



UltraTEV Plus² Operating Manual

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FCC Warning Statement

- This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

IC Warning Statement

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

1. What does the UltraTEV Plus² do?

The UltraTEV Plus² is a versatile hand-held tool used to easily detect and classify Partial Discharge (PD) in a wide range of electrical equipment.

The UltraTEV Plus² uses inbuilt TEV and Ultrasonic sensors and external accessories to detect the presence of potentially damaging PD in switchgear, cables and overhead line equipment.

The UltraTEV Plus² brings together three complementary sensor modes in a single hand held instrument by regularly checking switchgear while it's in service. Using the UltraTEV Plus², failure risks can be identified and action taken to avoid faults and downtime. Algorithms and analysis capability built in to the UltraTEV Plus² provide vital insight, classifying what you find to support the decisions you make and deliver the outcomes you need. It's never been simpler to interpret what you're seeing and choose a course of action.

The UltraTEV Plus² records measurements at the touch of a button. Internal storage can be used to provide access to historical data while you're out in the field. Capturing what you've measured allows you to see trends in the performance of your network.

2. What's in the Box?

Part	Kit 1	Kit 2	Kit 3	Kit 2 Upgrade	Kit 3 Upgrade
UltraTEV Plus ²	✓	✓	✓	✓	✓
Mains Charger	✓	✓	✓	✓	✓
Car Charger	✓	✓	✓	✓	✓
USB Lead	✓	✓	✓	✓	✓
8GB MicroSD & SD adapter	✓	✓	✓	✓	✓
Environmental Sensor	✓	✓	✓	✓	✓
Stylus x 2	✓	✓	✓	✓	✓
NFC Starter Pack	✓	✓	✓	✓	✓
Neckband Headphones	✓	✓	✓		
Ultrasonic Contact Probe		✓	✓		
Flexible Microphone Sensor		✓	✓		
UltraDish			✓		
RFCT & Cable		✓	✓	✓	✓
Tough Carry Case	X (T-Loc II)	X (T-Loc II)	X (T-Loc IV)	X (T-Loc II)	X (T-Loc IV)

For Spares and Accessories



For spares and accessories, please contact your local sales representative or sales@eatechnology.com

3. Important Information



- The UltraTEV Plus² is designed for use at ground potential only.
- When testing electrical plant ensure that the metalwork is earthed before taking any measurements.
- Maintain safety clearances between structures at high voltage and the instrument, its probes and the operator at all times.
- RFCTs, connecting leads and test equipment do not provide protection against high voltage.
- Under no circumstances are earth/ground connections to be loosened, disconnected or otherwise altered to allow use of this equipment.
- Adhere strictly to local safety procedures.
- Do not make measurements when there are electrical storms in the vicinity.
- Do not make measurements immediately following the energisation of a circuit.
- Do not disturb plant during measurements either mechanically (e.g. by shaking or striking it), electrically (e.g. by increasing the voltage) or physically (e.g. by applying heat).
- Do not operate the instrument or its accessories in an explosive atmosphere.
- Mains supply voltages are present within the battery charger.
- This unit contains no user serviceable parts, always return to EA Technology or your local distributor for service and repair.
- Care must be taken where work is performed in tight corners, where the proximity of other earth planes will affect the reading. If possible maintain a distance of more than 30cm from metal work which runs perpendicular to the sensor faceplate.



For application information please contact:

product-support@eatechnology.com

4. Non-Intrusive Detection of Partial Discharge Activity

4.1 What is Partial Discharge?

Partial discharges are electrical discharges that do not completely bridge the insulation between electrodes. The magnitude of these discharges is usually small, however they cause progressive deterioration of insulation that may eventually lead to failure.

Non-intrusive partial discharge detection provides a means for identifying these potential sources of insulation failure. If not detected the discharge may result in failure causing not only in loss of supply to customers and damage to plant but could also endanger staff.

4.2 How can Partial Discharge be detected?

A partial discharge emits energy in various ways and produces a number of effects which can be detected:

Electromagnetic:

- Radio
- Light
- Heat

Acoustic:

- Audio
- Ultrasonic

Gases:

- Ozone
- Nitrous oxides

The most practical techniques for non-intrusive testing are based on the detection of the radio frequency part of the electromagnetic spectrum and ultrasonic emissions. The UltraTEV Plus² has specifically been developed to enable electromagnetic and ultrasonic activity to be detected in a single simple to use instrument.

4.3 Airborne Ultrasonic Discharge Activity

Acoustic emissions from partial discharge activity occur over the whole acoustic spectrum. Audible detection is possible but depends on the hearing ability of the individual. Using an instrument to detect the ultrasonic part of the acoustic spectrum has several advantages; instruments are more sensitive than the human ear, are not operator dependent and are more directional when operating above the audible frequency.

The most sensitive method of detection is using an airborne ultrasonic Microphone centred at 40 kHz. This method is very successful at detecting partial discharge activity provided there is an air passage between the source and the Microphone.

4.4 Electromagnetic Discharge Activity

When partial discharge activity occurs within high voltage switchgear, it generates electromagnetic waves in the radio frequency range which can only escape from the inside of the switchgear through openings in the metal casing. These openings may be air gaps around covers, or gaskets, or other insulating components. When the electromagnetic wave propagates outside the switchgear, it produces a Transient Earth Voltage (TEV) on the metal casing of the switchgear. The Transient Earth Voltage (TEV) is only a few millivolts, of short duration having a rise time of a few nanoseconds and can be detected non-intrusively by placing a TEV probe on the outside of the earthed switchgear whilst the switchgear is in service.

4.5 Cable Partial Discharge Activity

When a partial discharge event occurs in a cable, there will be a resulting current pulse coupled onto the earthed sheath of the cable. These pulses will propagate away from the discharge site in both directions. Once the pulse reaches a change in impedance at a cable joint or termination, a partial reflection occurs. This results in the pulses travelling back down the cable several times (depending on the cable length) as they decay away. The current pulses can be detected non-intrusively using a Radio Frequency Current Transformer (RFCT) sensor placed around the cable earth strap.

5. Using the UltraTEV Plus²



5.1 Charging the UltraTEV Plus²



Micro USB charging port

Use the supplied USB cable to charge the UltraTEV Plus² with the mains charger, in-car charger or from a standard USB port.



Battery Level Indicator



Charging



UltraTEV Plus² is charging



UltraTEV Plus² is fully charged



For the quickest charging time, turn off the UltraTEV Plus² instrument during charging. Charging time is extended when connected to a USB port compared to the mains charger.




The TEV/Cable PD and Ultrasonic measuring features are automatically disabled when the instrument is being charged.


A fully-charged battery should provide approximately 6 hours of continuous use while switched on and measuring. For practical purposes, a fully charged battery should last a full day of surveying.

The UltraTEV Plus² needs to have sufficient charge to remain powered on while viewing data through a USB port.

A laptop USB port may not provide enough power to charge the UltraTEV Plus² and view data simultaneously.

5.2 Turning the UltraTEV Plus² On/Off

Power on press and hold  for 1 second

Power off press and hold  for 2 seconds

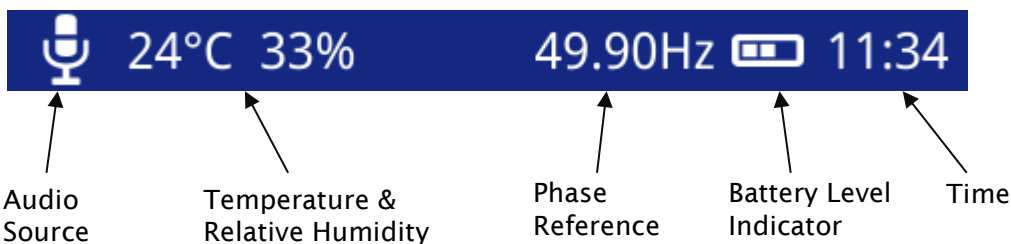
5.3 Self-Test

During power up the UltraTEV Plus² performs a self-test on TEV, ultrasonic and Cable PD using the inbuilt test sources. The self-test is not a calibration check.



If self-test consistently fails, contact Product-support@eatechnology.com

5.4 Notification Bar



Below are other icons that could appear on the notification bar:



This icon indicates that the current audio source is TEV



This icon indicates that the current audio source is Ultrasonic



This icon indicates that the current audio source is the RFCT



This icon shows when a UltraDish has been connected to the UltraTEV Plus²



This icon shows when a RFCT has been connected to the UltraTEV Plus²



This icon shows when a Contact Probe has been connected to the UltraTEV Plus²



This icon shows when a Flexible Sensor has been connected to the UltraTEV Plus



This icon shows when the UltraTEV Plus² is charging



This icon is used to show when a Wi-Fi connection has been established

5.4.1 Temperature & Humidity

The temperature and relative humidity reading is displayed on the notification bar only after connection of the Environmental Sensor.

The Environmental Sensor pictured below is connected to the Smart Accessory Port on the left hand side of the instrument. The connection of the accessory automatically starts the data collection with the latest reading being displayed in the notification bar at the top left of the screen.



In order to allow use of other optional accessories whilst still displaying a reference temperature, the final reading on removal of the sensor is persisted. Additional brackets around the measurement demonstrate that this is a historic reading.

(23°C 53%)



Wait for the temperature and humidity reading to settle. This may take a while if it has been stored in very high or low temperatures.

5.5 Menu Bar

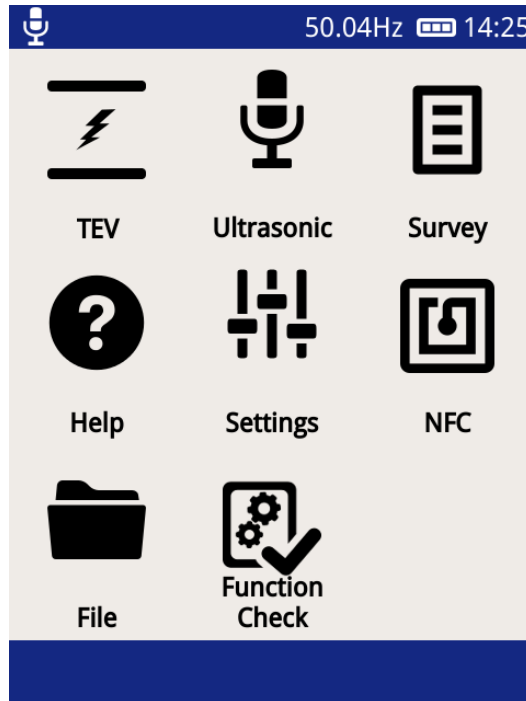
The menu bar is located at the bottom of the screen. It displays icons that correlate to the Left, Middle and Right Buttons. The icons on the Menu bar change depending on which mode the UltraTEV Plus² is in.




The Left button , Middle Button  and Right Button  can be pressed to select the Main menu buttons respectively

5.6 Main Menu

After powering up, the UltraTEV Plus² will load up to the Main Menu as shown below.



The Home Button  can be used to navigate back to the Main Menu at any time.

The TEV icon on the main screen will change to a Cable PD icon when a RFCT accessory is plugged in.

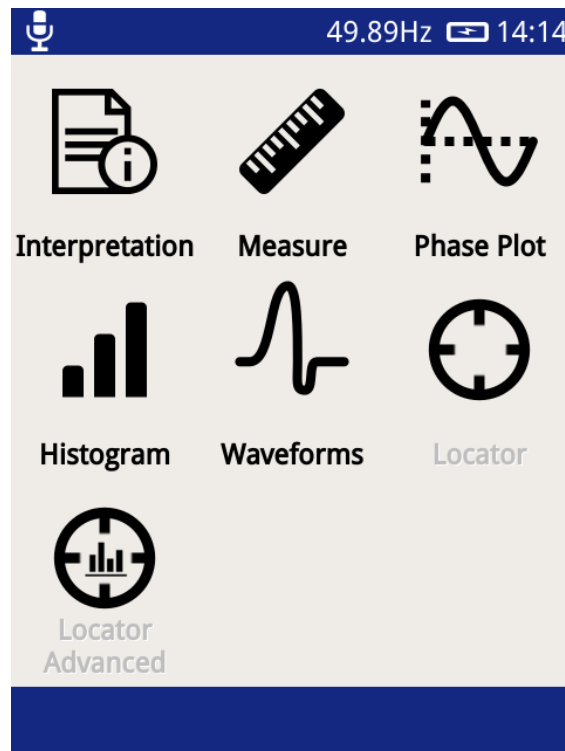


5.7 TEV/Cable PD Menu

The TEV/Cable PD screen, selected via the top left icon on the Main Menu contains different modes which can be used for the PD measurement. The locator modes require additional locator probe accessory.



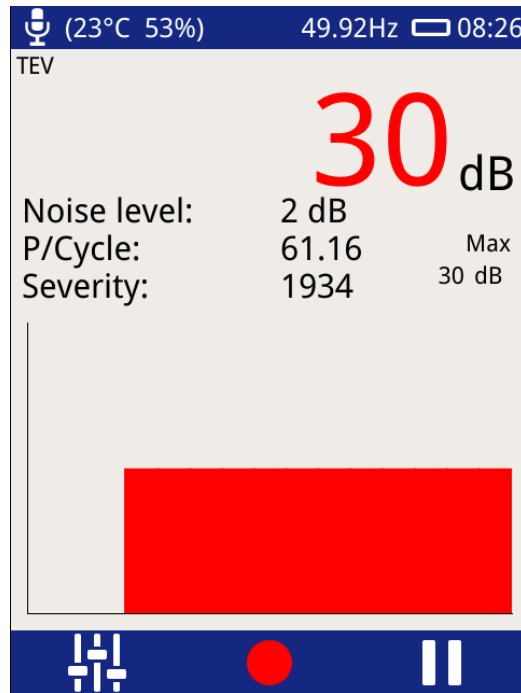
The Interpretation option is only applicable when in TEV mode



5.7.1 Measure Screen



The Measure mode is common to both TEV and Cable PD. This mode displays TEV readings in dBmV (dB) or (if the RFCT accessory is connected) Cable PD readings in picoCoulombs (pC).


To enter this mode, click the Measure icon .



- **P/Cycle** – Shows the pulses per cycle based on either a 50 or 60Hz mains frequency.
- **Severity** – Shows the short term severity (calculated by multiplying TEV magnitude (mV) by Pulses Per Cycle). When in Cable PD mode, this is calculated by Charge (pC) multiplied by Pulses Per Cycle.
- **Max dB** – displays the maximum dB value registered by the UltraTEV Plus² since the screen was entered or paused/reset. This value is displayed in pC.
- **Chart** - The bar chart is used to show the amplitude of the current values being read by the UltraTEV Plus², from right to left.
- **Noise Level** – This displays the amplitude in dB of the background noise level.

To exit the TEV screen back to the main menu, press the Home button .

There is an option to record a reading, this can be done by either clicking the red record icon on the screen  or by pressing the Middle button . All recordings are stored within a 'survey' detailed in a later section of this manual.

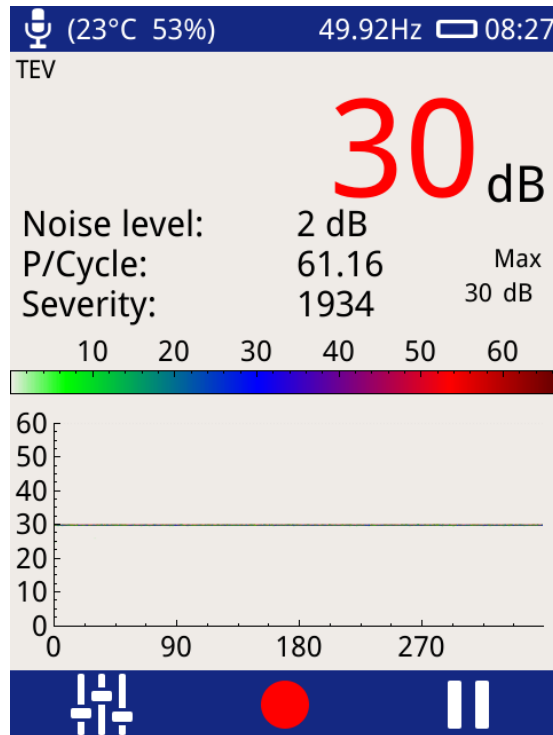
Pausing a reading can also be achieved by either pressing the Right button or clicking on the 'Pause'  icon. Audio output is also muted during a pause operation. After pausing the screen the measurement can be restarted by pressing the restart button.

5.7.2 Phase Plot

The Phase Plot mode is common to both TEV and Cable PD. The upper section of the screen shows measurement values as detailed previously under the 'Measure Screen'. The lower section contains a phase resolved intensity plot 'Phase Plot' of the measured activity.

The plot displays either TEV or Cable PD events' phase angles (x-axis) against their amplitude (y-axis). The colour scale represents the intensity (pulse count) at a given phase angle and amplitude.

This option is useful for distinguishing between whether a measured PD activity is a genuine discharge source or just noise. For example, genuine PD activity may manifest itself as a stable phase resolved plot which will occur at the same position with respect to phase angle cycle by cycle; whilst white noise will not be phase related occurring at irregular positions on the phase plot.



The Pause and Record option is also available in this mode; Severity, Noise Level and P/Cycle are calculated as described under the Measure Screen



To zoom in on a chart, slide your finger from bottom left to top right of the area of interest. To zoom out draw a diagonal line from top right to bottom left.

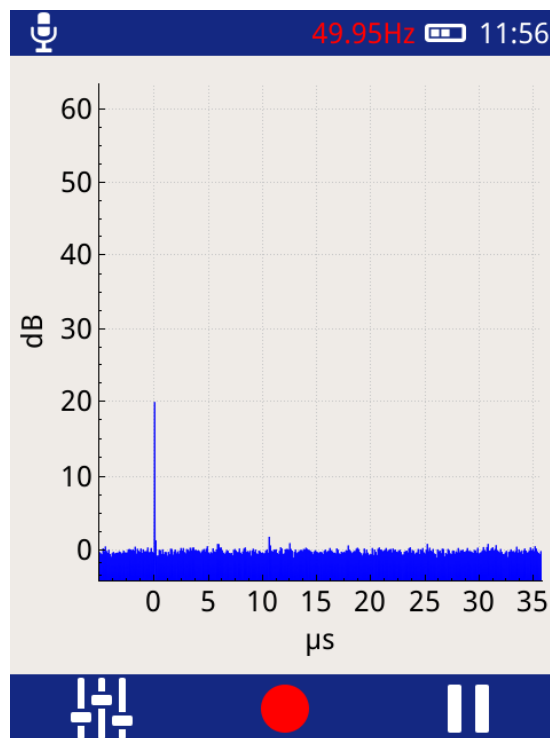
5.7.3 Waveform

The 'Waveform' mode is common to both TEV and Cable PD. When in Cable PD mode, values will be displayed in mA, whilst in TEV mode they will be measured in dBmV as below.



To enter this mode, click the Waveform icon

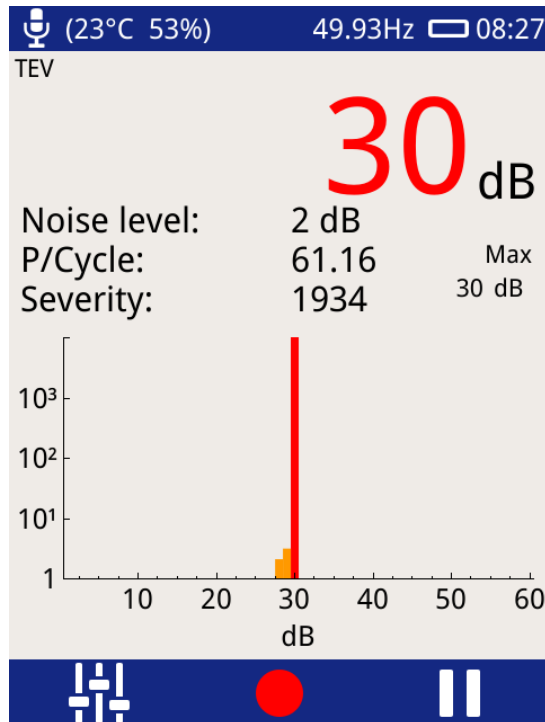
This mode displays a plot of a TEV or Cable PD activity as a function of time allowing an instantaneous view of an activity's amplitude with respect to time. This option can be used to assist in distinguishing between genuine PD activity and noise. A Partial Discharge pulse will normally manifest as a sharp fast rising edge pulse whilst noise is often slower and less repeatable.



The Pause and Record option is also available in this mode as described under the Measure Screen

5.7.4 Histogram

This option (shown below) displays the number of events registered (y-axis) for a given amplitude (x-axis). This measurement option is useful for determining if more than one discharge source is present; two distinct groups of bars on this chart could mean there are two sources of discharge at the respective dB (or pC) levels. The screen is also useful in positively identifying a genuine source of PD and assessing its pulse rate when there is a high pulse rate noise floor affecting the standard pulse per cycle calculation.



The Pause and Record option is also available in this mode; Severity, Noise level and P/Cycle are calculated and as described under the Measure Screen

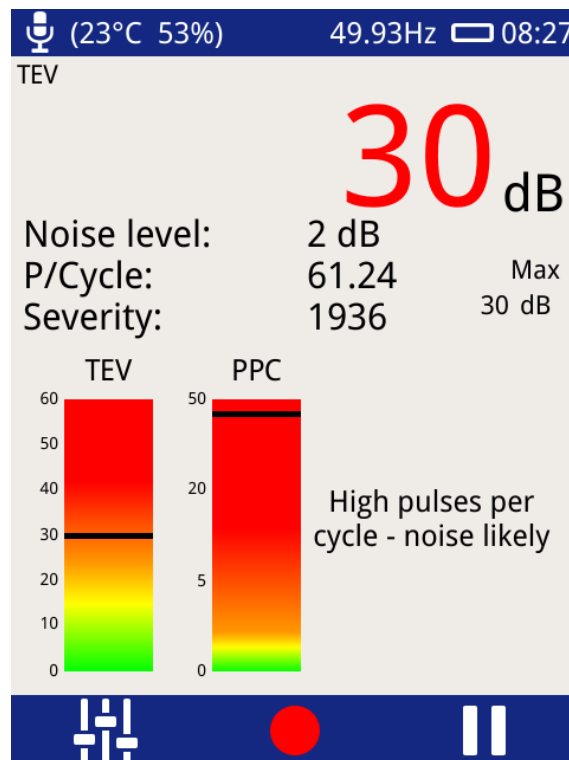
5.7.5 Interpretation

The 'Interpretation' mode available for TEV readings only.



To enter this mode, click the Interpretation icon Interpretation.

The interpretation screen provides a first pass summary of the switchgear's condition by taking into account both the magnitude and repetition rate of any detected pulses. The guide distinguishes between noise, surface tracking and internal discharge providing an indication of the suggested action.

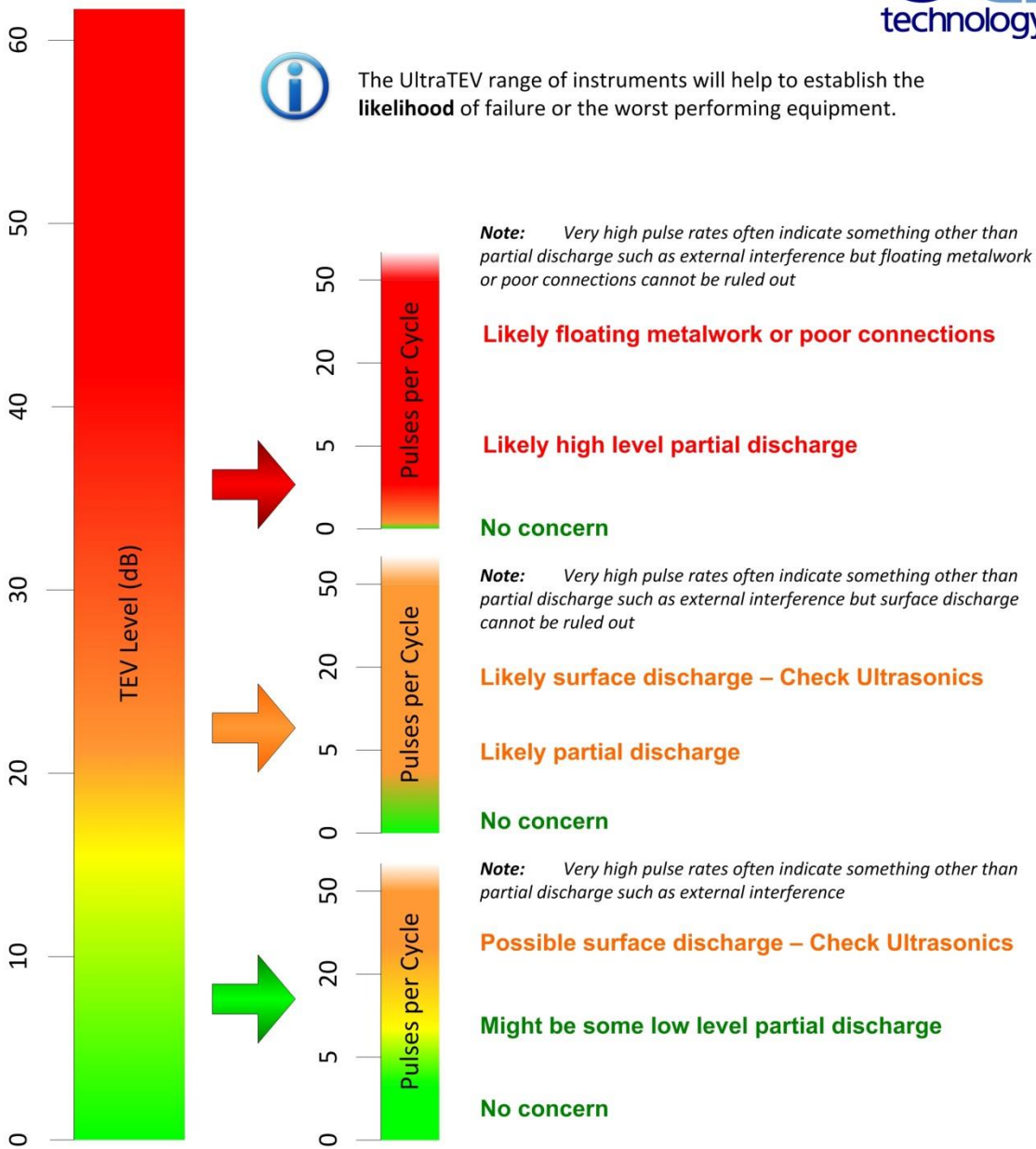


This display is an easy to use software implementation of the TEV measurement interpretation guide produced by EA Technology using decades of experience. The original summary document giving an overview of the original guidelines for the interpretation of TEV measurements is included on the next page.



The Interpretation screen is only available when in TEV mode

TEV Measurement Interpretation Guide



The TEV reading in dB gives you a good place to start



Look at the number of pulses per cycle to see how severe things are

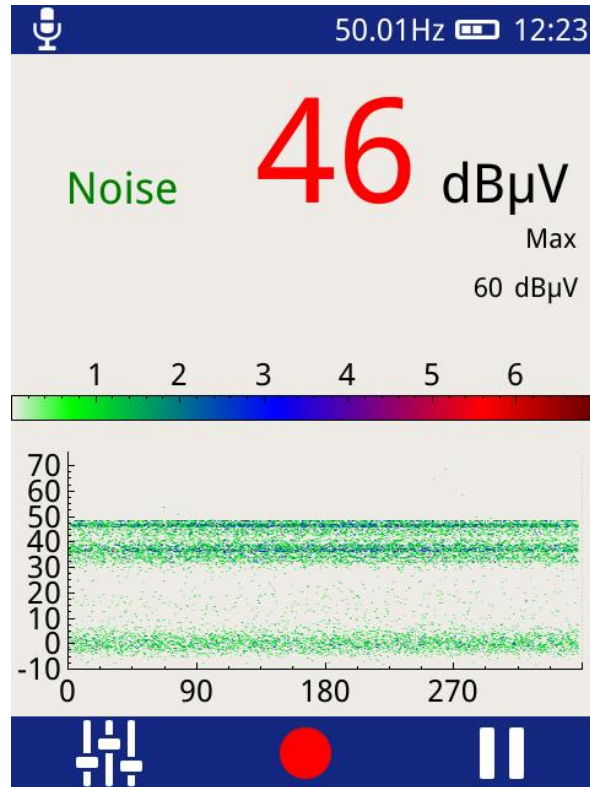


Use the measurements along with any **other information** you have about the equipment tested and the **consequence** of failure to assess the **risk to the network** so that you can decide what to do next



5.8 Ultrasonic Screen

The Ultrasonic screen shows measurements taken using either the inbuilt Ultrasonic sensor or the external Ultrasonic sensors (Contact Probe, Flexible Sensor or UltraDish) if connected.



Ultrasonic magnitude is measured in dB μ V and is displayed on the chart as phase angle (x-axis) against amplitude (y-axis). The colour chart represents a key to show the intensity (pulse count) at a given amplitude and phase angle.

This phase resolved plot can be used to further confirm the presence of a partial discharge activity. In general PD activity will be displayed as a stable area which will occur at the same to phase angle each cycle; whilst noise tends to be out of phase and occurs at irregular positions on the phase plot.



The Pause and Record option is also available in this mode as described under the Measure Screen

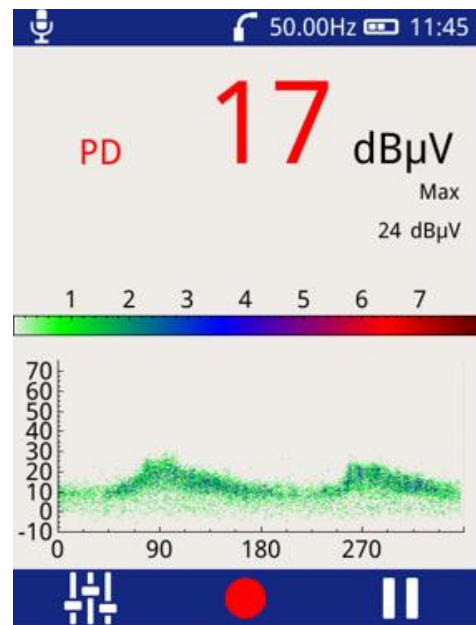
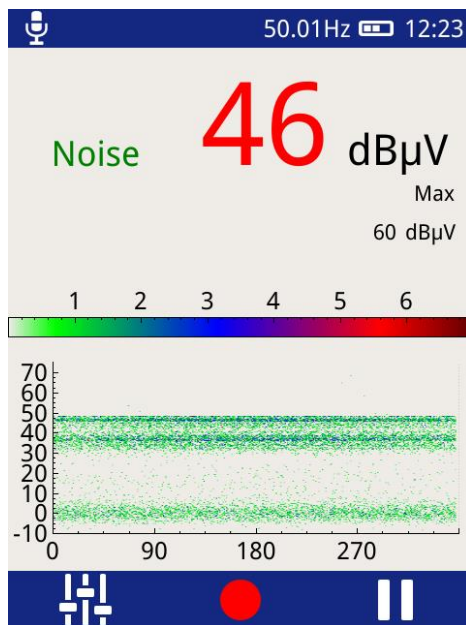
5.8.1 Ultrasonic classification

The Ultrasonic display on the UltraTEV Plus² includes the output of EA Technology's proprietary ultrasonic classification algorithm. The algorithm processes measured ultrasonic data in real time to give an indication whether the input data is a background noise source or partial discharge activity.

The algorithm processes the data from the ultrasonic Microphone along with the phase reference signal, and looks for patterns within the data stream which experts at EA Technology have identified as typical indicators of partial discharge.

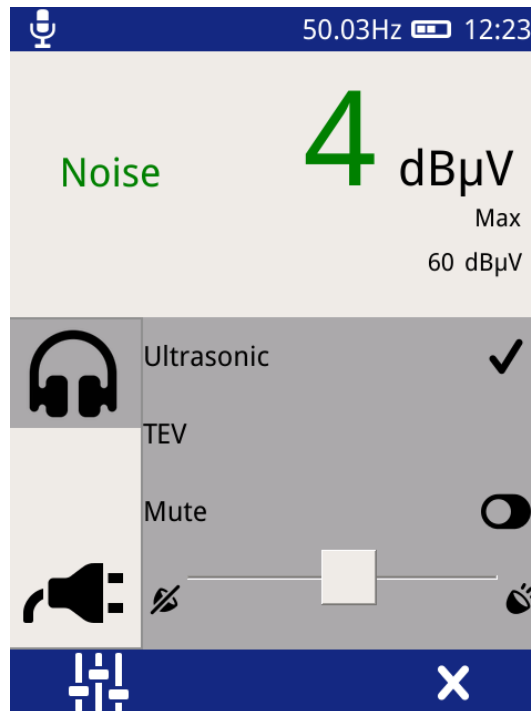


The ultrasonic classification will not be displayed if the phase lock has not been achieved.



5.9 Context Menu


Pressing the Left Button whilst in TEV, Cable PD or Ultrasonic modes brings up the Context Menu as shown below. The Context Menu consists of a number of items with only those relevant to the current mode of operation visible at any time. This mode allows commonly used settings to be modified from within the measurement screen.



The Context Menu contents is context specific; its contents will differ for each measurement mode

5.9.1 Audio output


The UltraTEV Plus² allows audio output of either Ultrasonic, TEV or Cable PD (dependent on whether RFCT is connected or not) activity through the connection of external headphones. The audio context menu allows control of the headphone output.

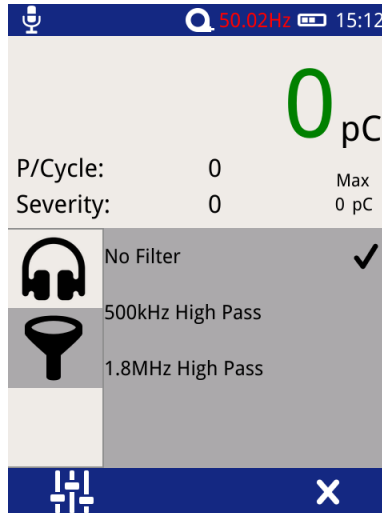
To modify the current audio settings click on the Audio icon . Within this sub menu the audio output (TEV, Cable PD or Ultrasonic) can be selected, note this selection will persist across modes.

To turn off the audio output toggle the Mute Button, the toggle icon will turn green to indicate the Mute mode has been activated.

The volume of the audio output can also be modified by adjusting the slider to the desired level as shown above.

5.9.2 Filters


Select the filter icon  to change the filter properties; this option is only enabled when in Cable PD Measurement Mode and enables noise to be filtered from the cable PD measurement.



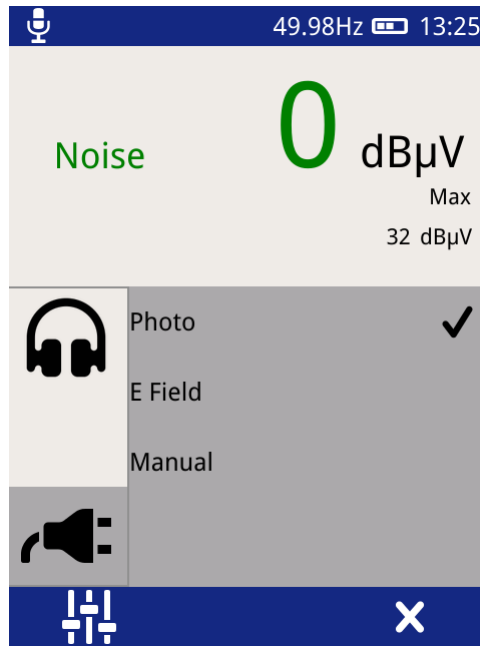
Select the desired filter properties, a tick should appear when a selection has been (shown above).

- **No Filter** – This option passes all frequency types.
- **500 kHz High Pass** – This option activates a high pass filter that passes all frequencies from 500kHz and above.
- **1.8 MHz High Pass** – This option activates a high pass filter that passes all frequencies from 1.8 MHz and above.

5.9.3 Phase Reference




Select the  icon on the context menu to access the phase reference settings page. This allows the source of the phase reference for the UltraTEV Plus² to be selected from the following options:

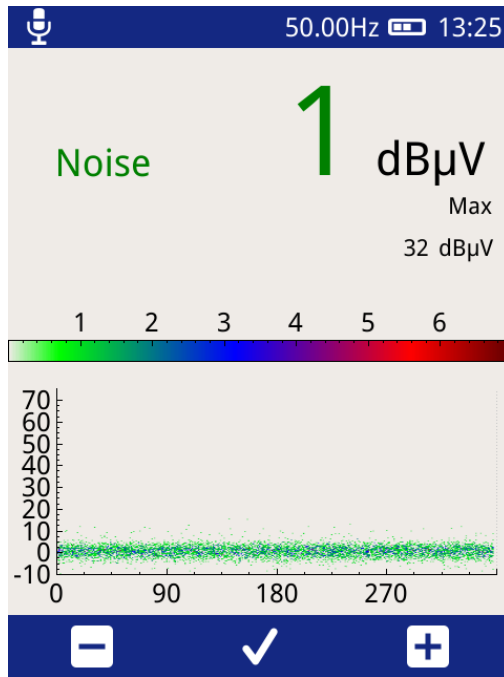
- **Photo** – This option selects the Photo-sensor located on the front upper section of the UltraTEV Plus² as the source of the Phase reference. The Photo-sensor requires line of sight to a mains frequency light source such as a fluorescent fitting.
- **E field** – This option selects the in-built E-field sensor as the source of Phase reference. The sensor detects the phase reference from the stray electric field within the substation.
- **Manual** – Allows the user to manually adjust the phase reference.



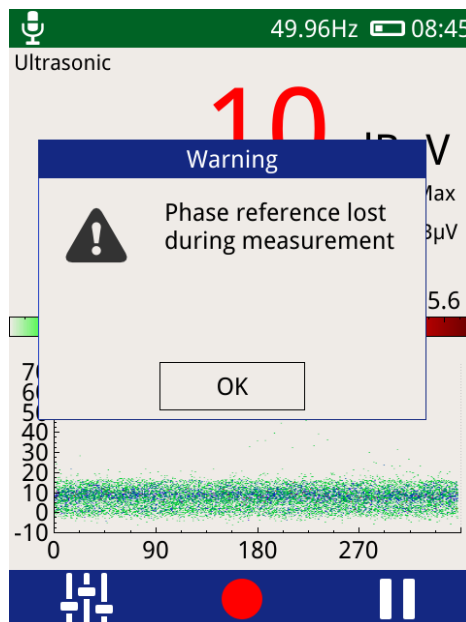
The current status of the phase reference is indicated by the colour of the phase readout.

	<p>A white phase display indicates a phase lock has been achieved.</p>
	<p>A red phase display indicates that a phase lock has not been achieved. A continuous red phase display would necessitate the change of mode.</p>
	<p>An amber phase display indicates that the frequency has been set manually.</p>


When in Manual Mode the Right  and Left  buttons can be used to increase or decrease the phase reference respectively. Once the desired value has been reached, press the middle button  to store as shown below.

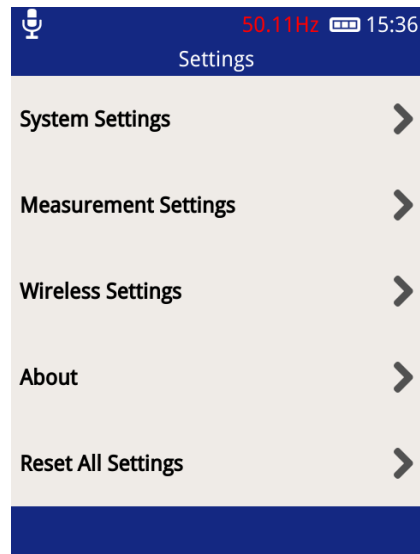


During a data capture the UltraTEV Plus² monitors the phase lock to ensure a continuous sync is achieved. If the phase lock is lost at any time during a capture the unit displays a warning message on completion of the recording. Every attempt should be made to ensure a phase lock is present as the lack of this may affect the analysis of the data captured.

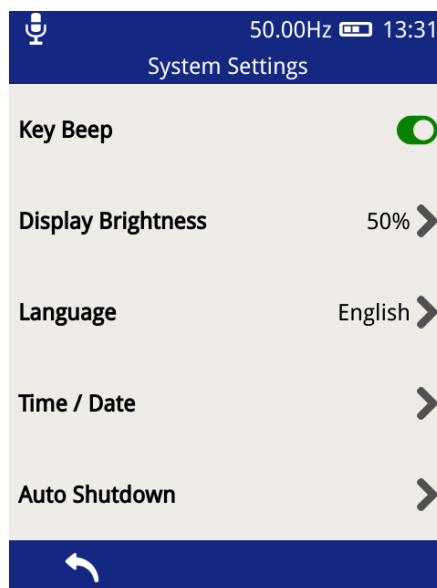


5.10 Settings Screen

To access the settings page, click the Settings icon  on the Main Menu and the screen shown below will be displayed.



5.10.1 System Settings

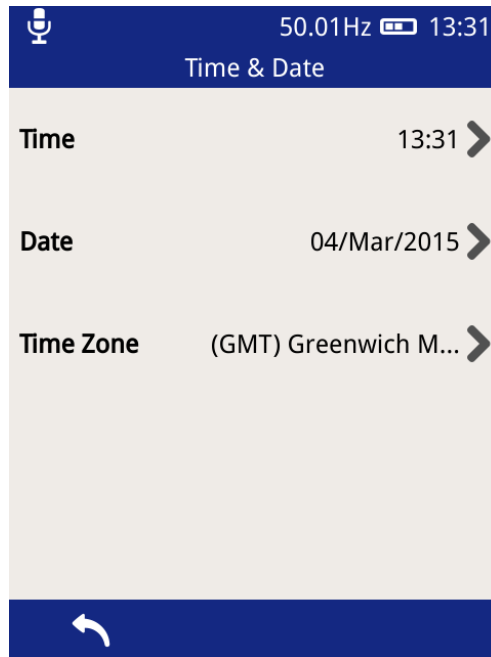


- **Key Beep** – allows the turning ON/OFF of the audible beeps when any of the buttons are pressed and when a NFC tag is detected. The button toggles to a green colour when Key Beep is activated.
- **Display Brightness** – click on this to change the intensity of the backlight.

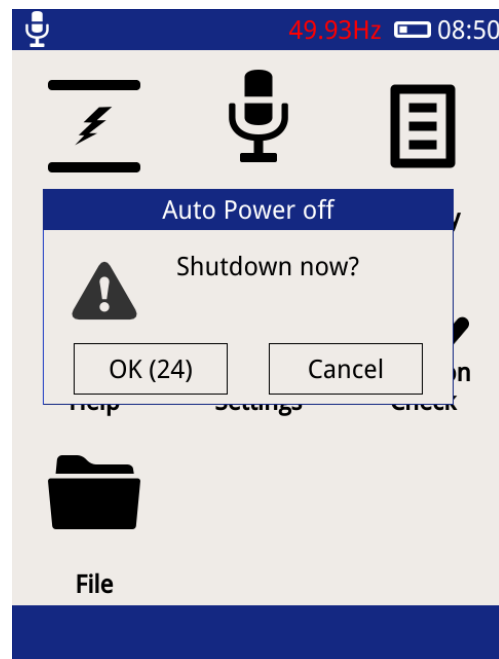
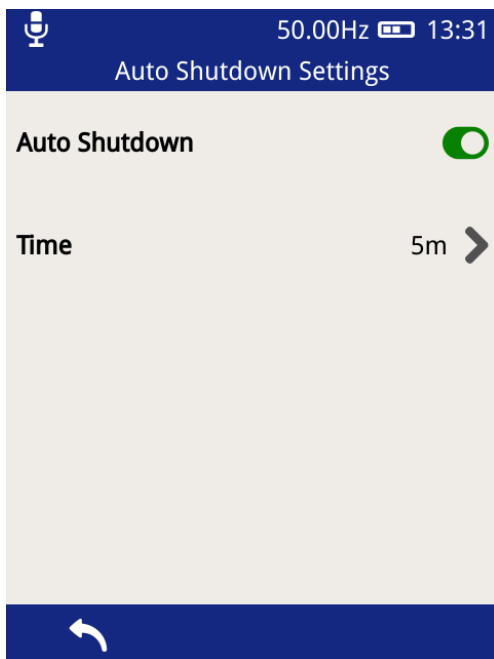


Keeping the backlight to a minimal level will improve battery life

- **Language** – select this option to change the UltraTEV Plus² display language.
- **Time/Date** – select this option to change the Time and Date settings on the UltraTEV Plus². The time zone can also be changed here as shown below.

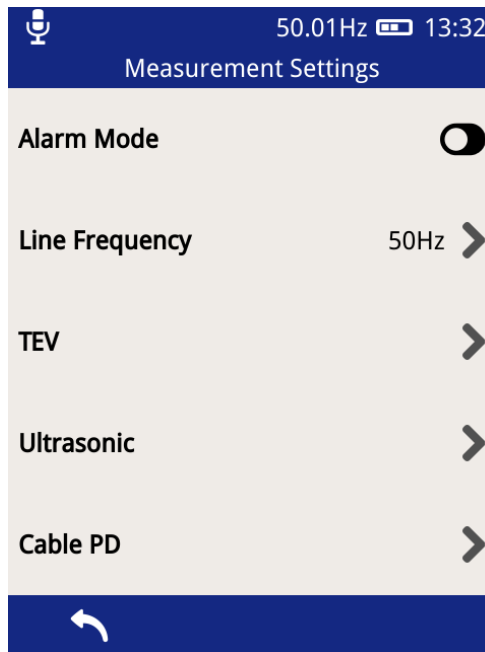


- **Auto Shutdown** – this option can be used to Enable/Disable the Auto shutdown feature of the UltraTEV Plus². After a defined period of push button inactivity, the UltraTEV Plus² will display a warning message and then proceed to shut itself down to conserve power. The inactivity period can also be changed here as shown below.



5.10.2 Measurement Settings

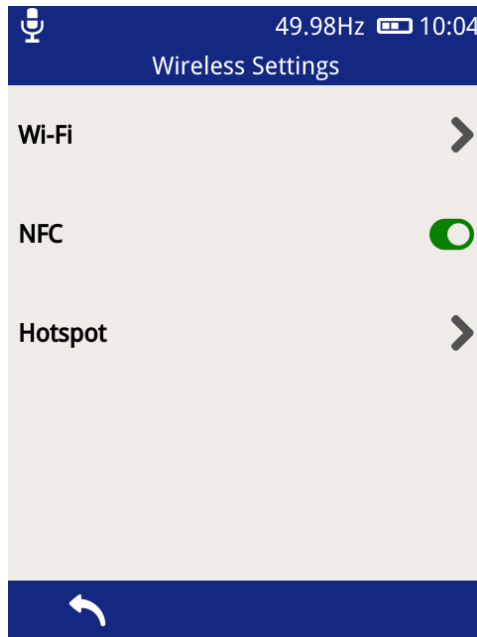
The Alarm Mode can be toggled on and off in this option. When the Alarm mode is activated, the inbuilt beeper of the UltraTEV Plus² will be activated whenever the set Red threshold level has been exceeded. In addition to this, threshold levels (Red and Amber levels) for the various measurement features of the UltraTEV Plus² can be modified here together with the line frequency.



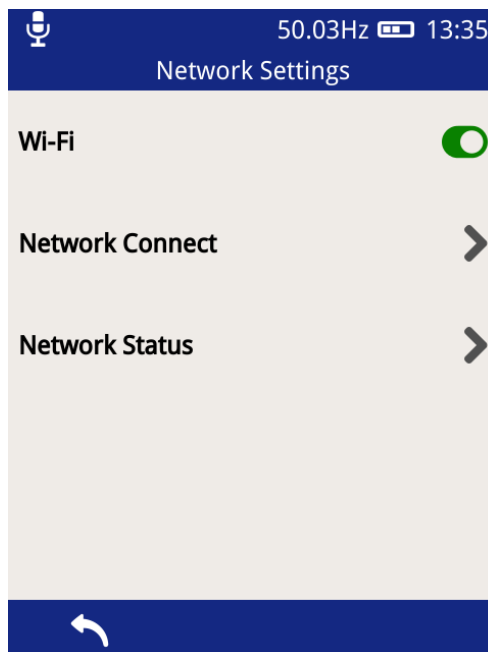
The Ultrasonic only contains a Red Level threshold setting

5.10.3 Wireless Settings

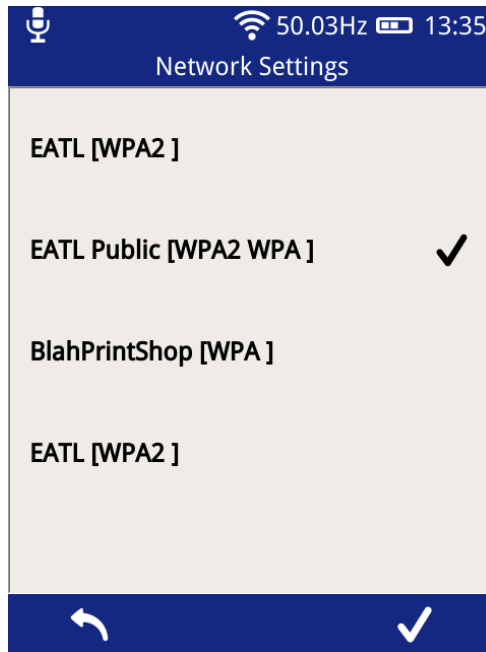
This section allows the setting of the Wi-Fi & NFC features of the UltraTEV Plus².




The NFC is enabled system wide by sliding the toggle switch to green. Once active the NFC features can be accessed through the survey and measurement screens.



The Wi-Fi functionality can be switched on/off using the toggle button shown above. Select **'Network Connect'** above to connect it to a Wi-Fi network.



Using the on-screen keyboard, enter the Wi-Fi password and then the Middle Button  to save the network.

The connection status of the UltraTEV Plus² can be viewed by selecting **'Network Status'**.

5.10.4 About

The about screen displays a summary of the UltraTEV Plus² components including both hardware and software version numbers. The display also provides details of EA Technology's dedicated Product Support team should any further information be required.




To book the UltraTEV Plus² in for calibration ahead of its recommended due date, please contact Product support :

Email: product-support@eatechnology.com

Tel: +44 (0)151 347 2293

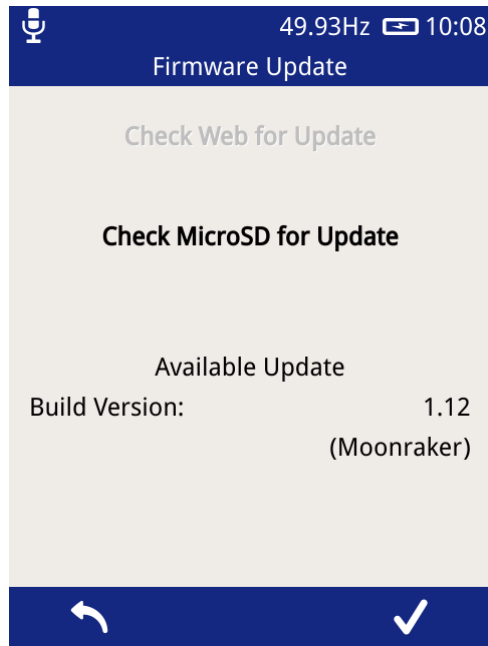
5.10.5 In-field Firmware Upgrade

Through the '**About**' screen, the firmware of the UltraTEV Plus² can be updated. To access the firmware update screen press the update icon .

The UltraTEV Plus² can be updated in the field from an update file loaded onto the MicroSD card. Please check with Product Support for any available update files. To use this feature the image will initially need to be copied from the distribution media to the 'updates' folder on the MicroSD card. An SD to MicroSD adapter is supplied for use with laptops or PCs which have an in built SD card reader.

To install a firmware update from the MicroSD card, press the "Check MicroSD for Update" button on the above screen. The MicroSD card will be checked for any available updates, and details populated on the display as shown below. To install the update found, press the tick icon on the right of the menu bar and await the process to complete.

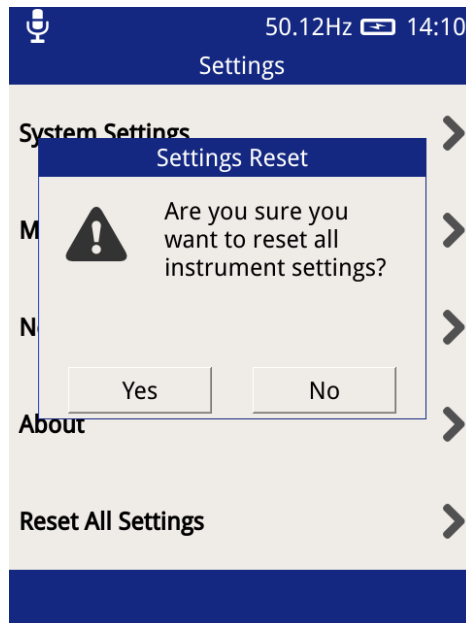
An update can only be installed if the instrument is plugged into the mains charger to avoid any unwanted shutdown due to low battery whilst performing the update process. Once installed, the instrument must be restarted to run the latest update.



To check you have the most current software version or if you need assistance in updating your instrument, please contact product support

5.10.6 Reset All Settings

This option can be used to reset the UltraTEV Plus² back to the default settings. Upon pressing the option a notification will appear asking for the action to be confirmed.




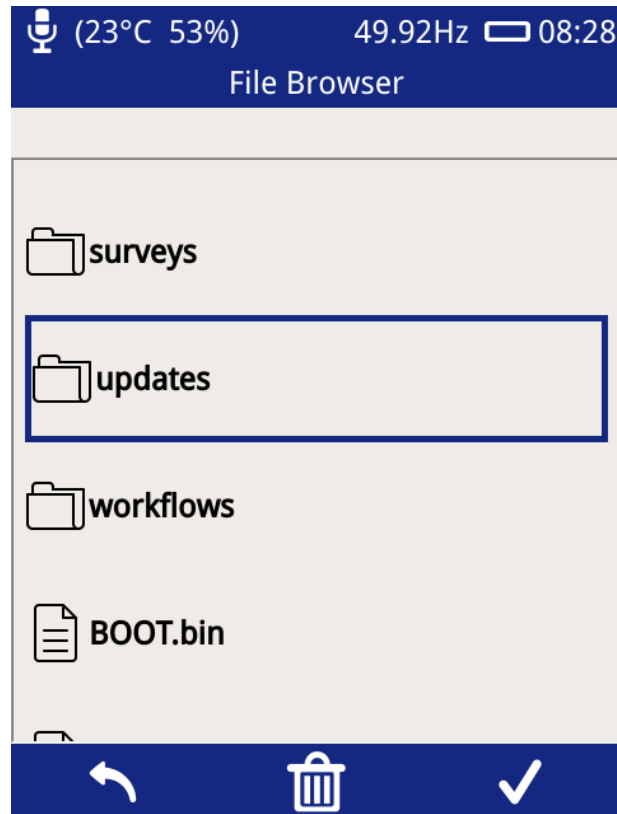
Once confirmed the follow settings will be reset back to their default state:




- Key Beep Enable
- Display Brightness
- Language
- Auto Shutdown Enable
- Auto Shutdown Time
- Line Frequency
- TEV Red and Amber Measurement Thresholds
- Ultrasonic Red Threshold
- Cable PD Thresholds
- Wi-Fi enable




Any Wi-Fi networks previously connected to and their login credentials will be preserved, and will not be cleared with the above.

5.11 File Browser

The File Browser screen can be used to manage files and folders stored on the UltraTEV Plus²'s microSD card. To access the file browser, click File icon  on the Home screen.



Upon opening the File Browser, the contents at the root of the memory card will be displayed. Selecting a folder, represented by the folder icon , will cause it to be highlighted within the File Browser. The contents of the folder can then be displayed by pressing the  icon or the physical button below it on the instrument. A folder can be deleted by pressing the  icon or the physical button below it.

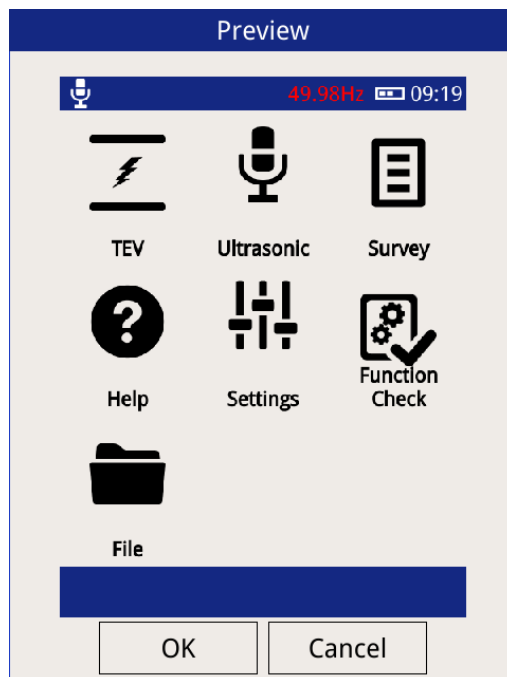
Selecting a file, represented by the file icon , will cause it to be highlighted within the File Browser. Information regarding the file such as size, date modified and time modified can then be displayed by pressing the  icon or the physical button below it on the instrument. A file can be deleted by pressing the  icon or the physical button below it.

5.12 Screenshot

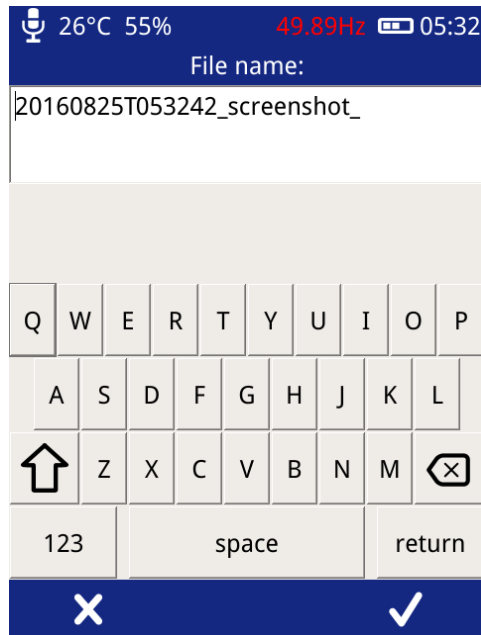
The UltraTEV Plus² allows the user to capture an image of the screen at any time. To initiate a capture press both the left and right hand buttons simultaneously for two seconds.



Once capture completes a pop up window will appear giving a preview of the screen capture. This preview can either be rejected by pressing cancel which discards the image and returns to normal operations or accepted which will move onto the file naming screen.



The file name screen provides the opportunity to rename the file from the default as shown below. Selecting the tick in the bottom left hand corner of the image stores the file to the removable microSD Card. The files are stored at \data and can be verified through the file browser

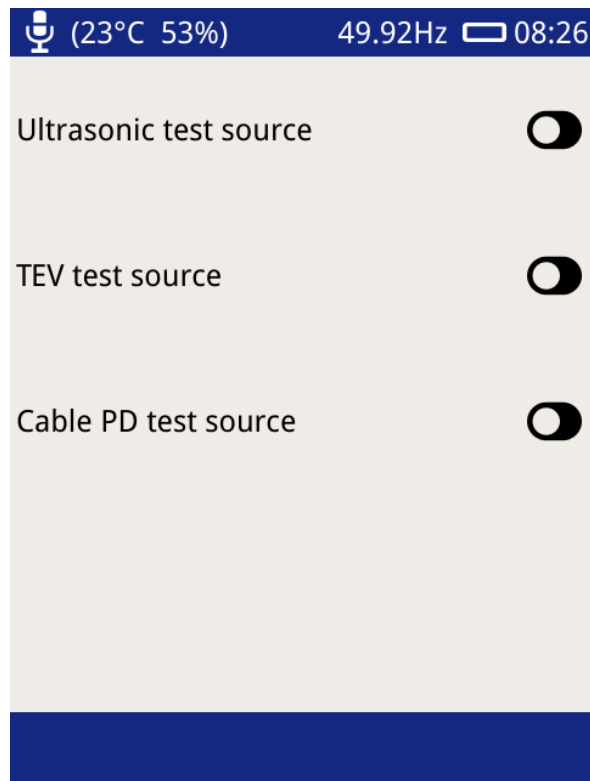


The screen shot image can be viewed by removing the SD card and inserting in to a PC or similar device and navigating to \data and opening the relevant .png file, or by connecting to the UltraTEV Plus² interface.

5.13 Function Check

The UltraTEV Plus²'s function checker is designed to allow users to verify the functionality of their instrument using inbuilt test sources. The Function Check display option can be used to toggle these inbuilt test sources. To launch the Function Check display, press the

Function Check icon  on the Home screen.



To test a given function, for example, the TEV function, toggle on the TEV test source. Navigate to any of the TEV measurement displays which should display TEV activity. Multiple test sources can also be toggled and checked.



Please note that this option is not in any form a calibration check.

6. NFC Functionality

The UltraTEV Plus² has a built-in NFC tag reader/writer that can program the tags when they are used for the first time and recall the information during a survey.



Blank NFC tags are identical and can be programmed with substation *or* asset information. There is a space on the tag to write 'asset', 'substation' or other information.

6.1 NFC Tag Installation

- NFC tags are not designed for outdoor installation
- NFC tags are designed to work on metal surfaces
- Clean the surface with alcohol prior to installation
- Install in a convenient place where the UltraTEV Plus² can be held in contact with the NFC tag while the display is observed

NFC functionality is enabled by default. To turn off the NFC function, go to Main Menu, Settings, Wireless Settings.



The NFC tag reader antenna is located behind the CE mark.

When taking a reading, align the centre button with the NFC tag.



6.2 Substation Tag

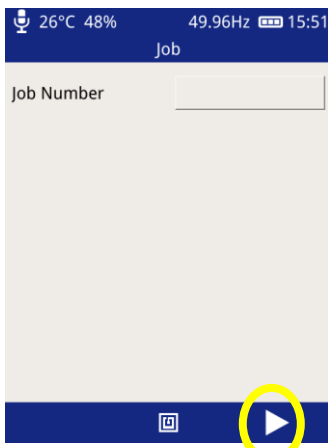
Use one NFC tag per substation to hold all the information relative to the substation being surveyed. This tag can be installed anywhere in the substation

The following information is stored:

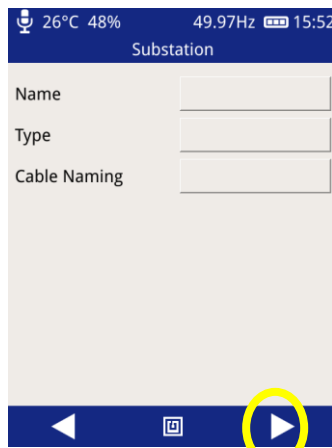
Substation Name	(up to 127 characters)
Substation type	(Indoor, outdoor, cabinet, other)
Switchgear Manufacturer	(up to 127 characters)
Switchgear Type	(up to 127 characters)
Installation Date	(Day, Month, Year)
Rated Voltage	(In KV)
Operating Voltage	(in KV)
Busbar Insulation Type	(Unknown, Air, Oil, Compound, SF6, Paper, XLPE, EPR)

6.3 Writing to a Substation Tag

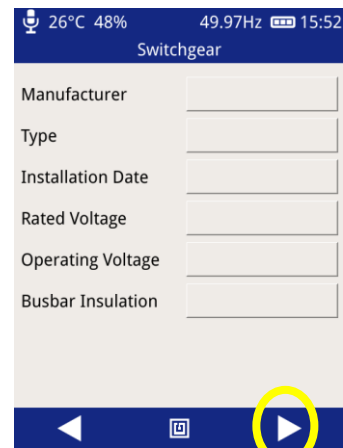
From the Main Menu select Survey, Start Survey, Skip Workflow



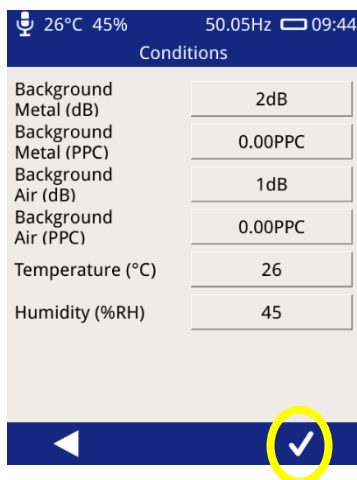
Enter unique survey reference



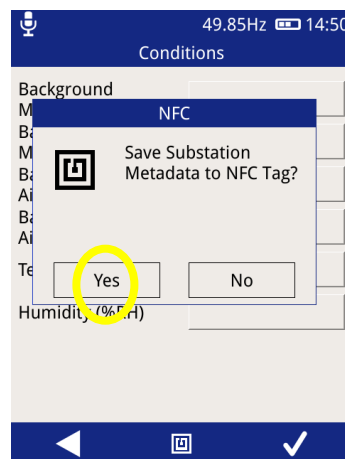
Enter substation name & type



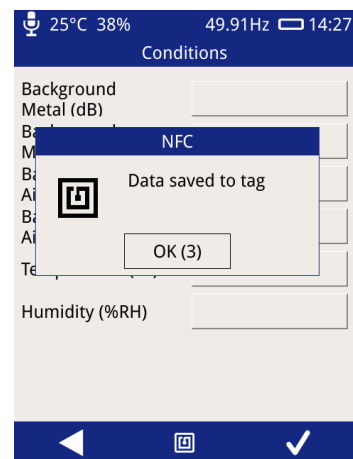
Enter switchgear information



Take background readings



Align the centre button with the NFC tag



The UltraTEV Plus² will beep once to indicate a tag has been detected, followed by

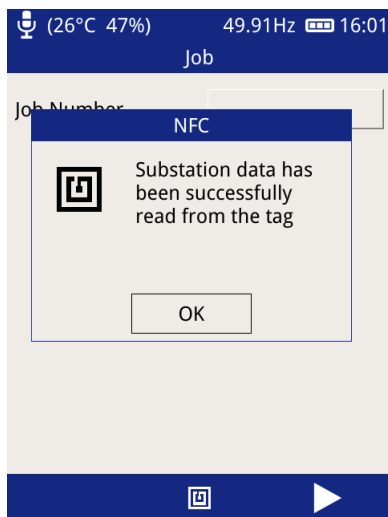
two beeps to indicate a successful tag write.

Following a successful tag write, the UltraTEV Plus² will continue in Survey mode.

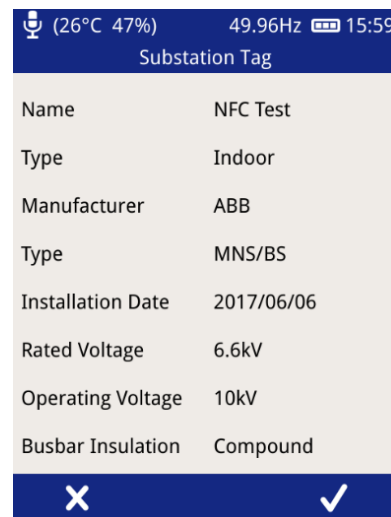
6.4 Reading a Substation Tag

Substation tag reads can take place in the Job, Substation and Switchgear screens within Survey mode.

From the Main Menu select Survey, Start Survey, Skip Workflow. Align the centre button with the NFC tag and press the centre button or NFC icon to trigger a scan. The UltraTEV Plus² will beep once to indicate a tag has been detected, followed by another beep to indicate a successful tag read.



Successful scan



Substation information added to survey

6.5 Asset Tag

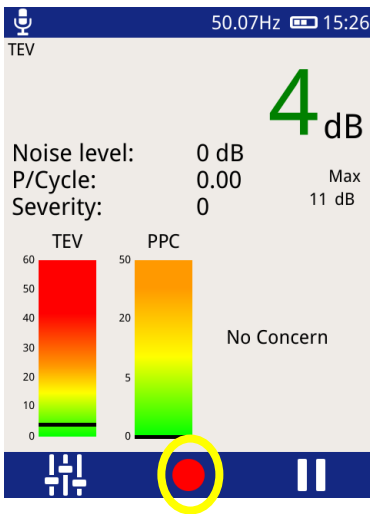
We suggest two NFC tags per panel, one on the front and one on the rear. The asset tag will store the following information required in the Metadata screen of Survey mode.

Asset Name (up to 127 characters)

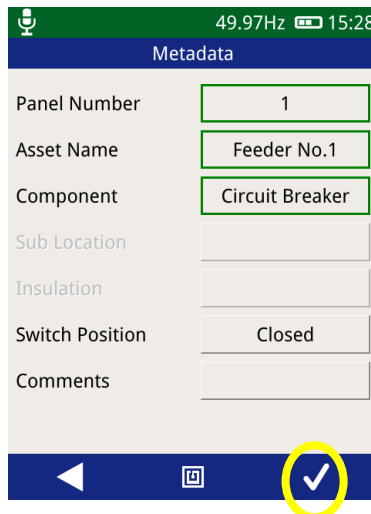
Panel Number (up to 127 characters)

6.6 Writing to an Asset Tag

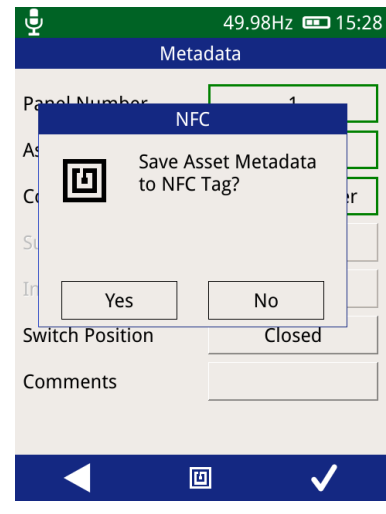
The recording data option is available in Survey, TEV and Ultrasonic mode.



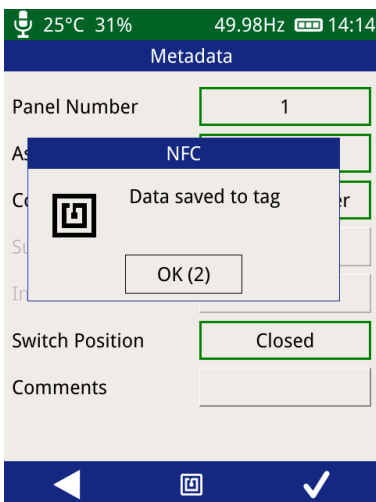
On any screen press record



Input asset information



Select 'yes' and align the centre button with the NFC tag

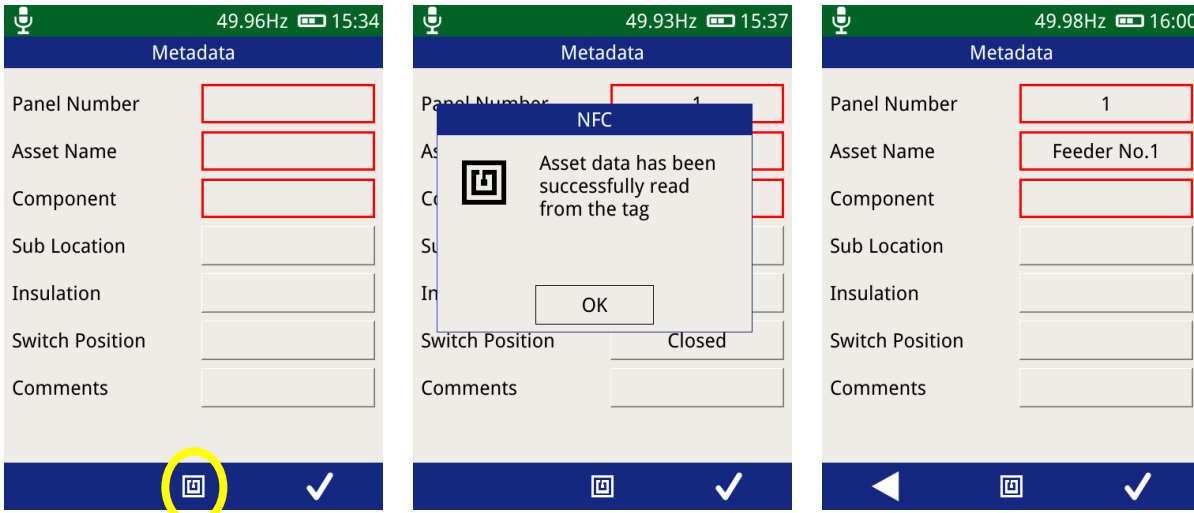


The UltraTEV Plus² will beep once to indicate a tag has been detected, followed by two beeps to indicate a successful tag write.

Once completed, the asset information is available for re-call on future measurements.

6.7 Reading an Asset Tag

Whenever the record option is used in Survey mode and the measurement 'Metadata' screen is displayed, a tag read is possible.



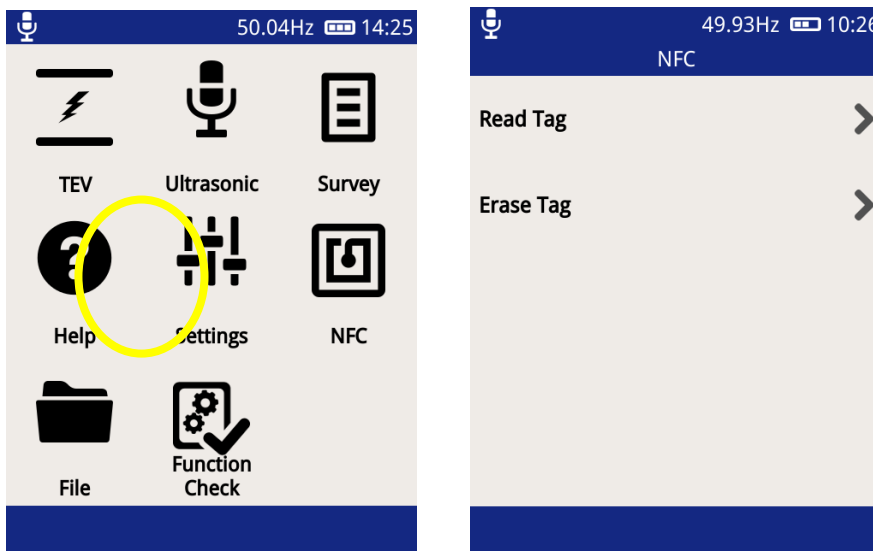
Press the centre button or NFC icon to trigger a scan

The UltraTEV Plus² will beep once to indicate a tag has been detected, followed by another beep to indicate a successful tag read.

Data will populate asset information

6.8 Reading an NFC Tag from the Main Menu

NFC tags which have previously been written to, can be read or erased from the Main Menu.



6.9 NFC Tag Trouble Shooting

'blank tag detected, no data read'	The tag has no data
'wrong tag type'	Attempting to read substation data from an asset tag
'no tag detected'	Re-position the UTP2 in contact with the NFC tag and try again.

7. Survey

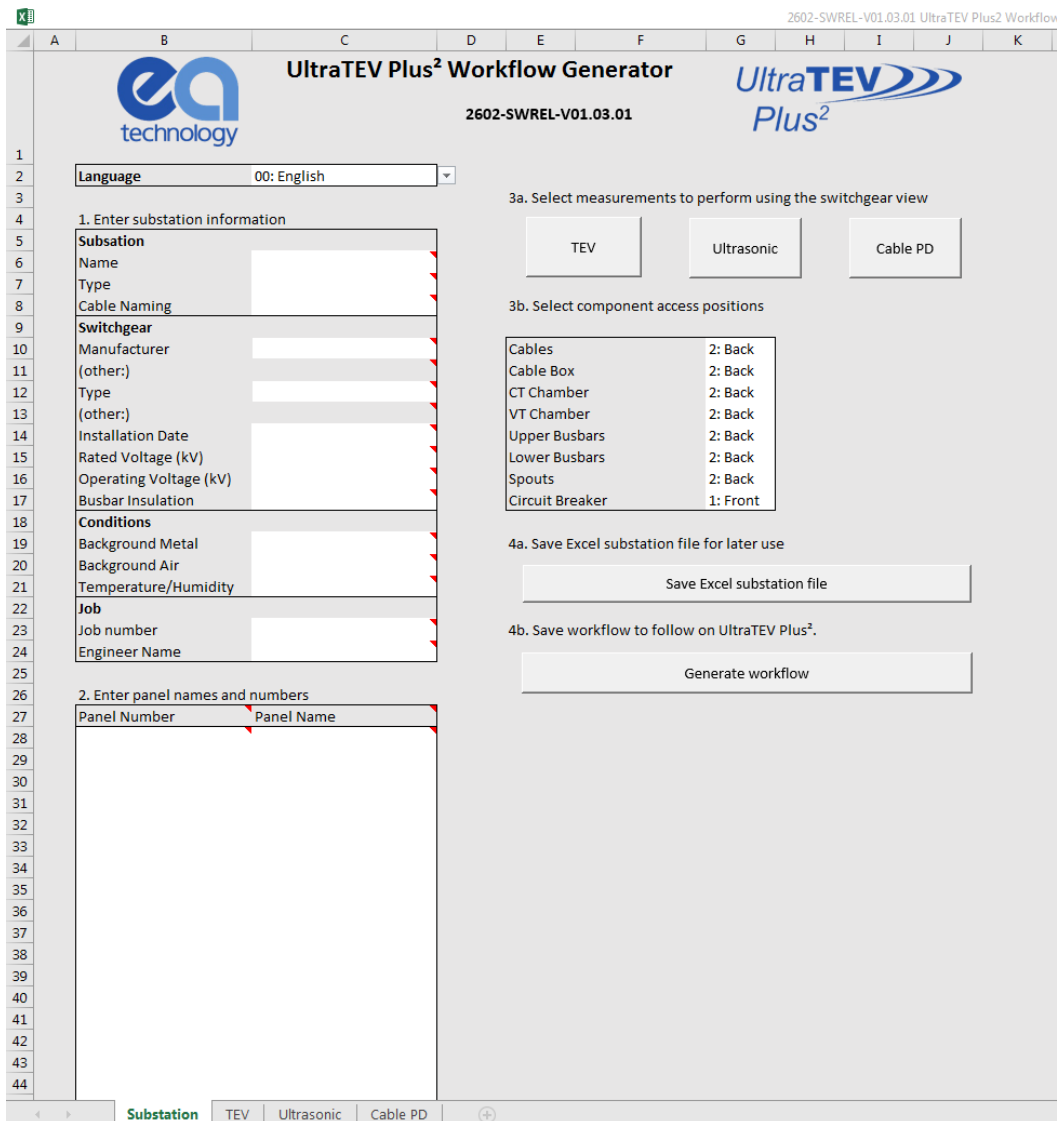
The Survey mode of the UltraTEV Plus² is a powerful yet easy way to collect and store data from a range of assets. Data from TEV, Cable PD or Ultrasonic measurement modes can be recorded and stored with corresponding metadata linking the data and its associated context.

All data recorded on the UltraTEV Plus² takes the form of a survey in order to give the data context and a common structure for use when analysing the data offline.

7.1 Create a Workflow using the Workflow Generator

Workflows are a pre-populated description of the measurements to be undertaken as part of a substation survey. A workflow consists of information regarding the assets and the specific measurements per asset that are to be performed.

Insert the UltraTEV Plus² SD card into your PC or laptop and open the Workflow Generator with Micorsoft Excel.



1. Enter substation information

Substation name cannot contain any special symbols *% ^ \$ # @ ! ' etc.

Pre-defined fields for Manufacturer and Type, or customise to suit by selecting 'Other:'.

We recommend selecting 'Yes' in Conditions/Job fields. 'Yes' will request that they are measured/entered during PD survey.

1. Enter substation information

Substation	
Name	Example Substation
Type	1: Indoor
Cable Naming	1: L1/L2/L3
Switchgear	
Manufacturer	ABB
(other:)	
Type	SACE
(other:)	
Installation Date	Mar-05
Rated Voltage (kV)	12
Operating Voltage (kV)	11
Busbar Insulation	2: Air
Conditions	
Background Metal	Yes
Background Air	Yes
Temperature/Humidity	Yes
Job	
Job number	Yes
Engineer Name	Yes

2. Enter Panel Names and Numbers

Maximum of 63 panels.

We recommend panel number 1 through to required number in sequential order.

Panel names must be unique and are case sensitive.

2. Enter panel names and numbers

Panel Number	Panel Name
1	FDR1
2	FDR2
3	TRANSFORMER 1
4	No1 CAP BANK
5	1-2 BT CB
6	FDR3
7	FDR4
8	TRANSFORMER 2
9	No2 CAP BANK

Substation | TEV | Ultrasonic | Cable PD | +

3. TEV, Ultrasonic or Cable PD Locations

Pre-determined locations for TEV, Ultrasonic or Cable PD can be designed into the substation layout.

This information is reviewed using the 'View Progress' screen within the UltraTEV Plus².

3. Select measurements to perform using the switchgear view

TEV | Ultrasonic | Cable PD

4a. Save Excel Substation File

Save the Excel Substation File for later use.

This allows for any changes to be made to Substation details or layout in the future. The name of the Excel file will be 'substation-name.xlsx'.

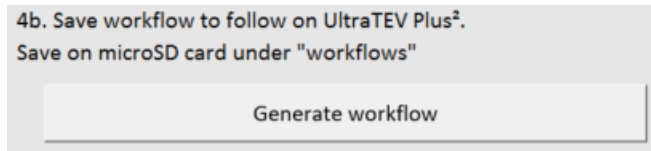
4a. Save Excel substation file for later use

Save Excel substation file

4b. Save Workflow to PC

Save the workflow file so that it can be used in the UltraTEV Plus² Instrument during a PD survey.

The file will be saved as *substation-name.json*.



4b. Save Workflow to SD card

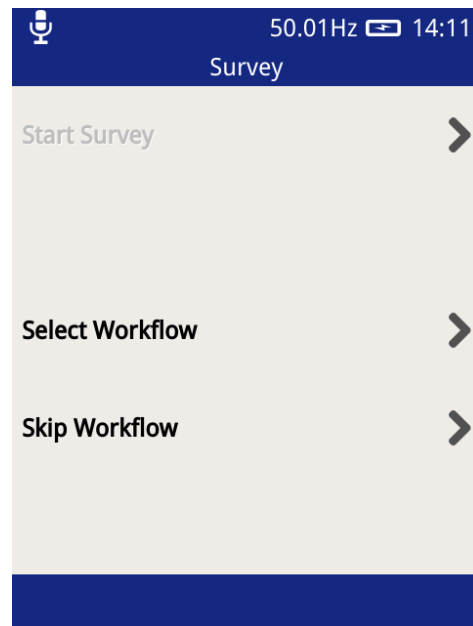
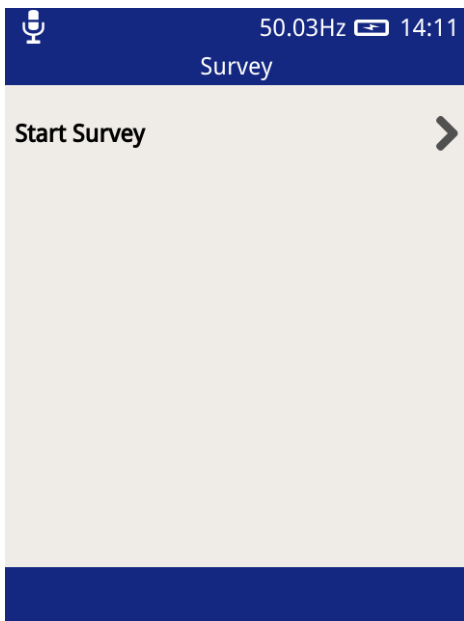
Save the workflow file or *substation-name.json* file under the folder 'workflows' in the UltraTEV Plus² units microSD card.


If this folder does not exist, it must be created (case sensitive).

data	31/01/2017 10:34 PM	File folder
surveys	30/03/2017 10:18 PM	File folder
updates	30/09/2016 8:02 AM	File folder
workflows	2/12/2016 4:01 PM	File folder
utp2_log	30/03/2017 10:18 PM	Text Document

7.2 Starting a Survey

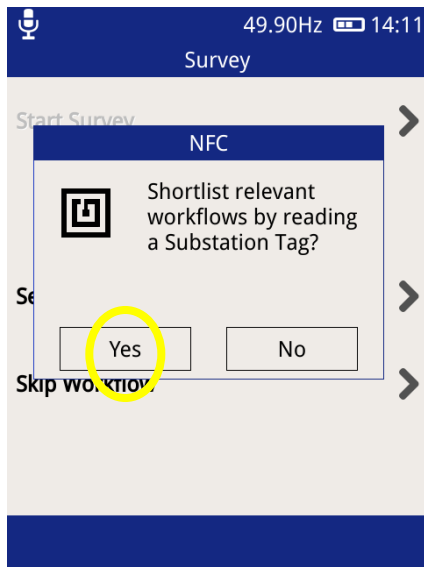
There are two ways to start a survey; either by going through the Survey display off the Main menu, or by starting a data capture from any measurement screen.



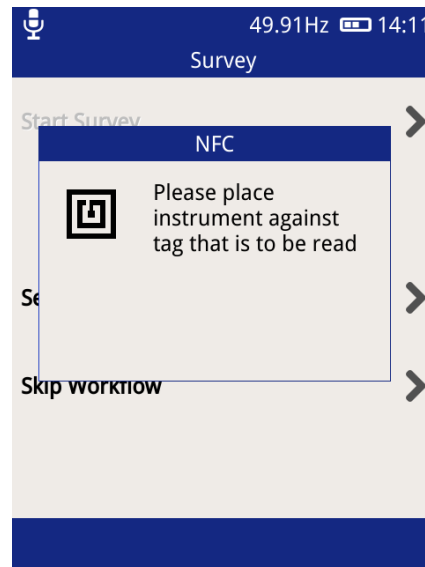
Pressing the Survey icon  on the Main menu will display the Survey Mode display. This display allows users to start, stop and view the progress of a survey.

To start a survey, press 'Start Survey' on the display. Doing this will show two options to select from; Select Workflow or Skip Workflow.

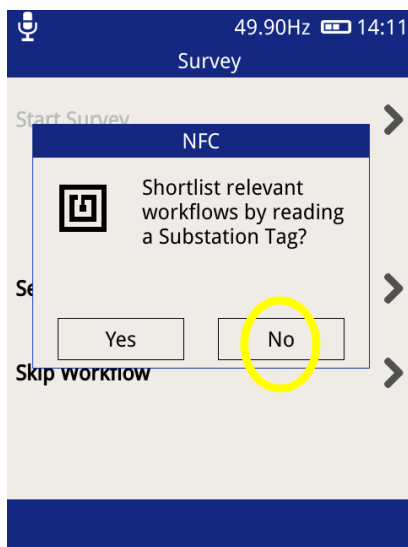
7.3 Select Workflow



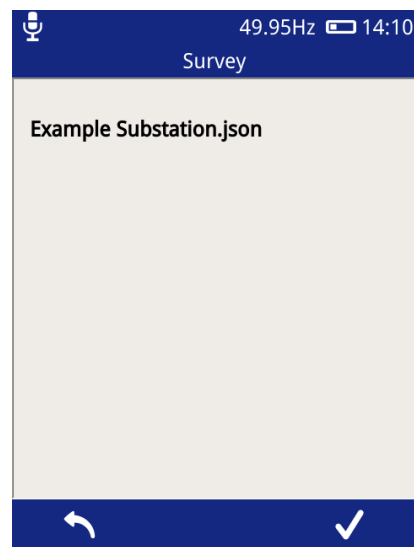
Recall workflow from substation tag



Read tag

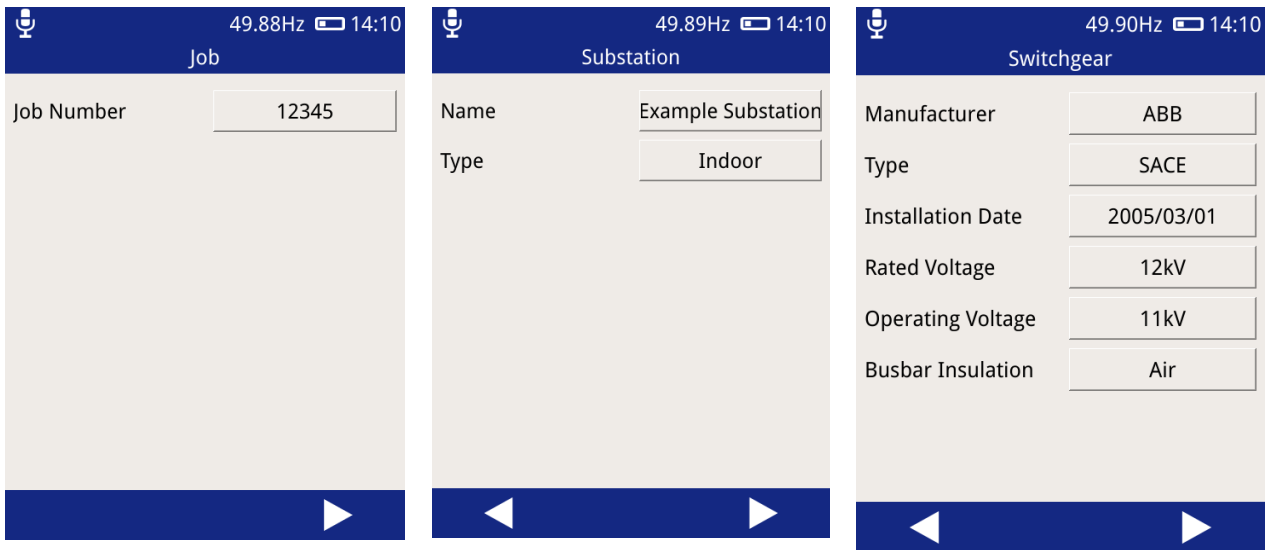


Go to workflow list

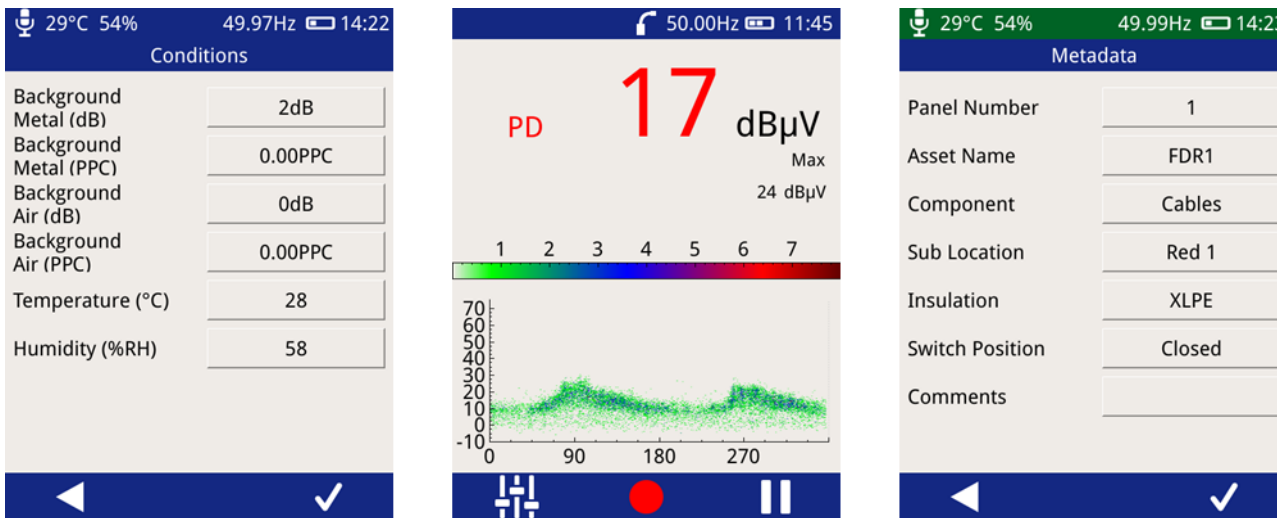


Select workflow

Enter your unique job number, the substation and switchgear information will be filled in using the information from the Workflow.



Capture background readings, if 'yes' was not selected when the workflow was created, this data will not be captured.



A workflow can be created from a previous survey using the 'Generate Workflow' option in the UltraTEV Plus² interface page.

7.4 Skip Workflow

To perform a survey without a workflow, press the “Skip Workflow” button. Similarly to the Workflow route, a series of forms will be displayed with fields about the substation, switchgear and conditions. The form field can be populated using the inbuilt virtual keyboard or a drop down list of available options.



The Notification bar changes from blue to green to indicate a survey is currently running.

7.5 Ad-hoc Measurement

If a survey is not in progress when the record button is pressed in any of the TEV, Cable PD or Ultrasonic measurement screens the data is still captured. On completion of the record, the default survey information fields are displayed to capture the measurement context data. This data is the same as entered when starting a survey through the menu icon. Once this information has been entered, survey mode stays active ready for further data to be recorded and added to the survey.

7.6 Survey Metadata Forms

As mentioned in the previous section, each survey requires the input of information about the substation the survey is being conducted in. Some fields have populated lists of values to select from, with each having the option to override by inputting a custom value, others allow only virtual keyboard input and a select few have special behaviours.

Navigation through the forms is done using the left and right buttons on the menu bar or using the corresponding physical buttons. The last form to be populated is indicated by the right hand button on the menu bar changing to become a tick icon. Pressing this will close the last form, save the entered information and return to the home menu ready to start recording data.

If a workflow is not being used, the default form fields used are set out below along with their behaviour:

Form	1	
Name	Job	
Field	Description	Behaviour
Job Number	The job number of the survey, used by many users to link a survey to a contract or package of work	Pressing the input field will show the virtual keyboard

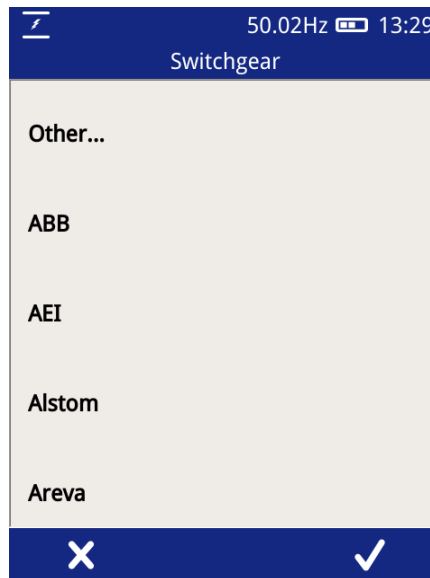
Form	2	
Name	Substation	
Field	Description	Behaviour
Name	Name of the substation being surveyed	Pressing the input field will show the virtual keyboard
Type	Type of the substation being surveyed	Pressing the input field will show a populated list of substation types, with the option to enter a custom value using the virtual keyboard

Form	3	
Name	Switchgear	
Field	Description	Behaviour
Manufacturer	Manufacturer name of the switchgear being surveyed	Pressing the input field will show a populated list of switchgear manufacturers, with the option to enter a custom value using the virtual keyboard
Type	The type of switchgear being surveyed	Pressing the input field will show a populated list of switchgear types with the option to enter a custom value using the virtual keyboard
Installation Date	Installation date of the switchgear	Pressing the input field will show a date selector to input the switchgear installation date
Rated Voltage	The rated voltage of the switchgear	Pressing the input field will show a populated list of voltages with the option to enter a custom value using the virtual keyboard
Operating Voltage	The operating voltage of the switchgear	Pressing the input field will show a populated list of voltages with the option to enter a custom value using the virtual keyboard
Busbar Insulation	The insulation material of the switchgear's busbar	Pressing the input field will show a populated list of busbar insulation materials with the option to enter a custom value using the virtual keyboard

Form	4	
Name	Conditions	
Field	Description	Behaviour
Background Metal	Background metalwork TEV value	Pressing the input field will cause a background TEV measurement to be performed
Background Air	Background Air TEV value	Pressing the input field will cause a background TEV measurement to be performed
Temperature	Temperature as read by the Environmental Sensor	Pressing the input field will cause it to be populated with the current Temperature. The Temperature & Humidity sensor must be connected to do this.
Humidity	Humidity as read by the Environmental Sensor	Pressing the input field will cause it to be populated with the current Humidity. The Temperature & Humidity sensor must be connected to do this.

7.7 Using Populated Lists

Populated lists used in many of the above fields will look like that of below.

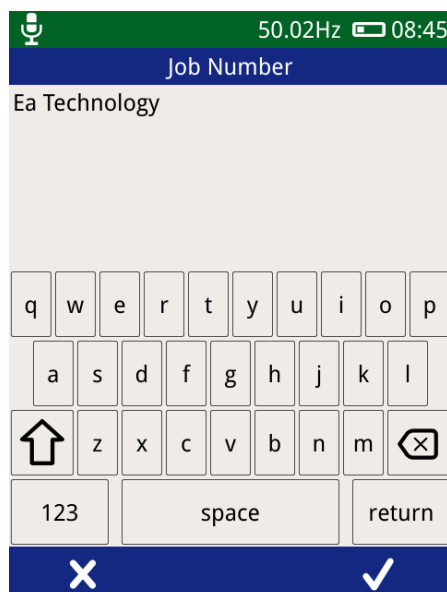


The list can be scrolled by dragging the list up and down using a finger or stylus. Selecting an item is done by pressing an item then pressing the tick in the menu bar. If the “Other...” option is selected a virtual keyboard prompt will be displayed for custom input. If the cross in the menu bar is pressed, the list will be closed and no input recorded.

7.8 Using the virtual keyboard

The virtual keyboard allows custom text to be input. Characters can be input using the buttons on the layout, with additional characters and numbers available through the “123” button. Uppercase letters can be entered by pressing the arrow (between A and Z). Double tapping the 0arrow will activate Caps lock, giving uppercase letters until it is next pressed.

To accept the input text as input to the field, press the tick button on the menu bar, to cancel, press the cross on the menu bar of the Left button.



7.9 Background Measurements

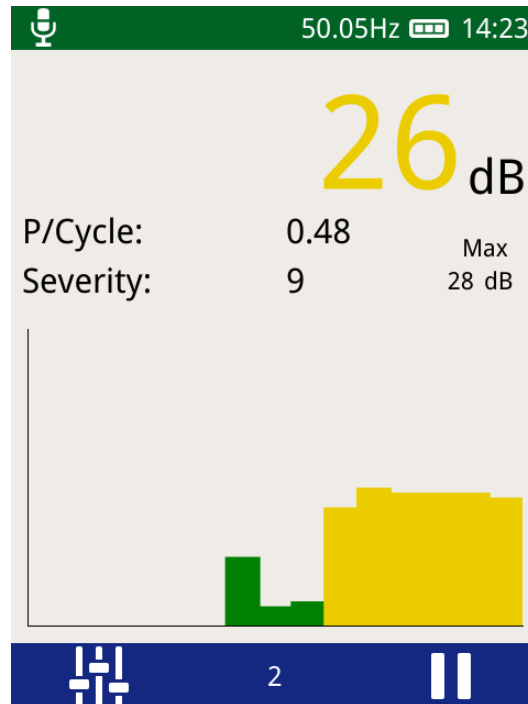
The background measurements fields on the survey metadata forms have special behaviour, pressing the input field triggers the UltraTEV Plus² to start measuring the TEV level for a ten second period. Following this, the average measurement for the period is stored. When performing the Background Metal measurement, the TEV plate of the UltraTEV Plus² should be held against an unearthed piece of metalwork in the substation not connected to the switchgear. The Background Air measurement requires holding the instrument in free space in order to get an ambient reading.

The background temperature and humidity is taken directly from the current measurement by the Environmental Sensor. Please note that the sensor needs to be connected to the UltraTEV Plus² device.

Conditions	
Background Metal (dB)	2dB
Background Metal (PPC)	0.00PPC
Background Air (dB)	1dB
Background Air (PPC)	0.00PPC
Temperature (°C)	26
Humidity (%RH)	45

7.10 Recording Data

Once a survey has been started, data can be recorded from any TEV, Cable PD or Ultrasonic displays. The same data is recorded for TEV or Cable PD independent of which TEV/Cable PD screen is currently displayed. To record data, simply press the record icon visible on the menu bar, which will then start a 10 second period of data capture.



Different data is recorded for the different measurement modes as summarised below:

7.10.1 TEV recorded data

When recording data in any of the TEV modes, the following data is recorded and stored:

- Event data including phase angle, cycle count, amplitude, pulse width and rise time
- TEV Waveforms
- TEV audio

7.10.2 Cable PD recorded data

When recording data in any of the Cable PD modes, the following data is recorded and stored:

- Event data including integral, pulse width and rise time
- Cable PD Waveforms

7.10.3 Ultrasonic recorded data

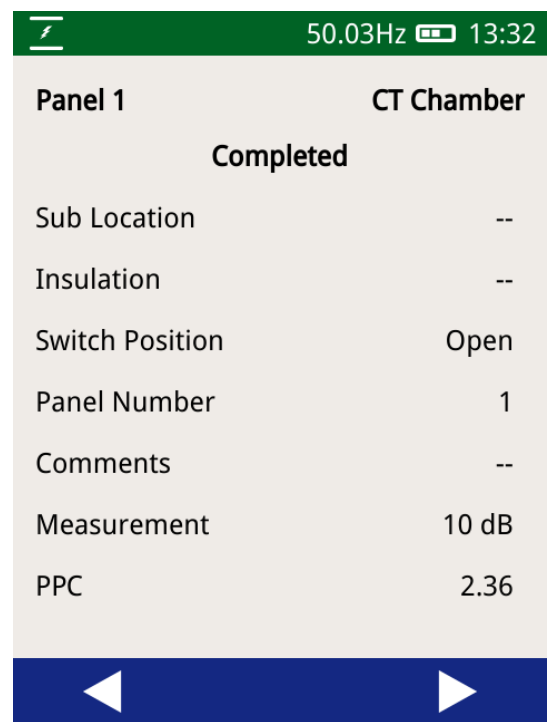
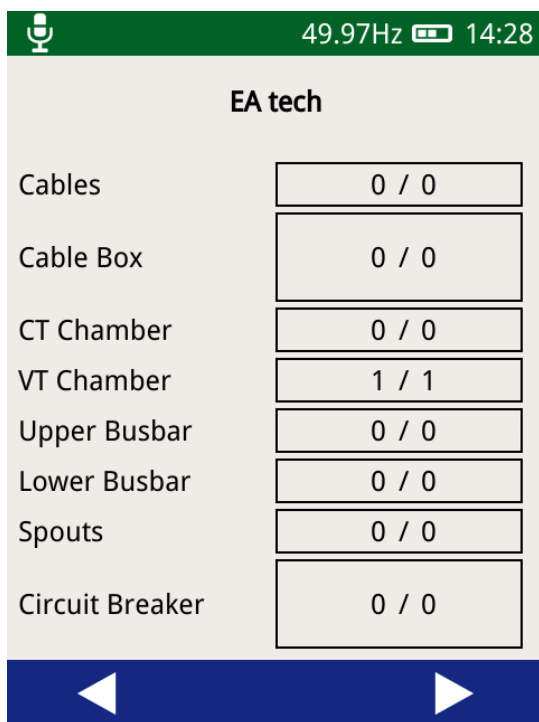
When recording data in Ultrasonic measurement modes, the following data is recorded and stored:

- Raw Ultrasonic audio
- Heterodyned Ultrasonic audio
- Processed Ultrasonic audio

7.11 Viewing Survey Progress

The progress of a survey can be viewed at by navigating to the Survey menu then pressing **‘View Progress’**. The view progress display shows a top view of a switchgear panel with the different components making up a panel separated out. Each component shows the total number of measurements taken on that component against the number of expected measurements. The expected measurements are only applicable to surveys which are following a workflow, which sets out the measurements that should be taken as part of that survey. Using the left and right buttons on the menu bar, other panels within the survey’s progress can be viewed.

Pressing any component on the panel view will display details of the measurements on that component, including the measurement location, sub-location and average measurement values.

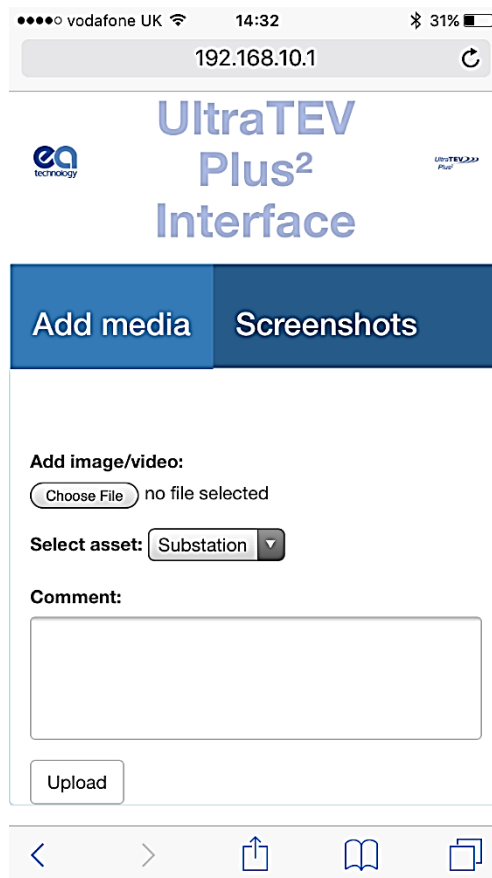


7.12 Adding Media to a Survey

A photograph or video can be added to the survey file by connecting your smart device to the UltraTEV Plus², via the Hotspot function. To add an image or video, open the UltraTEV Plus² interface by entering 192.168.10.1 to your web browser and select 'add image/video'.



Create a shortcut on your mobile device's homepage for quick access to the UltraTEVPlus² interface



7.13 Completing a Survey

A survey can be completed at any time by going to the Survey Menu and pressing the “Stop Survey” button. Upon completing a survey, a summary of the survey is written to the survey directory and the entire directory is archived into a zip file for safe keeping. If a large amount of data has been recorded, archiving the data can take up to a minute. Once archiving is completed the notification bar will return to its blue colour indicating that a survey is now no longer in progress.

8. Reviewing Results

- Data collected during Survey mode or through ad-hoc recording is stored on the UltraTEV Plus²'s MicroSD card. To facilitate viewing of the data the UltraTEV Plus² provides four methods of connection.
- Hotspot – Allows direct connection via the UltraTEV² personal hotspot to a Wi-Fi enabled device
- Wi-Fi – Allows a direct connection from the UltraTEV Plus² to a Wi-Fi enabled device.
- USB – Direct connection from the UltraTEV Plus² to a Windows based machine.
Removal of the MicroSD card for viewing on a Windows/Linux/ Mac OS X based machine.

8.1 Hotspot Connection

Go to Main Menu, Settings, Wireless Settings and enable Hotspot. Go to Wi-Fi settings on your Wi-Fi device, select the SSID and enter the Passphrase.

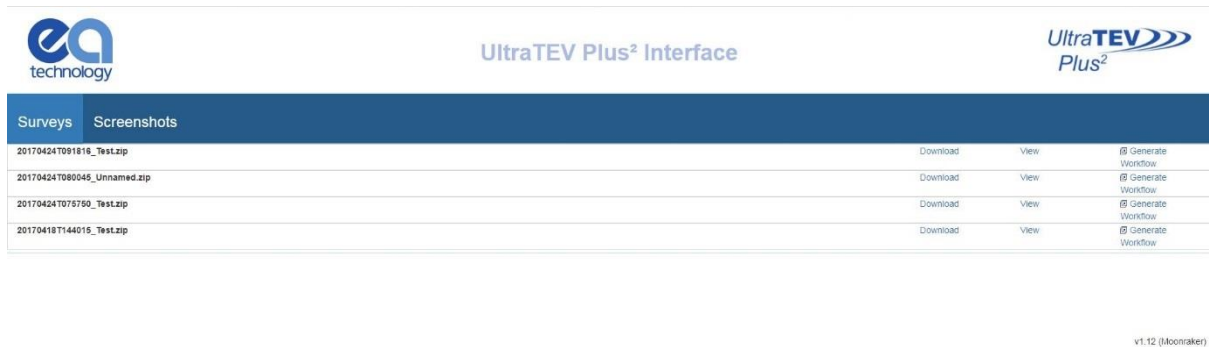


Once connected, enter the IP address 192.168.10.1 in a web browser such as Google Chrome, Mozilla Firefox or Microsoft Edge/Internet Explorer.

8.2 Wi-Fi Connection

Go to Main Menu, Settings, Wireless Settings and enable Wi-Fi. Select Network Connect, choose your network from the list and connect. Once connected, go to Network Status and make a note of the IP address. Enter this IP address in a web browser such as Google Chrome, Mozilla Firefox or Microsoft Edge/Internet Explorer.

The home page, shown below displays a list of all surveys and screenshots stored on the UltraTEV Plus²'s MicroSD Card.



Surveys	Screenshots	Download	View	Generate Workflow
20170424T091816_Test.zip		Download	View	Generate Workflow
20170424T080045_Unnamed.zip		Download	View	Generate Workflow
20170424T075750_Test.zip		Download	View	Generate Workflow
20170418T144015_Test.zip		Download	View	Generate Workflow

v1.12 (Moonaker)

8.3 USB Connection (Windows PC only)

Connect the UltraTEV Plus² via the USB port using the supplied cable. The UltraTEV Plus² should install as an Ethernet Gadget.

If the drivers do not install automatically, you can install them as follows:

Go to device manager and select the instrument from the network adaptors list, it will have a yellow triangle by it, then right click this and update driver software:

- Browse my computer for driver
- Let me pick from list of drivers on my computer
- Network adaptors
- Microsoft Corporation
- Remote NDIS based internet sharing device, next install

Note: The user needs to have administrator rights for the computer.

The index of surveys on the UltraTEV Plus² can be used to quickly identify the site of interest allowing the user to navigate either directly to the data analysis (view button) or to download a zip file (compressed folder) containing the raw data (download button).

Clicking the view button takes the user to the data analysis screens detailed overleaf.

8.4 MicroSD Card & Data Zip Files

An alternative method of viewing the data held on the UltraTEV Plus² is by direct file access. This can either be from a previously downloaded data zip as above or by accessing the MicroSD card directly.

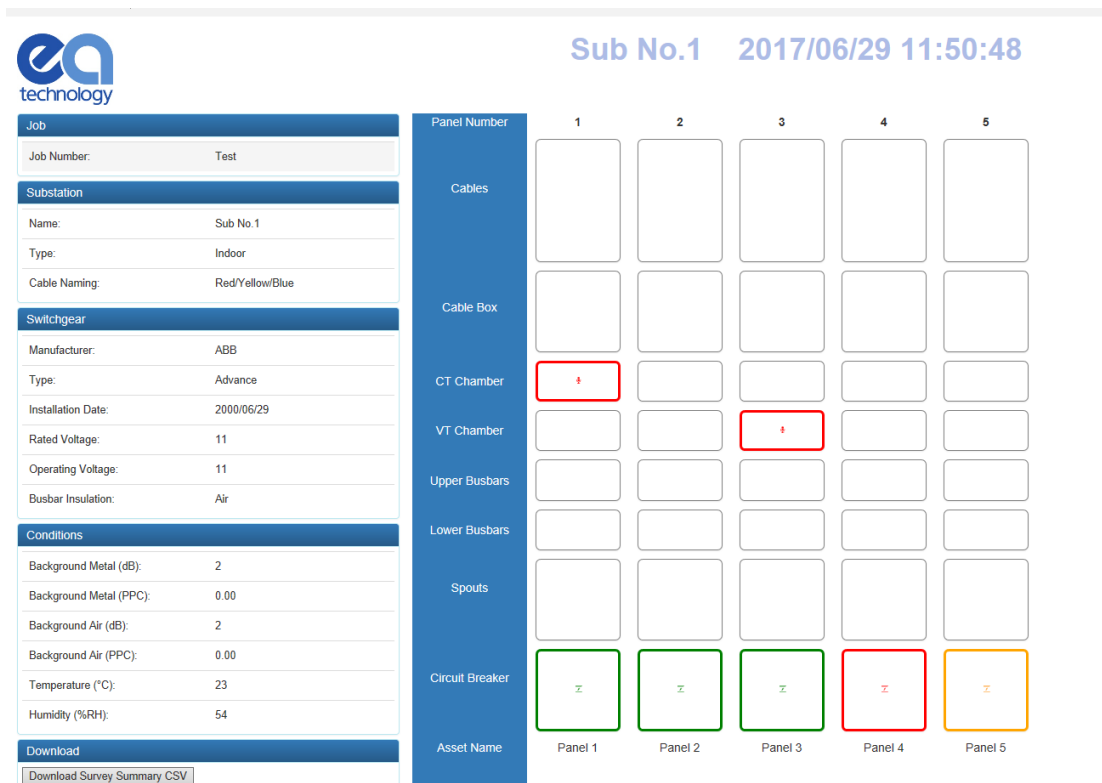
To directly access the MicroSD card ensure the UltraTEV Plus² is powered down, then locate the MicroSD card at the base of the instrument and gently push on the card to eject it.

The MicroSD card will contain a separate .zip file (compressed folder) for each survey and ad-hoc measurement undertaken. Inside each folder there is an html page named 'index.html'. Extracting the zip file and then opening the 'index.html' file inside this folder will direct you to the analysis pages.

8.5 Data Analysis Screens

The UltraTEV Plus² has a web interface for analysing data captured by the instrument. These analysis pages can be accessed through a web browser or downloaded for offline analysis as detailed above.

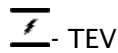
Following selection of 'View' on the landing page, or opening of an 'index.html' file from the decompressed zip folder, a new page will appear with a visualisation of the switchgear surveyed.



The overview or 'index' page provides diagrammatic representation of the switchgear surveyed along with an icon detailing each measurement. An overview of the metadata entered during the substation visit is included on the left hand side of the page. This data

includes substation information such as site name and switchgear information such as manufacturer, voltage etc. Below the metadata on the left hand side of the page a 'download survey summary' button is available. When pressed this button downloads a Comma Separated Variable (CSV) file containing an overview of the survey results.

The measurement icons shown below are positioned on the panels as per the location entered during the site survey. Clicking any of the available measurements on a panel component will open the analysis page for the corresponding measurement. The measurement section is colour coded, to correspond with the green/amber/red thresholds.



- TEV



- Cable PD



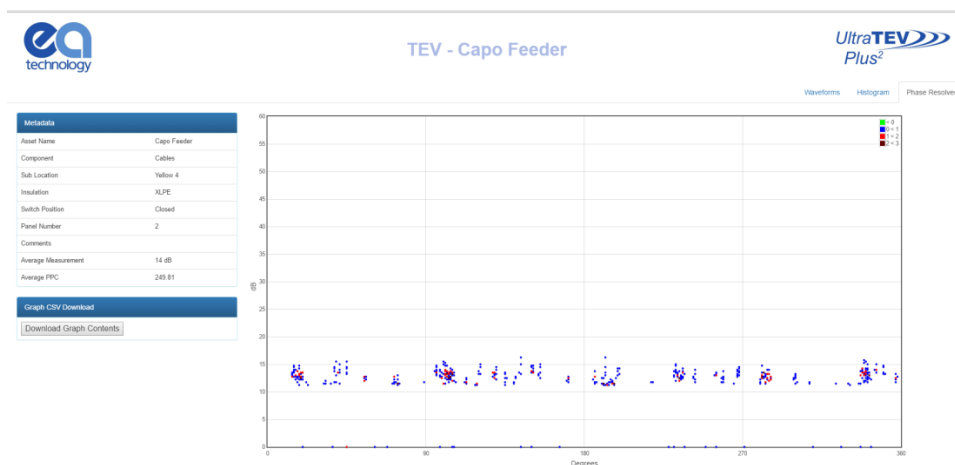
- Ultrasonic

8.5.1 TEV & Cable PD Analysis Screen

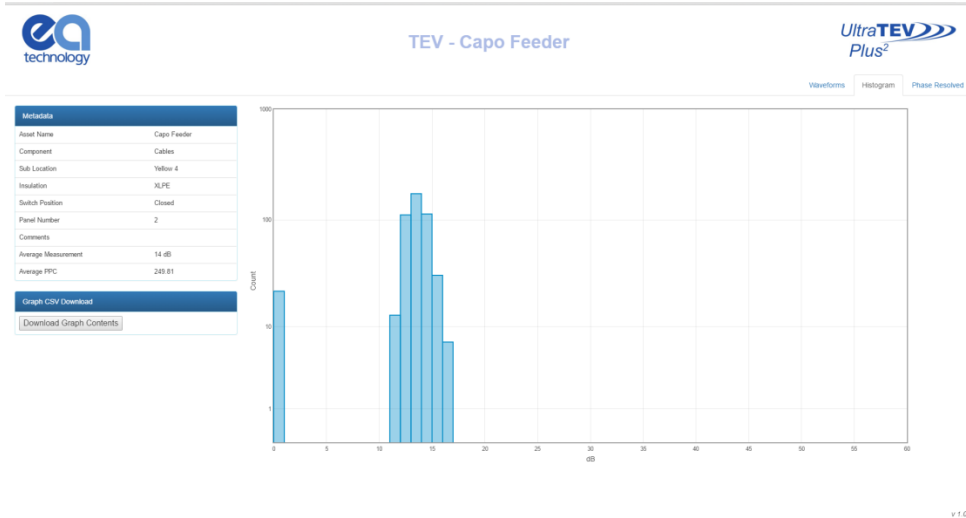
Both TEV and Cable PD recorded data share the same suite of analysis screens. Once a TEV or Cable PD measurement has been selected from the index page a new tab will open in the browser displaying the analysis page corresponding to the measurement selected. Multiple individual analysis pages can be opened simultaneously in this way to aid comparison.

The TEV and Cable PD analysis pages both have metadata regarding the current measurement on the left side of the page, with another button beneath to download the raw dataset for each graph to CSV. The chart displayed on each page can be changed between Waveform, Histogram and Phase Resolved by clicking the tabs in the upper right hand corner.

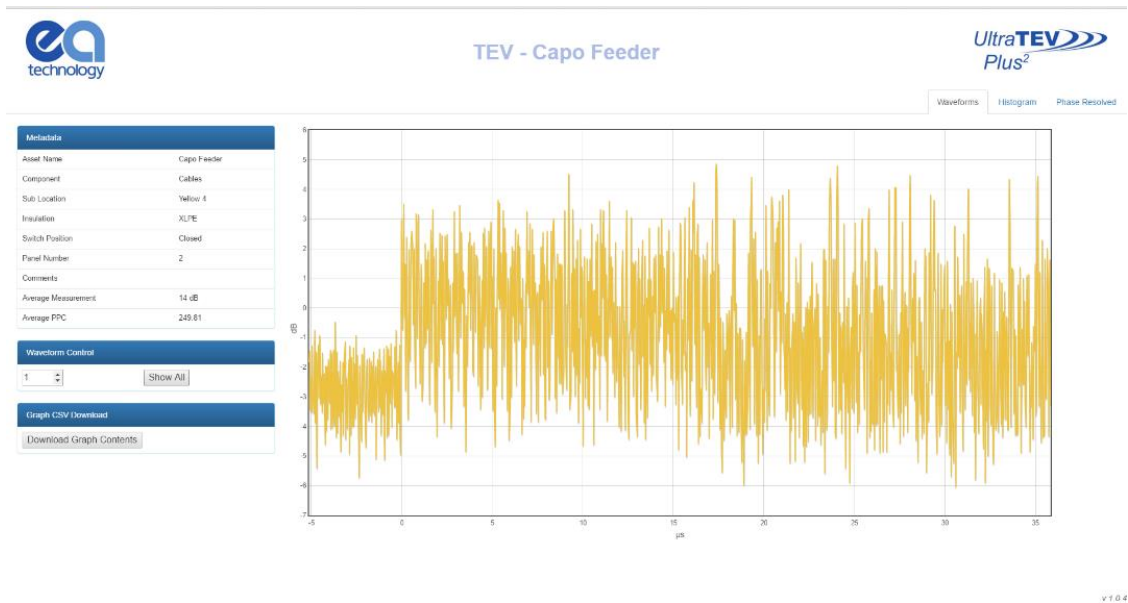
Both Phase Resolved and Waveform graphs are able to be zoomed by clicking and dragging on the graph area; the original zoom level can be returned to by clicking the respective graphing tab in the upper right hand corner. Hovering the mouse over a point/bar on each respective graph will produce a tooltip with information regarding that event. On the Phase Resolved graph a legend can be seen on the upper right of the graph area, indicating the scaling of colours for each point.



v 1.0.4



When the Waveforms tab is opened, a new control will appear beneath the metadata on the left. The 'Waveform Control' section allows navigation through the waveforms collected using the up/down arrows next to the waveform number. The 'Show All' button can be used to show all waveforms on the same graph.



8.5.2 Ultrasonic Analysis

Once an 'Ultrasonic' measurement has been selected on the index page, a new tab will open in the browser with the analysis page corresponding to the measurement selected. The metadata section will be displayed to the left side of the page, and the 'Play' button aligned with the 'Heterodyned Ultrasonic' label can be used to listen to or download the .wav file (browser dependent). If the browser does open the file and begin to play it, right click the player and select 'Save file as' to save the file.



9. Detecting Partial Discharge using the UltraTEV Plus²

Due to the tri-sensor capability, the UltraTEV Plus² is able to detect Partial Discharge activity on the surface of insulation using Ultrasonic detection, internal to insulation by measuring TEV signals and in cables and cable accessories using the RFCT accessory.

This section covers how to use the UltraTEV Plus² to detect PD activity using the three sensor technologies.

9.1 TEV Measurement

TEV measurements are performed using the TEV sensor embedded into the front face of the instrument.



TEV measurements cannot be taken with the RFCT accessory connected to the instrument

9.1.1 Background Noise

Electromagnetic signals from sources outside the switchgear can also produce voltages on the outside of the switchgear. These electromagnetic sources can come from a multitude of sources such as overhead line insulators, transformer bushings and strong radio signals.

These sources will produce equivalent signals on metalwork which is not electrically connected to the switchgear such as metal substation doors or fencing. Measuring the interference levels on these surfaces before taking readings from the switchgear will help allow identification of PD over background noise.



If the background noise is less than 10dB then the UltraTEV Plus² pulse counter is not incremented and will read zero

9.1.2 Measuring TEV

Switch on the UltraTEV Plus² and wait until home menu is displayed. Press the TEV icon on the home menu then choose which TEV display is required. The 'Interpretation' display is recommended for first pass with the advanced functionality of the other modes being utilised to further inform the user once a signal is detected.

To take a measurement, hold the TEV sensor squarely against the metalwork of the asset under test as shown overleaf. Any readings will be displayed on the screen with the interpretation message adjusted to take account of the reading's amplitude and pulses per cycle. Please note that the readings will not remain on the screen once the TEV sensor has been removed from the metalwork.



9.2 Cable PD Measurement

To perform Cable PD measurements, the RFCT accessory needs to be connected to the UltraTEV Plus². The RFCT connects to the Smart accessory port found on the left hand side of the instrument.

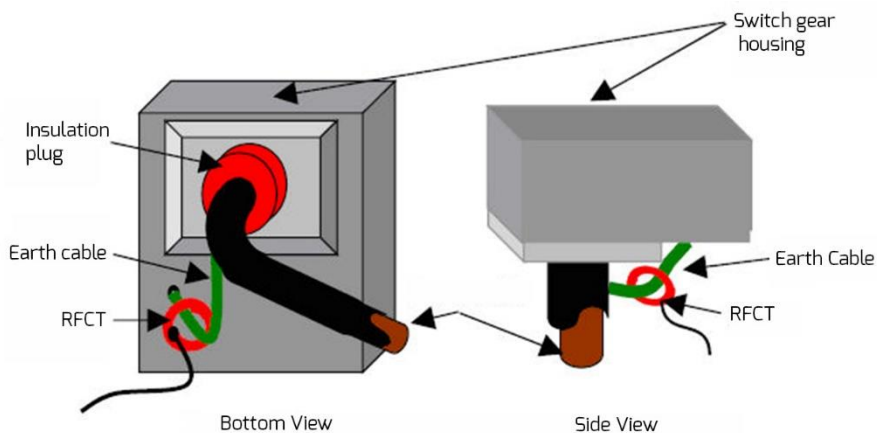


EA Technology RFCTs are designed to be installed by suitably competent operators on cable earth/ground straps which are suitably and efficiently connected to earth/ground to maintain safety.

RFCTs, connecting leads and test equipment **do not** provide protection against high voltage.

9.2.1 Practical RFCT Connection Requirements

Using the RFCT for online PD tests on medium voltage power cables requires direct access to the earth bonding strap. If present the split core radio frequency current transformer RFCT can simply be clamped around the earth cable. This method can be used on-line without disconnecting cables or switching off supplies to customers.



With XLPE cable installations the user can normally get access to the cable earth strap or the core of the cables. The earth strap can be looped out of the termination box to give better access. With PILC (Paper Insulated Lead Covered) cables difficulty may arise attaching the RFCT as the cable earth and switchgear earth can be bonded together. This is more usual on older PILC cables using compound filled cable boxes.

9.2.2 Measuring PD in cables

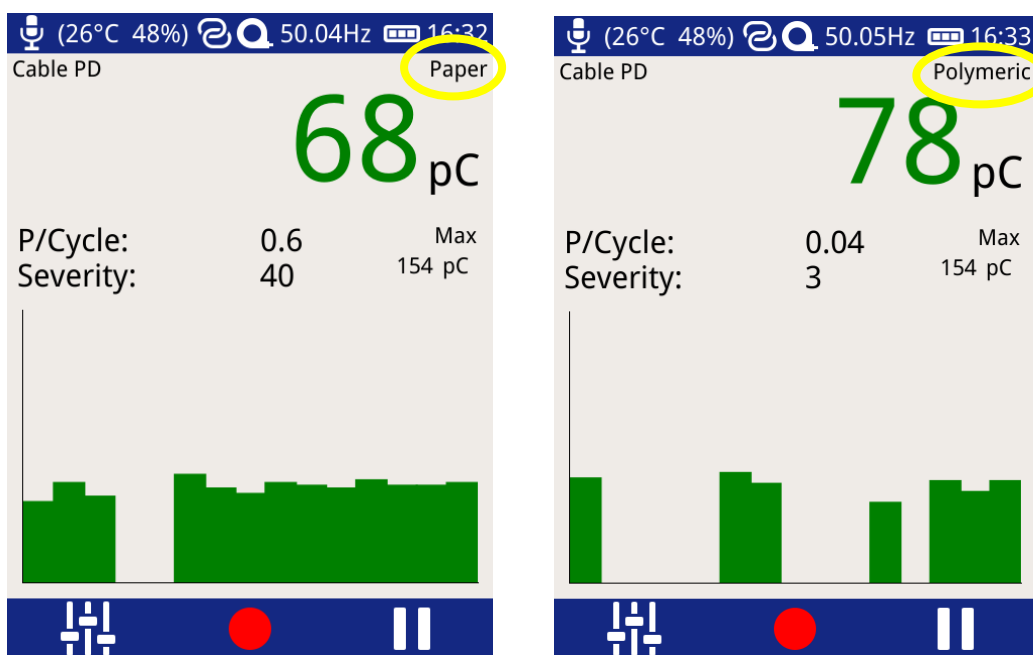
Switch on the UltraTEV Plus² and wait until home menu is displayed. If the conditions set out above are met, install the RFCT around the earth strap of the cable under test. Proceed to connect the fitted RFCT to the UltraTEV Plus² using the supplied cable; connect the BNC to the RFCT and the LEMO™ connector into the Smart accessory port. The home menu on the UltraTEV Plus² will now display a Cable PD icon in place of the usual TEV icon.



RFCTs, connecting leads and test equipment do not provide protection against high voltage. Ensure that the accessory is only connected to cables at earth potential.

Press the Cable PD icon on the home menu and proceed to press on the Measure option. The screen will display a bar graph of the measured PD values in picocoulombs (pC). To obtain a further insight into the discharge activity on a cable, select the 'Phase Plot' option on the Cable PD screen. This screen provides a phase resolved reading of Cable PD activity within the cable under test.

The cable type can be changed by pressing the text 'paper' or 'polymeric'. The UltraTEV Plus² green/amber/red thresholds will change according to which cable insulation type has been selected.



9.3 Ultrasonic Measurement

The UltraTEV Plus² is equipped with a built-in ultrasonic sensor which can be used to detect the acoustic emissions of surface partial discharge activity. External ultrasonic sensors are also available to use with the UltraTEV Plus² allowing use in outdoor compounds, on sealed assets or in hard to reach places. When taking airborne ultrasonic readings the sensor should not touch the asset or plant being investigated.

9.3.1 Measuring Ultrasonic

Switch on the UltraTEV Plus² and wait until home menu is displayed. Proceed to plug in the supplied Headphones; select the Ultrasonic icon on the main menu. The screen will now display a phase resolved plot of ultrasonic activity.

Ultrasonic activity above the background level may be significant. Genuine discharge can be identified by a crackling sound (like a sizzling frying pan) in the headphones or by phase related groups on phase plot. Further confidence of a detection can be obtained by the classification algorithm output displayed on the top left of the screen.



The UltraTEV Plus² defaults to the built-in ultrasonic sensor if no accessory is plugged into the Ultrasonic Accessory port

9.3.2 Measuring Ultrasonic with the UltraDish

The UltraDish provides a means of detecting discharge sources at a distance. It comprises a transparent parabolic reflector that focuses the ultrasonic sound on to a sensor mounted at the focus point of the reflector. The UltraDish gives an effective increase in gain compared to the built in sensor allowing discharges to be detected at much greater distances such as insulator strings on overhead assets.

To use an UltraDish the connector must be plugged in to the Ultrasonic sensor input on the side of the UltraTEV Plus². The UltraDish is aimed at the point of interest with either the optical sight or by switching on the laser pointer with the button on the handle.



Due to the gain of the UltraDish, readings taken with the UltraDish cannot be compared to readings taken with the Internal Sensor, the Flexible Sensor or the Contact Probe.

This accessory is available with the Kit 3 package. To discuss procuring this accessory please contact the product support team via email:

product-support@eatechnology.com



9.3.3 Measuring Ultrasonic using the Flexible Sensor

The Flexible Sensor provides a means of reaching inaccessible parts on the switchgear. The sensor is mounted at the end of a flexible goose-neck which allows the angle of the sensor to the handle to be adjusted. This allows the user to make measurements where it would be difficult to use the built in sensor and still be able to read the display.

To use a Flexible Sensor the connector must be plugged into the external sensor input on the Ultrasonic Accessory port of the UltraTEV Plus². To avoid damage to the socket or connector ensure that the red dots are lined up before attempting to plug in the Flexible Sensor. The Flexible Sensor is used in the same manner as the Internal Sensor.



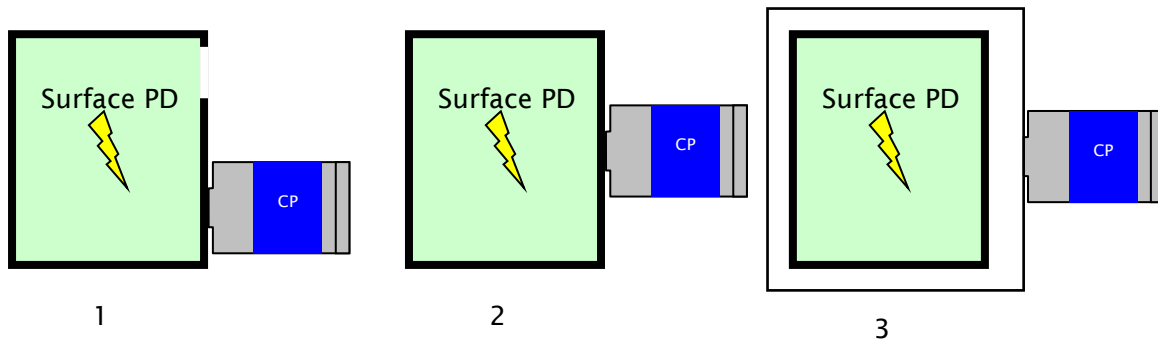
9.3.4 Ultrasonic Measurement using the Contact Probe Accessory

The Ultrasonic Contact Probe is provided to enable discharges to be detected in enclosed areas where there is no direct air path from the discharge source to the sensor. The Probe connects to the external sensor connector and is clamped on to the area of interest using the magnets surrounding the sensor plate. To avoid damage to the socket or connector ensure that the red dots are lined up before attempting to plug in the Ultrasonic Contact Probe. The probe will detect discharge sources inside the enclosed area by detecting the energy transmitted to the enclosure. Care must be taken to eliminate other sources that could cause the signals from discharges to be masked, e.g. accidental movement of the probe itself or strong vibration on the panel.

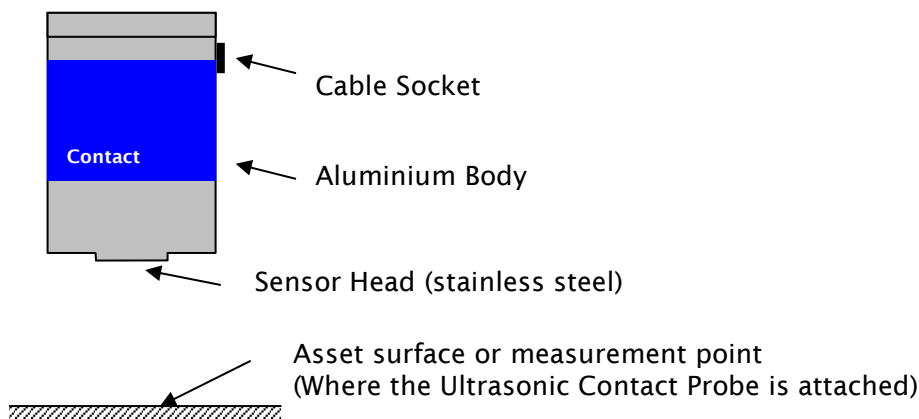


9.3.5 Using the Ultrasonic Contact Probe

The Ultrasonic Contact Probe should be used if there is not a direct path between the PD source and instrument sensor as shown in the second image below. However, it must not be used if the tank containing the expected PD source is separated with another layer (shown in the third image). In cases where there is a direct air path between the source of PD and the instrument, an airborne sensor should be used as shown in the first image below. Due to the physics of ultrasound, in most cases using an airborne sensor may offer better sensitivity than that obtained using the Ultrasonic Contact Probe.



- 1) Ultrasonic signal can propagate through the air path. The Ultrasonic Contact Probe can be used; however, better results may be obtained using the airborne sensor.
- 2) No available air gaps - using an Ultrasonic Contact Probe is the best practice.
- 3) There is no access to the tank containing PD source, neither the airborne sensor nor the Ultrasonic Contact Probe will provide a valid reading.



9.3.6 Detection, Measurement and Localisation of the Partial Discharge

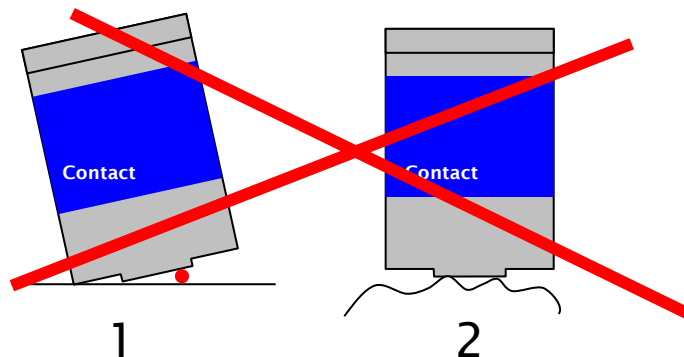
Detection of the Partial Discharge using the Ultrasonic Contact Probe is based on the PD pattern recognition carried out by operators. The audio signature of a Partial Discharge detected by the Contact Probe is similar to those obtained using airborne sensors. Special care has to be taken to distinguish phantom signals from genuine signals caused by surface PD.

Due to the differing propagation paths of the ultrasonic signals, measurements carried out using the Ultrasonic Contact Probe cannot be compared against measurements carried out using airborne sensors. In general signals detected by the Contact Probe are smaller as a result of the physical properties of the asset and propagation path. Comparisons between two measurements should only be made on assets of the same type using the same configuration of the Contact Probe.

9.3.7 Mounting Practices

The Ultrasonic Contact Probe was designed to provide sufficient sensitivity to allow it to be used to detect low level ultrasonic sources.

The image below shows scenarios where the Ultrasonic Contact Probe is mounted ineffectively to the asset enclosure. Any air gap between Sensor Head and measurement point will effectively attenuate signals to a level where even strong discharges will not be detected. Therefore before any permanent or temporary installation, the Sensor Head and asset surface need to be cleaned of any loose or unstable material. If the assets surface is very rough and uneven this will create air gaps which will result in poor contact between the Sensor Head and the asset.



- 1) Dust ingress between Ultrasonic Contact Probe Sensor Head and the asset surface
- 2) A rough or uneven surface will drastically decrease the amount of signal being transferred to the Sensor Head

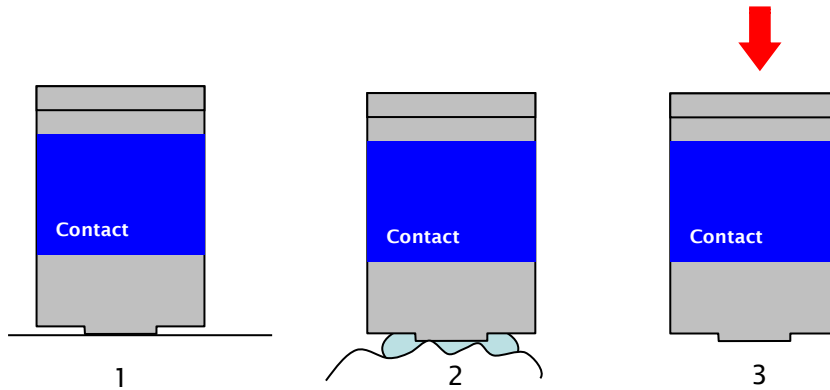
The images below show the correct way of mounting the Ultrasonic Contact Probe to the asset in order to take a valid measurement. Ideally the Ultrasonic Contact Probe will be attached to a relatively flat surface using its magnetic clamp. This will eliminate any phantom noises which are described in the section below.

The second image shows a case where the surface is very rough and uneven. One of the following couplants may be used:-

- Water based – suitable for quick measurement offers very good coupling.
- Oil based – suitable for long term monitoring as the oil will not evaporate quickly.

- Solid state – suitable for long term monitoring but does not offer as good coupling as oil based.
- Use of existing stickers on the switchgear such as ‘danger’ notices

The last image shows the application of pressure to the Ultrasonic Contact Probe against the asset under investigation. This can improve the signal transfer and increases its detection abilities. Please note, when the instrument dB values are read for comparison purposes, always use the same type of the sensor, in the same position as previously used. The asset measuring point can be marked on the plant item to facilitate easy location in future.



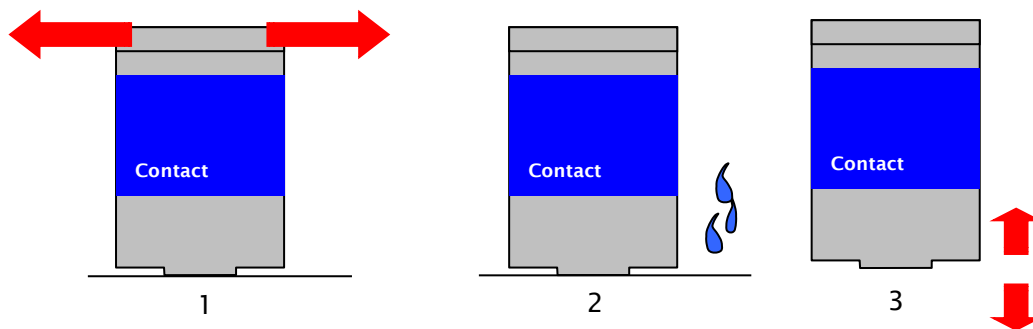
- 1) Relatively flat and smooth surface
- 2) Using suitable couplant in the case of a rough surface
- 3) Carefully pressing the Ultrasonic Contact Probe towards the asset to increase coupling may eliminate the need to use a couplant

9.3.8 Sources of Noise and Phantom Signals

The following images present some examples of how unwanted signals may be introduced during the PD detection process when using the Ultrasonic Contact Probe. These can be categorised as sources of noise and sources of phantom PD signals. The difference between the two is that noise decreases our detection capabilities by masking the PD signal, whereas phantom signals may be confused as a PD source.

The first image shows that when the UCP is kept in the hand during measurements, even tiny movements of the hand can introduce significant noise to measurements through surface noise. In cases where it is necessary to hold the Ultrasonic Contact Probe during measurements (e.g. pushing the sensor to obtain more signal or non-magnetic asset enclosure), a coupling fluid may help to reduce this type of noise.

Any vibrations of the asset surface caused for example by rain in outdoor assets or vibration of transformers may cause phantom signals. In such cases the audible signal may appear exactly the same as a genuine PD source. These two examples are illustrated in the second and third images.



1) Shaking Ultrasonic Contact Probe, e.g. when held in the hand

2) Rain in outdoor assets

3) Vibration (including transformers) of asset enclosure where the Ultrasonic Contact Probe is attached

10. UltraTEV Plus² Specification

TEV Measurements

Sensor:	Capacitive
Measurement Range:	0 – 60 dBmV
Measurement Bandwidth:	3 – 80 MHz
Resolution:	1 dB
Accuracy:	±1 dB
Max Number of Pulses/Cycle:	1953 at 50Hz or 1627 at 60Hz
Min Level for Pulse Count:	10 dBmV

Ultrasonic Measurements

Sensor:	Ultrasonic Microphone
Measurement Range:	-7dB μ V to 68 dB μ V
Resolution:	1 dB
Accuracy:	±1 dB
Transducer Sensitivity:	-65dB (0dB = 1volt/ μ bar RMS SPL)
Transducer Centre Frequency:	40 kHz
Transducer Diameter:	16mm

Cable PD Measurements

Sensor:	Radio Frequency Current Transformer
Measurement Range:	100 – 100 000 pC
Measurement Bandwidth:	41 MHz

Hardware

Enclosure:	Self-coloured vacuum formed plastic case
Screen:	3.5" TFT Touchscreen LED Backlight 640 x 480 Resolution
Indicators:	Charging indicator LED
Controls:	4 x Push-Buttons
Connectors:	Micro USB connection port MicroSD Slot 2 x Accessory connection ports
Headphones:	3.5mm jack; Min. 8 ohms
Wireless Communication:	NFC & Wi-Fi

Environmental

Operating Temperature:	-20 - 50 °C
Humidity:	0 - 90 % RH non-condensing
IP Rating:	54

Dimensions

Size:	201mm x 76mm x 34mm
Weight:	0.44kg

Power Supplies

Internal Batteries:	3.7V, 6.6Ah rechargeable Lithium-Ion
Typical Operating Time:	Approx. 8 hours
Battery Conservation:	Automatic shutdown after 5 minutes of inactivity (configurable)
Charging Time:	Approx. 6 hours

Battery Charger

Rated Voltage:	100 – 240 AC
Frequency:	50 - 60Hz
Charger Output Current:	2 A
Battery Charging Current:	1.8A @ 5V nominal
Dimensions:	61.89mm x 39mm x 32.3mm
Weight:	65g (approx.)
Operating Temperature:	0 - 40°C
Operating Humidity:	20% – 85%
Storage Humidity:	5% – 95%

11. Declaration of Conformity

Manufacturers Name: EA Technology Ltd

Manufacturers Address: Capenhurst Technology Park
Capenhurst
Chester
CH1 6ES
UK


Type of Equipment: UltraTEV Plus²

Model Number: UTP2

I hereby declare that the equipment specified above is tested to and conforms with the essential radio test suites included in the following standards:

Standard	Issue Date
ETSI EN 300 328-2	V1.8.1 April 2012
ETSI EN 302 291-1	V.1.1.1 July 2005

and therefore complies with the essential requirements and provisions of the R&TTE directive 1995/5/EC of the European Parliament and of the council of 9th March 1999 on radio equipment and Telecommunications Terminal Equipment and the mutual recognition of their conformity and the requirements of Annex III (conformity assessment procedure referred to in article 10(4)).



Robert Davis

Chief Executive Officer

EA Technology Ltd

12. Maintenance

No attempt should be made to gain access to the internal circuitry of the UltraTEV Plus², or its accessories. Advice should be sought from the manufacturer, or the supplier, if any doubt exists over the equipment's performance or operation.

Avoid storage in damp and humid conditions and do not subject it to temperature extremes, excessive vibration or shocks. Do not stand on the case of the UltraTEV Plus².

13. Warranty Policy

What Does the Warranty Policy Cover?

EA Technology products and accessories are warranted against defects in material and workmanship for twelve months from the date of despatch from our premises.

During the warranty period, EA Technology will, at its option, either repair or replace products, parts or accessories which prove defective.

What is Not Covered by the Warranty Policy?

The following are not covered: damage caused by accident, misuse, abuse, product modification or neglect; damage resulting from failure to follow instructions contained in your operating manual; damage resulting from the performance of repairs by someone not authorised by EA Technology.

Warranty Policy for Repairs

Repaired products are warranted against defects in workmanship and materials for a period of six months, or the remainder of the original warranty period, whichever is greater.



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14. Calibration

Calibration interval: 12 months

The calibration date and due date can be viewed through the About screen. A warning message will be displayed on start up, when the UltraTEV Plus² is past the calibration due date.

Your application may require a different calibration interval dependant on the frequency of use.

15. Repair

For information on repairs



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16. Waste Electrical and Electronic Equipment Directive (WEEE)

EA Technology is a member of an approved compliance scheme as defined by the WEEE directive. When an EA Technology product reaches the end of its operational life, it must be recycled by a licensed waste management operator or returned to EA Technology for recycling.

17. Continuous Improvement

EA Technology has a policy of continual product development and enhancement. Consequently, there may be minor variations in specifications or operation that are not covered in this operating manual.

Every effort has been made to ensure that the information provided in this operating manual is accurate at the time of going to print.

If any errors or omissions are noticed, please notify



product-support@eatechnology.com

18. Contact Us

Head Office

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19. Record of Changes

Date	Version	Author(s)
15 th April 2016	2388L011	Gareth Devine
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Global Footprint

We provide products, services and support for customers in 90 countries, through our offices in Australia, China, Europe, Singapore, UAE and USA, together with more than 40 distribution partners.



Our Expertise

We provide world-leading asset management solutions for power plant and networks.

Our customers include electricity generation, transmission and distribution companies, together with major power plant operators in the private and public sectors.

- Our products, services, management systems and knowledge enable customers to:
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- Optimise network operations
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- Build smarter grids
- Achieve the latest standards
- Develop their power skills

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