UT2 – 20/29 UltraTEV Detector Operating Manual

Version 6

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Alpine Components

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Contents

1 Declaration of Conformity

Manufacturers Name: EA Technology Ltd,

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

Type of Equipment: UltraTEV Detector

Model Number: UT2

I hereby declare that the equipment specified above conforms to the provisions of the **EC DIRECTIVE 89/336/EEC** on Electromagnetic Compatibility (EMC). Having met the requirements of the following standards;

EN 61000-6-2: 1999
IMMUNITY STANDARD (INDUSTRIAL ENVIRONMENT)

EN 50082-2: 1992
EMISSION STANDARD (RESIDENTIAL, COMMERCIAL and LIGHT INDUSTRY ENVIRONMENT)

2 Safety Note

The instrument is designed to detect partial discharge sources in high voltage (HV) Plant. If no discharges are detected, this does not necessarily imply that an item of HV Plant is discharge free. Discharge sites often have dormant periods and insulation structures can fail through causes other than those attributable to partial discharges. If discharges of considerable magnitude are detected in plant that is connected directly to the high voltage power system, the authority responsible for the plant should be notified immediately.

Warning

The UltraTEV Detector is designed for use at ground potential only.

- When testing electrical plant ensure that the metalwork is earthed before applying the probes.
- Maintain safety clearances between structures at high voltage and the instrument, its probes and the operator at all times.
- 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.

Approved Service Supplier

3 Operational Note

WHEN USING TEV BASED INSTRUMENTS THE FOLLOWING POINTS SHOULD BE NOTED:

1) The probe pick-up is affected by the proximity of the UltraTEV Detector's electronic circuitry to the PD source and also the proximity of the user (i.e. body effects).

2) The unit is calibrated to compensate for an operator holding the UltraTEV Detector in a normal grip with the probe faceplate flat against the plant equipment under test.

3) Holding the unit by fingertips or leaving the unit free standing will have an effect on the readings and is the incorrect method of operation.

4) 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 probe faceplate.

5) Strong electromagnetic fields from mobile phones, RF transmitters, VDUs and un-screened electronics in the frequency range DC to 1GHZ can have an effect on the readings. A measure of local fields can be obtained by holding the unit in free-air at least 1 meter away from any conducting surface. If the mixed or red LEDs illuminate, the substation may be unsuitable for the UltraTEV Detector.

If you have any specific requirement or operating conditions then please contact *instruments@eatechnology.com.*

4 Non-Intrusive Detection of Partial Discharge Activity

4.1 General

Partial discharges are electric discharges that do not completely bridge the electrodes. The magnitude of such discharges is usually small however they do cause progressive deterioration of insulation that may lead to eventual failure.

Non-intrusive partial discharge detection provides a means for identifying these potential sources of insulation failure that result not only in loss of supply to customers but can also endanger staff.

A partial discharge emits energy in the following ways:

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 Detector has specifically developed to enable electromagnetic and ultrasonic activity to be detected in a single simple to use instrument.

4.2 Airborne Ultrasonic Discharge Activity

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

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.

4.3 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 also impinges on the metal casing of the switchgear producing a transient in the earth potential. The Transient Earth Voltage (TEV) is only a few millivolts and lasts only a short time with a rise time of a few nanoseconds.

The partial discharge activity may be detected non-intrusively by placing a probe on the outside of the switchgear whilst the switchgear is in service.

5 The Partial Discharge Range of Equipment

The range consists of the UltraTEV Detector, UltraTEV Plus+, MiniTEV2, UltraMet, PD Locator (PDL1), UltraTEV Alarm, PD Monitor (PDM03CF) and PD Monitor Plus+.

UltraTEV Detector

The UltraTEV Detector is an easy to use hand-held instrument which combines ultrasonic and Transient Earth Voltage (TEV) detection. The instrument is capable of early detection of both surface and internal partial discharge in electrical switchgear. The UltraTEV Detector can be used as part of a Condition Monitoring regime and also as a personal Safety Tool.

UltraTEV Plus+

The UltraTEV Plus+ is the ultimate hand held instrument for the detection and measurement of partial discharge in switchgear. Both TEV and surface discharges can be detected and are displayed as numerical values on a colour screen. The instrument also has the ability to display the number of PD pulses per cycle, severity levels, maximum levels for internal discharges, and a numerical value for ultrasonic emissions, which can be heard with the supplied headphones.

MiniTEV2

The MiniTEV2 is used to detect and measure TEV activity. The magnitude and rate of the TEV discharge activity is displayed on a LCD screen. A simple calculation is used to determine the severity of any discharge found.

UltraMet

The UltraMet is used to detect and measure ultrasonic (surface discharge) activity. The instrument operates in the 40kHz band (ideal for the detection of airborne surface discharge), and the magnitude of the discharge activity is displayed on an LCD screen. This is dependant on an un-obstructed air path between the discharge source and the instrument.

(shown with optional Parabolic Dish)

PD Locator

The PD Locator can be used in single probe mode for TEV magnitude measurements, or two probe mode to accurately locate the source of PD activity using the time of flight technique. The PD Locator can measure PD magnitude over a large range with high accuracy and is the benchmark instrument for the assessment of partial discharge activity.

UltraTEV Alarm

The UltraTEV Alarm provides substation monitoring of TEV and ultrasonic activity and gives an alarm indication locally and remotely if there is any significant activity above the UltraTEV alarm levels. The UltraTEV Alarm can have multiple nodes connected to allow full substation coverage. The system also reports on relative humidity and temperature within the substation, when the GPRS communication option is chosen.

PD Monitor

The PD Monitor is a twelve-channel instrument capable of monitoring discharge activity of a switchboard for a week or more and recording the results. Due to its sophisticated time of flight circuits this instrument is particularly effective where high background activity is present as it will screen out interference sources. The PD Monitor is also useful for detection of intermittent discharge activity, which is often missed when carrying out a survey with, for instance, the UltraTEV Detector or UltraTEV Plus+.

PD Monitor Plus+

The PD Monitor Plus+ provides permanent and semi-permanent substation monitoring. It has all of the capabilities of the PD Monitor and can have up to 255 nodes attached. This provides the ultimate in TEV detection and location with full analysis available, over the internet, from anywhere in the world, providing continuous monitoring of critical assets.

6 The UltraTEV Detector

The UltraTEV Detector comprises a hand held unit with a separate battery charger.

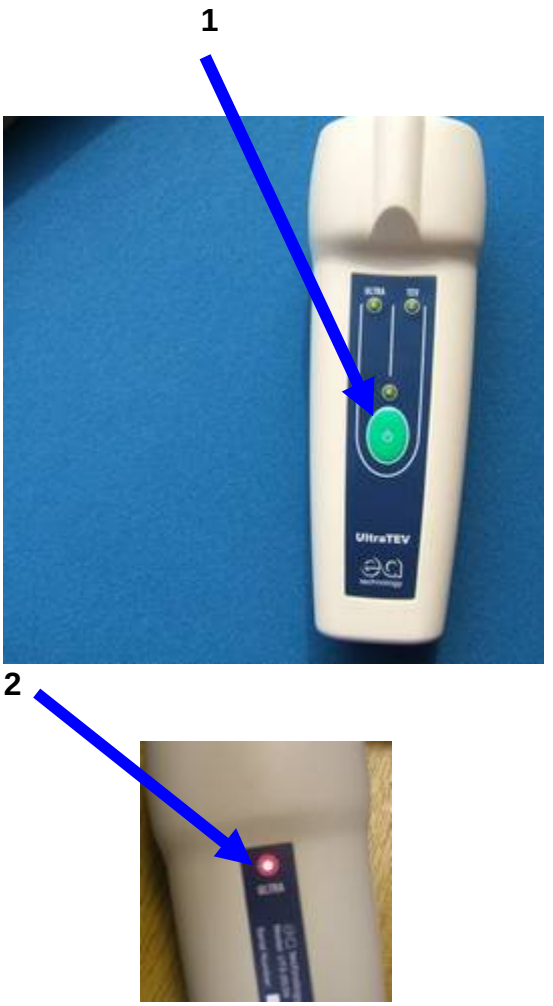
Both the ultrasonic and TEV probes are housed at the larger end of the instrument.

During ultrasonic testing, the switchgear is surveyed by scanning around any air paths to the inside of the switchgear.

When testing for TEV activity the probe end must be held flat against the surface of the switchgear.

Pressing the On/Off (**1)** button once switches the instrument On, it then enters measurement mode and is immediately ready for use.

The results of the measurement are displayed continuously on the two Discharge Status LEDs, on the front of instrument. In addition there is a single red LED (**2**) indicating ultrasonic status on the back. The battery status is displayed on the Power LED.



Pressing the On/Off (**1)** button again switches the instrument Off.

7 Function Checker

Each UltraTEV Detector is supplied with a function checker. The purpose of this accessory is to check that the UltraTEV Detector is operational. It is not intended to check the calibration of the instrument.

The function checker consists of a combined discharge and ultrasonic source which is energised via the charger socket on the UltraTEV Detector. To check whether the UltraTEV Detector is operating plug the function checker into the charger socket on the instrument and hold the checker adjacent to the front face of the UltraTEV Detector. By moving the checker around the front face of the instrument both the TEV and Ultrasonic LEDs should illuminate.

Disconnect the function checker after checking the UltraTEV Detector; do not attempt to use the UltraTEV Detector with the checker plugged in.

It is recommended that the UltraTEV Detector is checked before each use and periodically thereafter.

Function Checker

Ultrasonic Test

Amber TEV

Red TEV

8 Battery Charging

A LV Power Connector is used for charging the batteries, which typically provide up to 8 hours continuous operation. A charging LED is adjacent to the Power Connector and is lit when the unit is on charge. The charger will charge the batteries in 14 hours and can be left on when the batteries are fully charged. The UltraTEV Detector should be switched off when charging; even if it is inadvertently left on it will switch off after 5 minutes.

UltraTEV Detector Charging LED

When there is approximately two hours battery charge remaining the Power LED will change from Green to Mixed (Red-Yellow-Green). When the batteries are too low to operate the instrument the Power LED will change from Mixed (Red-Yellow-Green) to Red and after ten seconds it will automatically shut down.

The unit will automatically shut down after five minutes of operation, to continue making measurements simply press the On/Off (**1)** button.

If the instrument has not been used for a significant period of time it should be fully charged before it is used. Please note that NiMH batteries self discharge at a rate of 1% per day, therefore in 100 days they are completely discharged.

The unit should not be used while the charger is connected.

9 Measurement Procedure

9.1 Background Noise

9.1.1 Ultrasonic Discharge

If the level of acoustic background noise at 40 kHz is excessive, the ultrasonic discharge status LED could turn red when holding the instrument steady within the substation and not directing it towards the switchgear. In practice this situation is encountered only in very few substations. When this situation is encountered, the UltraTEV Detector may be unsuitable for the detection of ultrasonic discharge activity.

9.1.2 Electromagnetic Discharge

Electromagnetic signals from sources outside the switchgear also produce transient earth voltages on the outside of the switchgear. These sources may be from other items of plant such as overhead line insulators or transformer bushings. These sources also produce TEV signals on metalwork not connected to the switchgear such as metal substation doors or fencing.

The background noise levels generally encountered in substations have been taken into account when the TEV threshold levels of the UltraTEV Detector were determined and therefore there is no absolute need to make a background measurement.

However, taking spot background measurements on reasonably sized metalwork not connected to the switchgear can provide useful information to help with interpretation of results. For example, if the background indication is green and the indication on the switchboard is amber or red, then this provides additional confidence that the source is associated with partial discharge on the switchgear.

It must also be remembered that partial discharge activity within switchgear emits electromagnetic waves that will impinge on other metalwork within the substation. Therefore, amber and red signals on metalwork not connected to the switchgear within the substation may be associated with high levels of partial discharge coming from the switchboard if the switchgear also indicates red. If situations like these are encountered then the other instruments in the TEV range must be used to determine the source of electromagnetic activity.

9.2 General Operation

Pressing the On/Off (**1**) button turns the unit on; it will stay on for five minutes after which time it will automatically shut down. To continue making measurements press the On/Off (**1**) button to switch the unit on again.

With the unit clear of any metalwork switch the unit on and the LEDs will light. The Power LED will indicate Mixed (Red-Yellow-Green) for one second. After one second the Power LED should indicate Green or Mixed (Red-Yellow-Green) and the two Discharge Status LEDs should indicate Green. If the UltraTEV Detector does not follow this sequence return the unit to your service provider. The operation of the instrument should be checked using the function checker as described in Section 7.

9.3 Making a Measurement

9.3.1 Ultrasonic Measurements

Red Indication Pointing Towards Switchgear

Green Indication Pointing Away From Switchgear

The switchgear is ultrasonically surveyed by slowly scanning around any air paths to the inside of the switchgear. For vented chambers measurements can be made immediately outside the vent. For non-vented chambers measurements should be made around the covers searching for small gaps between the cover and the chamber. Therefore, for gasketed chambers the ultrasonic technique may not prove useful.

Depending upon the construction of the switchgear, the instrument may be directed towards the region of the circuit breaker bushings / fixed portion spouts and the gap between the fixed and moving portion of voltage transformers to detect problems in these regions.

The rear ultrasonic status LED allows the instrument to be used in optimum orientation for detecting ultrasonic signals

Note: Safe distances between the instrument and high voltage components must be maintained at all times.

9.3.2 TEV Measurements

Correct

Incorrect

Measurements on switchgear are made at the centre of each component of each panel e.g. cable box, cable sheath, CT chamber, busbar chamber, circuit breaker and VT. The UltraTEV Detector should be held in position for approximately five seconds or until the Discharge Status LED gives a continuous steady indication.

Please note, if there is high electrical background noise within the operating bandwidth of the ultrasonic sensor it is possible for the ultrasonic LED to indicate. This is due to direct electrical coupling to the ultrasonic sensor, rather than a genuine ultrasonic signal which requires an air path from the source to the sensor.

Illumination of the ultrasonic LED when the unit is placed against the metalwork of the switchgear should be discounted as this is not an indication of genuine airborne ultrasonic activity from surface discharge.

10 Significance of Measurements

10.1 General

There will be instances when one or other of the discharge status LEDs indicates partial discharge activity within switchgear but the other remains in the green status. There will also be occasions where both LEDs indicate that discharge has been detected. This can help in determining the type of discharge that is occurring, **see appendix A.**

11 Interpretation of Readings

11.1 Ultrasonic Discharge

The level for further investigation of ultrasonic measurements is determined more by the knowledge that a source has been found than by the amplitude of the measurement. This is because the amplitude is very dependent on the size of the opening through which the airborne ultrasonic signal can pass and a clear direct air path between the source and the opening. Therefore, if moving the ultrasonic probe towards and away from openings in the switchgear positively indicates the presence of ultrasonic activity, it is recommended that the source be further investigated.

The further investigation in the first instance may involve surveying the switchgear using a more sophisticated ultrasonic detector where the ultrasonic signal is converted into the audible range and amplified, e.g. the UltraMet. This then enables the noise characteristic of the ultrasonic activity to be analysed to determine whether it is consistent with discharge activity or not. These instruments will also allow the level of discharge to be quantified however; this may be less useful as the air path often dictates the signal level.

The ultrasonic element of the UltraTEV Detector is very sensitive but has been chosen to equate to a level where the ultrasonic signal can be positively detected and heard using a good ultrasonic instrument with headphones.

An example procedure for using the UltraTEV Detector is shown in Appendix A.

11.2 TEV Discharge

The UltraTEV Detector is designed to provide an indication of the presence of partial discharge activity which, if found, should be investigated further with one of the more sophisticated instruments e.g. the PD Locator or the PD Monitor.

Guide to Interpretation of UltraTEV Detector readings

Discharge Status LED	Conclusion
Green	Re-survey annually.
Mixed (Red-Yellow-Green)	Survey more frequently.
Red	Further investigation required with one of the more sophisticated instruments.

An example procedure for the use of the UltraTEV Detector is provided in Appendix A.

12 Instrument Specification

12.1 Signal Inputs

Type of Signal:	Partial discharge voltage pulses
Number of Thresholds:	Ultrasonic 1; TEV 2
TEV Threshold Levels:	20 dBmV and 29 dBmV
TEV Accuracy:	1 dBmV
Pulse Polarity:	Positive or negative
Ultrasonic Threshold Level:	25.4 dB rms SPL minimum

12.2 Indicators

Ultrasonic Status LEDs:	Bi-colour red/green
TEV Status LEDs:	Bi-colour red/green
Power LED:	Bi-colour red/green
Rear Ultrasonic Status LED:	Red
Charging LED:	Red

12.3 Power Supplies

Internal Batteries:	4 x 1800 mAh, NiMH, rechargeable cells
Typical Operating Time:	8 hours continuous
Battery Conservation:	Automatic switch off when low battery voltage detected or 5 minutes elapsed.

12.4 Dimensions

Size:	180 x 52 x 52mm
Weight:	0.28 Kg

12.5 Environmental

Operating Temperature:	0 - 55 degrees C
Humidity:	0 – 90% RH non-condensing
IP Rating:	54

12.6 Probe

Mode of Operation:	Capacitive coupling
Coupling Capacitance:	5pF nominal

12.7 UK and European Battery Charger

Rated Voltage:	230V
Frequency:	50 - 60Hz
Output Voltage:	9V DC
Time for Full Charge:	14 hours
Dimensions:	Size: 80 x 60 x 50 mm
Weight:	0.34 Kg
Operating Temperature:	0 - 30 degrees C
Humidity:	0 – 90% RH non-condensing
IP Rating:	54

12.8 North American Battery Charger

Rated Voltage:	120V
Frequency:	60Hz
Output Voltage:	9V DC
Time for Full Charge:	14 hours
Dimensions:	Size: 80 x 60 x 50 mm
Weight:	0.34 Kg
Operating Temperature:	0 - 30 degrees C
Humidity:	0 – 90% RH non-condensing
IP Rating:	54

13 Maintenance

It is important that the unit is kept clean and dry. It is not weatherproof. 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.

Internal, rechargeable batteries power the instrument.

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

The unit should be cleaned with a damp cloth. If more heavily soiled, a foam cleanser may be used, provided care is taken not to allow fluid to enter the instrument. Abrasive cleaners must not be used. Take care not to scratch the plastic overlay of the front panel.

14 Calibration

The operation of the instrument should be tested prior to use using the function checker. If the unit fails it should be returned to EA Technology. It is recommended that the operation of the instrument is checked on an annual basis by returning the unit to EA Technology for calibration.

15 Waste Electrical and Electronic Equipment Directive (WEEE)

EA Technology is a member of an approved compliance scheme as defined by the WEEE directive. When the PDM03CF reaches the end of its operational life it must be recycled by a licensed waste management operator, or alternatively be returned to EA Technology for recycling.

16 Warranty

This product is warranted against defects in material and workmanship for twenty four months from the date of shipment subject to its return for annual calibration. The battery and accessories (charger, function checker, etc.) are guaranteed for a period of twelve months. During the warranty period, EA Technology will, at its option, either repair or replace units that prove defective.

For warranty service and repair, this product should be returned to EA Technology at the address below. The warranty shall not apply to defects caused by improper maintenance, modification or misuse.

Note

EA Technology has a policy of continual product development and enhancement. While every effort has been made to ensure the accuracy of this document, there may be minor variations between the details given and the equipment supplied.

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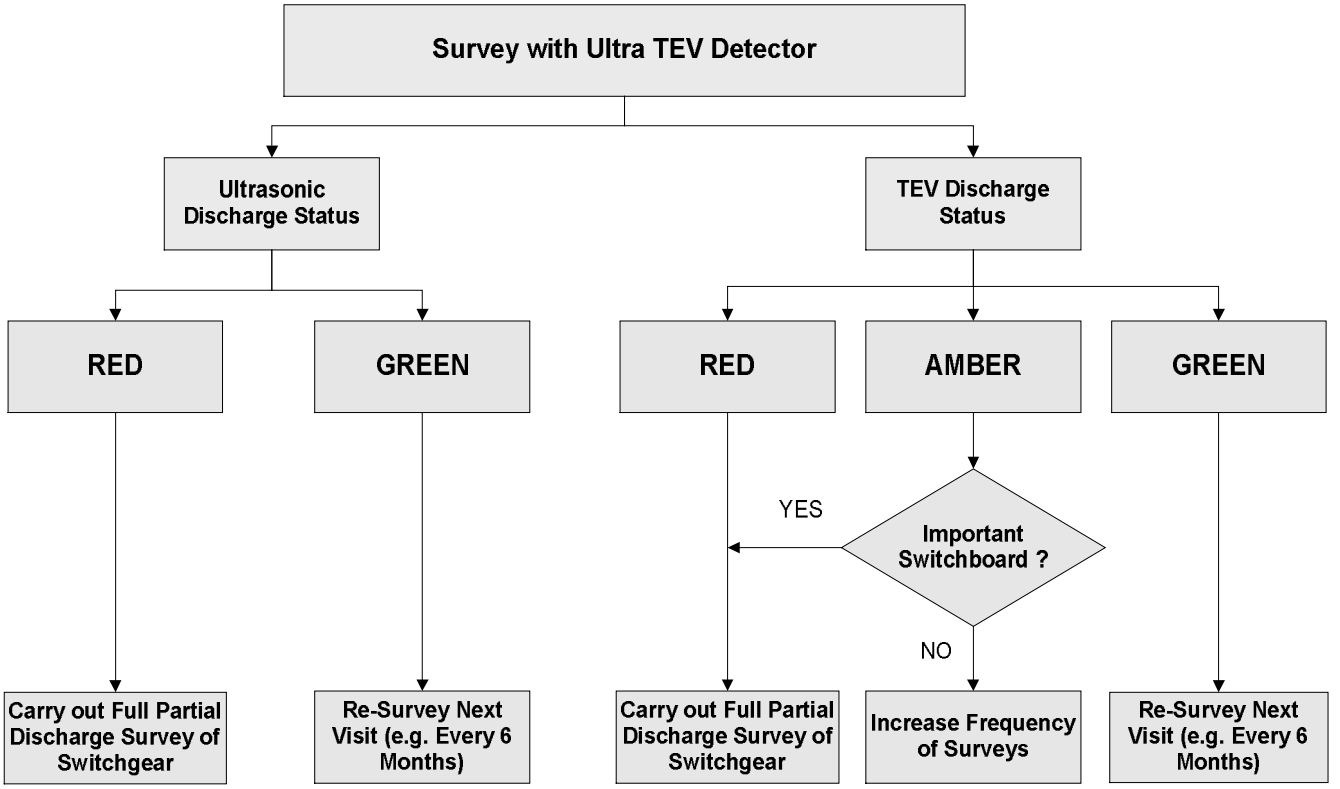
Appendix A – UltraTEV Detector Measurement Flow Chart



Notes