

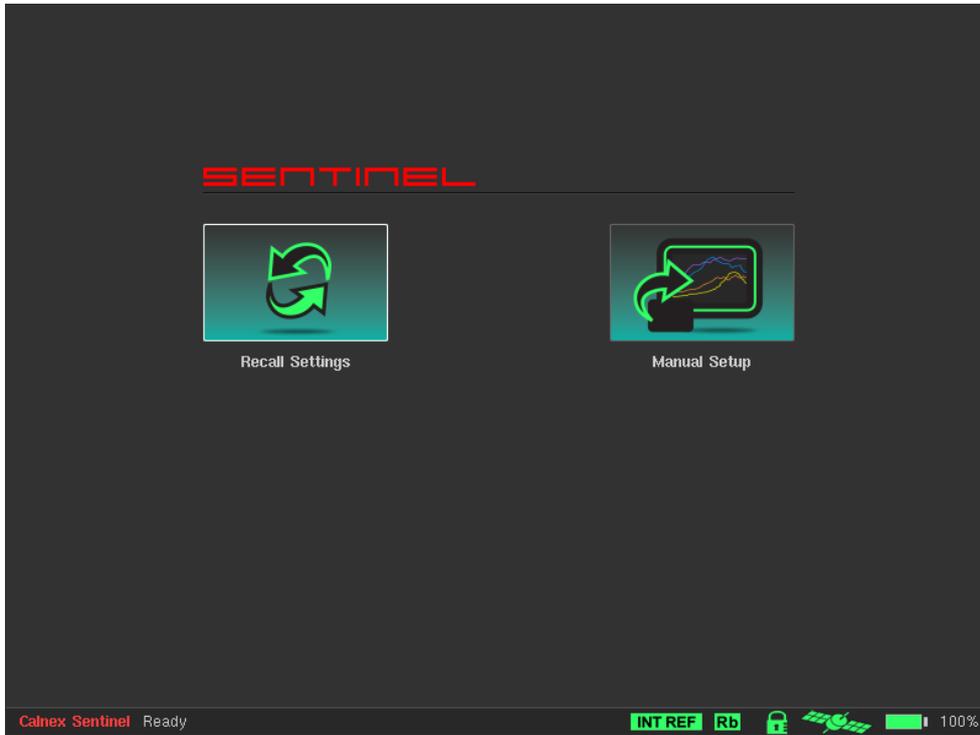


## GETTING STARTED GUIDE

# ITU-T G.8275.1 Measurement

## Initial Power On

Upon initial power on of Sentinel, the following screen appears. The **Recall Settings** option allows previously saved configuration files to be re-loaded, automatically setting up Sentinel to the state defined in the preset file and move to the main operating screen. Selecting the **Manual Setup** option moves directly to the main operating screen.



## Main Screen



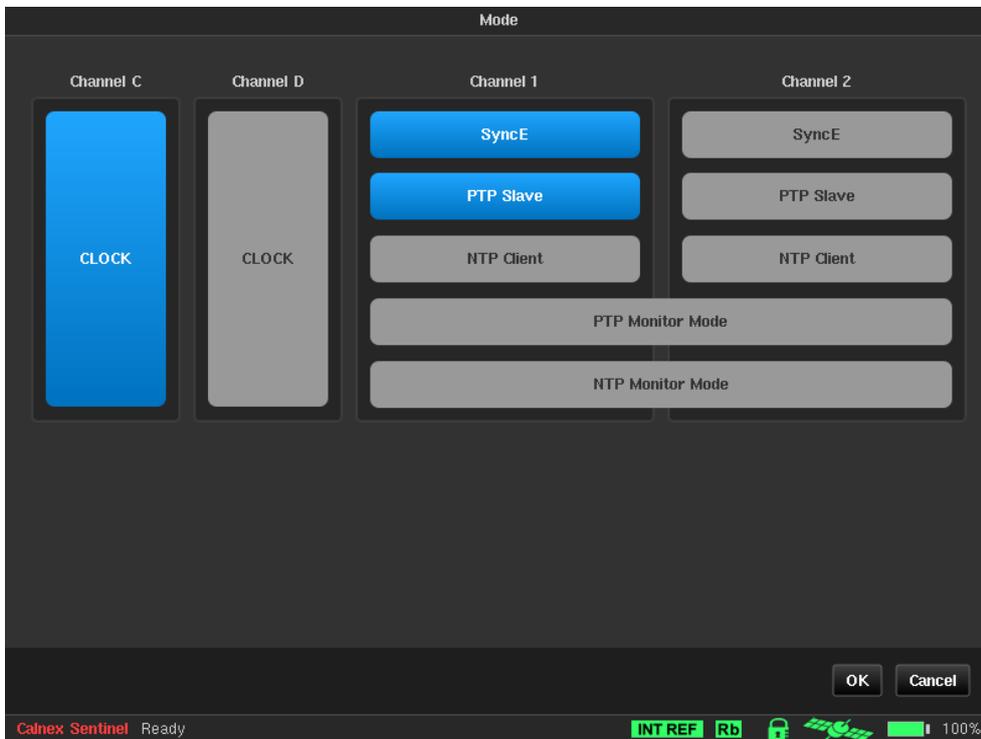
The main screen contains controls to allow simple, ordered configuration (1) and operation (2) of Sentinel. Navigation buttons allow movement between each measurement result graph (3) and change the mode of viewing results (4). The status of the measurement sub system is shown in widgets and icons at the bottom of the screen (5).

### Measurement Setup

Manual configuration of Sentinel is simply a process of working through the tabs on the main screen as detailed below.



The **Mode** screen allows the Sentinel measurement subsystem to be configured as required by the type of testing being performed. In this example Sentinel is performing a G.8275.1 time/phase measurement and requires a clock channel to measure the 1 PPS signal from the DUT and an Ethernet connection to an output from the edge router. This Ethernet connection will be used to communicate with the PTP GM and can additionally perform a TIE measurement on the SyncE recovered clock. Here clock channel C is chosen for the 1 PPS input and packet card 1 for the PTP connection.



Disabling unused channels simplifies configuration and result viewing by removing these channels from the configuration and results screens.

The **Settings** screen contains tabs to configure all the relevant measurement subsystems selected through the mode screen.



The **Measurement > Common** screen allows the measurement duration and type to be defined.

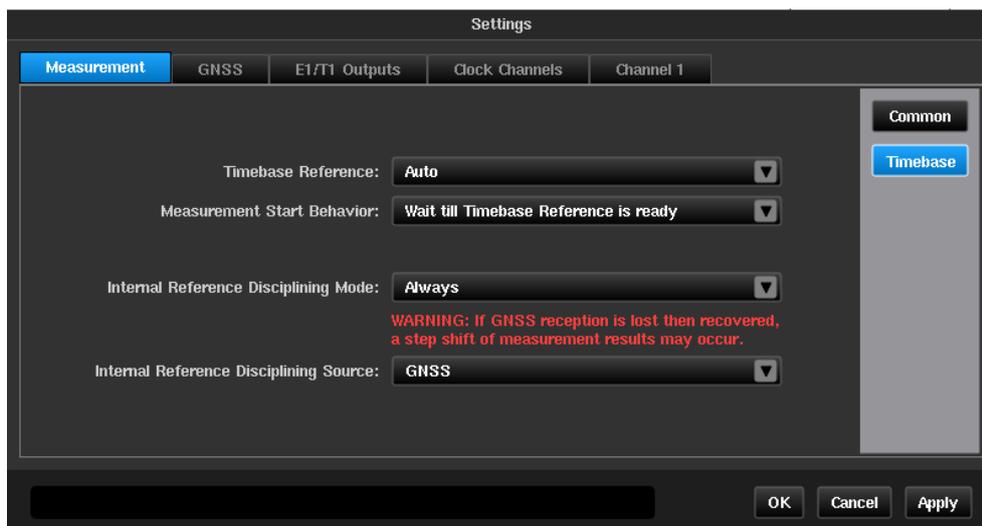


For a G.8275.1 measurement, the fields should be set as:

- **Continuous Measurement** is set to **Off**
- **Duration** should be at least **10000s** to comply with G.8275.1 dTE<sub>L</sub> MTIE observation interval
- **Metrics** is set to **On**
- **TIE mode** must be set to **TIE + 1 PPS TE**
- **Diff TIE reference** is set to the internal Rb **1 PPS Ref**

To get an automatic PASS/FAIL check on the 1 PPS of the DUT, the **G.8271.1 TE Mask Value** is set to **1.1µs**. If testing with end clock holdover, this value should be set to **1.35µs**.

Sentinel has an internal Rb oscillator and for phase measurements it requires disciplining prior to the measurement taking place. The **Measurement > Timebase** screen allows configuration of the reference used for the measurement.



- **Timebase Reference** can be set to **Auto**, **Internal** or **External**. If an external reference is supplied and Auto or External is selected, then this will be used rather than the internal Rb oscillator.
- The measurement can be deferred until the timebase reference is ready, aborted if it is not ready or started even if the timebase is not ready through the **Measurement Start Behavior** setting.
- **Internal Reference Disciplining Mode** can be left to **Always** even if the source is not available – Sentinel will only discipline if the disciplining source selected is producing a valid disciplining output.
- As the G.8275.1 DUT is likely to be referenced to **GPS**, this should be selected as the **Internal Reference Disciplining Source**. If the last disciplining was less than 1 week ago, Sentinel should be disciplined for at least 6 hours, otherwise Sentinel should be disciplined for at least 12 hours.

The channel used for the PTP connection was selected on the mode screen and a **Channel x** tab will be present for each PTP connection chosen: in this case only Channel 1 was enabled.

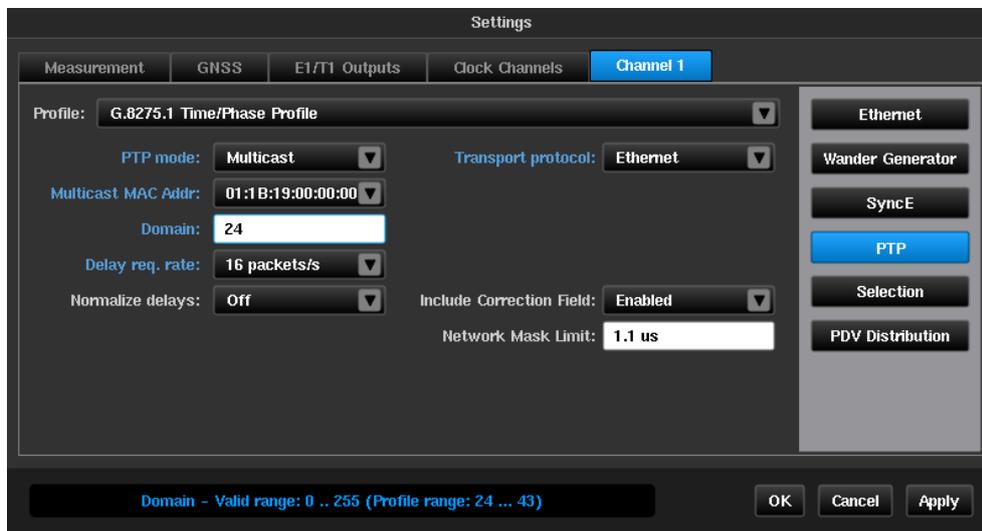
The **Ethernet** screen allows the physical media and link transport properties to be selected. G.8275.1 specifies Ethernet multicast as the transport and the IP parameters can be left un-initialised, however the **Gateway** field must be on the same subnet as the **IP Address**.

The screenshot shows the 'Settings' window for 'Channel 1'. The interface is divided into several sections:

- Measurement**: Auto-Negotiation: Enabled (dropdown), Ethernet Media: 1000BASE-T (dropdown).
- GNSS**: VLAN 802.1Q: Off (dropdown), VLAN ID: 2 (text input), VLAN Priority: 7 (text input).
- E1/T1 Outputs**: DHCP: On (dropdown).
- Clock Channels**: IP Address: 192.168.4.200 (text input), Mask: 255.255.255.0 (text input), Gateway: 192.168.4.1 (text input), MAC Address: 00:50:C2:8B:72:A7 (text input).

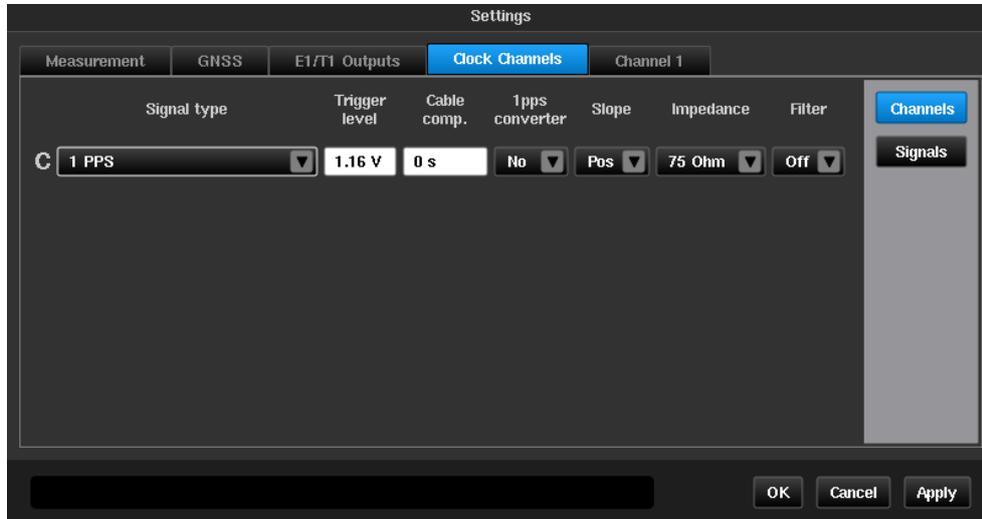
On the right side, there is a vertical stack of buttons: Ethernet (highlighted in blue), Wander Generator, SyncE, PTP, Selection, and PDV Distribution. At the bottom right, there are 'OK', 'Cancel', and 'Apply' buttons.

The **PTP** screen allows configuration of the PTP profile. Selecting **G.8275.1 Time/Phase Profile** sets up all the relevant fields with the default values specified in the ITU-T G.8275.1 profile. Fields with blue text are defined in the ITU-T specification, other fields are set to enable 2Way TE measurements. Context sensitive help is shown when specific fields are selected. For example, the **Domain** can be set to a value between 24 and 43 and still be compliant to the G.8275.1 profile.



The **Network Mask Limit** should be set to **1.1 $\mu$ s** (the limit at network point C, as per G.8271.1).

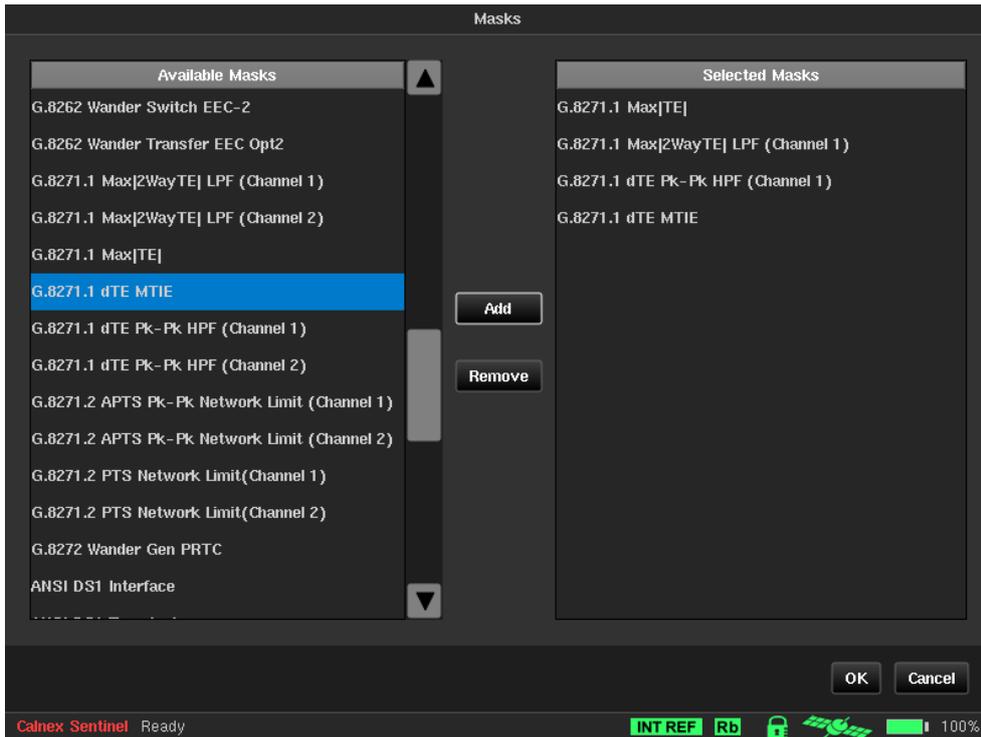
The **Clock Channels** screen allows information to be entered about the clock of the DUT, i.e. the **Signal Type**, **Trigger level**, **Slope**, **Input Impedance** and **Filter** to be used. These values are normally automatically populated when a Signal Check is run (see later).



Compensation for cable lengths and whether the *Calnex 1pps Converter* is used can be entered here when the **Signal Type** is **1 PPS**.

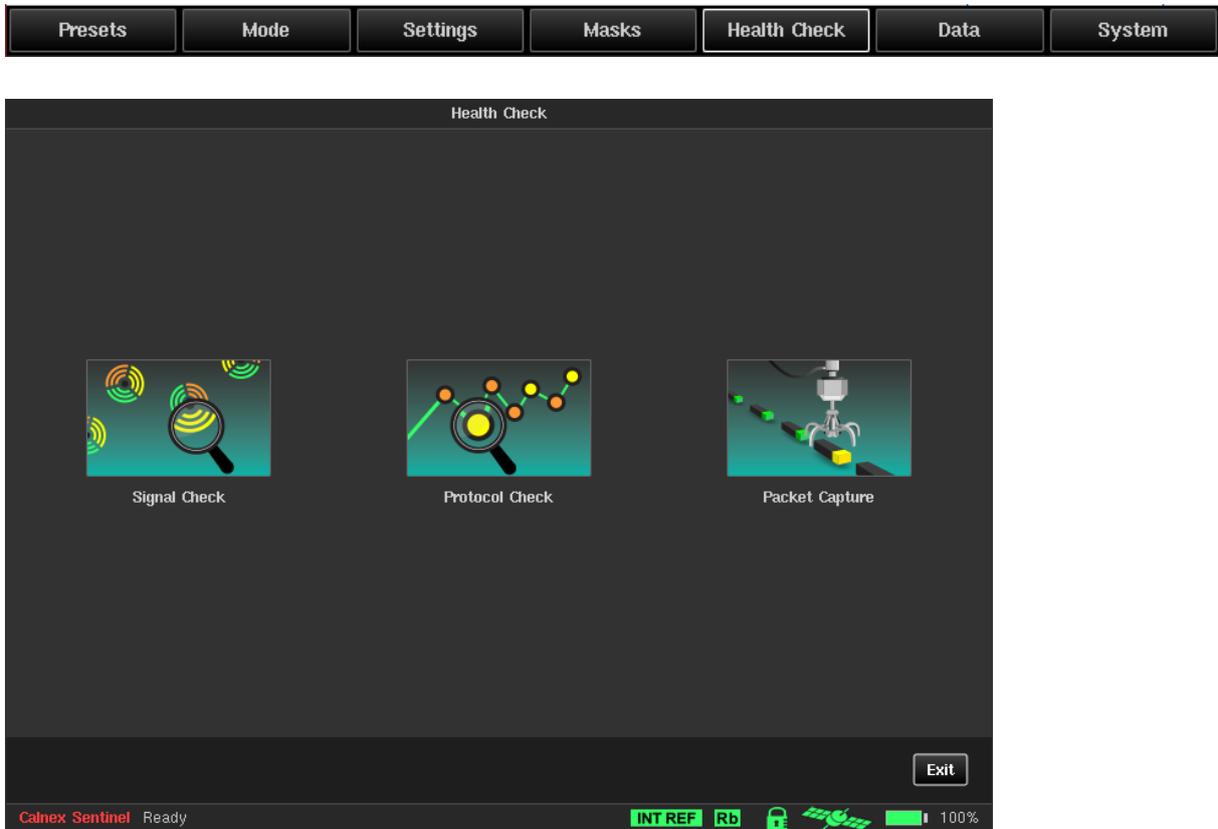
The **Masks** screen allows selection of standard masks to be applied to graphs. ITU-T G.8271.1 defines limits for maximum absolute low-pass filtered time error, MTIE mask for low-pass filtered dynamic time error and maximum peak-to-peak high-pass filtered dynamic time error. Highlight the following masks and click **Add** to display them on the relevant plots:

- **G.8271.1 Max|TE|**
- **G.8271.1 Max|2wayTE| LPF**
- **G.8271.1 dTE Pk-Pk HPF**
- **G.8271.1 dTE MTIE**

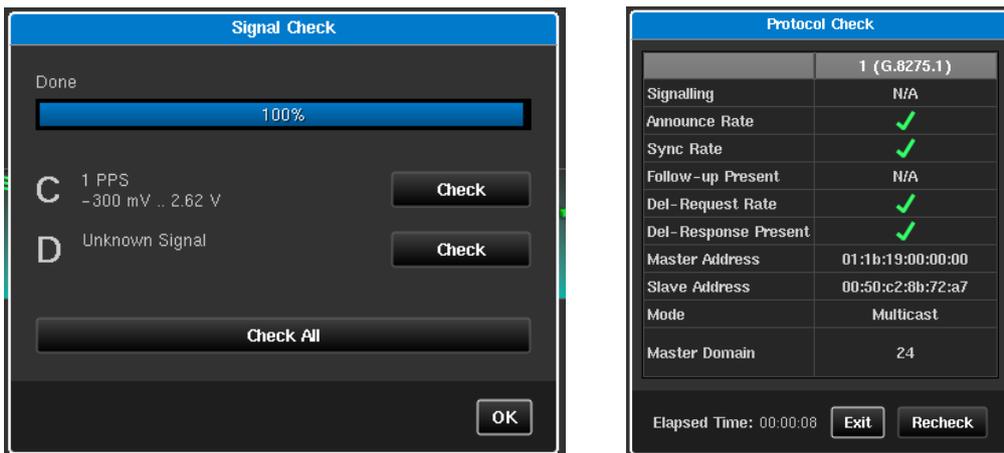


## Running a Measurement

Prior to running a measurement, the measurement subsystem and PTP connection should be checked for correct configuration using the **Health Check** screen.



Running **Signal Check** will detect all clocks connected to Sentinel and set up the measurement subsystem. If a signal check is not performed, then 1 PPS TE measurements may display erroneous data.



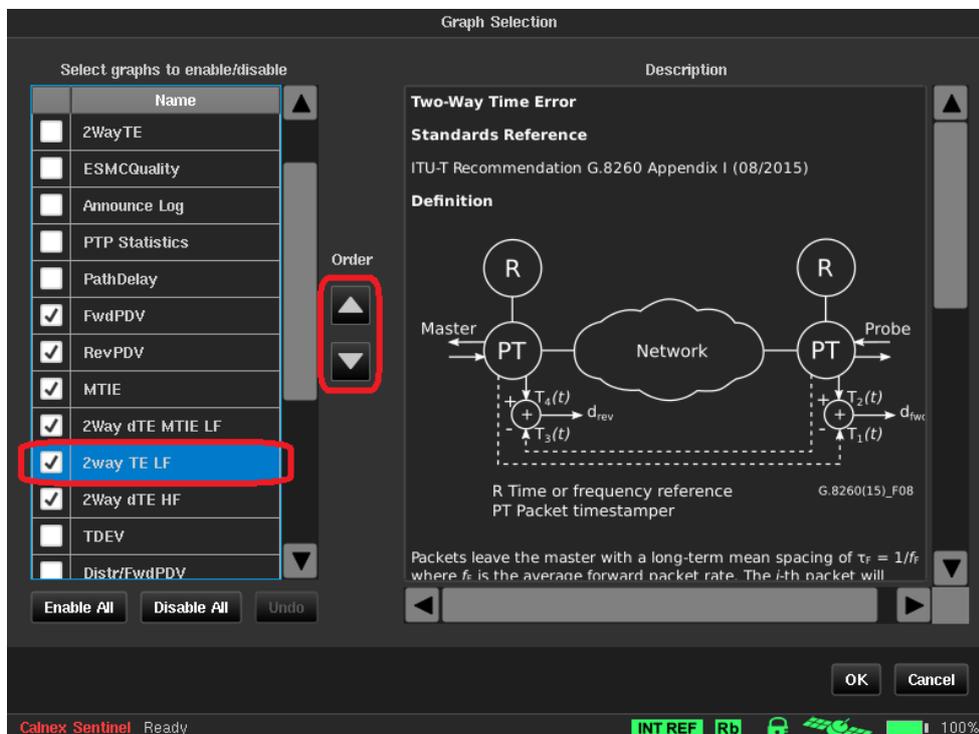
For this measurement the results should show a 1 PPS signal connected to channel C and an Ethernet link on channel 1. If this is not the case, check the physical connections then press the **Re-check** button beside the failing channel.

Running **Protocol Check** is recommended - this will verify that Sentinel can communicate with the PTP GM and that the expected message rates are correct.

Sentinel creates a graph for every measurement and its associated metric. The graphs that are displayed and the order that they appear in the navigation panel can be configured by pressing the **Graph Selection** button.



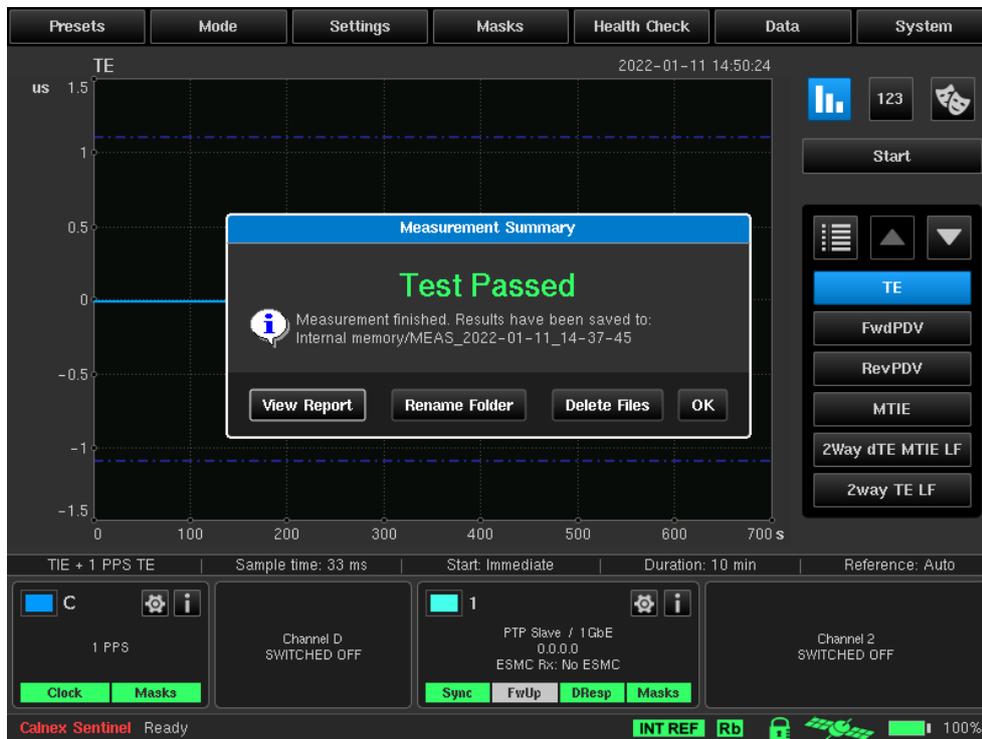
A **Hide/Show** checkbox and associated measurement description is available for each graph. Graph ordering can be changed by highlighting the graph name and pressing the **Order** arrow buttons.



ITU-T G.8271.1 limits apply to **2way TE LF**, **2way dTE MTIE LF** and **2way dTE HF** for the PTP ethernet interface. For 1 PPS, **TE** and **MTIE** are selected. The PTP PDV graphs may also be of interest so in this example the **FwdPDV** and **RevPDV** are selected.

The measurement can now be run by pressing the **Start** button on the main screen.

When the test completes a popup box appears giving the overall test PASS/FAIL status. A text report file can be viewed by pressing the **View Report** button.



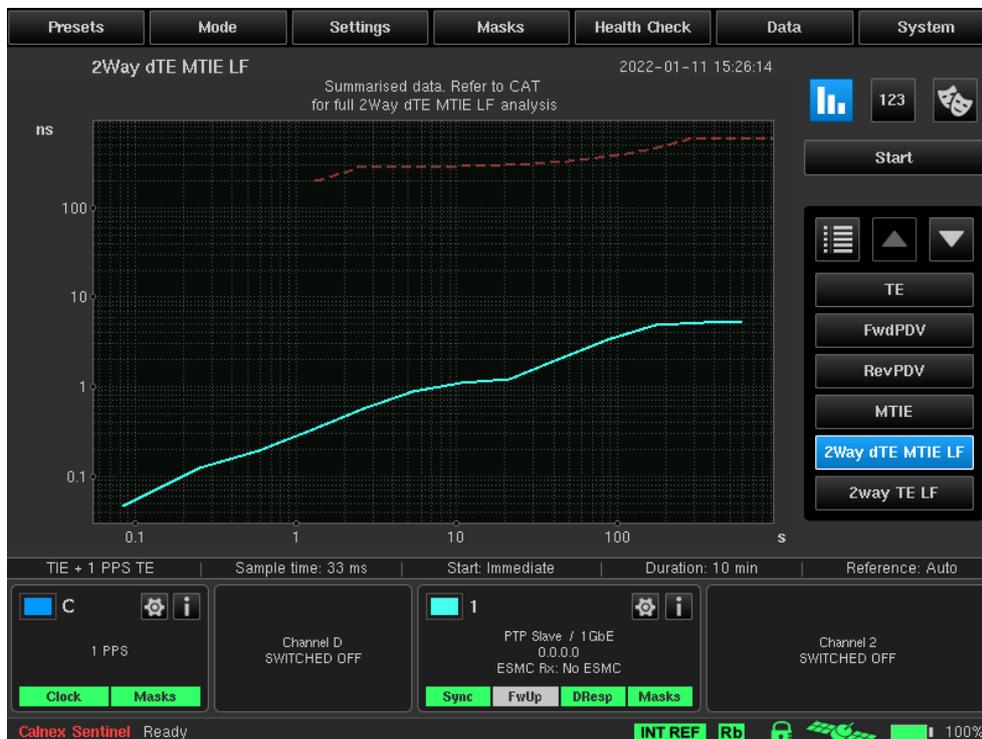
1 PPS TE is shown on the **TE** graph. The signal passes if the 1 PPS TE remains within the upper and lower limits of the TE mask.



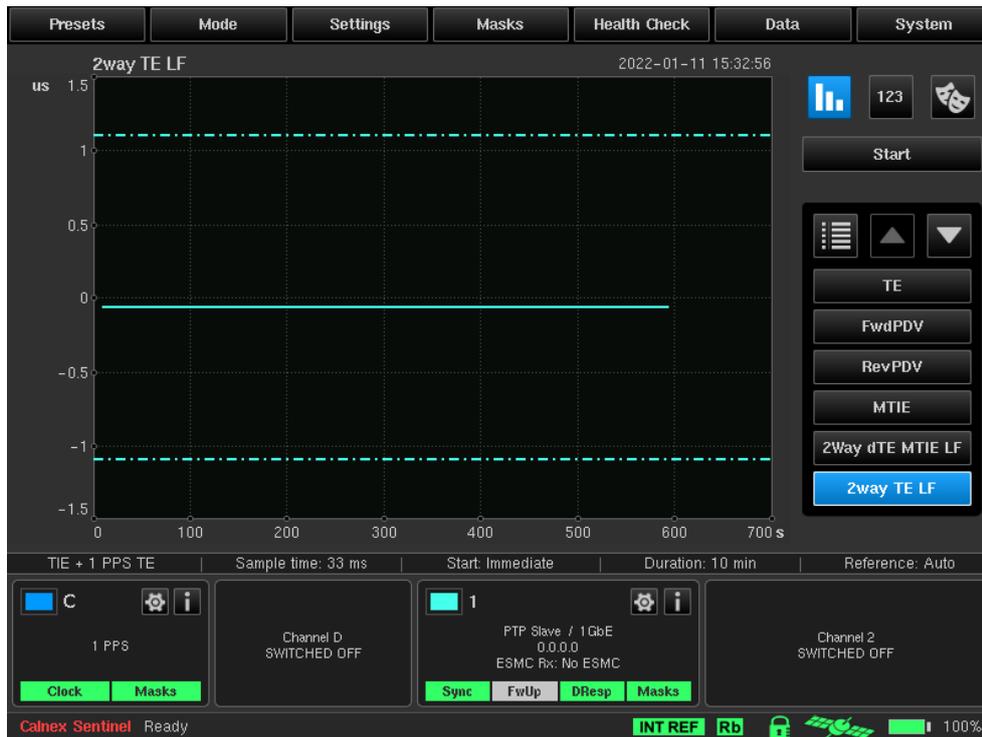
The MTIE of the 1 PPS and SyncE is shown on the **MTIE** graph along with the ITU-T G.8271.1 network limits mask. To hide the SyncE MTIE graph, press the **Hide/Show** button in the channel widget and select **Hide**. The signal passes if the 1 PPS MTIE values remain below the limit line.



The MTIE of PTP is shown on the **2way dTE MTIE LF** graph along with the ITU-T G.8271.1 network limits mask. The signal passes if the 2way MTIE values remain below the line.



2way low-pass filtered time error is shown on the **2way TE LF** graph. The signal passes if the 2way TE remains within the upper and lower limits of the TE mask.

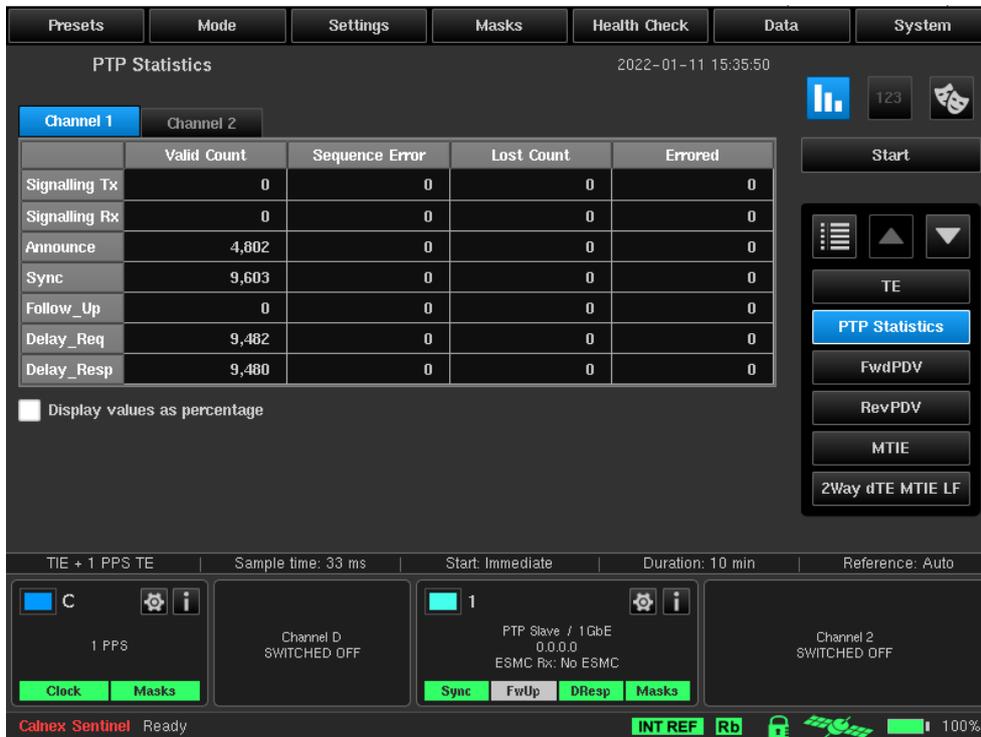


2way high-pass filtered dynamic time error is shown on the **2way dTE HF** graph. No masks are shown on this display since the limit given in G.8271.1 is a peak-to-peak value. The signal passes if this value is below the G.8271.1 dTE Pk-Pk HPF mask value.



The PTP message statistics for the measurement duration can be viewed by adding the **PTP Statistics** metric from the **Graph Selection** screen.

This shows totals for Valid packets, packets with PTP Sequence ID errors, Lost packets and Errored packets. The totals can also be displayed as a percentage.



Measurement analysis can be toggled on/off by pressing the **Analysis** button. This displays the mean, standard deviation, initial phase offset and final value of the measurement for the currently displayed graph.



A summary of the PASS/FAIL of individual MTIE and TE masks is available by pressing the **Masks Summary** button on the main screen.



Each populated measurement channel has an associated widget to indicate the status and configuration of the channel and to allow quick access to the channel settings.

Loss of signal LEDs and Mask pass fail results are displayed at the bottom of the widget.

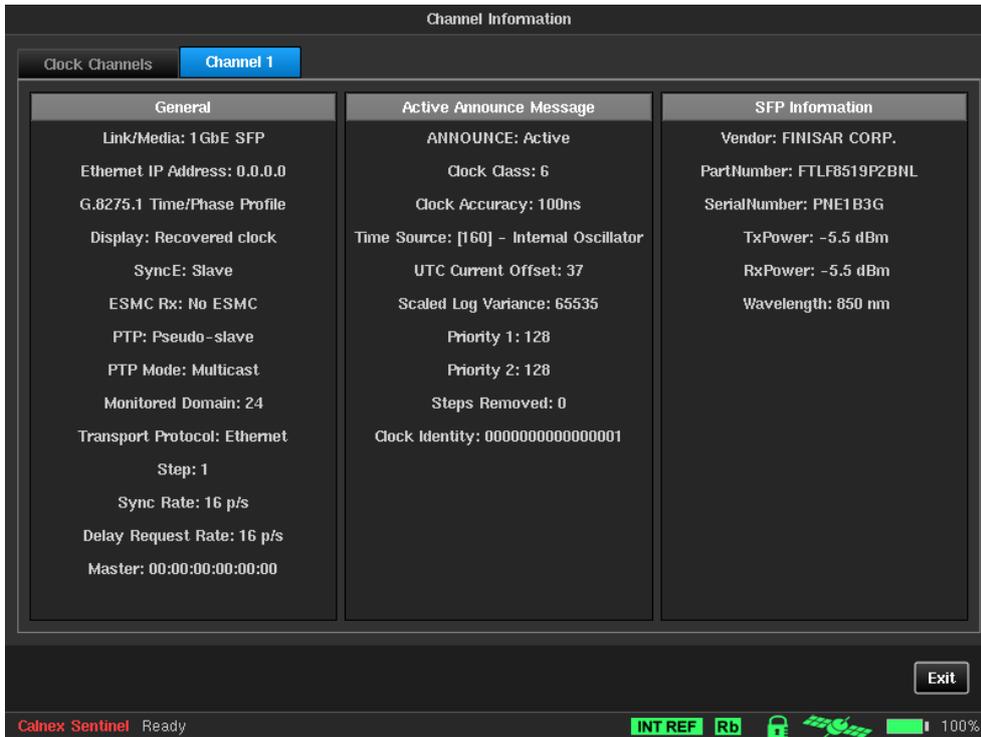


- A green LED indicates that the associated clock signal or PTP message is present or that the mask has passed.
- A red LED indicates that the associated clock signal or PTP message is absent or that the mask has failed.
- A yellow LED indicates that the associated clock signal or PTP message has been absent but is now present again.
- A grey LED indicates that the associated PTP message is not relevant (e.g. Follow Up when running in 1 step mode) or the test has not run long enough to validate the mask.

The **Settings** button on a widget will navigate directly to the settings page for that channel.



The **Info** button will display more detailed information on the selected channel.



## Post Measurement Report Generation using CAT

Sentinel provides results for 1 PPS max|TE|, PTP max|2WayTE| and G8271.1 network limits for recovered clock low-pass filtered dTE and high-pass filtered dTE. To generate a report on full G.8271.1 compliance the results should be loaded into the Calnex Analysis Tool (CAT).

For this particular example (1 PPS connected to channel C and Ethernet on channel 1), Sentinel stores the measurement results in the following files:

- 1 PPS TE – channelC.dset
- 2WayTE – channel1\_FWD\_PDV.dset and channel1\_REV\_PDV.dset
- SyncE recovered clock TIE – channel1.dset

These files can be retrieved to the local computer through FTP or by copying on to a USB stick. After opening CAT the relevant .dset files should be dragged and dropped onto the CAT window. Should you attempt to download files not recognised by CAT, an error message will be generated. If this happens, close the message and continue.

When measuring to the requirements of ITU G.8271.1 at reference point C, we are interested in three metrics:

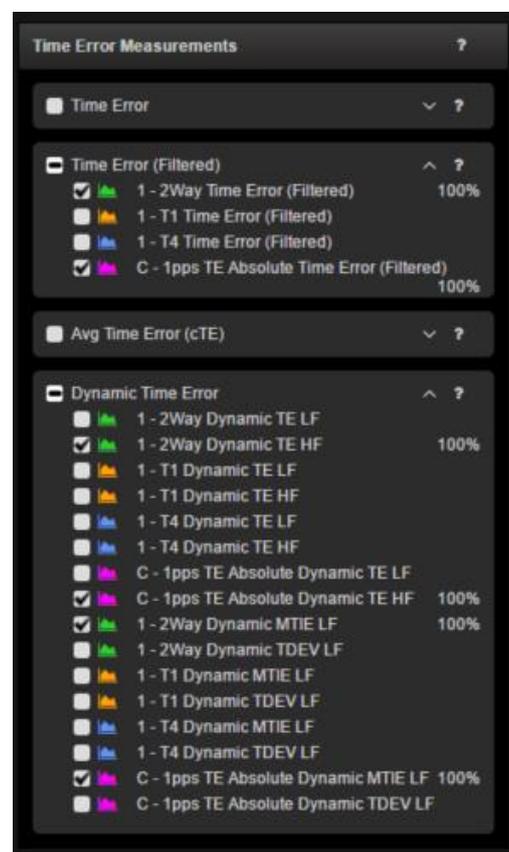
1. Constant Time Error, which is the maximum absolute low pass filtered time error (max|TE<sub>L</sub>|). Set this value to  $\pm 1.1\mu\text{s}$ .
2. Dynamic Low pass filtered time error (dTE<sub>L</sub>). The limits are specified in terms of MTIE and this MTIE limit as specified in the ITU recommendations is available in CAT.
3. Dynamic High pass filtered time error (dTE<sub>H</sub>). Set this value to  $\pm 200\text{ns}$ .

It is recognised in the ITU recommendations that these measurements can be made in either directly from the two-way PTP flow or from a 1 PPS signal derived from the two-way PTP flow. In this example, the PTP flow is channel 1 on Sentinel and the 1 PPS in channel C.

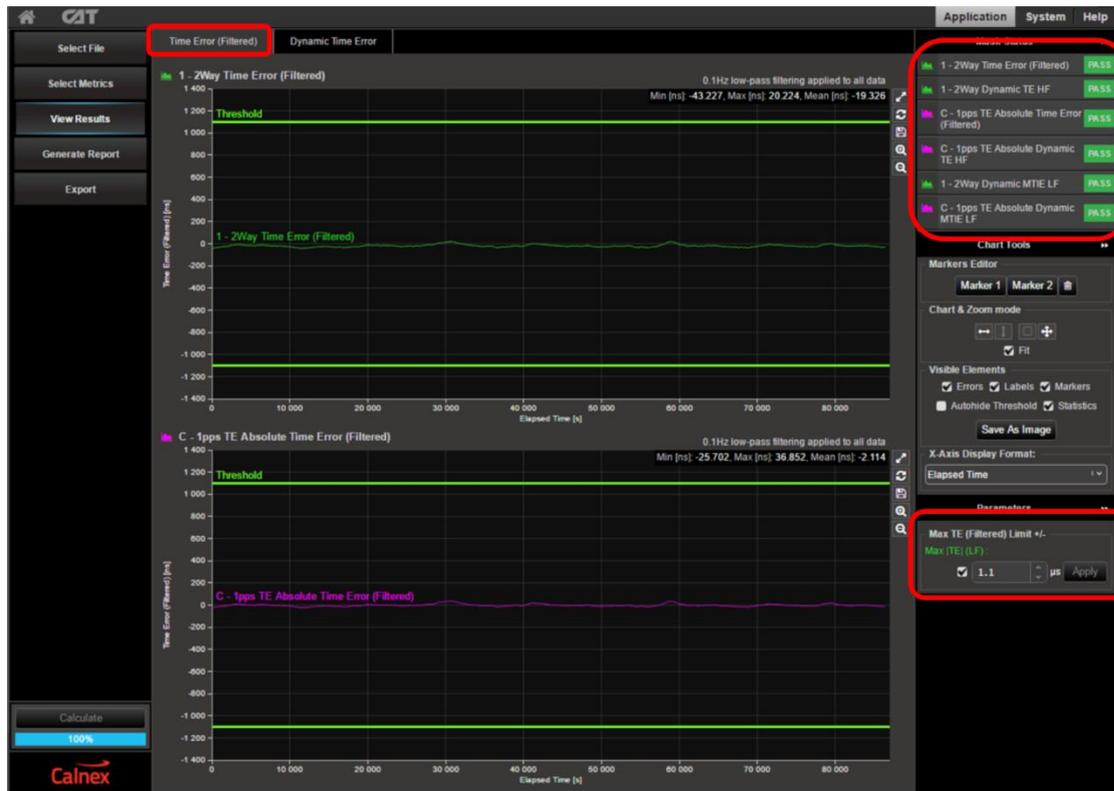
CAT generates a wide range of metrics from the input data and to simplify the report the appropriate G.8271 metrics can be selected by clicking on the **Select Metrics** button on the left-hand menu and selecting only the following metrics:

- Time Error (Filtered)
  - 1 – 2Way Avg Time Error (Filtered)
  - C – 1 PPS TE Absolute Avg Time Error (Filtered)
- Dynamic Time Error
  - 1 – 2Way Dynamic TE HF
  - C – 1 PPS TE Absolute Dynamic TE HF
  - 1 – 2Way Dynamic MTIE LF
  - C – 1 PPS TE Absolute Dynamic MTIE LF

Note: If measuring SyncE recovered clock, leave the **Clock Measurements > TIE / ESMC** check box ticked.



Press the **Calculate** button at the lower left of the screen and wait for the status bar to reach 100%. Press **View Results**. The results are displayed on two tabs.



Selecting the **Time Error (Filtered)** tab displays the time error data smoothed with a 0.1Hz low pass filter. The  $\pm 1.1\mu\text{s}$  limit specified in ITU-T G.8271.1 is entered under parameters. The measured data is then compared to this limit and PASS/FAIL status is displayed in the upper right portion of the display.

The **Dynamic Time Error** tab shows 0.1Hz high pass filtered TE results and the MTIE of the 0.1Hz low pass filtered TE results as defined in the ITU-T G.8271.1 recommendation.



Select the **G.8271.1 Network Dynamic TE, point C** mask under Dynamic MTIE LF in the lower right of the display and set the Dynamic TE Limit +/- to **0.2µs**, tick the box and select **Apply**. Press the **Calculate** button at the lower left of the screen and wait for the status bar to reach 100%.

The Dynamic TE LF data for both the 1 PPS and PTP inputs are graphed as is the MTIE mask as specified in the ITU G.8271.1 recommendation. The high pass filtered data for the PTP and 1 PPS are graphed separately.

The status of each mask and limit is displayed in the upper right of the display.

To produce a PDF measurement report, simply click on the **Generate Report** button.

The screenshot displays the CAT software interface during report generation. The top navigation bar includes a home icon, the CAT logo, and a status bar showing 'Report File Name: REPORT\_2021-03-26\_1355\_27', a 'pdf' dropdown, a 'Save Report' button, and a progress indicator 'Preparing images - complete!'. A sidebar on the left contains buttons for 'Select File', 'Select Metrics', 'View Results', 'Generate Report' (highlighted), and 'Export'. The main area is titled 'General Information' and contains the following fields:

- Report Title: Test to G.8271.1
- Report Description: (empty)
- Company: Calnex
- User Name: (empty)
- Network Operator: (empty)
- Test Location: (empty)
- Report Date: 2021-03-26 13:55:28
- Beginning of Test: 2020-10-05 05:24:40 (local instrument time)
- End of Test: 2020-10-06 05:24:39 (local instrument time)
- Test Duration: 00:23:59:59
- Instrument Type: Sentinel
- Instrument Serial Number: 400071
- Software Version: 2.12.0.0.5411-20200407
- CAT Version: 25.20.20261.1431 [S]
- Notes: (empty text area)

Below the form, the 'Mask results' section shows the following:

- All Mask Results: Pass
- Mask 1 Time Error (Filtered) Result: Pass
- Mask 1 Dynamic TE HF Result: Pass
- Mask 1 Dynamic MTIE LF Result: Pass
- Mask C Time Error (Filtered) Result: Pass
- Mask C Dynamic TE HF Result: Pass
- Mask D Dynamic MTIE LF Result: Pass

At the bottom left, there is a 'Calculate' button and a progress bar showing '100%'. The Calnex logo is visible in the bottom left corner.



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