confirmation time	Time required for continuous trip state before actual trip is issued	0.0 s	2.0 s

8. Config tool

8.1 Chapter overview

This chapter describes the config tool which is used for managing DES Interrogators throughout their lifetime.

This chapter contains the following sections:

- Chapter Overview
- Accessing the config tool
- Monitoring and configuring Interrogator systems

8.2 Accessing the config tool

8.2.1 Basic connection

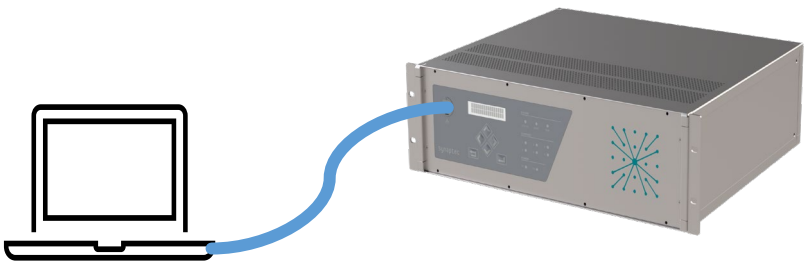
The config tool is integrated within the Interrogator, so no external software needs to be downloaded or installed. It uses a web-based interface which can be accessed using a web browser (recent versions of Chrome, Firefox, and Edge are supported).

As illustrated in Figure 8.1, connect a computer/laptop to the front panel Ethernet port of the Interrogator. In the computer's IPv4 network settings, set the computer's network port to (assuming the default settings are used):

- IP address: 192.168.99.66
- Subnet: 255.255.255.0 (24)

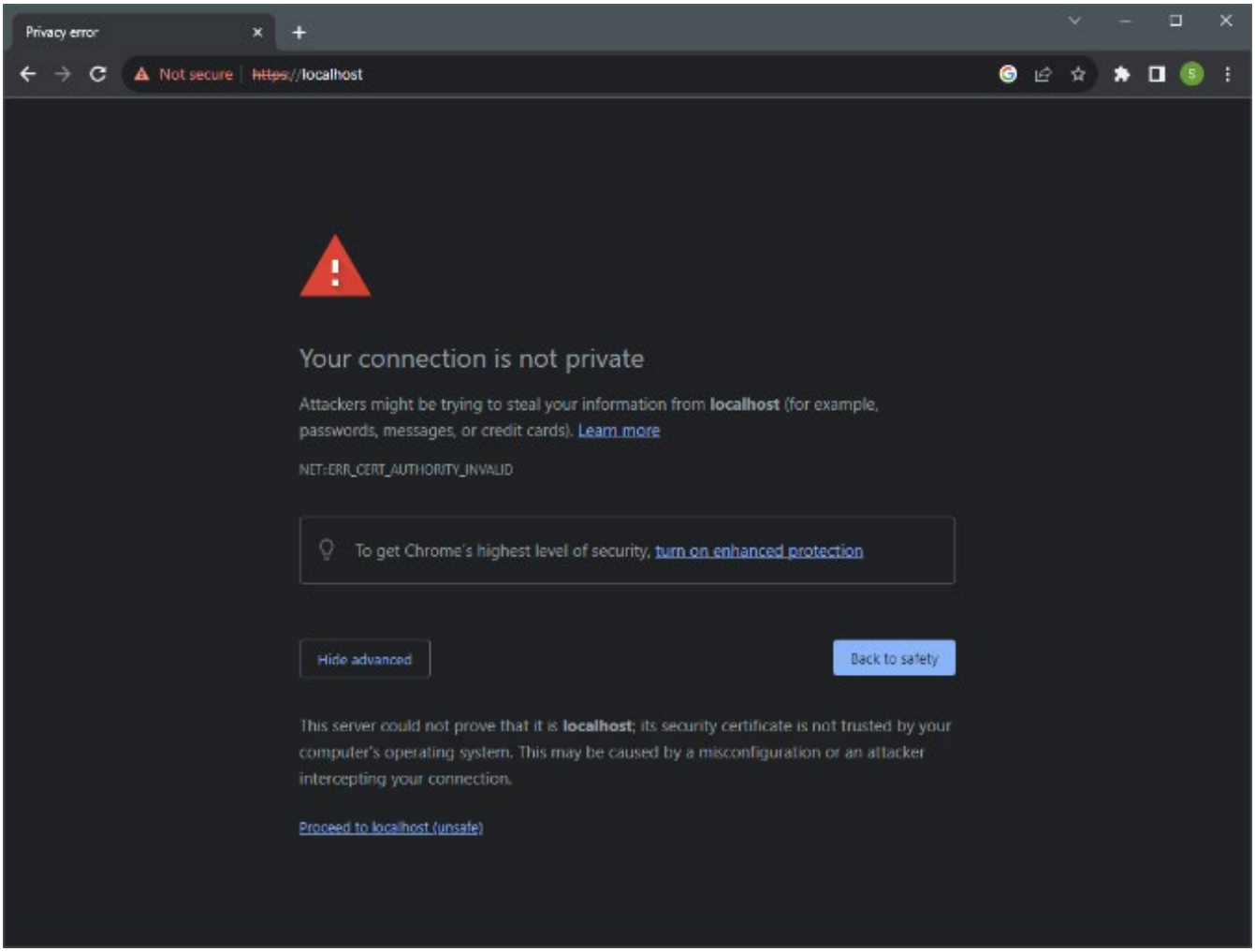
Open a web browser on the computer and type the address https://192.168.99.60 in the address bar (where 192.168.99.60 is the default IP address of the Interrogator, which can be checked from the front panel HMI).

Figure 8.1: normal certificate warning when accessing using a web browser.



8.2.2 Role-based access control (RBAC)

Figure 8.2: Front panel Ethernet connection to access the config tool.



A username and password are required to log in to the config tool. The Interrogator supports the following user account types:

- **Read-only**: can view most data and settings, but cannot modify any settings.
- **Operator**: can view and modify most settings.
- **Admin**: can view and modify all settings – reserved for configuring special system functions such as modifying user accounts.

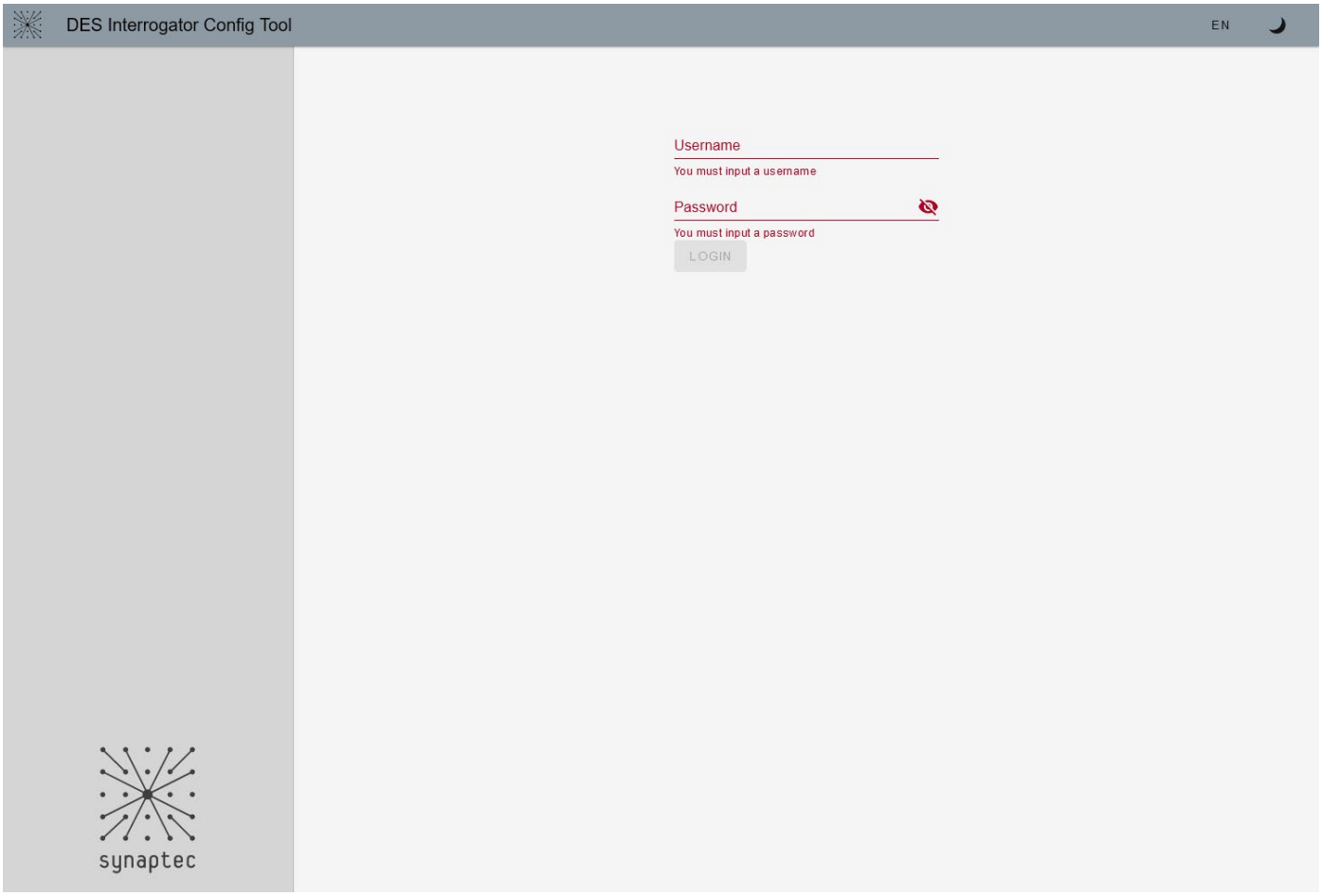
At present, one user account of each type is created by default. There must be at least one admin-level account defined. At present, admin accounts cannot be removed once created.

8.2.3 General user interface operation

Login page

The login page requires a valid username and password to be provided for accessing the config tool. The input fields will provide feedback if invalid information is entered (e.g. the username or password is missing).

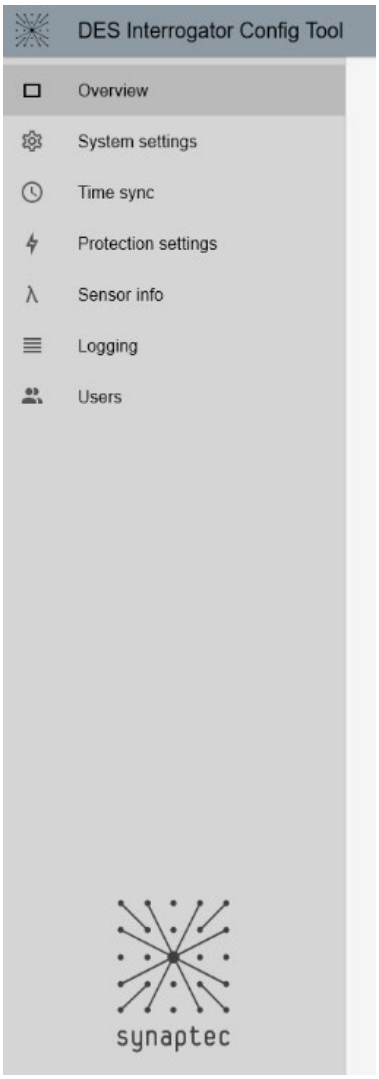
Figure 8.3: Login page



Left menu

The left menu allows selecting the pages for monitoring the Interrogator's main subsystems and modifying relevant settings.

Figure 8.4: Left menu



Top navigation bar

The top navigation bar provides critical information such as the Interrogator status icon (which can be green or amber) and the Interrogator's IP address. Green indicates that the system is healthy and operating correctly. Amber indicates a warning, such as the sensor fibre being disconnected.

There is an option to change the language of the config tool. Note that this does not change the language of the Interrogator front panel HMI, which has a separate setting. If supported by the web browser, the language selection will persist between sessions.

The config tool user interface can be toggled between light mode (the default) and dark mode.

On any page, the Refresh button in the top bar can be used to reload the presently applied settings from the Interrogator. This will replace any settings that have been modified in the config tool but not applied.

When logged in, the pressing the "logout" button will log out the user.

Figure 8.5: Top navigation bar

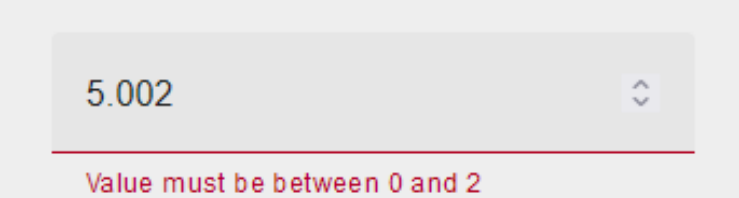
Main content area

Each page contains relevant information to monitor the operation of the Interrogator and modify settings. Common user interface elements (drop-down boxes, text inputs, etc.) have been used to ensure that the user experience is intuitive.

Each page in the config tool has one or more “Apply” buttons. This will save the state of the settings as presently entered into the screen. For some critical options, such as protection settings, a confirmation dialog will be shown before the settings are applied.

All settings are validated by the Interrogator before being applied. If any setting value is rejected (e.g. due to being outside the allowed numerical range, or the user not having permission to write new settings) none of the new settings will be applied. The user interface will validate all settings values as they are typed and notify any issues with an error message.

Figure 8.6: Validation of setting values



8.3 Monitoring and configuring Interrogator systems

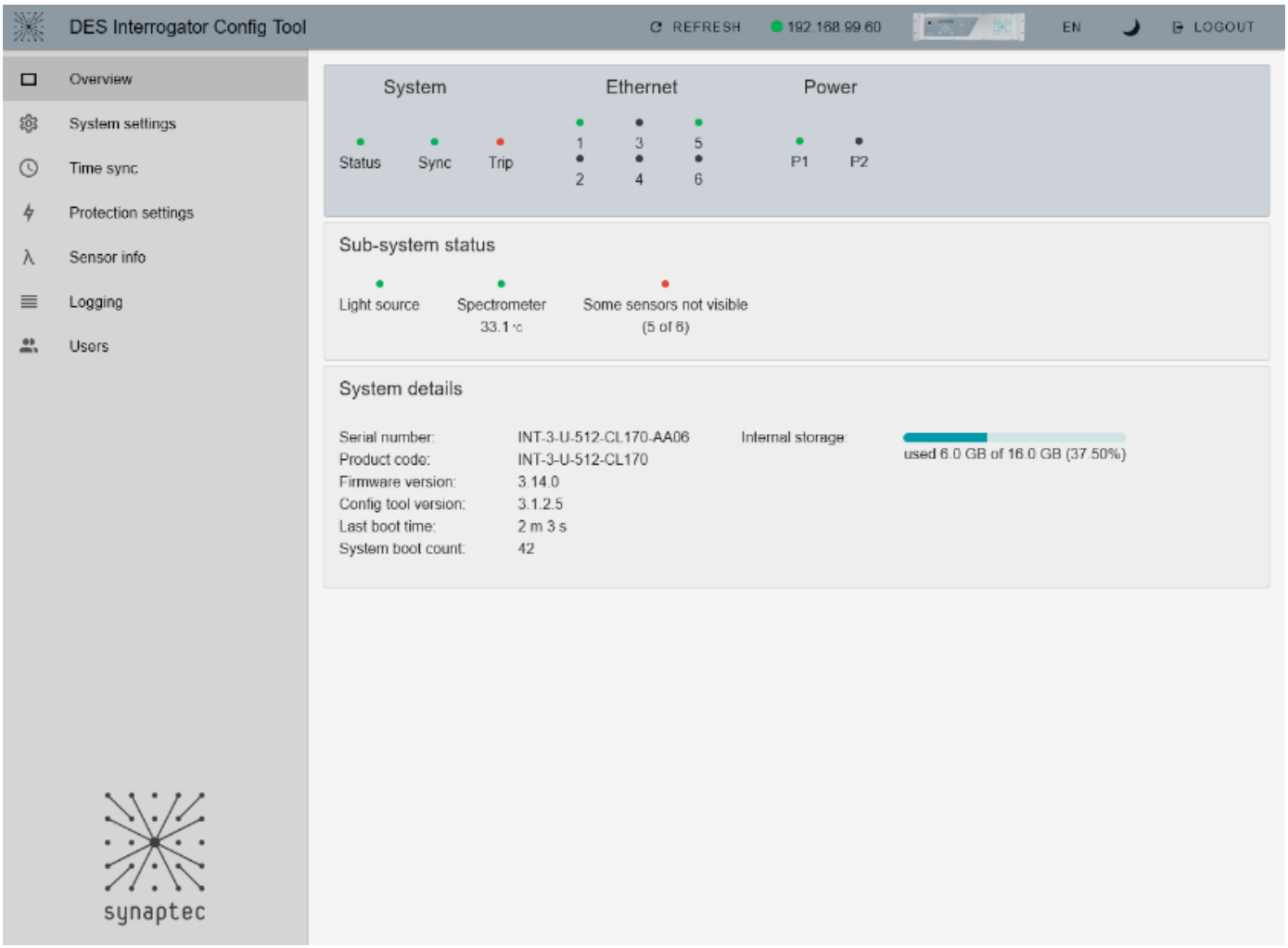
8.3.1 Overview page

The top area is designed to directly reflect the front panel LEDs (see Section 4.2 for the full details of their meanings). The status icon colour is controlled by the same signal as the icon in the top navigation bar.

The “sub-system status” area provides a simple overview of the status of key components within the Interrogator. This can help to quickly identify and diagnose any problems. In particular, the number of configured sensors which are visible will indicate if there are issues with the sensor optical array.

The “system details” area lists the nameplate data, including the serial number, product code, and software version numbers.

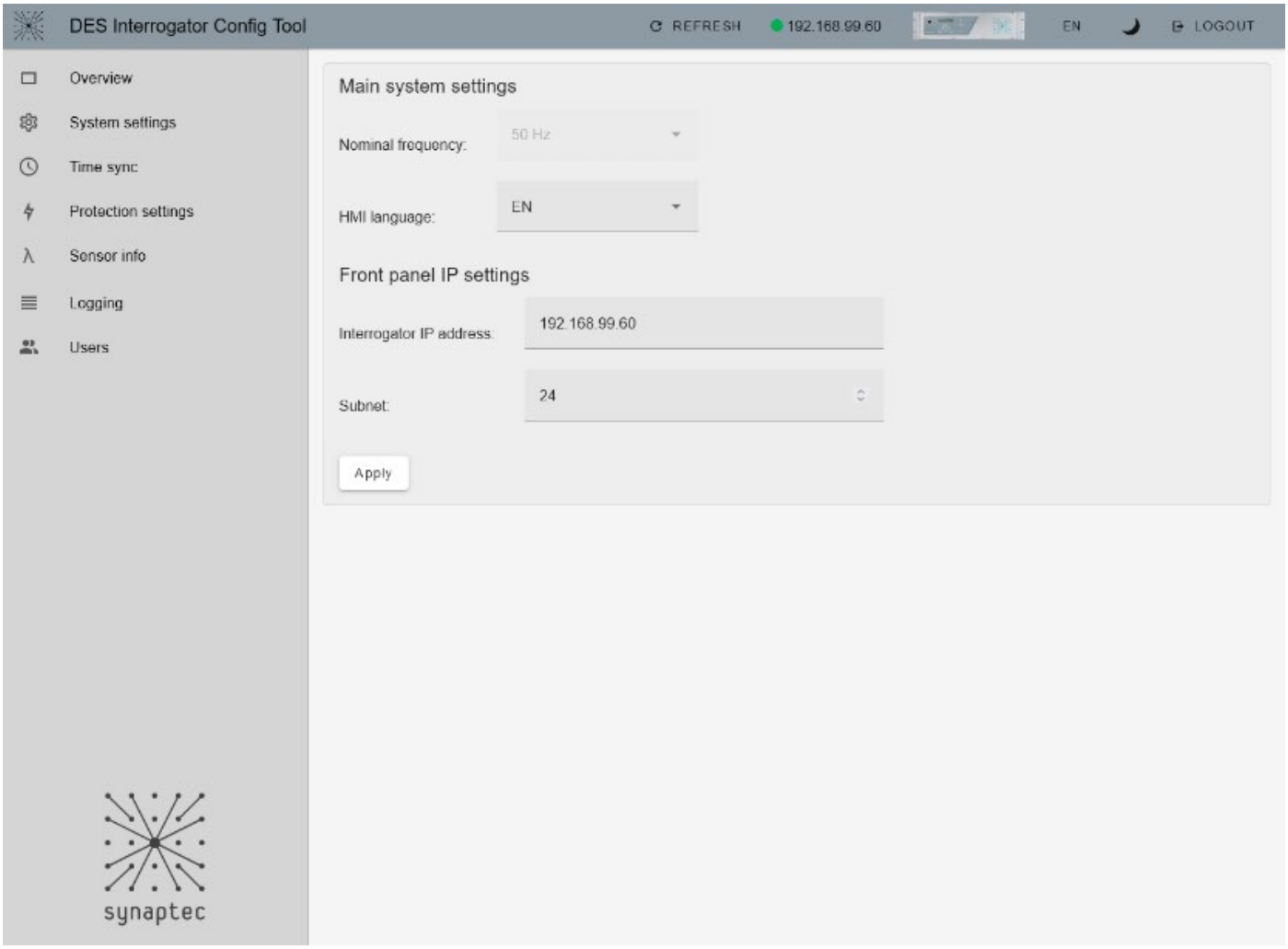
Figure 8.7: Overview page



8.3.2 System settings page

Important system-wide settings can be configured from the system settings page. At present, the nominal system frequency cannot be changed. The HMI language setting controls the language of the front panel LCD screen messages (which is separate from the config tool language selection in the top navigation bar). The Interrogator's front panel IP address and subnet can be updated, but note that this will stop communication with the config tool and the user must connect to the new IP address to access the config tool.

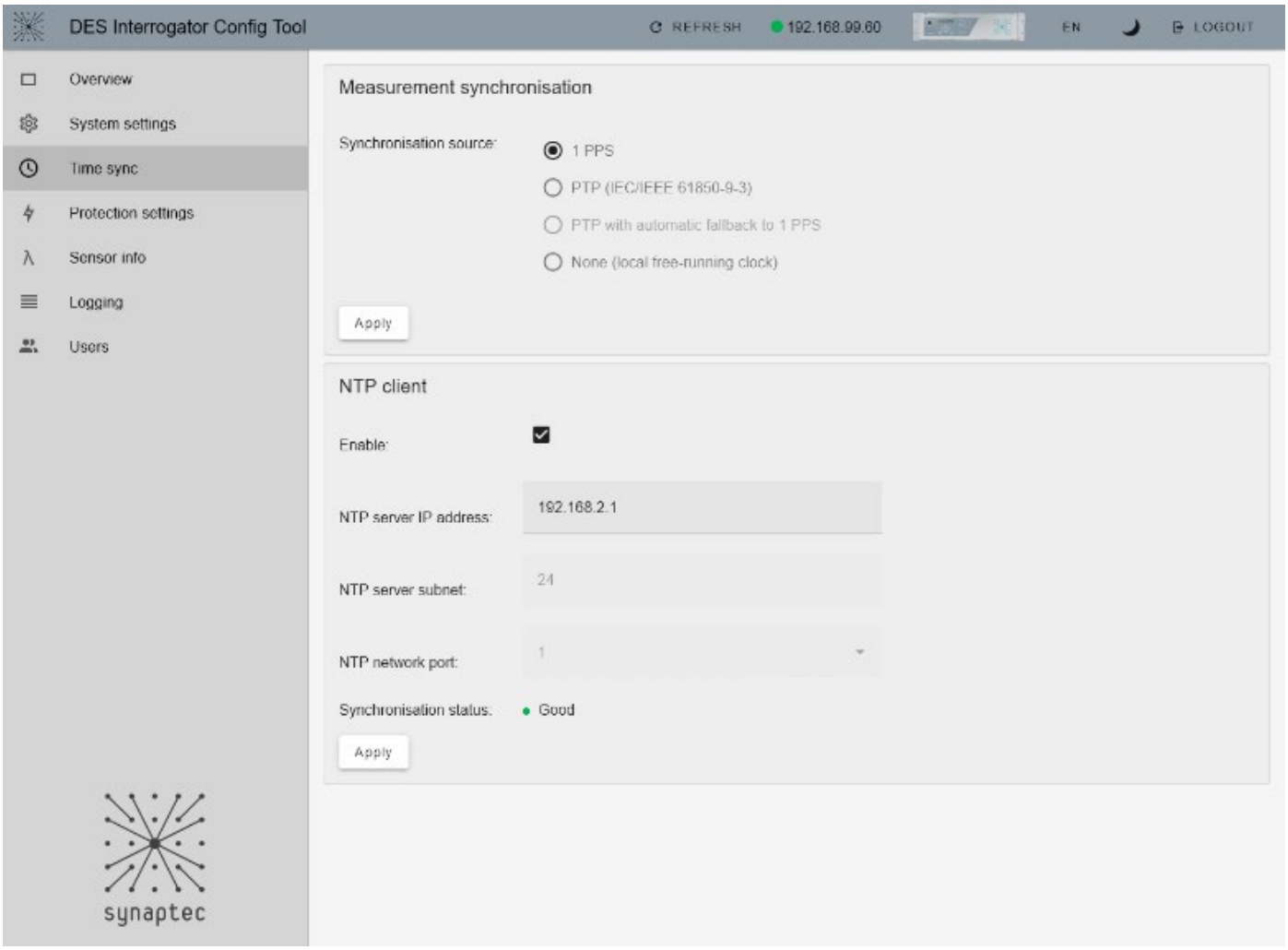
Figure 8.8: System settings page



8.3.3 *Time sync page*

The time sync page allows setting the measurement synchronisation method and configuring NTP sync.

Figure 8.9: Time sync settings page



When PTP or NTP are active, the page will show their respective synchronisation status.

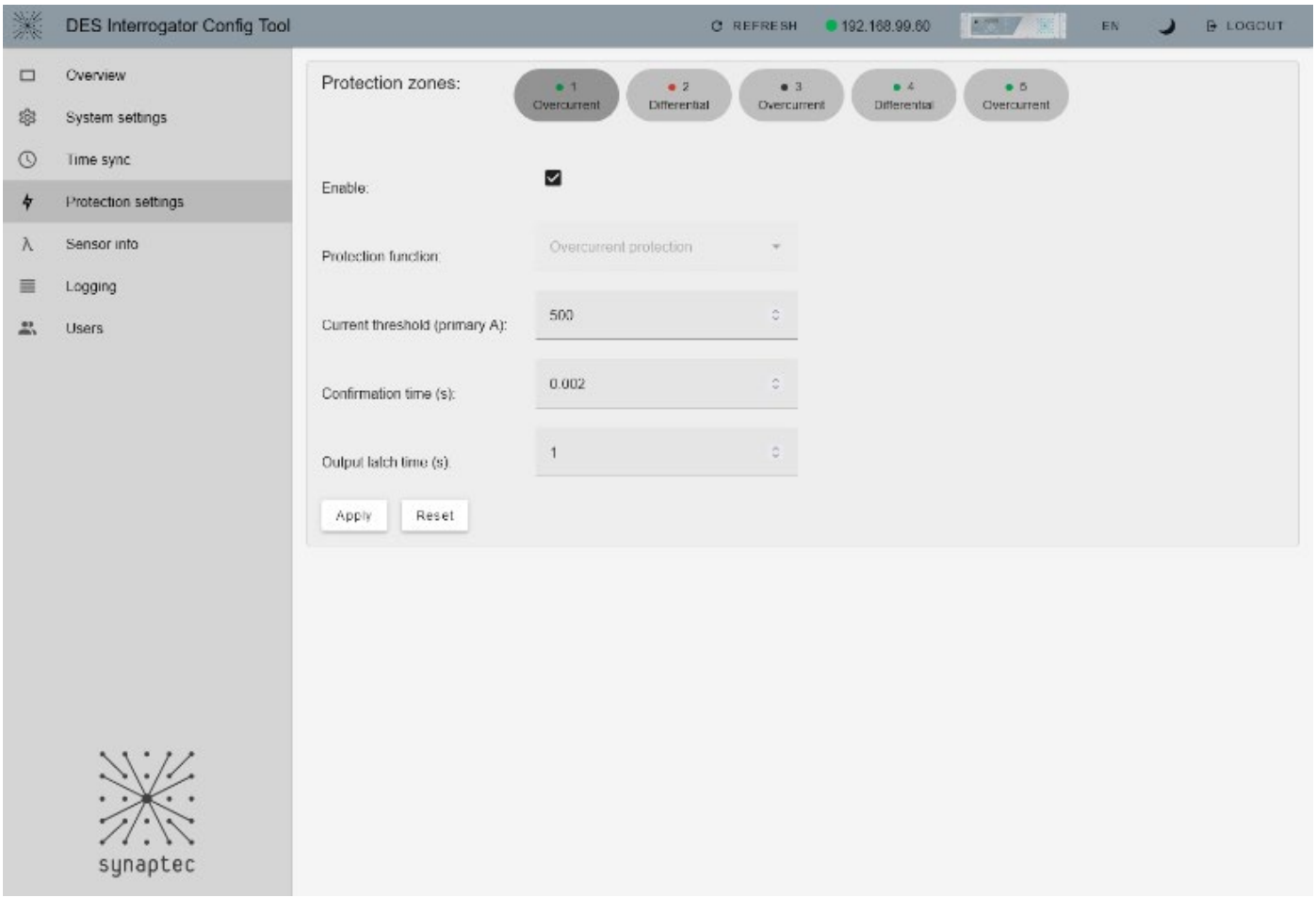
Figure 8.10: PTP status when synchronised

8.3.4 Protection settings page

The protection page uses a set of “tabs” at the top to select between protection zones/instance. These zones are presently configured by Synaptec in the factory – zones cannot be added or removed by the user. Clicking on any tab will display the settings for that zone. Each zone operates independently, has its own protection settings, and is configured to use data from specific sensors (preconfigured by Synaptec depending on the application requirements). Each zone uses either a differential protection scheme or an overcurrent scheme.

Each zone can be enabled or disabled as required. If disabled, note that the protection function no longer operates. The zone icon colour within each tab represents its status: green is operational/enabled, black/grey is disabled, and red indicates that a trip is latched on this zone. The reset button can be used to clear the latched trip for any zone.

Figure 8.11: Protection settings page



For differential protection zones, the protection settings are illustrated in Figure 8.12 and 8.13 In addition, differential protection zones can optionally enable the CT supervision feature (which is not available for overcurrent zones).

Figure 8.12: Differential protection zone settings

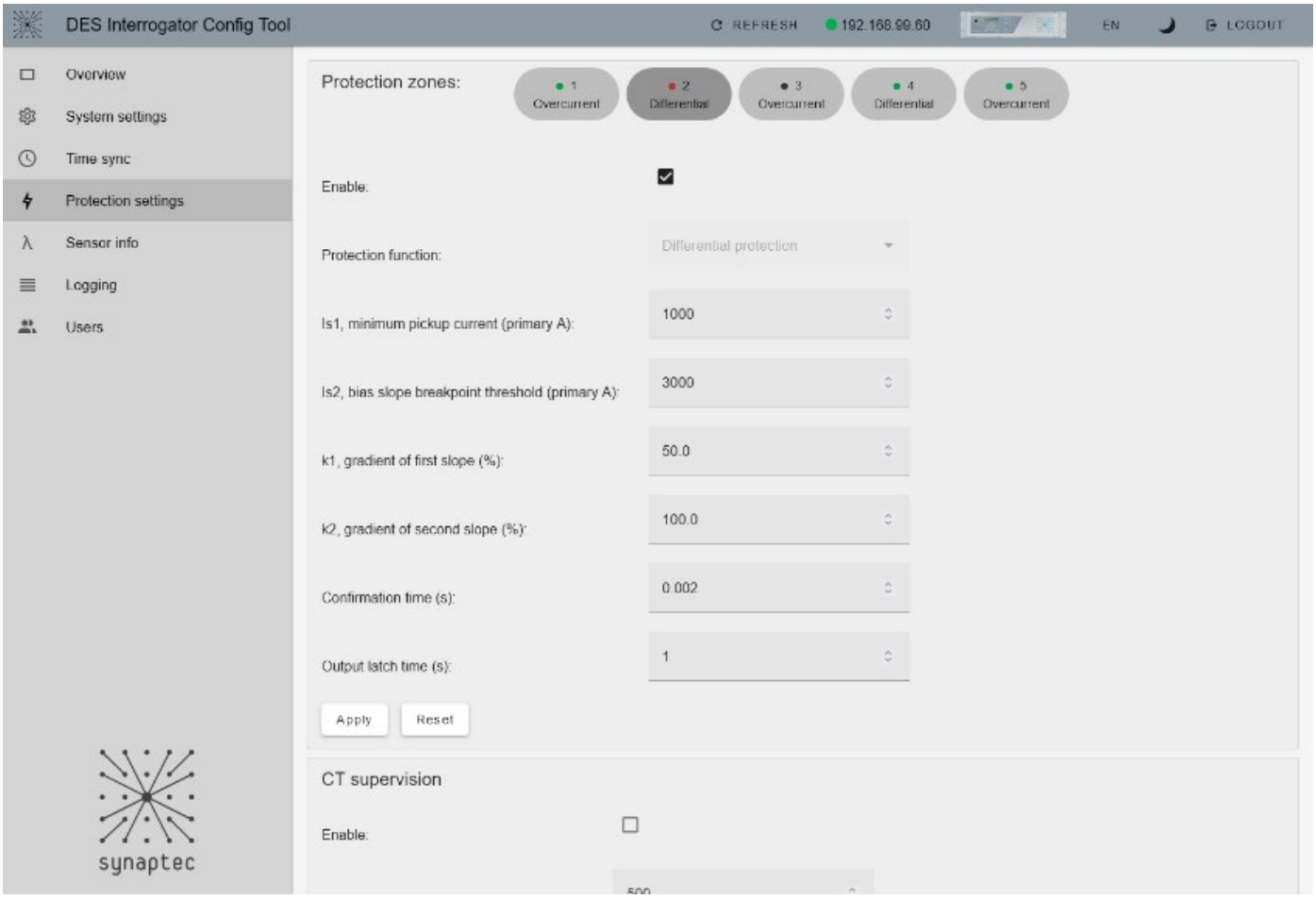
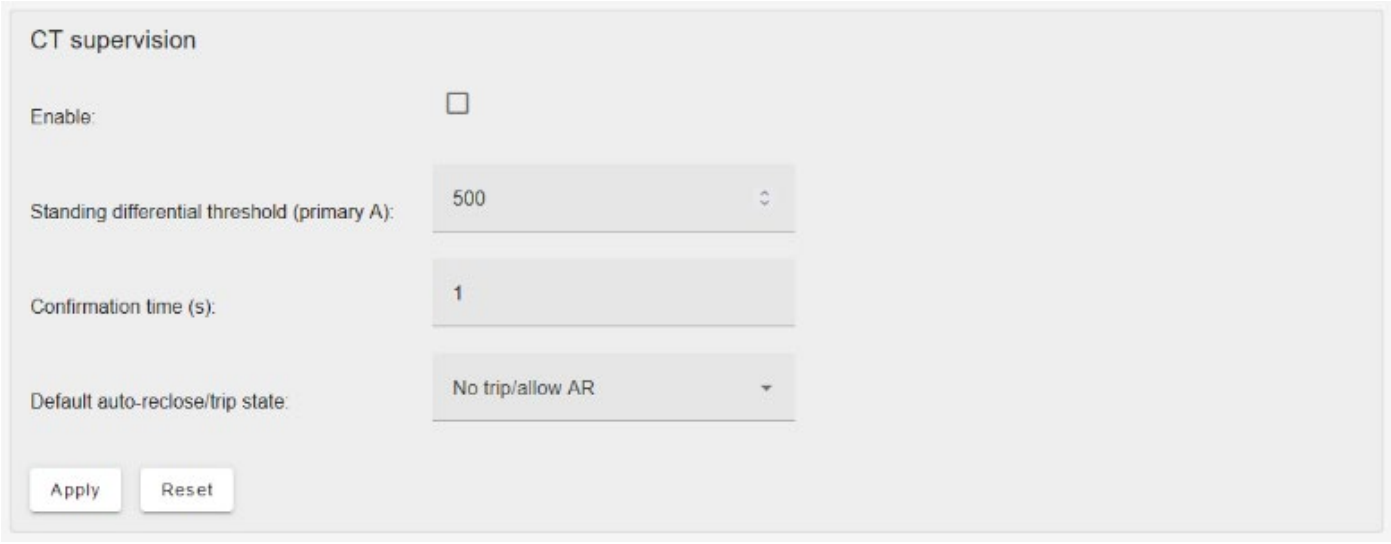


Figure 8.13: CT supervision settings



8.3.5 *Sensor info page*

The sensor info page is a unique feature of the Interrogator and provides important information for commissioning and monitoring systems.

The sensor fibre optical spectrum is displayed (this is only intended to be used by Synaptec or qualified commissioning staff). The optical spectrum data can be saved and downloaded as a file for offline analysis.

The page also lists all configured current sensors (other sensor types will be shown in a future release). The values are typically listed starting from the phase A sensor physically closest to the substation/Interrogator. The following details are given for each sensor:

- The sensor number.
- The label or description of the sensor.
- The type of the sensor (current).
- The RMS value of the sensor, in primary amps.
- The phase angle of the sensor. The first sensor is used as the reference and all angles are expressed relative to this.
- The validity of the sensor. An invalid sensor will typically mean that there is an issue with the sensor optical fibre.

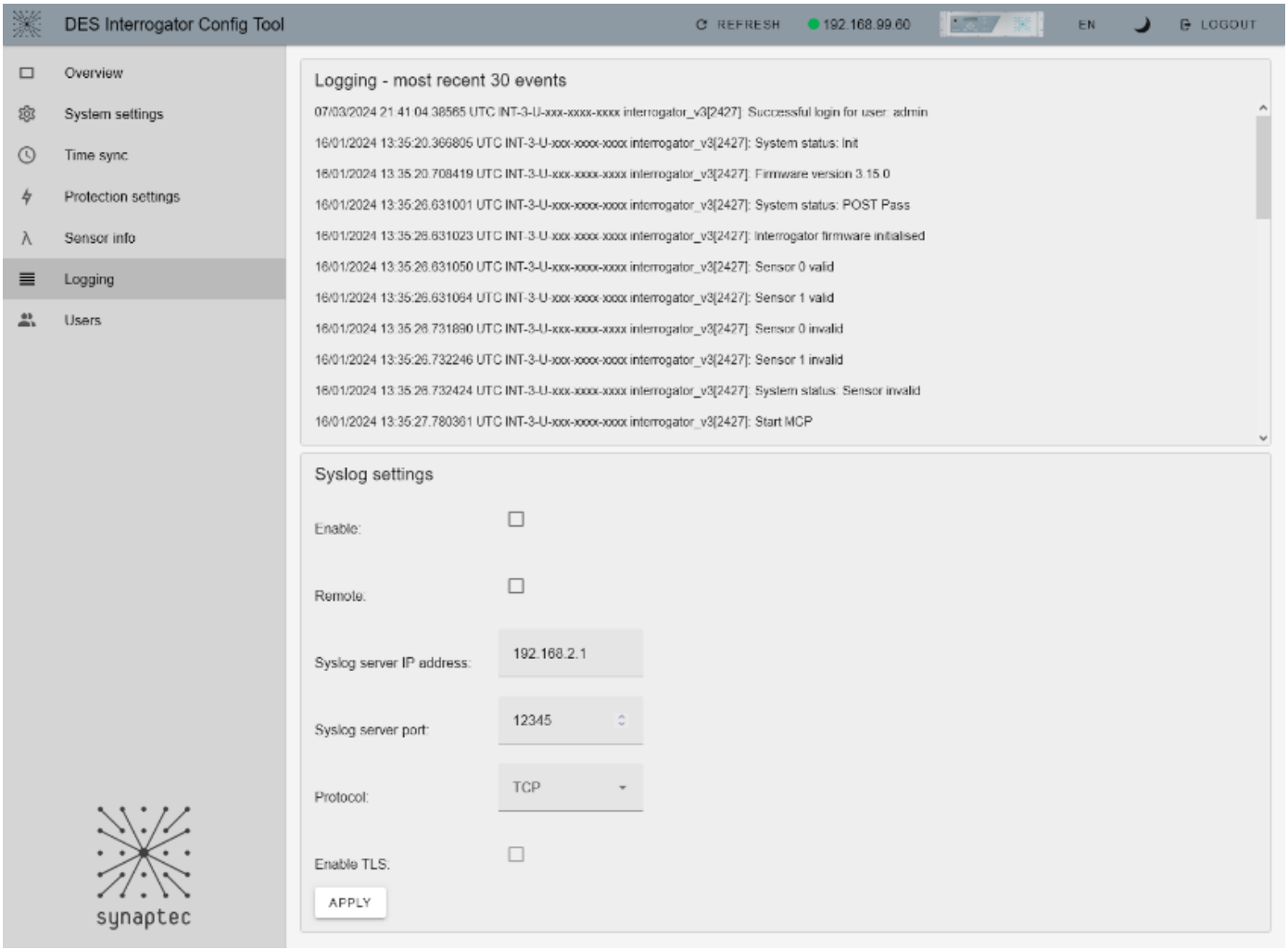
Figure 8.14: Sensor info page

8.3.6 Logging page

The logging page displays recent system logs with critical system information, events such as protection trips, and authentication events. At present, only the 30 most recent events are displayed.

The syslog server can be enabled and configured. The details for a remote server can be specified.

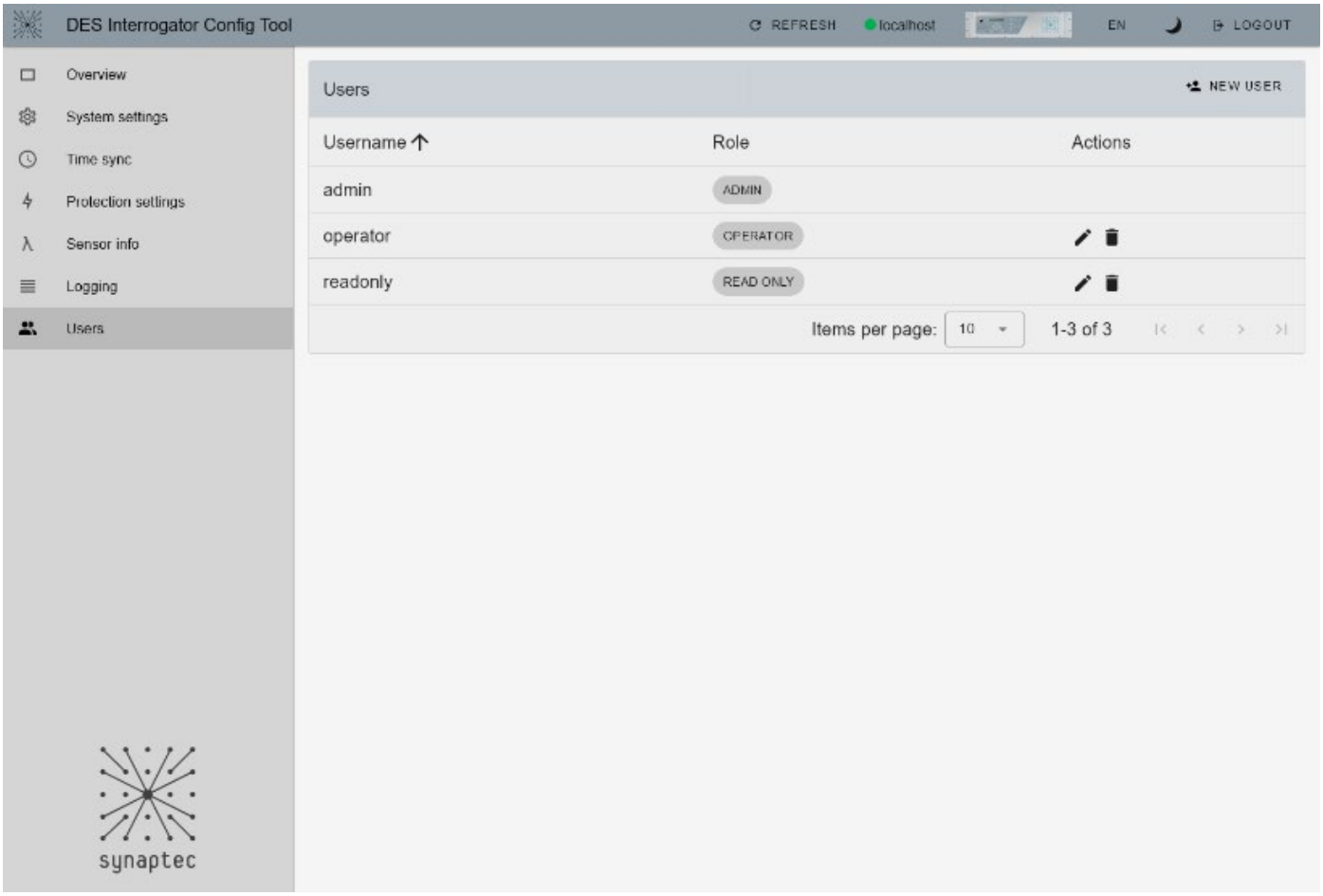
Figure 8.15: Logging page



8.3.8 Users page

The users page allows user authentication details to be managed. It is only available for admin-level users.

Figure 8.16: Users page



New user accounts can be added, and existing accounts can be edited. The associated username, password, and role level can be specified. Passwords must be at least 8 characters long.

Figure 8.17: New user popup

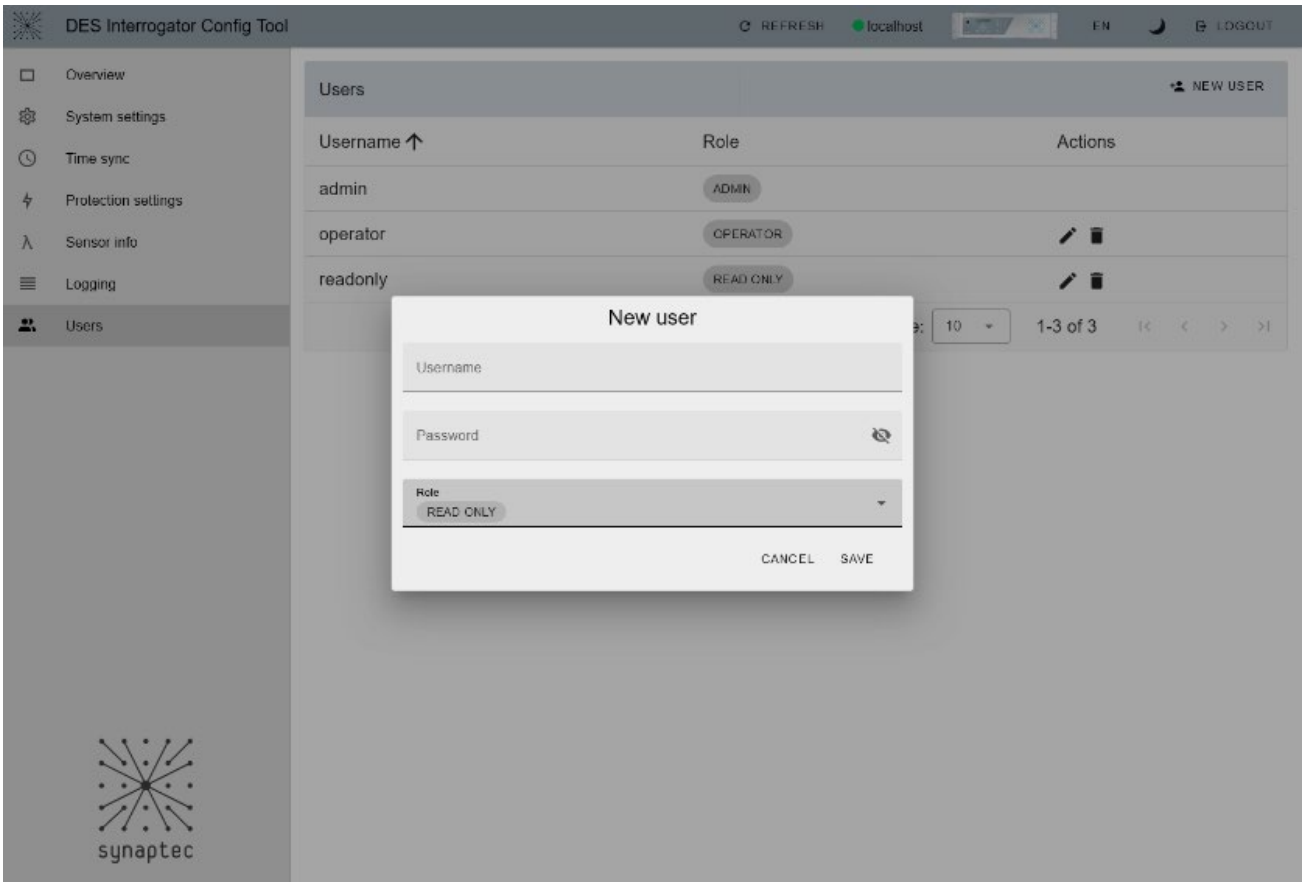
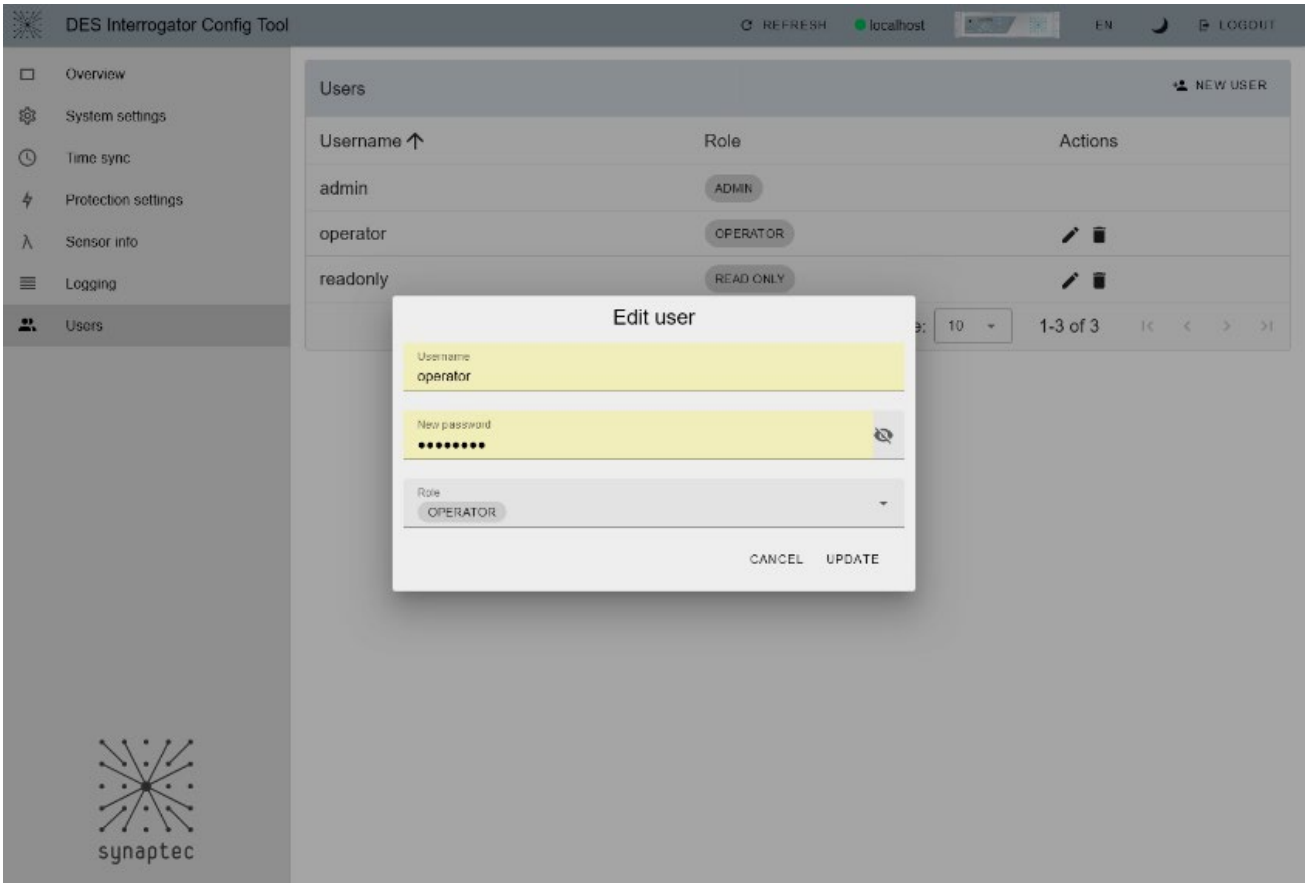


Figure 8.18: Edit user popup



Note that configured user account information is not guaranteed to be preserved after a system firmware update.

9. Technical Data

9.1 Chapter overview

This chapter describes the technical specifications of the product.

This chapter contains the following sections:

- Chapter Overview
- Mechanical Specifications
- Environmental Conditions
- Regulatory Compliance

9.2 Mechanical specifications

9.2.1 Physical parameters

Table 9.1

Item	Specification
Dimensions (main body only)	W: 448 mm H: 132 mm D: 399 mm
Dimensions (including mounting and rear panel components	W: 482 mm H: 132 mm D: 431 mm
Weight	8.3 kg

9.2.2 Enclosure protection

Table 9.2

Item	Specification
Enclosure protection	IP2X (IEC 60529)

9.2.3 Mechanical robustness

Table 9.3

Item	Specification
Vibration test per IEC 60255-21-1	Class 1
Shock and bump test per IEC 60255-21-2	Class 1
Seismic test per IEC 60255-21-3	Class 1

9.3 Environmental conditions

9.3.1 Ambient temperature range

Table 9.4

Item	Specification
Compliance	IEC 60255-27
Test method	IEC 60068-2-1 and IEC 60068-2-2
Operating temperature range	-25 °C to +55 °C (continuous)
Storage temperature range	-25 °C to +70 °C (continuous)

9.3.2 *Ambient humidity range*

Table 9.5

Item	Specification
Compliance	IEC 60068-2-78
Durability	93% at +40°C

9.3.3 *Altitude*

Table 9.6

Item	Specification
Operating altitude	Below 2,000 m

9.4 Regulatory compliance

The DES Interrogator complies with the general requirements of IEC 60255-1:2009, including:

Product safety	IEC 60255-27
Electromagnetic compatibility	IEC 60255-26 (Zone A)
Climatic	IEC 60068-2
Mechanical	IEC 60255-21 (Class 1)
Laser safety	IEC 60825-1