CableData® Collector

ea technology

Technical Information

For detecting & locating Partial Discharge (PD) activity in LIVE HV cables

www.eatechnology.sg

Product Brochure

Background and Introduction

Asset managers around the world have a very real need to understand the condition of their ageing High Voltage (HV) cables, to help with the management of these assets and ultimately improve network reliability.

There is a growing concern about the increasing age and reliability of HV distribution networks: and considerable pressure to implement the most cost–effective management of network assets.

The strategy of moving towards maintaining and replacing assets only when strictly necessary (Condition Based Maintenance) can help considerably in meeting these needs. Implemented correctly, this approach can deliver significant cost savings, whilst keeping reliability and quality at the required level for electrical assets.

Replacing and maintaining underground cable circuits, particularly with the need for excavation, can be very expensive, hence network managers need evidence to justify maintenance/replacement actions.

The Value of Partial Discharge (PD) Testing

Detection and measurement of Partial Discharge (PD) is a highly effective technique for assessing the condition of HV cable systems. PD is the most common cause of failure of insulation on HV equipment and cables and the detection of PD can indicate the presence of harmful defects, thus helping to identify potential future faults.

Testing of large parts of the network can help in the assessment of its overall condition, show how the assets are ageing, predict future failure rates and help assess the level of on-going expenditure (Capex and Opex) needed to meet requirements for future network reliability.

The CableData® Collector Solution

EA Technology has developed an online solution for the collection of partial discharge information in HV cables, the CableData® Collector (CDC).

This solution allows companies to:

1. Introduce a simple-to-use, effective tool for the collection of PD signals on live HV cables
2. Quickly assess large numbers of cables and build up a total view of the condition of the distribution cable network
3. Collect accurate cable PD data without the need for deployment of specialist engineers and expensive off-line test equipment on all circuits

The CableData® Collector

Partial discharge is the most common cause of failure of insulation on HV equipment and cables, and provides an accurate indication on the health of assets. Through the collection and analysis of partial discharge information, electricity companies can ascertain the health of their cable networks and assess requirements for capital and operational expenditure and intervention (whether maintenance or replacement).

However, traditional techniques for partial discharge measurements in cables involved taking the cables out of service and energising them via a discharge-free power supply, using a Very Low Frequency (VLF), Oscillating Wave Test Set (OWTS) or resonant test set.

By contrast, the CableData® Collector has been developed as a simple-to-use, effective tool for collecting PD signals in LIVE HV cables.

Advantages of On-line PD Testing

The disadvantage of testing with the cables live is that PD signals may be affected by electrical noise signals on the earth sheath, which can also somewhat limit the length of cable that can be tested.

The CableData® Collector combats these problems by capturing raw unfiltered signal data, then automatically applies filters, without the need for selecting and plugging in external filtering units. This helps to eliminate noise and identify PD signals accurately.

The huge time saving that results from using this online technique means that it is possible to test complete cable networks quickly and cost-effectively. Remedial actions or off-line cable testing can subsequently be applied where necessary.

PD testing without the need to take cables off-line has the obvious benefit of being safer to undertake and allows many more cables to be tested in a shorter time. Testing off-line generally takes 3–4 hours per cable, whereas the CableData® Collector captures the data for a single circuit (single phase or three phase) in 5–10 minutes.

The CableData® Collector has the added benefit of greatly de-skilling the data collection process, compared with other available live testing techniques. The technician collecting the data does not need to read and assess oscilloscopes or determine what filtering is required to separate discharge signals from noise sources. This frees up engineering resource for the analysis and management of the data, and enables the condition of cable networks to be undertaken at a lower cost.

CableData® Collector Hardware

The CableData® Collector is a portable and a very rugged solution for determining the condition of cables online. The instrument contains sophisticated Digital Signal Processing and Filtering, which enable PD to be detected even when obscured by large levels of noise.

It can be used to capture PD in single core cables or 3-core cables using one or 3 HFCTs simultaneously, depending upon the configuration of the circuit. The HFCTs plug into the CableData® Collector central unit, which itself connects via USB connectors to a laptop computer. The laptop is used to drive the collector and capture and store the data. Figure 1 shows a schematic of the equipment setup to capture data from three single core cables.

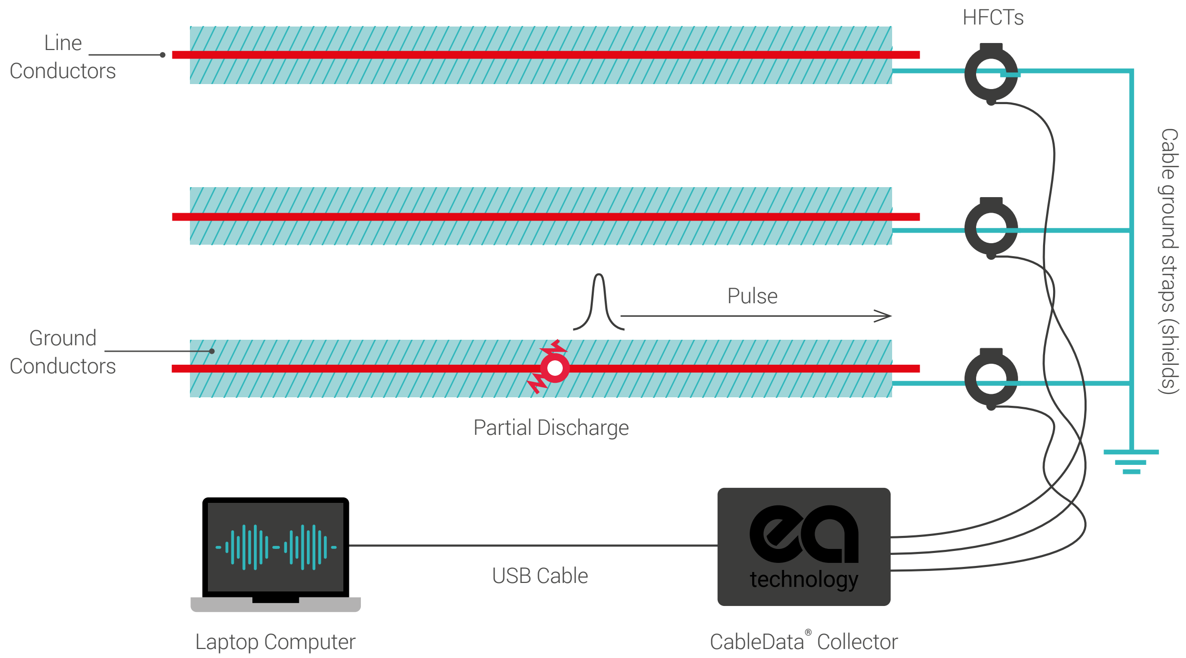


Figure 1: Setup for three phase data capture

The CableData® Collector kit includes:

Figure 2: The CableData® Collector Kit

- 1 x Protective Case and Foam Insert
- 1 x CDC
- 1 x Data And Power USB Cable
- 4 x 5M BNC Cables
- 3 x HFCT
- 1 x Phase Reference Transformer
- 1 x Phase Reference Transformer Mains Cable
- 1 x Data Acquisition Software
- 1 x User Manual

HFCTs

The supplied HFCTs are connected to the earth braid of the cable as shown in Figure 3 and Figure 4.

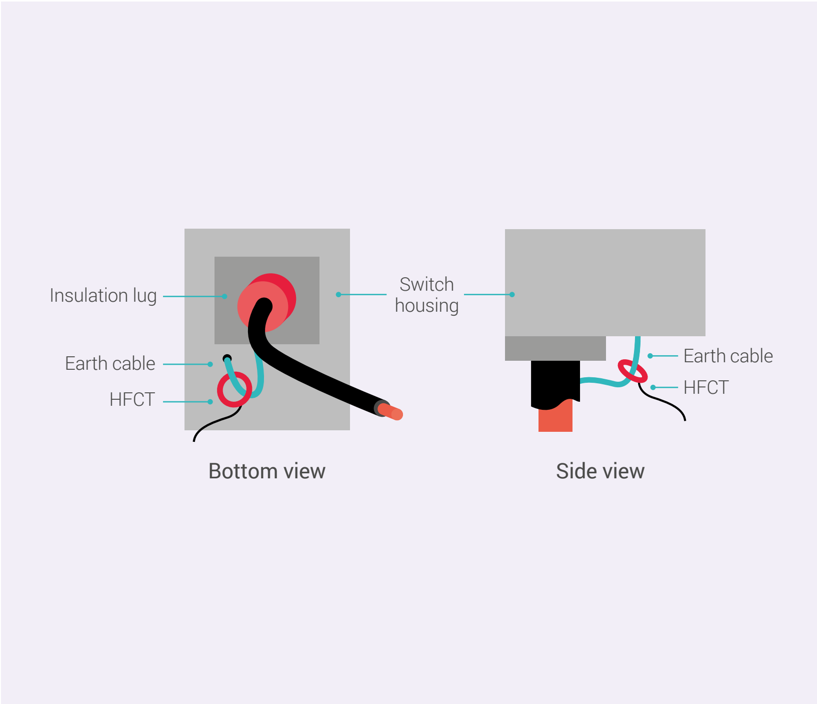


Figure 3: HFCT Connections

Figure 4: HFCT on earth braid of HV cable

Central Unit

On the front panel, there are four BNC connectors that will be used during testing. Three of the connectors are for use with the supplied HFCTs for capturing data. The fourth connector is the auxiliary input, which can be used to provide a phase reference.

A phase reference is required by the CableData® Collector to improve the data analysis and allows classification of events based on the phase position. A phase reference can be supplied to the CableData® Collector by one of two sources: either by a phase reference transformer or one of the measurement HFCTs. The phase reference transformer is the default source for the phase reference, but the instrument can also detect the phase reference from the connected HFCTs when possible.

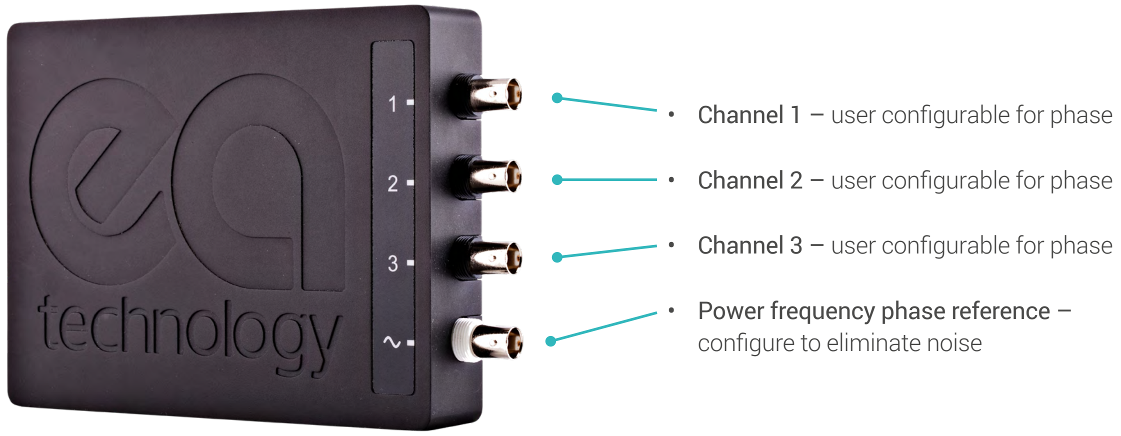


Figure 5: CableData® Collector central unit

CableData® Collector PD Data Capture Process

The CableData® Collector connects to a laptop PC via a USB cable. The laptop is used to drive the software and collect the data.

The technician collecting the data simply has to input a prompted series of information on the cable under test and then press the start button. The instrument will automatically acquire the cable PD data on the circuit under test, applying the series of filters in turn. Within 5 minutes the data has been collected and the testing is complete.

The sequence of data capture screen shots is show in Figure 6.

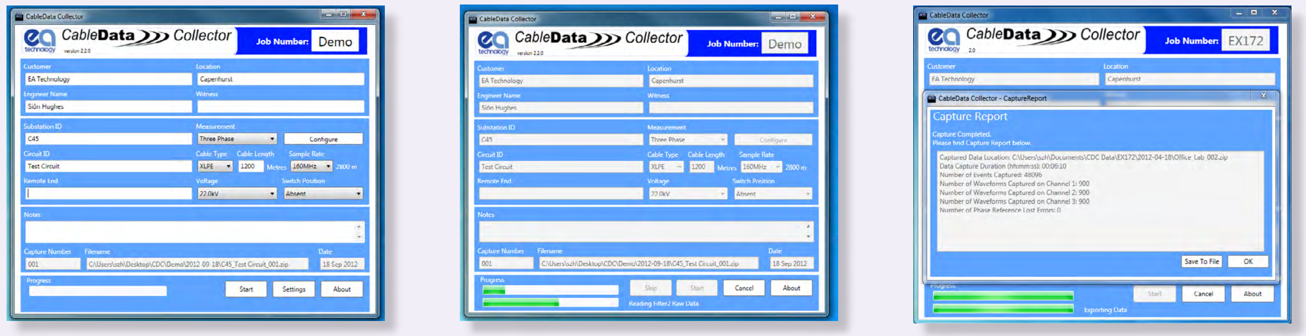


Figure 6: Data capture process

PD Testing: Practical Considerations

Access and Earthing

When carrying out an online PD test, the plant item must allow access to the safe earth strap and there must be insulation between the switchgear earth and the cable earth.

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 paper insulated cables, difficulty may arise attaching the HFCT unit, as the cable earth and switchgear earth can be bonded together. This is more usual on older paper insulated cables using compound filled cable boxes. The placement of the HFCT is then not possible until an insulated gland has been installed with an earth strap bridging the gland. This provides a single earth connection between the cable and the switchgear allowing capture of the PD signals.

Cable Type Restrictions

In cable types like XLPE, the phase cores are separately screened. On belted cables, there is a common screen around the three phases.

On the 3-phase HV belted cable types, the HFCT will not see a PD occurring between phases when placed over the earth strap, as the discharge current flows only in the phase conductor.

The implications for online PD tests of belted cables is that only phase-to-ground PD measurements can be taken, with the phase-to-phase measurements not being possible unless access to the individual cores is obtained.

Effects of PD in Cables

The power cables being tested for a PD event must be earthed via an earth strap to allow measurements to be made of PD between phase and earth. Once a PD event has occurred through the electrical insulation of a cable, a set of pulses both equal in magnitude but opposite in polarity are seen on the line conductors and the earth conductor. In addition, if a PD event occurs between two phases, the effect of equal magnitude and opposite polarity is seen on the phase conductors that the PD event occurred.

It should also be noted that on XLPE cables, the PD event will normally take place on the cable terminations, joints or splices.

The illustration below shows the effect of a partial discharge. However, the PD effect has been exaggerated for the purpose of this explanation.

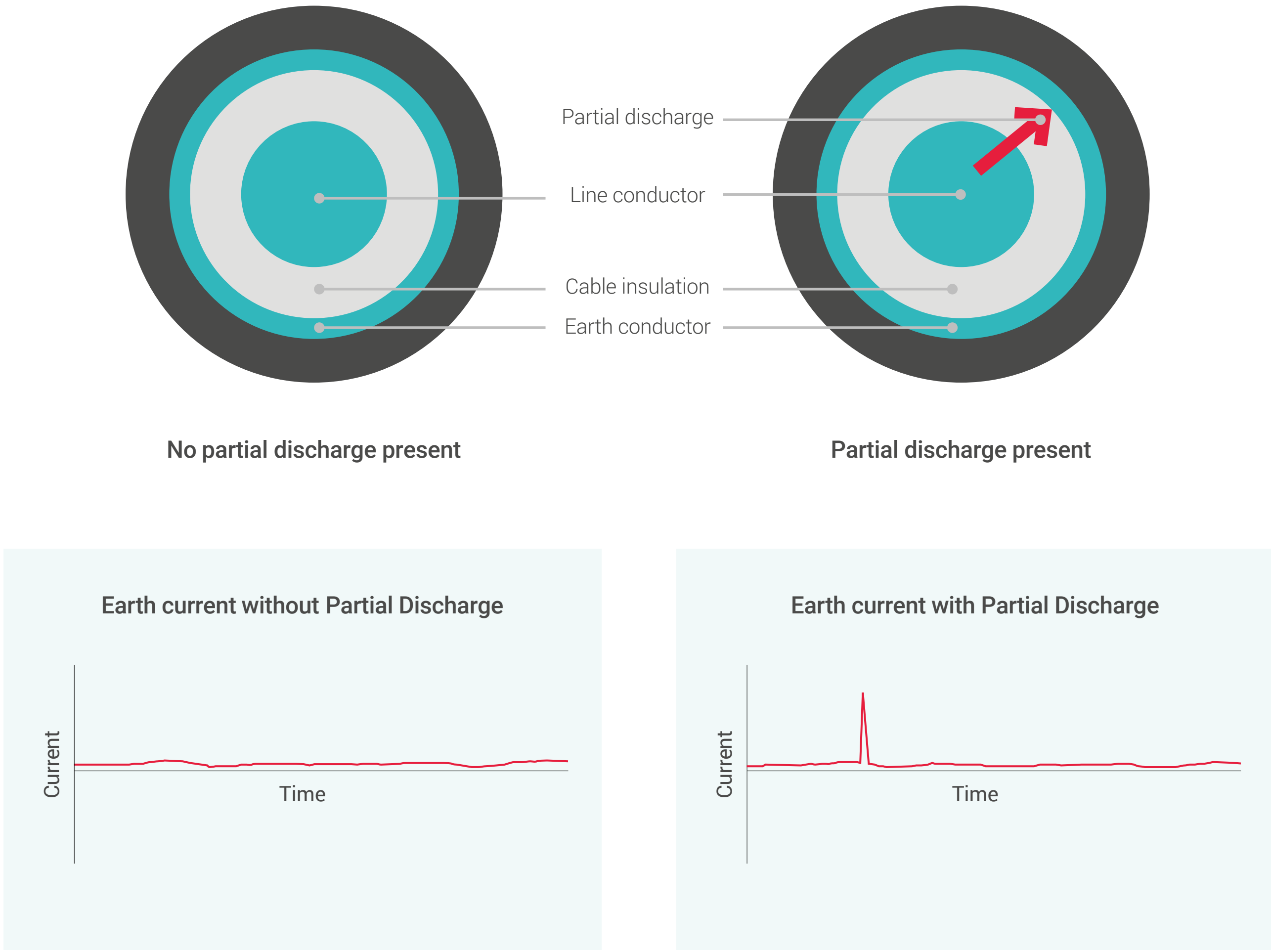


Figure 7: Effect of Partial Discharge on a cable

HFCT Connection Requirements

The HFCT detects the occurrence of a partial discharge between the line conductor and earth, by monitoring the cable using one of the three connection methods illustrated in Figure 8.

Connections can be made:

i. By monitoring the earth cable only (A) - the preferred connection method

ii. By monitoring the line conductor without the earth (B)

iii. By monitoring the line conductor and earth within the sheathing and the earth cable external to the sheathing, when passed back through the HFCT (D, close up Figure 9).

If the HFCT is placed over both the line conductor and earth cable at the same time, the discharge currents are cancelled. This is illustrated in (C). Monitoring the earth only (A) shows the preferred connection method, as the other connection methods should only be used for three phase cables, or single phase cables with a light load.

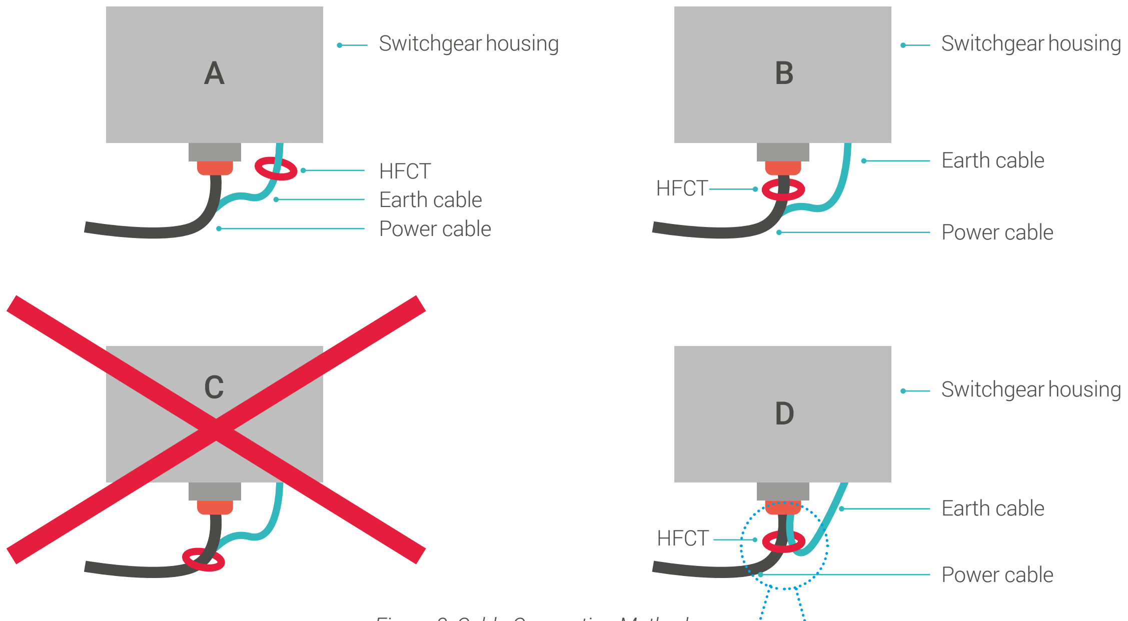


Figure 8: Cable Connection Methods

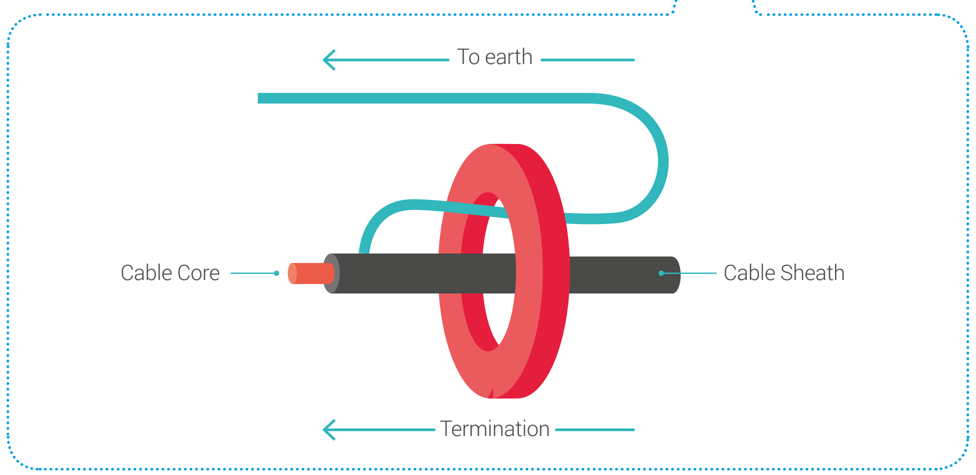


Figure 9: Close up - Overcoming cancellation of discharge currents by looping back earth strap

CableData® Analysis

With the data from the cable safely collected and stored on the laptop computer, it is a simple task to transfer the files and analyse the data on the CableData® Analysis Suite (CDAS). This software suite can be installed onto the most appropriate computer to perform the analysis e.g. on the engineer's desktop PC, rather than the laptop used to collect the data.

The data can be analysed individually in single phase mode or, for ease of interpretation, if three phases of the same circuit have been captured simultaneously, the data can be processed and analysed together. Figure 10 shows screen shots of the analysis windows of the software suite.

PD Classification & Location

The data that has been collected in the substations is processed by the CableData® Analysis Suite (CDAS) software. Both filtered and unfiltered data can be analysed to determine the level of noise on the cable and identify partial discharge activity.

If reflected pulses are detected from the far end of the cable, it is possible with assumed signal propagation speeds to estimate the location of any detected partial discharge activity.

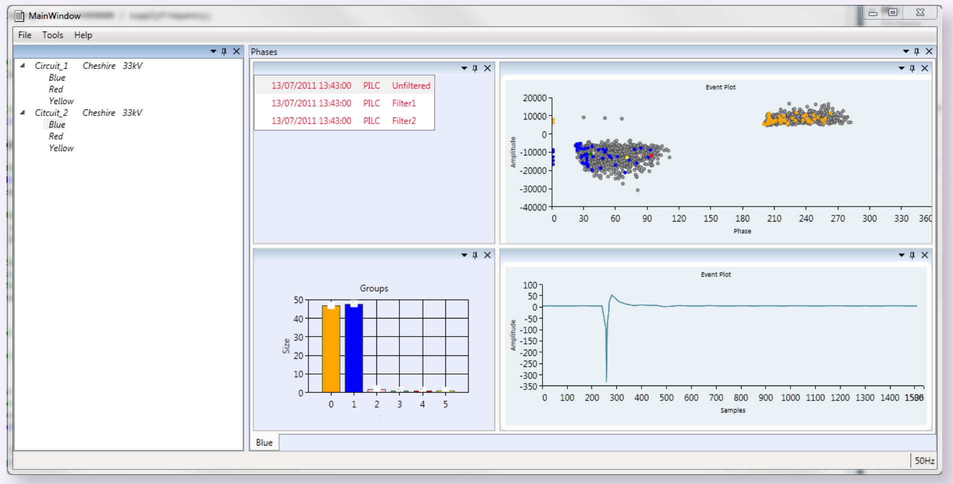
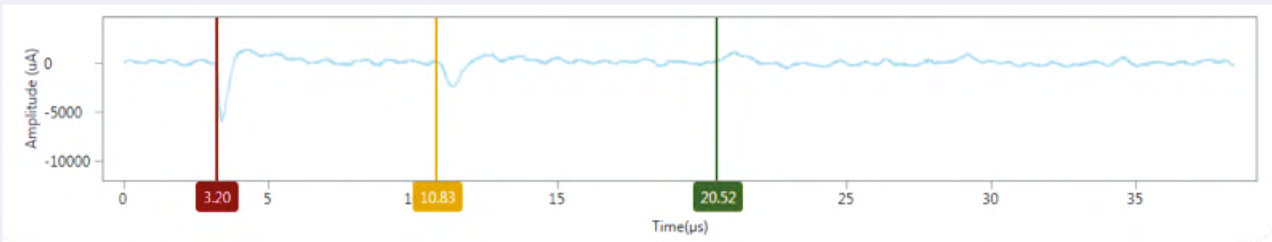
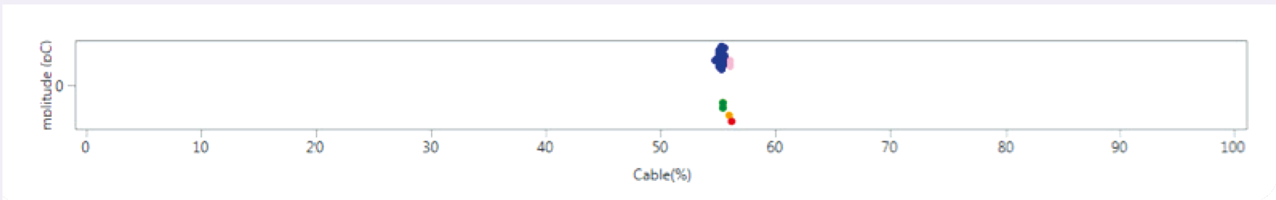


Figure 10: CableData® Analysis Suite screenshot



Waveform showing PD location at 56% from the measurement position.



Map showing multiple PD events at around 56% of the cable length.

Figure 11: PD Location using CableData® Analysis Suite

PD Activity Reports

It is relatively simple for an operator to identify local discharges, together with discharges on joints and splices along the cable and start classifying the type of discharge detected.

The data can be easily exported from the software suite, in a standard report template that can be modified to meet local company requirements.

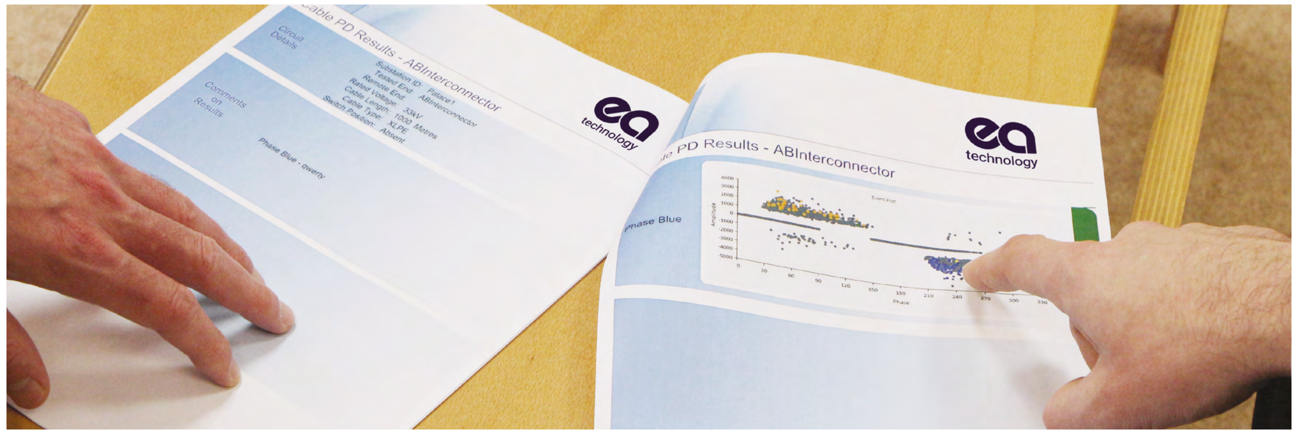


Figure 12 : Print Sample report page from the CableData® Analysis Suite

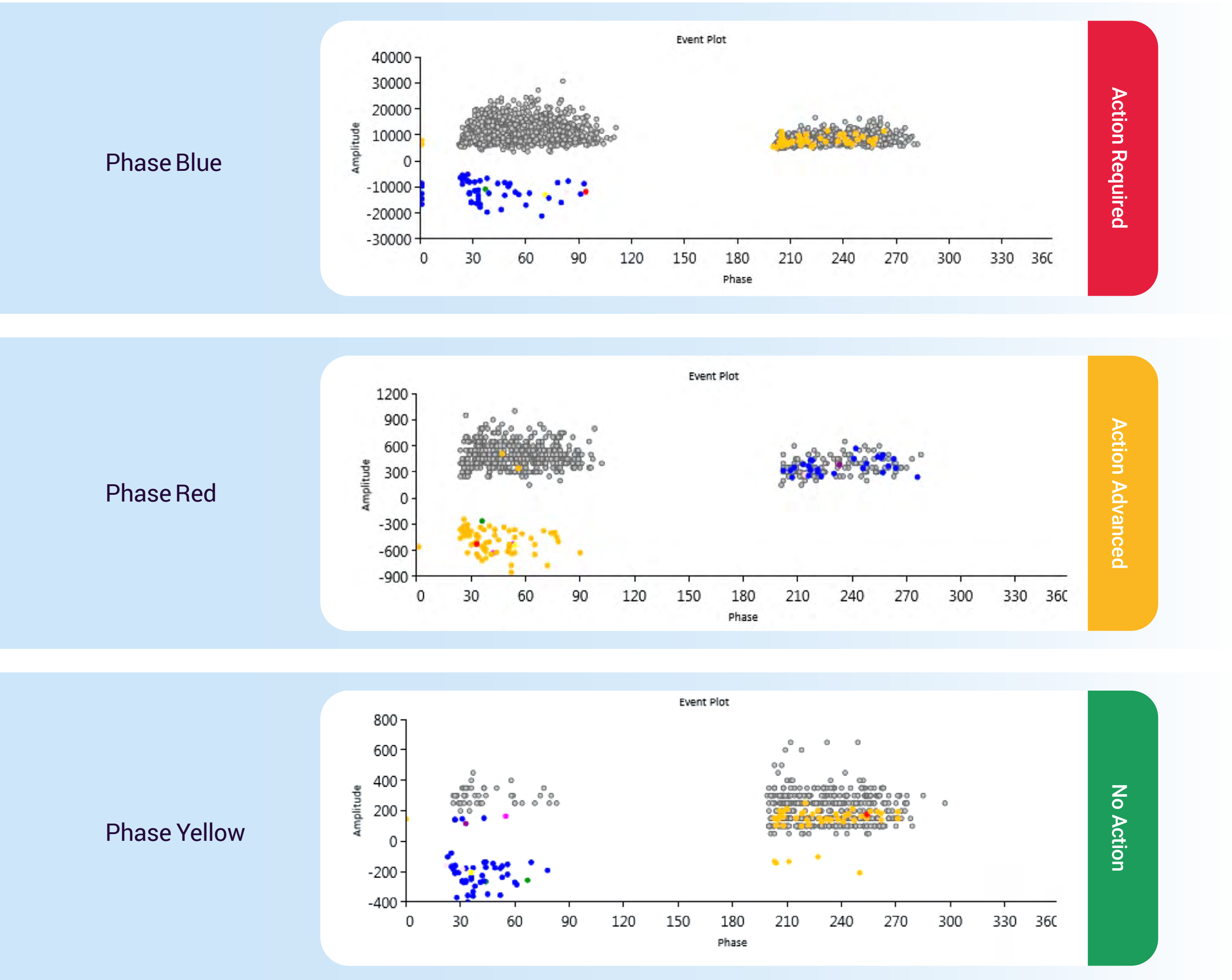


Figure 13: Sample report page from the CableData® Analysis Suite

CableData® Collector Technical Specification

PHYSICAL	
Size	176 mm x 120 mm x 28 mm
Weight	0.57 kg
Enclosure	Anodised Aluminium
Indicators	Phase Reference Events Capture Cable Construction Dependent
Connectors	3x BNC (Cable PD) 1x BNC (Phase Reference) 1x Mini-USB (Power & Communication) 1x SD Card (not used) 1x Ethernet (not used)

CABLE PD MEASUREMENT	
Sensor	3x High Frequency Current Transformer (HFCT)
Maximum cable length	Cable construction dependent
Measurement type	Single-phase or three-phase
Digital Filter Ranges	Unfiltered, 500kHz (high pass) 1800kHz (high pass)
Bandwidth (Unfiltered)	4KHz – 49 MHz
Minimum Event Detection	5pC (with HFCT1-F50)
Gain ranges	4 (-12dB, -6dB, 0dB, +6dB)
Measurement Accuracy	±1 dB
Phase reference	Auxiliary phase reference transformer (CDC2-PRT) or HFCT (10A minimum primary current)

ENVIRONMENTAL	
Operating Temperature	-20 – +50 degrees C
Humidity	0 – 90% non-condensing
IP Rating	IP3X (In accordance with EN 60529 1992+A2-2013)

POWER SUPPLY	
Power supply	Powered through USB connection from a PC

PC / SOFTWARE REQUIREMENT S	
Operating System	Windows 10
Peripheral Connectors	1x USB Port
Date Acquisition Software	CableDataCollector 4.1.0 (or greater)
Data Analysis Software	Cable Data Acquisition Studio (CDAS) 1.0.2.0 (or greater)

COMPLIANCE / SAFETY	
Electromagnetic compatibility (EMC)	**EN 61326-1:2013** Electrical equipment for measurement, control, and lab use – EMC requirements **EN 61000-6-2:2019** Electromagnetic compatibility (EMC) Generic standards Immunity for industrial environments **EN 61000-6-4:2019** Electromagnetic compatibility (EMC) Generic standards Emission standard for industrial environments

For more information please call us on +65 6443 3833 or email us at sales@eatechnology.sg

Global Footprint

At EA Technology we specialise in asset management solutions for owners and operators of power network assets.

Founded in 1966 we have over 50 years' experience in the industry and 6 regional offices around the world to support our global customer base.

We work with a lot of our clients on a long-term basis to help them safeguard their power networks.

We advise our clients on strategy and implementation of a range of technology solutions to manage power assets, delivering maximum life and minimise cost.

ea technology

Safer, Stronger, Smarter Networks

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