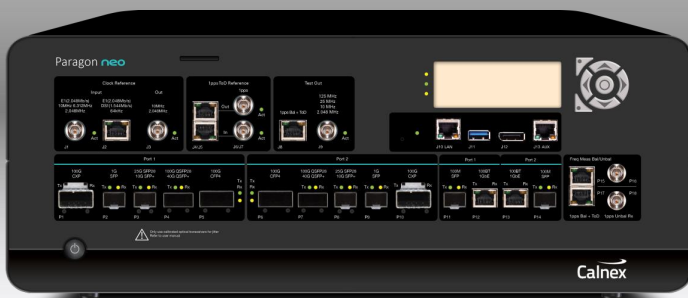# Calnex Paragon-neo

Enhanced Accuracy Synchronization Tester
PTP and SyncE for rates up to 400GbE

GETTING STARTED GUIDE

Notices

This document refers to Calnex Paragon-neo Software Revision 11.00.xx and higher.
Last Updated: January 2024

Warranty

Warnings and Cautions

 WARNING
A WARNING notice denotes a hazardous situation that, if not avoided, could result in death or personal injury.

 CAUTION
A CAUTION notice denotes a hazardous situation that, if not avoided, could result in damage to, or destruction of, this equipment or other property.

 IMPORTANT
Indicates information, procedures or recommendations that need to be followed to make correct measurements.

Contents

1   Introduction

This guide shows you how to install and operate the Calnex Paragon-neo hardware and navigate the user interface.

The operational guidance is generic, detailed operational steps for specific test scenarios and results interpretation can be found in the Calnex Test Guides and Software Release Notes available on the instrument.

1.1   Overview

Calnex Paragon-neo provides direct insight into the performance of high-accuracy timing signals at interfaces up to 400GbE, and the ability to generate real-world scenarios to validate the operation and behavior of network devices.

This guide describes all versions of the instrument: Paragon-neo first generation, Paragon-neo second generation, Paragon-neo R and Paragon-neo PAM4.

Paragon-neo functions (with appropriate options installed):

- Ethernet interface rates of –
  - NRZ ports: 100M, 1GbE, 10GbE, 25GbE, 40GbE, 50GbE and 100GbE.
  - PAM4 ports: 50GbE, 100GbE, 200GbE and 400GbE.
- PTP timeTransmitter/timeReceiver emulation, impairments, and time error measurements to ITU-T G.826x and G.827x standards, including Class-C, Class-D and other Enhanced Timing devices.
- PTP and Time of Day message decode and analysis.
- SyncE wander tolerance, transfer and generation testing to ITU-T G.8262.1 and G.8262.
- SyncE jitter tolerance and generation testing to ITU-T G.8262.1 and G.8262. Jitter testing available only on NRZ interfaces.
- ESMC message generation and measurement to ITU-T G.8264.
- 1PPS/ToD generation and measurement.
- Background traffic generation.

1.2   Terminology

This document uses the following definitions:

- **Paragon-neo** – a general description applying to both Paragon-neo NRZ and Paragon-neo PAM4 instruments.
- **Paragon-neo NRZ** – an item or description specific to the Paragon-neo NRZ first or second generation instrument.
- **Paragon-neo R** – an item or description specific to the Paragon-neo R instrument.
- **Paragon-neo PAM4** – an item or description specific to the Paragon-neo PAM4 instrument.

2   Installation

The Paragon-neo is bench portable and operates stand-alone in a normal laboratory environment. If the Paragon-neo is to be mounted in an equipment rack, either use the Calnex supplied rack mounting kit, or the Paragon-neo can be placed on an appropriately secured and weight rated shelf in the rack.

Always position the equipment with unrestricted access to the AC power connector.

The vents to the left and right sides of the Paragon-neo chassis must always be unimpeded to allow for the cooling of the internal components (airflow is left to right when looking at the front panel). Ensure that there is at least 75mm unobstructed space on each side of the instrument to allow airflow.

Environmental operating conditions must comply with the specifications in section 2.2.4.

2.1   Supplied Accessories & Paperwork

After unpacking the Paragon-neo, make sure that the accessories below are present. If anything is missing, contact Calnex Solutions by telephone: +44 (0) 1506 671 416 or by email: support@calnexsol.com

- Power cord (1)
- Getting Started Guide (1)
- Declaration of Conformity (1)
- CSS Brochure (1)
- Customer Information Sheet (1)
- Calibration Certificate (instruments fitted with Jitter measurement option only) (1)
- Rackmount Instructions (1)
- Packing List (1)

2.2   Specifications and Operating conditions

WARNING
Use of this equipment in a manner not specified by Calnex Solutions may impair the protection afforded by the equipment and invalidate the warranty. Note that there are no user-serviceable parts inside the Paragon-neo. The instrument should be returned to Calnex Solutions for all repairs. Unauthorized opening of the instrument will invalidate the warranty.

WARNING
To prevent fire or shock hazard, do not expose the unit to rain or moisture.

WARNING
To avoid electrical shock:
- Use the only power cord supplied, or one with adequate ratings, and connect only to a properly grounded power socket outlet. Ensure the power socket outlet is easily accessible and near the unit.
- Do not open covers. Refer servicing to qualified personnel only.

2.2.1 Dimensions

Paragon-neo: 45cm x 40cm x 17cm (W x D x H).

Cardboard Shipping Carton: 63cm x 60cm x 33cm.

Carry Case: 63cm x 60cm x 33cm.

2.2.2 Weight

Paragon-neo: 13kg (max).

Gross Packed Weight (shipping carton): 25kg (max). Paragon-neo plus Power Cord fitted in Carry Case with Cardboard Shipping Carton.

Gross Packed Weight (carry case): 24kg (max). Paragon-neo plus Power Cord fitted in Carry Case.

2.2.3 Power Requirements

The unit requires a power source of:

Voltage: 100 – 240V AC.

Power: 800W max.

Frequency: 50 – 60Hz.

2.2.4 Environmental Conditions

The environmental conditions the instrument is designed to support are as listed below:

- For indoor use only
- Altitude: Operating: ≤2000m
- Operating temp: 0 – 40℃
- Relative Humidity: Operating: ≤90% non-condensing
- Pollution degree of the intended environment: PD2
- Mains supply voltage fluctuations: ±10%
- Overvoltage category: OVC II

2.2.5 Regulatory

CE and EMC (incl. EN-61010, EN-61326, etc.) certified.

- Safety: EN 61010-1:2010 +A1:2019, CAT II
- EMC: EN 61326-1:2021

2.3 Cleaning

If the surface of the Paragon-neo becomes dirty, remove the AC power and clean with a soft lint-free cloth. Never use flammable liquids to clean the instrument.

2.4 Shipping Packaging

Paragon-neo is supplied in a carrying case. This case is designed and tested specially to protect your Paragon-neo during transport. Please retain for future use, as transporting in any other packaging will void the instrument warranty.

2.5 Labels and Disposal Information

The Waste Electrical and Electronic Equipment regulations label indicates that the equipment should only be disposed of through an approved method. At the end of life please dispose of the equipment through a recognized and approved scheme fulfilling the local environmental requirements.
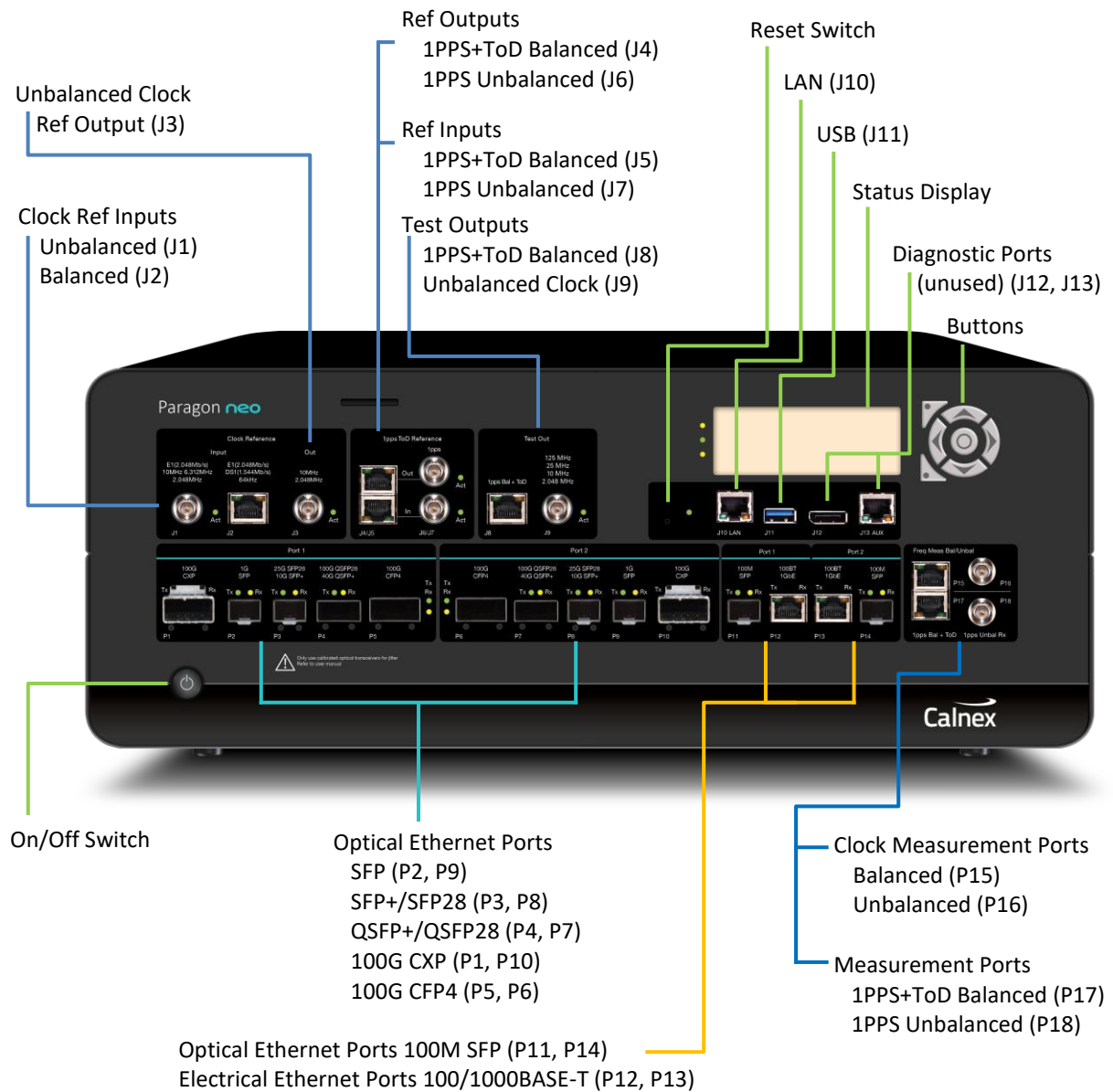
The CE mark indicates that the product meets all the appropriate provisions of the relevant legislation contained in the European Directives.
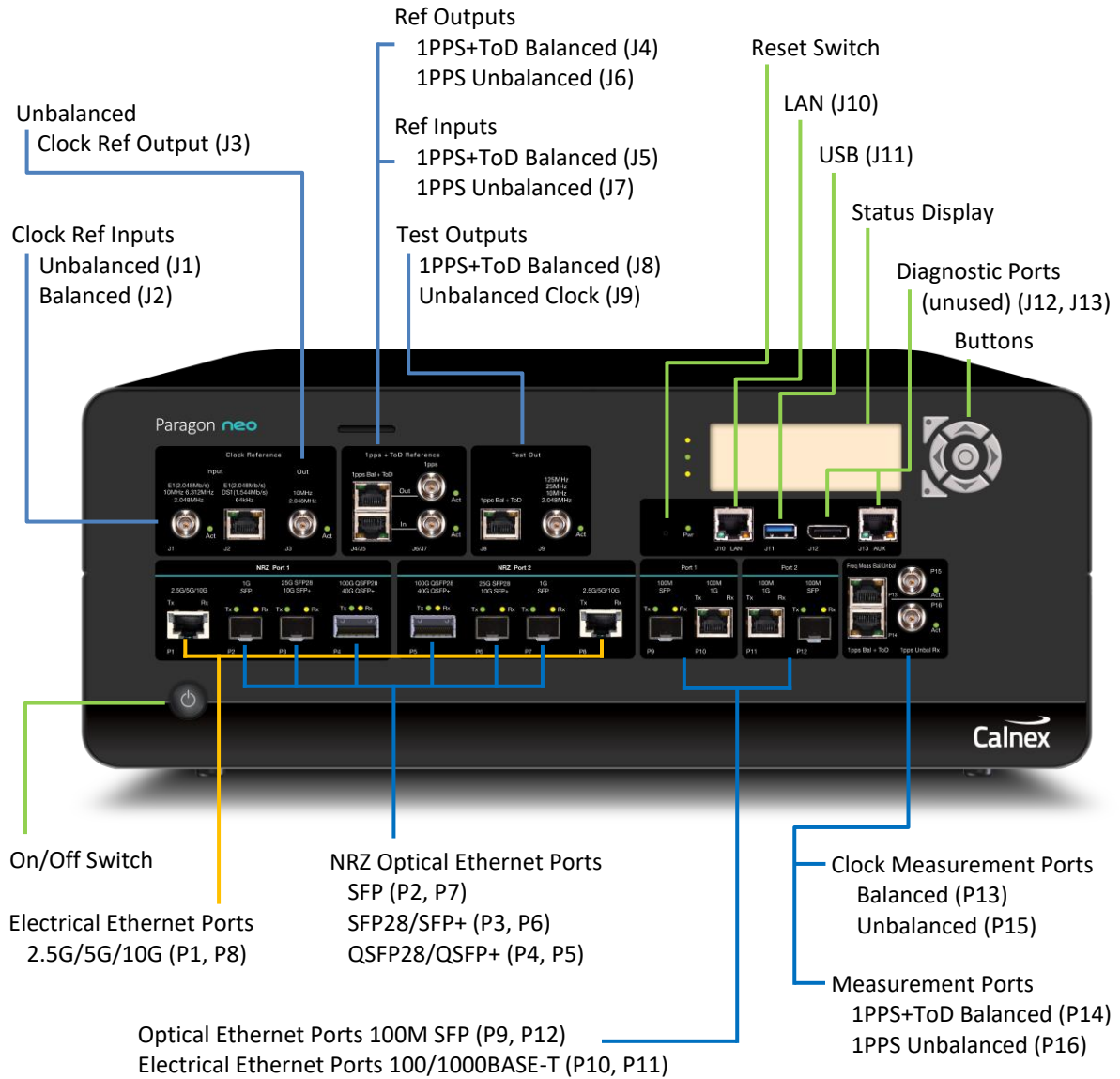
3   Paragon-neo Front Panels

3.1   First Generation Paragon-neo NRZ Front Panel

First generation Paragon-neo NRZ instruments can be identified by the presence of two CFP4 transceiver ports on the front panel.

Ref Outputs
    1PPS+ToD Balanced (J4)
    1PPS Unbalanced (J6)

Reset Switch

LAN (J10)

Unbalanced Clock
    Ref Output (J3)

Ref Inputs
    1PPS+ToD Balanced (J5)
    1PPS Unbalanced (J7)

USB (J11)

Status Display

Clock Ref Inputs
    Unbalanced (J1)
    Balanced (J2)

Test Outputs
    1PPS+ToD Balanced (J8)
    Unbalanced Clock (J9)

Diagnostic Ports
    (unused) (J12, J13)

Buttons

On/Off Switch

Optical Ethernet Ports
    SFP (P2, P9)
    SFP+/SFP28 (P3, P8)
    QSFP+/QSFP28 (P4, P7)
    100G CXP (P1, P10)
    100G CFP4 (P5, P6)

Clock Measurement Ports
    Balanced (P15)
    Unbalanced (P16)

Measurement Ports
    1PPS+ToD Balanced (P17)
    1PPS Unbalanced (P18)

Optical Ethernet Ports 100M SFP (P11, P14)
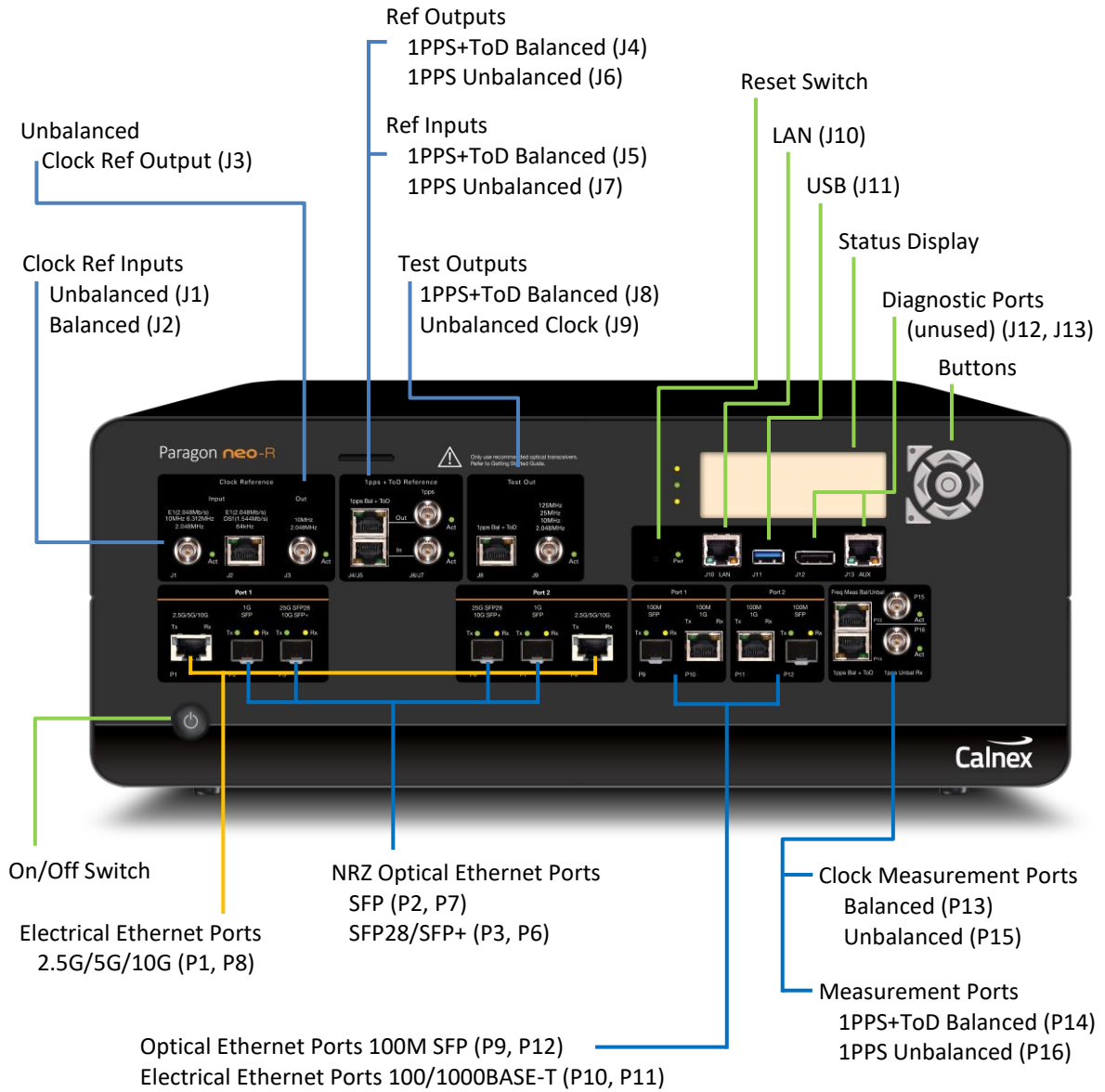Electrical Ethernet Ports 100/1000BASE-T (P12, P13)

3.2 Second Generation Paragon-neo NRZ Front Panel

Second generation Paragon-neo NRZ instruments can be identified by the presence of two high speed electrical (2.5G/5G/10G) Ethernet ports on the front panel. Second generation instruments do not have CFP4 transceiver ports.
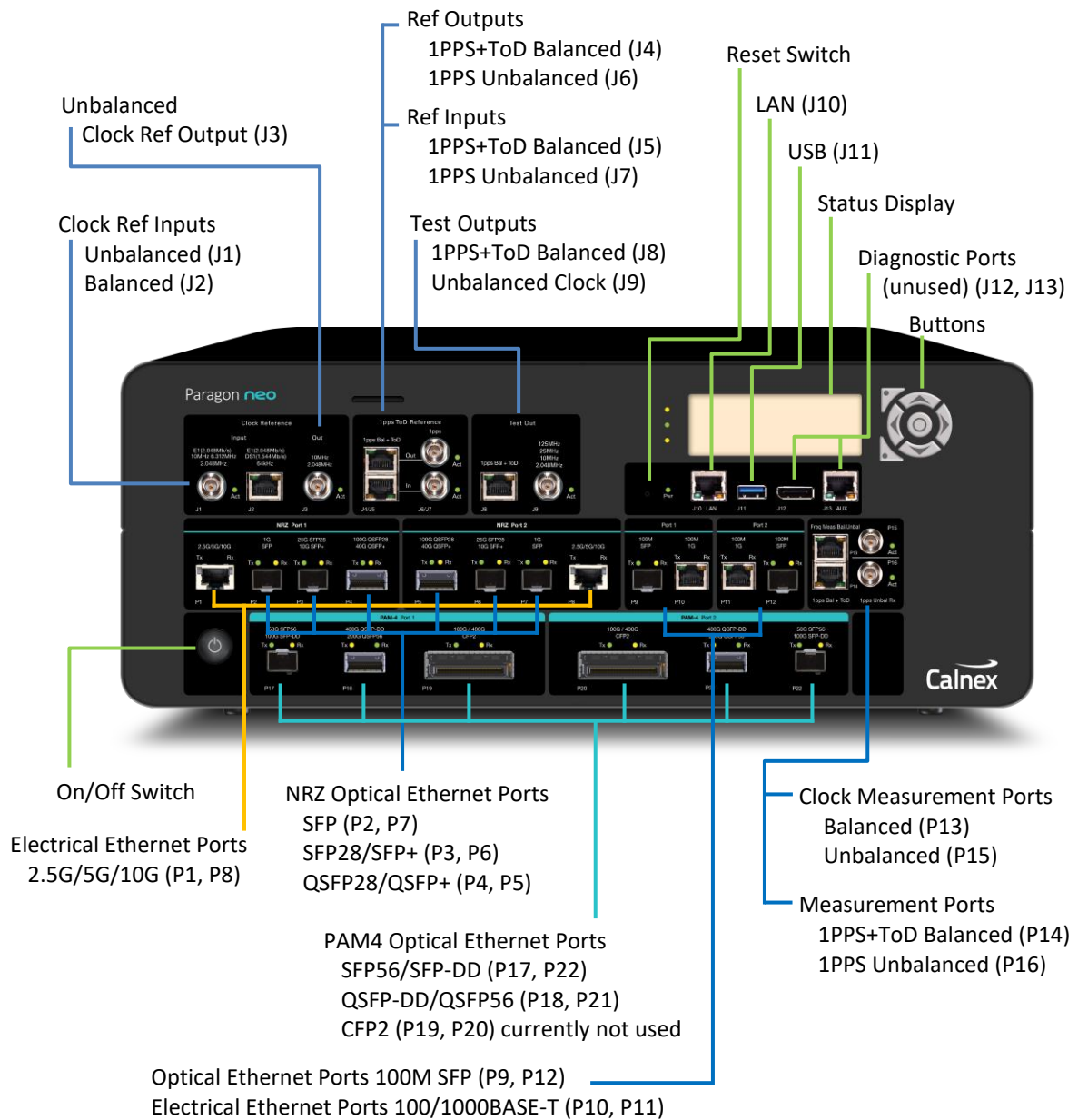

Ref Outputs
  1PPS+ToD Balanced (J4)
  1PPS Unbalanced (J6)

Ref Inputs
  1PPS+ToD Balanced (J5)
  1PPS Unbalanced (J7)

Test Outputs
  1PPS+ToD Balanced (J8)
  Unbalanced Clock (J9)

Reset Switch

LAN (J10)

USB (J11)

Status Display

Diagnostic Ports
  (unused) (J12, J13)

Buttons

Unbalanced
  Clock Ref Output (J3)

Clock Ref Inputs
  Unbalanced (J1)
  Balanced (J2)

On/Off Switch

Electrical Ethernet Ports
  2.5G/5G/10G (P1, P8)

NRZ Optical Ethernet Ports
  SFP (P2, P7)
  SFP28/SFP+ (P3, P6)
  QSFP28/QSFP+ (P4, P5)

Clock Measurement Ports
  Balanced (P13)
  Unbalanced (P15)

Measurement Ports
  1PPS+ToD Balanced (P14)
  1PPS Unbalanced (P16)

Optical Ethernet Ports 100M SFP (P9, P12)
Electrical Ethernet Ports 100/1000BASE-T (P10, P11)

3.3 Paragon-neo R Front Panel

Paragon-neo R instruments can be identified by the Paragon-neo R logo on the front panel.

Ref Outputs
 1PPS+ToD Balanced (J4)
 1PPS Unbalanced (J6)

Reset Switch

LAN (J10)

USB (J11)

Ref Inputs
 1PPS+ToD Balanced (J5)
 1PPS Unbalanced (J7)

Unbalanced
 Clock Ref Output (J3)

Status Display

Test Outputs
 1PPS+ToD Balanced (J8)
 Unbalanced Clock (J9)

Diagnostic Ports
 (unused) (J12, J13)

Clock Ref Inputs
 Unbalanced (J1)
 Balanced (J2)

Buttons

On/Off Switch

NRZ Optical Ethernet Ports
 SFP (P2, P7)
 SFP28/SFP+ (P3, P6)

Clock Measurement Ports
 Balanced (P13)
 Unbalanced (P15)

Electrical Ethernet Ports
 2.5G/5G/10G (P1, P8)

Measurement Ports
 1PPS+ToD Balanced (P14)
 1PPS Unbalanced (P16)

Optical Ethernet Ports 100M SFP (P9, P12)
Electrical Ethernet Ports 100/1000BASE-T (P10, P11)

3.4 Paragon-neo PAM4 Front Panel

Paragon-neo PAM4 instruments can be identified by the presence of a second row of PAM4 transceiver ports.

Ref Outputs
  1PPS+ToD Balanced (J4)
  1PPS Unbalanced (J6)

Ref Inputs
  1PPS+ToD Balanced (J5)
  1PPS Unbalanced (J7)

Test Outputs
  1PPS+ToD Balanced (J8)
  Unbalanced Clock (J9)

Unbalanced
  Clock Ref Output (J3)

Clock Ref Inputs
  Unbalanced (J1)
  Balanced (J2)

Reset Switch

LAN (J10)

USB (J11)

Status Display

Diagnostic Ports
  (unused) (J12, J13)

Buttons

On/Off Switch

Electrical Ethernet Ports
  2.5G/5G/10G (P1, P8)

NRZ Optical Ethernet Ports
  SFP (P2, P7)
  SFP28/SFP+ (P3, P6)
  QSFP28/QSFP+ (P4, P5)

PAM4 Optical Ethernet Ports
  SFP56/SFP-DD (P17, P22)
  QSFP-DD/QSFP56 (P18, P21)
  CFP2 (P19, P20) currently not used

Optical Ethernet Ports 100M SFP (P9, P12)
Electrical Ethernet Ports 100/1000BASE-T (P10, P11)

Clock Measurement Ports
  Balanced (P13)
  Unbalanced (P15)

Measurement Ports
  1PPS+ToD Balanced (P14)
  1PPS Unbalanced (P16)

4   Front Panel Controls

Paragon-neo NRZ first- and second-generation instruments have different Ethernet port numbers as shown in the tables below. Paragon-neo NRZ second generation, Paragon-neo R and Paragon-neo PAM4 have consistent ports numbers for the Ethernet ports. All other ports (reference, measurement, management) have consistent port numbers across the Paragon-neo family.

4.1   On/Off Switch

Use this button to switch Paragon-neo On or Off. Switch off at the front panel before switching off the AC input on the rear panel.

4.2 Ethernet Ports

Optical Transceivers

⚠️ **CAUTION**
Take care when inserting and removing transceivers from all ports. Excessive insertion and extraction force, leverage and vertical movement can permanently damage the internal circuitry.

Direct Attach Cables (DACs)

⚠️ **CAUTION**
Paragon-neo ports are designed for optical transceivers only. Direct Attach Cables, both active and passive, are not supported on any ports. Use of Direct Attach Cables can permanently damage the internal circuitry.

100M/1G Electrical Ethernet ports

100M SFP Ethernet ports	Paragon-neo NRZ 1st gen:	P11, P14	For connections to 100M NRZ interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P9, P12	
100M/1G Electrical Ethernet ports	Paragon-neo NRZ 1st gen:	P12, P13	For connections to 100M/1G RJ45 electrical interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P10, P11	

Note: During a Boundary Clock Relative Time Error test, the Port 1 100M SFP port operates at 1G. Further details are given in the G.8273.2 BC Conformance Test Guide, document ref CX3009.

2.5G/5G/10G Electrical Ethernet Ports

2.5G/5G/10G Electrical Ethernet ports	Paragon-neo NRZ 1st gen:	n/a	Contact Calnex for software support schedule.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P1, P8	

1G SFP Ethernet Ports

1G SFP Ethernet ports	Paragon-neo NRZ 1st gen:	P2, P9	For connections to 1G NRZ optical interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P2, P7	

SFP+/SFP28 Ethernet Ports

10G SFP+ Ethernet ports	Paragon-neo NRZ 1st gen:	P3, P8	For connections to 10G NRZ optical interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P3, P6	
25G SFP28 Ethernet ports	Paragon-neo NRZ 1st gen:	P3, P8	For connections to 25G NRZ optical interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P3, P6	

QSFP28/QSFP+ Ethernet Ports

40G QSFP+ Ethernet ports	Paragon-neo NRZ 1st gen:	P4, P7	For connections to 40G (4 x 10G) NRZ optical interfaces on Ethernet devices.
	Paragon-neo R	n/a	
	Paragon-neo NRZ 2nd gen, PAM4:	P4, P5	
100G QSFP28 Ethernet ports	Paragon-neo NRZ 1st gen:	P4, P7	For connections to 100G (4 x 25G) NRZ optical interfaces on Ethernet devices.
	Paragon-neo R	n/a	
	Paragon-neo NRZ 2nd gen, PAM4:	P4, P5	

100G CXP Ethernet Ports

100G CXP Ethernet ports	Paragon-neo NRZ 1st gen:	P1, P10	For connections to 100G NRZ optical interfaces on Ethernet devices.
	Paragon-neo NRZ 2nd gen, R, PAM4:	n/a	

100G CFP4 Ethernet Ports P5, P6 – Do Not Connect

100G CFP4 Ethernet ports	Paragon-neo NRZ 1st gen:	P5, P6	Do not connect.
	Paragon-neo NRZ 2nd gen, R, PAM4:	n/a	These ports are not used.

SFP56/SFP-DD Ethernet Ports

50G SFP56 Ethernet ports	Paragon-neo NRZ 1st gen, 2nd gen, R:	n/a	For connections to 50G PAM4 optical interfaces on Ethernet devices.
	Paragon-neo PAM4:	P17, P22	
100G SFP-DD Ethernet ports	Paragon-neo NRZ 1st gen, 2nd gen, R:	n/a	For connections to 100G PAM4 optical interfaces on Ethernet devices.
	Paragon-neo PAM4:	P17, P22	

Note: PAM4 100G support was first introduced in Paragon-neo Software Revision 11.00.xx.

QSFP56/QSFP-DD Ethernet Ports

200G QSFP56 Ethernet ports	Paragon-neo NRZ 1st gen, 2nd gen, R:	n/a	For connections to 200G PAM4 optical interfaces on Ethernet devices.
	Paragon-neo PAM4:	P18, P21	
400G QSFP-DD Ethernet ports	Paragon-neo NRZ 1st gen, 2nd gen, R:	n/a	For connections to 400G PAM4 optical interfaces on Ethernet devices.
	Paragon-neo PAM4:	P18, P21	

CFP2 Ethernet Ports

100G/400G CFP2 Ethernet ports	Paragon-neo NRZ 1st gen, 2nd gen, R:	n/a	Do not connect.
	Paragon-neo PAM4:	P19, P20	These ports are not used.

4.3 References Inputs & Outputs

Calnex recommend that all cables carrying reference signals are as short as possible. ITU G.703 Section 19.2 states that 50Ω cables carrying 1PPS signal must be less than 3m length to ensure signal integrity.

Clock Reference Input

RJ48 Balanced Clock Reference Input	Paragon-neo NRZ 1st gen:	J2	Balanced clock reference signals (RJ48): E1, T1, 64k+8k, 64k+8k+400. Pin 1 (Ring), Pin 2 (Tip). All other pins must be left unconnected. Max differential input voltage: 3.3V.

	Paragon-neo NRZ 2nd gen, R, PAM4:	J2	AC coupled.
			Input impedance:
			  E1 120Ω differential,
			  T1 100Ω differential,
			  64k+8k, 64k+8k+400 120Ω differential.

BNC Unbalanced Clock Reference Input	Paragon-neo NRZ 1st gen:	J1	Unbalanced clock reference signals: 2.048MHz, 10MHz, E1.
			Max input voltage:
			  10MHz, 2.048MHz 5Vp-p,
			  E1 3.3Vp-p.

	Paragon-neo NRZ 2nd gen, R, PAM4:	J1	Input impedance:
			  2.048MHz 50Ω or High Impedance, AC coupled,
			  E1 75Ω AC coupled,
			  10MHz 50Ω or High Impedance, AC coupled.

⚠ **IMPORTANT**

Paragon-neo allows the option to input balanced and unbalanced clock reference signals. Calnex recommend using an unbalanced clock reference signal (BNC connector J1) for the best measurement accuracy.

1PPS and ToD Reference Inputs

RJ48 Balanced 1PPS and ToD Reference Input	Paragon-neo NRZ 1st gen:	J5	Balanced 1PPS and ToD reference input. Pins 3 (–) and 6 (+) 1PPS balanced input. Pins 7 (–) and 8 (+) ToD balanced input. Pins 4 and 5 ground. All other pins must be left unconnected.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J5	Min input voltage: 0.3V differential. Max input voltage: 10V differential. ToD and 1PPS inputs are DC coupled. Input impedance: 100Ω differential.
BNC Unbalanced 1PPS Reference Input	Paragon-neo NRZ 1st gen:	J7	Unbalanced 1PPS reference input. Max input voltage: 5V DC coupled. Threshold voltage adjustable in the GUI. Input impedance: 50Ω or High Impedance.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J7	
1PPS reference input pulse timing requirements: 100ns minimum pulse width, 500ms maximum pulse width.			

⚠ IMPORTANT

Paragon-neo allows the option to input balanced and unbalanced 1PPS reference signals. Calnex recommend using an unbalanced 1PPS reference signal (BNC connector J7) for the best measurement accuracy.

Unbalanced Clock Reference Output

BNC Unbalanced Clock Reference Output	Paragon-neo NRZ 1st gen:	J3	Connection to unbalanced clock reference output: 2.048MHz or 10MHz. Output voltage: -1.5/+1.5V High Impedance load, -0.75/+0.75V 50Ω load.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J3	Output impedance: 2.048MHz 50Ω, AC coupled, 10MHz 50Ω, AC coupled.

1PPS and ToD Reference Outputs

RJ48 Balanced 1PPS and ToD Reference Output	Paragon-neo NRZ 1st gen:	J4	For connection to the reference input of other pieces of lab test equipment, or other Paragon-neos. The output ToD data cannot be modified. Pins 3 (–) and 6 (+) 1PPS balanced output. Pins 7 (–) and 8 (+) ToD balanced output. Pins 4 and 5 ground.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J4	All other pins must be left unconnected. Output voltage: 2.0V differential, V_{cm}=2.5Vtyp into 100Ω load, DC coupled. Output drives 100Ω load.
BNC Unbalanced 1PPS Reference Output	Paragon-neo NRZ 1st gen:	J6	Connection to unbalanced 1PPS reference output. Output voltage: 0.6/3.8V High Impedance load, 0/1.8V 50Ω load.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J6	Output impedance: 50Ω DC coupled.
1PPS reference output pulse width: 20ms.			

⚠️ **CAUTION**

The 1PPS and ToD Reference Output connectors are designed for output only. Care must be taken when connecting that an input signal is not applied, as this can permanently damage the internal circuitry.

Test Outputs

RJ48 Balanced 1PPS and ToD Test Output	Paragon-neo NRZ 1st gen:	J8	For connection to a 1PPS and ToD input of devices under test. The output ToD data can be modified to emulate the behavior of a real ToD source. Pins 3 (–) and 6 (+) 1PPS balanced output. Pins 7 (–) and 8 (+) ToD balanced output.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J8	Pins 4 and 5 ground. All other pins must be left unconnected. Output voltage: 2.0V differential, V_{cm}=2.5Vtyp into 100Ω load, DC coupled. Output drives 100Ω load.
BNC Unbalanced Clock Test Output	Paragon-neo NRZ 1st gen:	J9	Connection to unbalanced 10MHz clock test output. Output voltage: -1.5/+1.5V high impedance load, -0.6/+0.6V 50Ω load.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J9	Output impedance: 50Ω AC coupled.
1PPS test output pulse width: 20ms.			

CAUTION

The 1PPS and ToD Test Output connectors are designed for output only. Care must be taken when connecting that an input signal is not applied, as this can permanently damage the internal circuitry.

4.4 Measurement Ports

Calnex recommend that all cables carrying measurement signals are as short as possible. ITU G.703 Section 19.2 states that 50Ω cables carrying 1PPS signal must be less than 3m length to ensure signal integrity.

Cable compensation values can be configured in Paragon-neo depending on the measurement running. Typical cable propagation delay values are 4.9ns/m for single-mode optical cables, 4.94ns/m for multimode optical cables and 5.1ns/m for electrical cables. Note that these are only typical values and the actual value will differ between specific cable types, therefore, for the most accurate cable compensation, the actual propagation delay value for a specific cable should be provided by the cable manufacturer or measured by the user.

Clock Frequency Measurement Inputs

RJ48 Balanced T1/E1 Clock Frequency Measurement Input	Paragon-neo NRZ 1st gen:	P15	Connection to balanced T1/E1 clock frequency measurement input. Pins 1 (ring) and 2 (tip) – balanced frequency input. All other pins must be left unconnected. Max input voltage: 3.3V differential. Input impedance: T1 100Ω differential, AC coupled, E1 120Ω differential, AC coupled.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P13	
BNC Unbalanced Clock Frequency Measurement Input	Paragon-neo NRZ 1st gen:	P16	Connection to unbalanced E1 / 2.048MHz / 10MHz / 25MHz clock frequency measurement input. Max input voltage: 2.048MHz, 10MHz, 25MHz 5Vp-p, E1 3.3Vp-p. Input impedance: 2.048MHz, 10MHz, 25MHz 50Ω AC coupled, E1 75Ω AC coupled.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P15	

1PPS and ToD Measurement Inputs

RJ48 Balanced 1PPS and ToD Measurement Inputs	Paragon-neo NRZ 1st gen:	P17	Connection to balanced 1PPS and ToD measurement inputs. Pins 3(–) and 6(+) 1PPS balanced inputs. Pins 7(–) and 8(+) ToD balanced inputs. Pins 4 and 5 ground.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P14	All other pins must be left unconnected. Min input voltage: 0.3V differential. Max input voltage: 10V differential. Input impedance: 100Ω differential DC coupled.
BNC Unbalanced 1PPS Measurement Input	Paragon-neo NRZ 1st gen:	P18	Connection to balanced 1PPS measurement input. Max input voltage: 5V DC coupled.
	Paragon-neo NRZ 2nd gen, R, PAM4:	P16	Threshold voltage adjustable in the GUI. Input impedance: 50Ω or High Impedance.
1PPS measurement pulse timing requirements: 100ns minimum pulse width, 500ms maximum pulse width.			

IMPORTANT

Paragon-neo allows the option to input balanced and unbalanced 1PPS measurement signals. Calnex recommend using the unbalanced 1PPS measurement port (BNC connector P16/P18) to ensure best measurement accuracy

4.5 Control & Configuration

Status Display

After booting, the Paragon-neo management port IP address is displayed on the LCD Status Display.

Buttons

The buttons to the right of the LCD Status Display are used to configure the Paragon-neo management port IP address, see section 7 for details.

LAN (J10)

This is for connection to the network or a to a PC. The connection to the Paragon-neo LAN control port (RJ45) is 1GbE.

USB (J11)

This is for firmware upgrades via a memory stick and can also be used to power any USB accessories.

Reset Switch

Using a pointed implement, gently press the RESET button to return the Paragon-neo to its power-on condition. This resets the IP address to factory default.

Diagnostic Ports J12, J13 – Do Not Connect

Diagnostic Ports	Paragon-neo NRZ 1st gen:	J12, J13	Do not connect. These ports are reserved for diagnostic use by Calnex.
	Paragon-neo NRZ 2nd gen, R, PAM4:	J12, J13	

5   Rear Panel Description

AC Power Inlet + Switch

High-Speed
Data Inputs
(not used)

GPS Antenna
Input + Output
(not used)
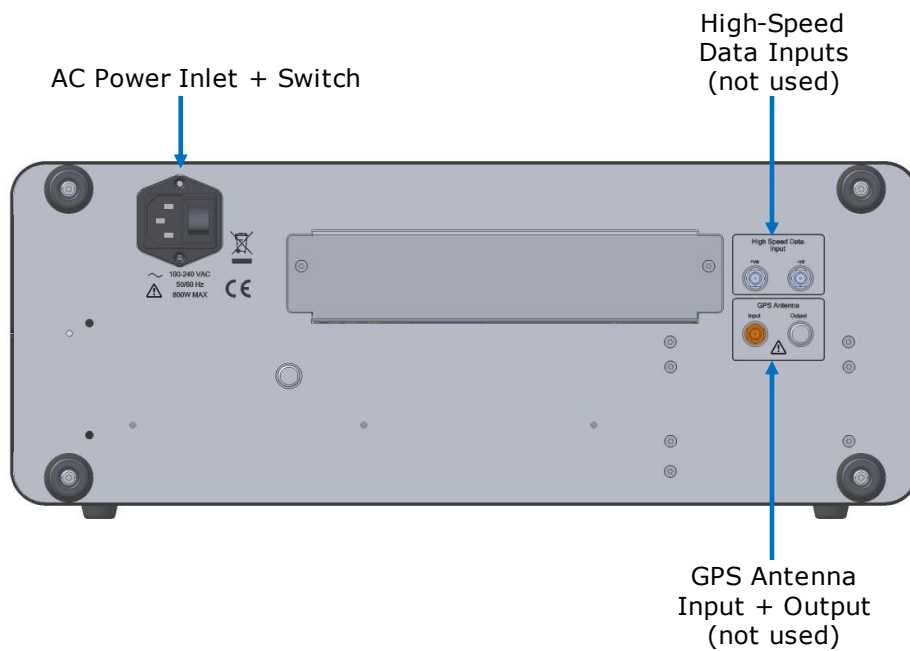
AC Power Input

For connection to supplied AC power using the power cord supplied, or one with adequate ratings. See section 2.2.3 for details of the power requirements.

AC Power Switch

Use this switch to turn the Paragon-neo AC Input On or Off.

GPS Antenna Input & Output

The GPS antenna input and output connections are not used. Do not connect.

High-Speed Data Inputs

The high-speed data input connections are not used. Do not connect.

6 Optical Transceivers

Accurate PTP and SyncE timing measurement requires the use of high-quality optical transceivers (user supplied) with Paragon-neo. Transceivers that exhibit high degrees of timing variability should be avoided.

6.1 Supported NRZ Optical Transceivers

NRZ transceivers generally exhibit low latency asymmetry that is compensated for by Paragon-neo. Most NRZ optical transceivers can be used for PTP timing and SyncE wander measurements. SyncE Jitter testing requires the use of specific optical transceivers qualified by Calnex. Qualified transceivers have low inherent jitter and can be correctly configured by Paragon-neo to make accurate measurements.

For the complete list of Calnex-supported optical transceivers please see the relevant section of the Calnex FAQ (keyword "optics") accessed through the support pages at www.calnexsol.com.

6.2 Supported PAM4 Optical Transceivers

PAM4 optical transceivers (50G, 100G, 200G and 400G) typically exhibit variable and asymmetric latencies that negatively impacts timing measurement accuracy. Therefore, Calnex have qualified specific PAM4 transceivers that must be used with Paragon-neo.

For the complete list of Calnex-supported optics please see the relevant section of the Calnex FAQ (keyword "optics") accessed through the support pages at www.calnexsol.com.

7   Connecting Your Paragon-neo

You can either connect to Paragon-neo across a network or connect directly to a PC. Paragon-neo instruments shipped from Calnex default to obtaining an IP address using DHCP, users can assign a static IP address as described below.

7.1   Connecting Paragon-neo to a Network using DHCP

1. Connect the AC power cord and switch on Paragon-neo using the rear-panel power switch.

2. Press the front panel power button to start the instrument. A message appears on the LCD Status Display to indicate Paragon-neo is Initialising:
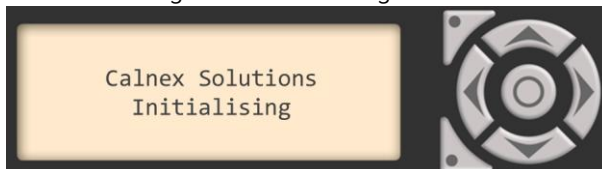
3. Wait for the Paragon-neo to power up and show 'Obtaining IP …' on the LCD Status Display. Power-up may take 2-3 minutes.
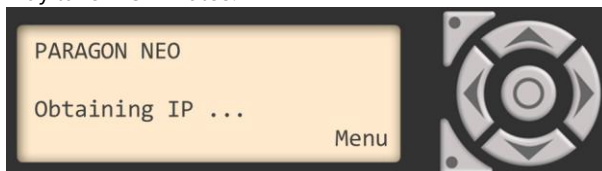
4. Connect an Ethernet cable between the Paragon-neo management port (J10) and your network.

5. DHCP is enabled by default so Paragon-neo should obtain an IP address on the network. The IP address will be displayed on the LCD Status Display.
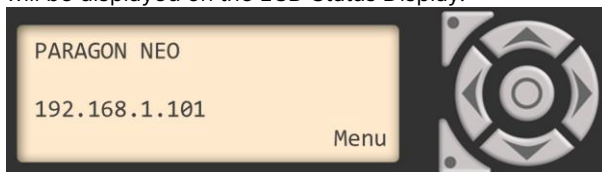
6. If the DHCP process times out (5 mins) before obtaining an IP address, the default static IP address will be used and displayed on the LCD Status Display. New instruments shipped from Calnex have a default static IP address of 169.254.1.100.

7.2   Connecting Paragon-neo to a Network using a Static IP Address

1. Connect the AC power cord and switch on Paragon-neo using the rear-panel power switch.

2. Press the front panel power button to start the instrument. A message appears on the LCD Status Display to indicate Paragon-neo is Initialising:
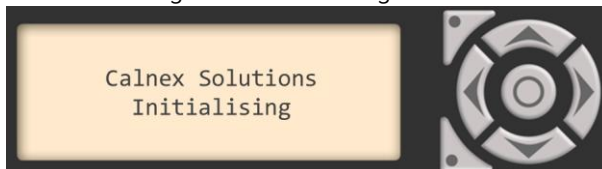
3. Wait for the Paragon-neo to power up and show 'Obtaining IP …' on the LCD Status Display. Power-up may take 2-3 minutes.

4. Press the bottom left button next to the LCD Status Display (labelled 'Menu') to show the Main Menu on the LCD Status Display.

```
    Main Menu
 >  IP
    Display
```
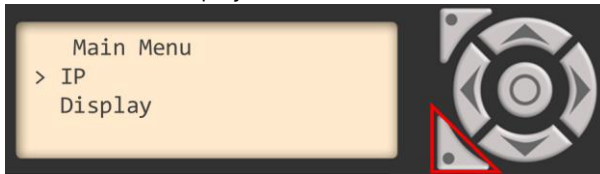
5. Select the IP menu by pressing the centre button.

```
    IP Editor
 >  Automatic          ☑
```
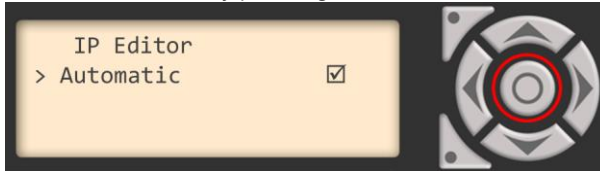
6. In the IP menu, select Static IP address by pressing the centre button to clear the 'Automatic' checkbox.

```
    IP Editor
 >  Automatic          ☐
    I       169.254.1.100
    M         255.255.0.0↓
```
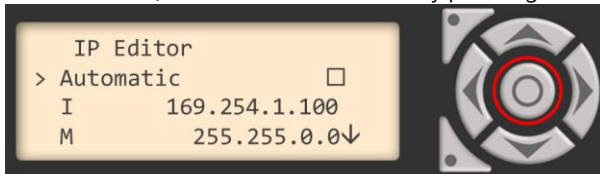
7. In the IP menu, use the up, down, left, right and centre buttons to set a Static IP address, address mask and gateway address on Paragon-neo. Press the centre button to save the settings.

```
 I

    169.254.1.100
```
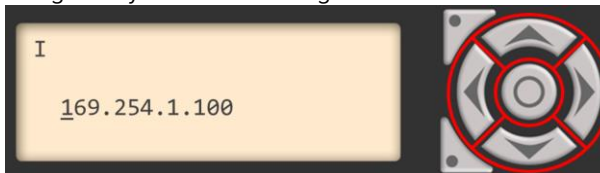
8. Press the bottom left button once to exit the IP menu and a second time to exit the Main Menu and return to the main display.
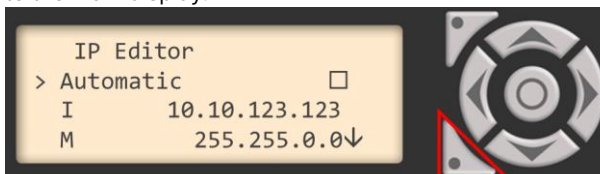
```
    IP Editor
 >  Automatic          ☐
    I       10.10.123.123
    M         255.255.0.0↓
```

9. Connect an Ethernet cable between the Paragon-neo management port (J10) and your network.

```
PARAGON NEO

10.10.123.123
                    Menu
```
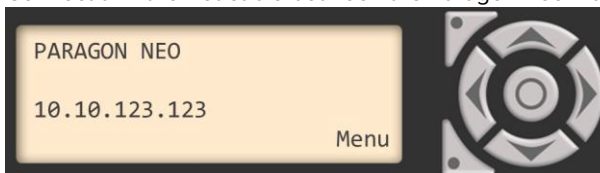
7.3 Connecting Paragon-neo Direct to a PC using a Static IP Address

1. Follow the steps in section 7.2 to assign a static IP address to Paragon-neo.

2. Assign a static IP address to your PC Ethernet port that is on the same subnet as Paragon-neo. Instructions for setting a static IP address depend on your specific PC, please refer to PC documentation.

3. Connect an Ethernet cable directly between the Paragon-neo management port (J10) and your PC.

7.4 Browser Access to Paragon-neo GUI

Once Paragon-neo has an IP address, operation and management of Paragon-neo is through a PC based web browser. Browse to the IP address displayed on the Paragon-neo LCD Status Display to see the main Paragon-neo GUI.

Windows 10 and 11 PCs running Edge, Firefox and Chrome browsers are supported, other browsers are not precluded.

See section 12 to enable additional access security.

8   Switching On/Off & User Interface Basics

8.1 Switching On

Connect the power cord supplied with Paragon-neo to the AC power inlet on the Paragon-neo rear panel (see section 5) and switch the power switch next to the AC power inlet. Press the on/off button on the front panel and Paragon-neo will start to boot. Once the LCD display shows an IP address, you can connect through a browser, see section 7. Boot time may be several minutes.

8.2 User Interface

Paragon-neo has embedded software that is pre-installed prior to delivery. No application software is required to be installed on your computer.

To connect to the Calnex Paragon-neo, enter the IP address shown on the front panel status display into your web browser address bar to see the user interface shown below. The availability of specific functionality is dependent on the fitted hardware and software options.
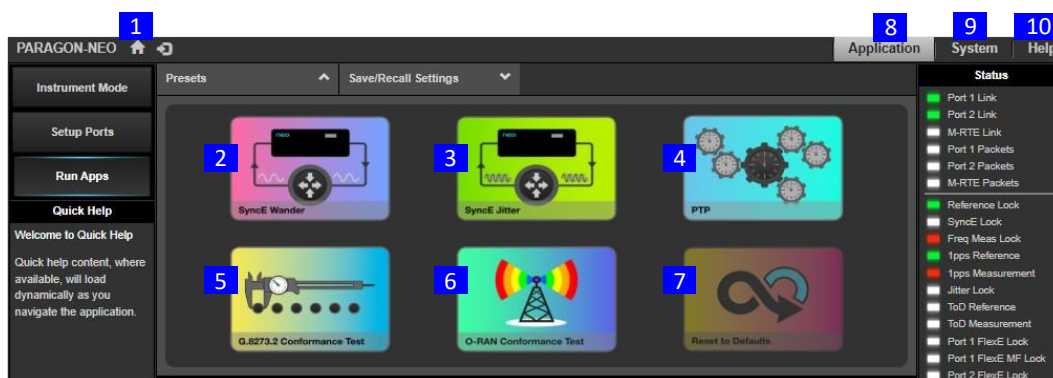
1   Home

The Home button will always take you to the Paragon-neo home screen. The **Presets** panel is displayed by clicking on ▼ symbol and closed by clicking the ▲ symbol.

2   SyncE Wander

Select if you want to test SyncE Wander up to 400GbE to ITU-T G.8262.1/G.8262.

3   SyncE Jitter

Select if you want to test SyncE Jitter up to 100GbE to ITU-T G.8262.1/G.8262.

4   PTP

Select if you want to test PTP up to 400GbE in user-defined scenarios.

For ITU-T testing, the **G.8273.2 Conformance Test** selection is recommended.

For O-RAN testing, the **O-RAN Conformance Test** selection is recommended.

5   G.8273.2 Conformance Test

Select if you want to test PTP up to 400GbE to ITU-T G.826x/G.827x standards.

6   O-RAN Conformance Test

Select if you want to test PTP up to 400GbE to the O-RAN WG4.CONF 3.3 S-Plane Functional and Performance tests standard.

7   Reset to Defaults

Resets the Application configuration to default settings.

8 **Application**

Select to browse to the main application page to configure and run tests.

9 **System**

Provides information on Serial Number and Options fitted, IP Status, System Status, Error logs. It also enables setting of the Time and Date, and shows how to access the file server on the instrument using your browser.

10 **Help**

This provides access to Test Guides, Application Notes, links to ITU-T recommendations and instrument software plus licensing information.

8.3 Instrument Shutdown

The power button icon in the bottom right of the User Interface allows you to switch off or restart the instrument.

8.4 Software Version & Instrument Serial Number

The Paragon-neo instrument serial number and software version information is provided in the **Help** > **About** GUI.
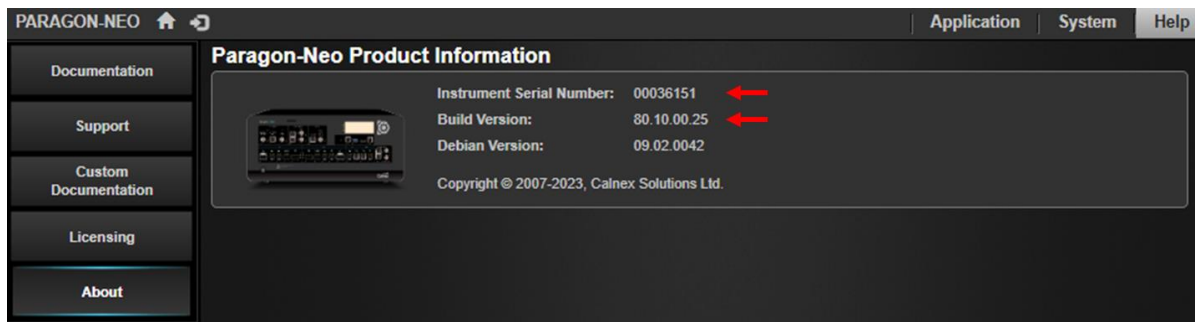
9   Workflow

The availability of specific functionality is dependent on the fitted hardware and software options.

1   Instrument Mode

Selecting the **Instrument Mode** page allows setup of reference and seed times for Paragon-neo features such as PTP and ToD message generation.

2   Setup Ports

Selecting the **Setup Ports** page allows selection and configuration of reference and measurement ports.

3   Run Apps

Run Apps is the main instrument control screen where you can setup and start defined synchronization testing.

4   Status Indicators

The colors of the status indicators reflect the status of the associated function.

Green	**Green:** No alarms
Red	**Red:** Current alarm
Orange	**Orange:** Historical alarm, now cleared
White	**White:** Not active in selected Paragon-neo configuration

The indicators describe the current state of the following functions:

Port 1 Link Ports 2 Link TT-RTE Link	Indicates physical Ethernet connections to Paragon-neo test ports by detecting transitions on the selected port Rx side.
Port 1 Packets Port 2 Packets TT-RTE Packets	Indicates that Paragon-neo is receiving Ethernet packets with no PCS or checksum errors.
Reference Lock 1PPS Reference ToD Reference	Indicates that Paragon-neo reference inputs are present and locked. The references are selected under the **Setup Ports** key.
SyncE Lock Freq Meas Lock Jitter Lock 1PPS Measurement ToD Measurement	Indicates the presence and lock status of incoming measurement signals. Measurements are activated using the applications under the **Run Apps** key.
Port 1 FlexE Lock Port 1 FlexE MF Lock Port 2 FlexE Lock Port 2 FlexE MF Lock	Indicates FlexE frame lock status and FlexE multi-frame (MF) lock status. FlexE parameters are configured under **Setup Ports → Ethernet → FlexE Settings**

5 Activity Indicators

Activity Indicators show which of the applications (e.g. PTP Emulation, SyncE Wander, Wander Generation, ESMC generation, Background Traffic Generation) under the **Run Apps** key are currently active. The color provides an indication of the status, with green = active, white = inactive. **P1** indicates Port1 and **P2** indicates Port2.

6 Measurements

This area provides the global Start/Stop control for all Wander measurements. Select **Start All** to start both Port1 and Port2 Measurements. Select **Stop All** to stop all active Measurements.

7 Analysis Tools

CAT and **PFV** buttons appear in applications where measurements are made.

Click **CAT** to open the Calnex Analysis Tool in a separate tab in your browser. CAT provides graphical Timing Analysis measurements and results as well as Pass/Fail performance against selected metrics and masks, for example to ITU-T standards.

Click **PFV** to open the Protocol Field Verifier in a separate tab in your browser. PFV provides graphical packet analysis as well as Pass/Fail performance against selected PTP profiles.

8 Script Recorder

The **Script Recorder** records all key presses and stores them as a script enabling you to cut and paste the recorded script into your own programming environment enabling easy automation. Scripts are recorded in tcl and Python.

9 Quick Help

Quick Help content loads dynamically as you navigate through the various fields in the application. Provides hints and help on setting up selected applications and fields including information on the units, resolution and ranges of specific fields.

10   Example Paragon-neo Workflow

Connect to the Calnex Paragon-neo by entering the IP address shown on the front panel status display into your browser address bar and then the user interface is displayed as shown below:

From the Workflow keys:

1. Start the **Paragon-neo** GUI.

2. Select a preset test mode e.g. **PTP**.
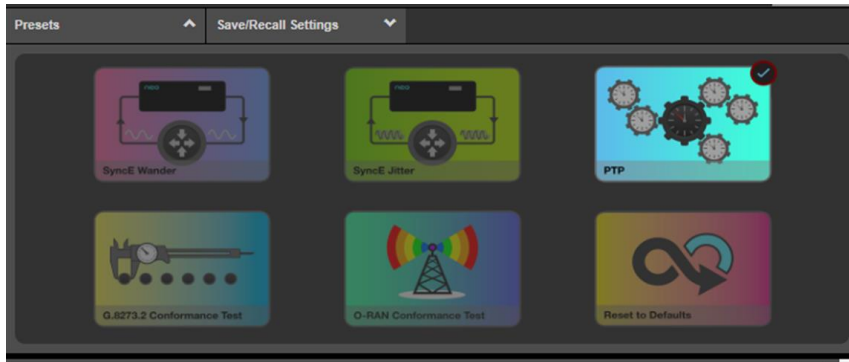
3. If the test selection requires an absolute time reference, select **Instrument Mode** from the left-hand side of the GUI. The **Time Source** can be selected and configured to use a predetermined start time, the instrument's internal time, or a Time of Day reference (if connected to Paragon-neo 1PPS/ToD reference port). Press **Apply** after making any changes.
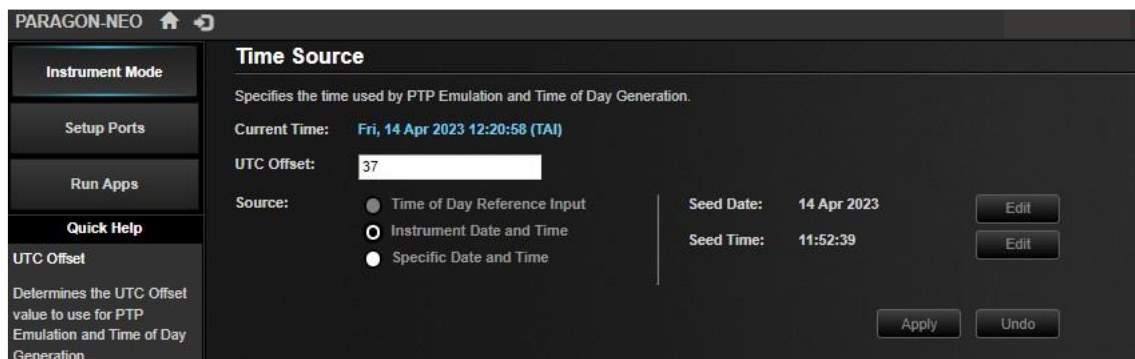
4. Click **Setup Ports**

On the front panel image, click the appropriate Clock Reference and 1PPS ToD Reference selectors for your test environment. Configure reference input parameters in the lower panel. Check the reference status indicators.
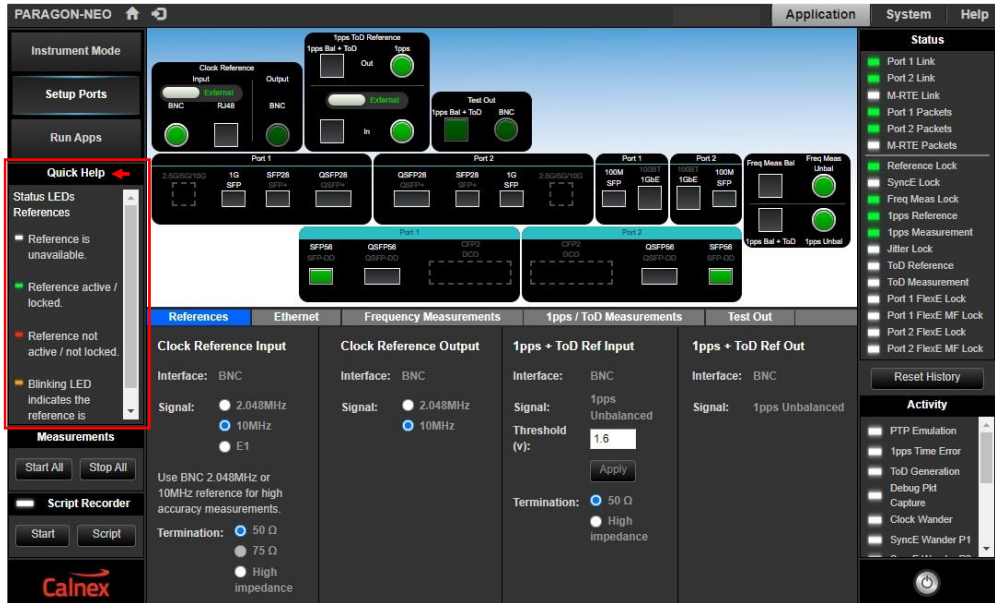
The **Quick Help** panel is context sensitive and shows help relative to the item in the GUI where the cursor is active.

5. On the front panel picture, click the appropriate Ethernet port selectors for connection to your device. Configure Ethernet port details input details in the lower panel. Check the Port 1 Link and Port 2 Link status indicators.

6. Select **Run Apps** and open/close application panels as required for your test scenario.

7. Configure the parameters for generation and measurement as required for your test environment then click the appropriate **Generate** and **Measure** buttons. The buttons turn green and indicate **Stop**.
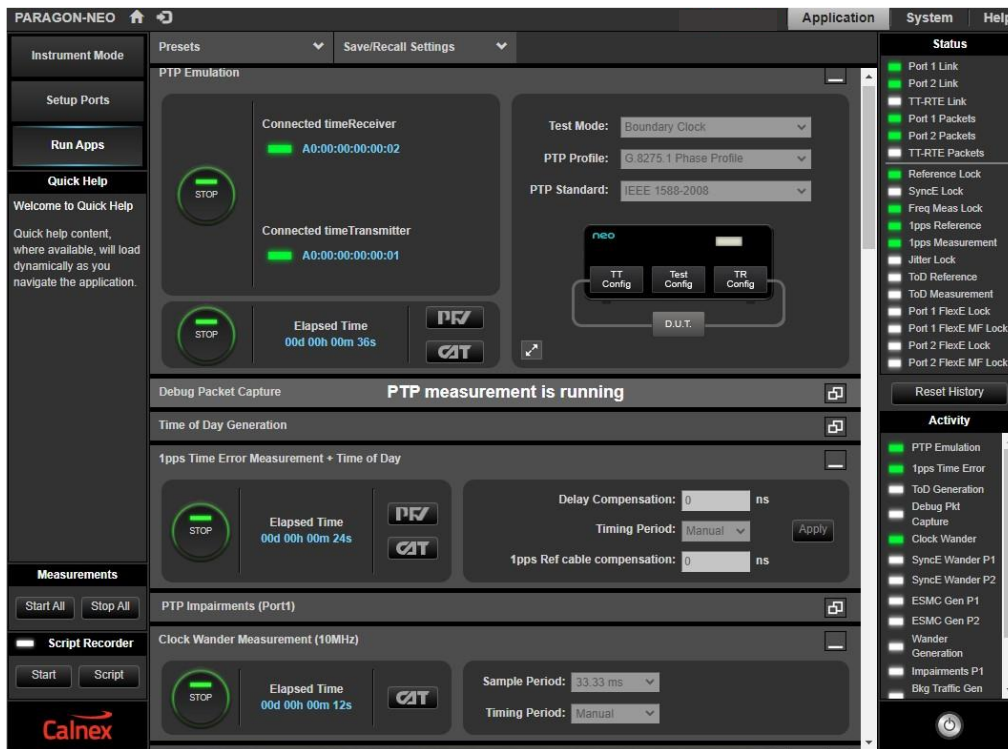
8. To stop a measurement after running the test, click the button.

9. Click one of the [CAT] buttons to display and analyse timing measurements in CAT.

10. Click one of the [PFV] buttons to open PFV for protocol analysis.

Please refer to appropriate Calnex Application Notes and Release Notes for detailed operational steps and result interpretation in relation to specific tests.

11   Remote Live CAT & PFV

Remote Live CAT and Remote Live PFV enable the use of standalone CAT and PFV software running on a PC to display real-time measurement data from the Paragon-neo, the primary use-case is to provide on-going visibility of measurements should the instrument enter "Starvation Mode".

Starvation mode is initiated if local resources (memory) on Paragon-neo are depleted due to very long or metric-intensive measurements being run. In this mode the instances of CAT and PFV on the instrument stop metric calculation, message analysis and presentation of new data to the GUI to ensure sufficient resources remain for stable operation of the instrument. No measurement data is lost – all captures continue running and measurement files are saved.

Remote Live CAT enables real-time plotting of data and metric calculation regardless of the measurement duration or complexity of the configured metrics.

Remote Live PFV enables real-time analysis of packet flow and PTP profiles.

Please refer to the detailed instructions provided on the standalone CAT **Select File** > **Remote Live** page or the standalone PFV **Select File** > **Remote Live** page for more details.

Note – remote file access must be enabled for Remote Live operations, see section 12.2 of this document.
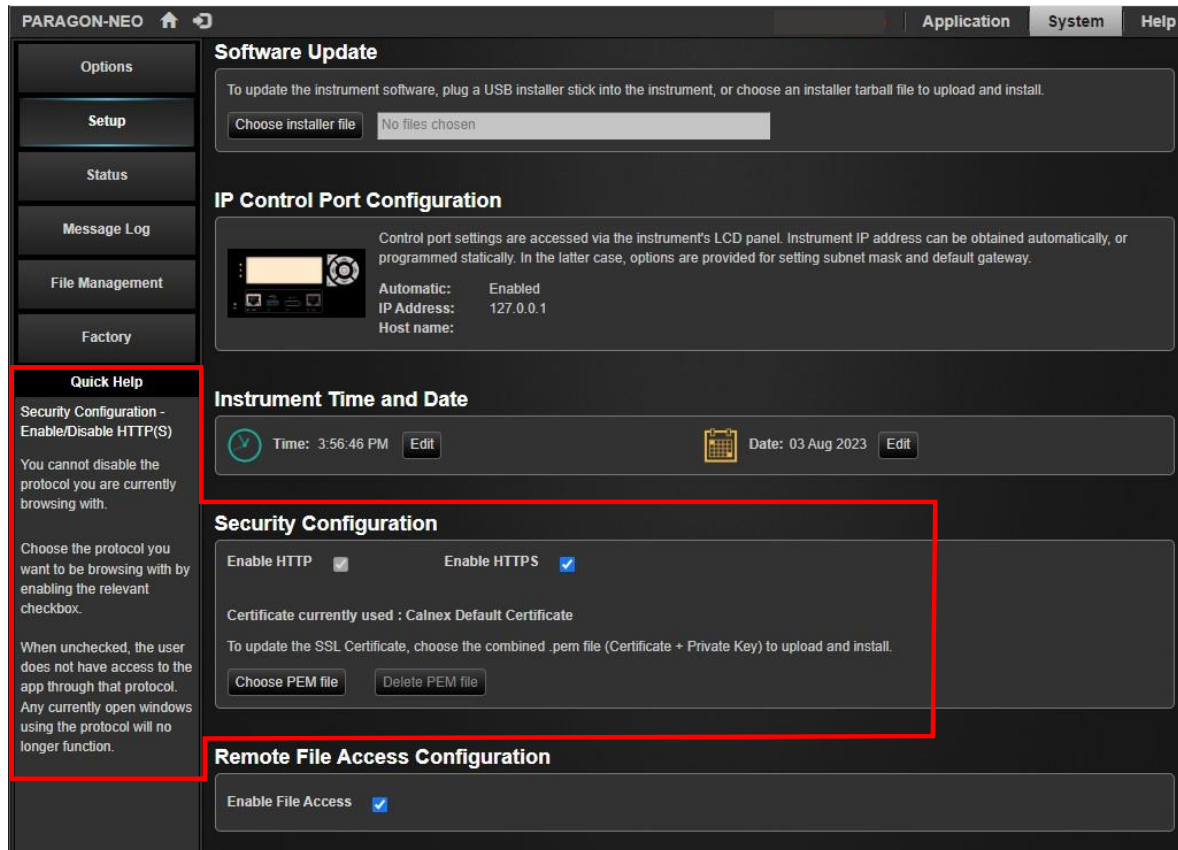
IMPORTANT
Start Remote Live CAT/PFV operations after starting measurements on Paragon-neo and disconnect Remote Live CAT/PFV before stopping Paragon-neo measurements. Remote Live CAT/PFV polls the measurement files on Paragon-neo so analysis errors may result if data files have been closed on Paragon-neo.

12   Access Security

12.1 Using Secure Connections to Paragon-neo

The Paragon-neo GUI is accessed with a web browser using either HTTP or HTTPS connections. The default setting is that both protocols are enabled, users may disable HTTP and force HTTPS access for enhanced network security. Calnex provide a default security certificate that enables an HTTPS encrypted connection without authentication.

Users must replace the Calnex certificate with an organization specific signed certificate to enable encrypted and authenticated HTTPS connections. Configuration and security certificate management is controlled through the **System** > **Setup** screen:

Note: Paragon-neo does not redirect HTTP connection requests to HTTPS if HTTP is disabled, and vice versa. The connection will timeout and fail.

CAT and PFV windows follow the same security protocol that is used when you access the main Paragon-neo GUI.

> **⚠ CAUTION**
>
> If your Paragon-neo must be returned to Calnex for jitter calibration or maintenance, please remove any security certificates that have been loaded.

Clicking the Delete PEM File button will permanently delete any PEM file that you have installed, overwriting it with the Calnex default PEM file data.

12.2 Samba Remote File Access

Remote access to settings files, measurements and impairment files is provided by Paragon-neo using Samba, allowing PCs to connect using the SMB/CIFS protocol.
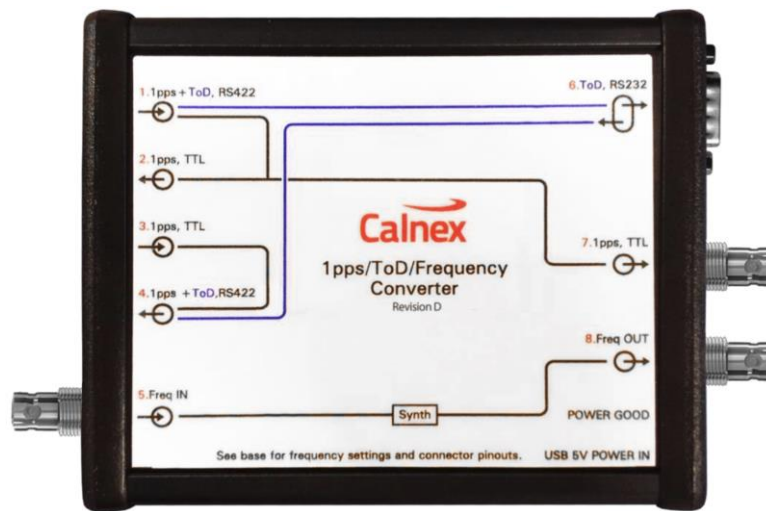
Samba also enables the Remote Live CAT function, see section 11.

By default, Samba is enabled on Paragon-neo, it can be enabled and disabled through the **System** > **Setup** screen:

13 Paragon-neo Option 133 1PPS/ToD/Frequency Converter

The Calnex external 1PPS/ToD/Frequency converter may be purchased as an option to use with Paragon-neo.

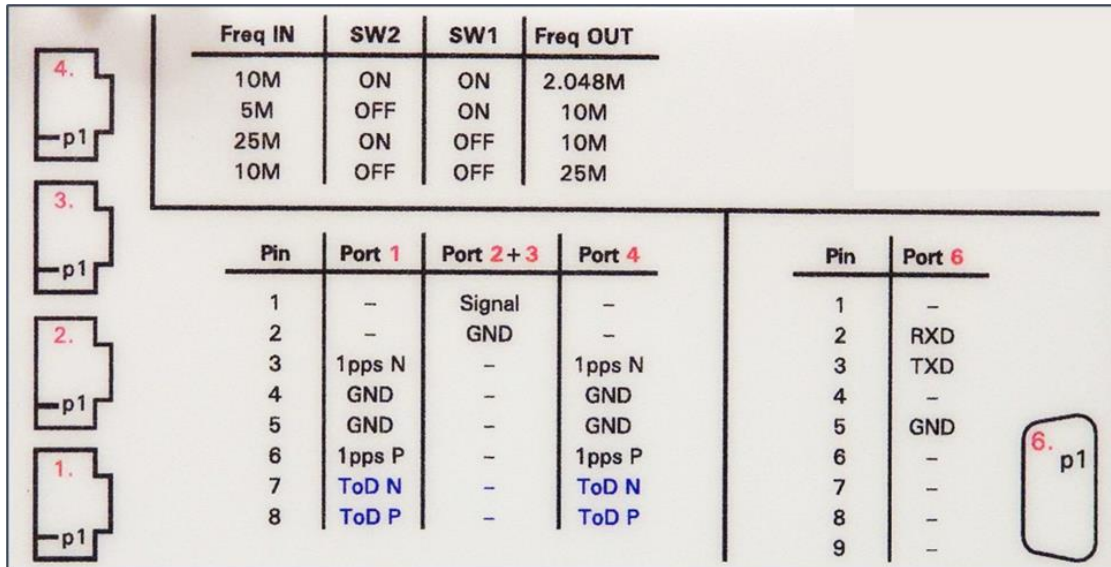| Function	Input	Output
Split balanced 1PPS+ToD signals to separate unbalanced 1PPS and ToD RS232 signals	RJ48 connector port 1. Balanced 1PPS and RS422 ToD.	Unbalanced 1PPS on RJ48 connector (port 2) and on BNC (port 7). ToD RS232 signal on DB9 connector (port 6).
Convert ToD RS232 signal to RS422	RS232 on DB9 connector (port 6)	RS422 on RJ48 connector (port 4)
Convert unbalanced 1PPS signal to balanced 1PPS signal	Unbalanced 1PPS on RJ48 connector (port 3)	Balanced 1PPS on RJ48 connector (port 4)
Frequency conversion. See picture below for conversion options.	BNC connector (port 5)	BNC connector (port 8)

Size: 140 x 35 x 105 mm.
Weight: 320g.
Power Supply: USB 5V DC / 3W.
Environmental Specifications: Same as Paragon-neo.

The peak-peak frequency input to the converter should be in the range of 200mV–3V into 50Ω. The converter can accept either sinusoidal or square waveform. The frequency output is 1.5Vp-p square wave into 50Ω.

The **POWER GOOD** LED is on when power is supplied to the converter. There is no power switch. Power can be supplied from an active USB port.

Switches SW1 and SW2 are the only controls on the device. Set these switches according to the table printed on the rear panel and desired input/output frequencies.

Freq IN	SW2	SW1	Freq OUT
10M	ON	ON	2.048M
5M	OFF	ON	10M
25M	ON	OFF	10M
10M	OFF	OFF	25M

Pin	Port 1	Port 2+3	Port 4
1	–	Signal	–
2	–	GND	–
3	1pps N	–	1pps N
4	GND	–	GND
5	GND	–	GND
6	1pps P	–	1pps P
7	ToD N	–	ToD N
8	ToD P	–	ToD P

Pin	Port 6
1	–
2	RXD
3	TXD
4	–
5	GND
6	–
7	–
8	–
9	–

To reduce sources of inaccuracy Calnex recommend that 1PPS measurement signals are not passed through the converter. If 1PPS measurement signals are passed through the converter, great care must be exercised to determine the precise propagation delay and add this into the cable compensation value in Paragon-neo.

If the precise port-to-port propagation delays are not printed on the converter, a method to determine the delays is provided in the Calnex FAQ (keyword "Option 133") accessed through the support pages at www.calnexsol.com.

14 Help and Support

A **Quick Help** panel appears on the left side of the Paragon-neo GUI giving definitions of parameters and settings that the cursor is hovering over.

Release notes, test guides and application notes can be found by clicking the **Help** button in the top right corner of the GUI.

The Calnex Support Website (https://calnexsol.com/support/) is a gateway for additional information and support:

- The Calnex Product FAQ provides help using various aspects of Paragon-neo. The FAQ is searchable.
- Browse a library of application notes, test guides, articles, and blogs.
- Download software updates.
- Access the Calnex support ticket system.

Contact your local Calnex representative for further support using one of the email addresses below.

Region	Email
Americas	support.americas@calnexsol.com
Europe, Middle East, Africa	support.emea@calnexsol.com
India	support.india@calnexsol.com
Japan	support.japan@calnexsol.com
China	support.greaterchina@calnexsol.com
Southeast Asia and Australasia	support.sea@calnexsol.com
Korea	support.korea@calnexsol.com
Other	support@calnexsol.com

When contacting Calnex, please include your Paragon-neo serial number and software version that it is running. These details can be found on the **Help** > **About** screen:

14.1 Diagnostic Log Files

Calnex may request that users supply the Paragon-neo diagnostic log files to help with support provision. A zip file of diagnostic logs can be taken from Paragon-neo by clicking the **Diagnostics** button on the **Help > Support** GUI page:
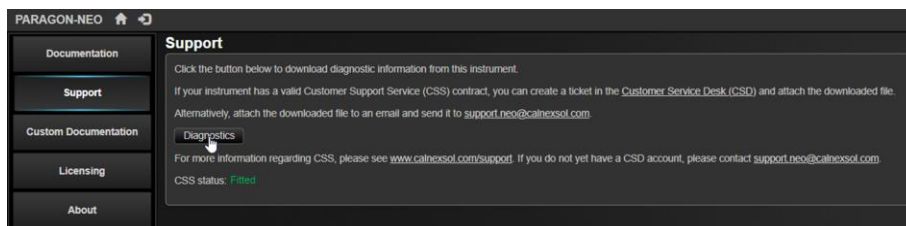
This function creates and downloads .zip file containing the full diagnostics logs from the Paragon-neo into the local browsers default "Downloads" folder.

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