CableData Collector

Operating Manual

Product Code: CDC2

Version: 1

January 2013

www.eatechnology.com

Delivering Innovation in **Power Engineering**

Contents

1 Record of Changes

Date	Drawing Number	Changes
December 2012	1365/L/01/1	First Issue.

2 EA Technology Range of Products

Cable Instruments

CableSniffer™ - Locate underground LV cable Faults in minutes, with fewer excavations, less disruption and lower costs.

Partial Discharge Instruments

UltraTEV Detector™ - hand held, dual sensor, Partial Discharge (PD) detector, which enables swift and simple 'first pass' identification of potentially damaging HV equipment faults and MV equipment faults before they become failures.

UltraTEV Plus+™ - advanced hand held, dual sensor, Partial Discharge (PD) detector, which enables more detailed identification and comparison of PD activity across multiple substation assets.

UltraMet Plus+™ - simple hand held tool for measuring Partial Discharge (PD) activity by detecting ultrasonic sound. The sounds detected are displayed on screen as decibel readings, as well as relayed to headphones as an audible signal

UltraTEV Locator™ - simple to use tool that can measure and record the exact location of Partial Discharge (PD) activity to within 30cm in any substation assets, including cables and overhead equipment. The most versatile PD investigation unit in the world, it can identify faults before they become failures and deliver an accurate assessment of asset condition

UltraTEV Alarm™ - PD system that combines all the benefits of EA Technology's award winning Partial Discharge (PD) detection and monitoring, in one simple to install, automatic set up. It can monitor over 100 assets simultaneously and raise the alarm if one or more reaches critical PD levels.

UltraTEV Monitor™ - The ultimate system in EA technology's PD instrument range, the UltraTEV Monitor™ is much more than a fault detection and alarm system. It is the most powerful tool ever developed for collecting and recording information on the condition of large numbers of assets. It detects and locates, measures and monitors, records and analyses all the data from all your substation equipment, including cables, to give you unrivalled information on the condition of your assets.

PD Monitor GIS™ - purpose designed, retrofit condition monitoring system for all commonly used pressurised Gas Insulated Switchgear (GIS). It provides 24 hour detection, location and analysis of PD activity to identify faults early and avoid costly failures and repairs.

Ultrasonic Contact Probe™ - high tech detector that can identify the sounds of surface discharge activity in sealed chambers by monitoring the vibrations produced in the chamber walls. Designed to work with EA Technology's extensive portfolio of Partial Discharge instruments, including the UltraTEV Plus™, UltraTEV Locator™ and UltraTEV Monitor™.

UltraTEV Calibration Checker™ - instantly checks whether your UltraTEV Detector or UltraTEV Alarm Nodes are operating within specification

Field Instruments

PURL™ - Pole Ultrasonic Rot Locator™ is the world's most effective instrument for accurately establishing the condition of pine poles, producing accurate condition assessments without the guesswork of hammer tests or the intrusion of drill through tests.

Polarity Test Kit ™ - comprises an accurate and versatile Polarity Test Pen and a Test Pen Checker, in one lightweight, portable unit that is essential for safe working around potentially live cables. It detects live cables in all standard 220-250V 50/60Hz supplies, with or without current flow.

Extended Voltstick™ - essential safety tool for identifying low voltage cables that have been damaged during excavations.

3 EA Technology Training Courses

MSc in Power Asset Management
Postgraduate Certificate
Postgraduate Diploma
Master of Science

Substations
Partial Discharge
Insulating Oil Handling & Analysis
Switchgear Technology for Power Systems
SF6 Training
Substation Earthing
Transformers for Power Systems
Substation Design Course

Cables
Power Cable Fault Location
Cables for Power Systems (Part 1)
Cables for Power Systems (Part 2)
Oil Filled Cables

Protection
LV/HV Protection
Power System Protection
Commissioning & Testing

For further information on our complete range of products and training courses, please contact:

Email: sales@eatechnology.com

4 Declaration of Conformity

Manufacturers Name:	EA Technology Ltd
Manufacturers Address:	Capenhurst Technology Park Capenhurst Chester CH1 6ES UK
Type of Equipment:	CableData Collector
Model Number:	CDC2

I hereby declare that the equipment specified above conforms to the provisions of the **EC DIRECTIVE 2004/108/EC** on Electromagnetic Compatibility (EMC). Having met the requirements of the following standards;

BS EN 61000-6-2 :2001
GENERIC EMC IMMUNITY & EMISSION STANDARDS
INDUSTRIAL

BS EN 61000-6-3 :2001
GENERIC EMC EMISSION STANDARDS
RESIDENTIAL, COMMERCIAL AND LIGHT INDUSTRY

Robert Davis
Chief Executive Officer
EA Technology Group Ltd

5 Operator Safety

- The CableData Collector is designed to detect partial discharge sources in High Voltage (HV) cables. If no discharges are detected, this does not necessarily imply that an item of HV cable 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.

- The CableData Collector is designed for use at ground potential only.

- When testing electrical plant ensure that the metalwork is earthed before taking any measurements.

- 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.

6 Warnings & Tips

6.1 Warnings

- Do not leave any of the Current Transformers connected in place for a measurement while a switching operation is being performed. Due to the charging of the cable capacitance, this can create a large inrush current that may overwhelm the input protection circuits and cause damage to the board.

- Maintain safety clearances between structures at high voltage and the instrument, its probes and the operator at all times.

- Do not connect the CableData Collector to a USB hub. It is important that the CableData Collector is connected directly to the machine it is being used on, as use of a USB hub may result in intermittent errors.

- Always take the Phase Reference Transformer in the event that it is not possible to acquire phase information from the RFCTs. It is only possible to collect data with a phase reference present. The CableData Collector will attempt to detect the phase from the RFCTs used for data capture. In some cases, this may not be possible and an alternative reference may be needed.

- Only the supplied RFCT should be used with the CableData Collector. The RFCT we supply has an integral protection circuit to protect the instruments against transients caused by HV switching.

- Only the supplied Phase Reference Transformer should be used with the CableData Collector.

- Do not insert an SD card into the SD card slot, it is currently unsupported and not functional.

- Do not insert a network cable into the Ethernet Socket, it is currently unsupported and not functional.

6.2 Tips

- The unit contains no user serviceable parts, always return to EA Technology or your local distributor for service and repair.

- The CableData Collector unit is designed to function with a mains frequency signal present, which may occur because of imbalanced phases. The presence of higher frequency signals may cause interference. An example of a source for an interfering signal is a power line carrier system. These will introduce a higher frequency signal into the power cable that may be picked up by the CableData Collector and may reduce the accuracy of the measurements. Wherever safely possible, attempt to eliminate any sources of higher frequency signals.

- The CableData Collector contains relays inside that may make a clicking sound shortly after power up and during data capture. This is to be expected and may occur during normal use.

7 Introduction

Non-Intrusive Detection of Partial Discharge Activity

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

When the partial discharge event occurs in a cable, there will be a resulting voltage pulse coupled into the earth sheath of the cable. These pulses will propagate away from the PD side in both directions. Once the pulse reaches a change in impedance, this will cause a partial reflection. This results in the pulses travelling back down the cable several times (depending on the cable length) as they decay away.

A measurement is taken using the Radio Frequency Current Transformer (RFCT) at one end of the cable. This will reveal a pattern of pulses, where the first pulse is the direct pulse from the PD event. The second pulse is the reflected pulse from the far end. If the PD site is at the far end of the cable, then the direct pulse and the reflection will be very close to each other, or perhaps superimposed on each other. Conversely, if the PD site is at the near end of the cable, the direct pulse will be received first, and then there will be a longer gap as the pulse travelling away will have to travel nearly twice the length of the cable until it is detected.

8 Kit Contents

CableData Collector Unit
3 x RFCTs
4 x 5m BNC Leads
USB Data & Power Cable
Phase Reference Transformer
Carry Case
Operating Manual
Software USB drive

Spares and Accessories

For spares and accessories, please contact:

Email: sales@eatechnology.com

9 CableData Collector Hardware

9.1 Connectors

The CableData Collector, shown in Figure 1, has connectors on the front and rear, which are required for testing.

Figure 1 - CableData Collector

On the front panel, there are four BNC connectors that are used during testing. Three of the connectors are for use with the supplied RFCTs for capturing data. The fourth connector is the Auxiliary input, which the phase reference transformer should be connected to. Only the supplied phase reference transformer specifically designed for the CableData Collector should be used with this input. The channels are identifiable from the label on the top of the instrument. RFCT input channels can also be identified from the auxiliary channel by the colour of the connector; RFCT input channels have black connectors and the auxiliary channel has a white connector.

To the rear of the CableData Collector, as shown in Figure 2, there are four items. On the very left is the SD card slot. Currently this is unsupported and is not functional - please do not insert an SD card into the slot. Underneath the SD Card Slot, are three status LEDs. Further information on the LEDs is available in the next section.

To the right of the SD Card Slot, is the USB Connector. This connector is used for both powering the instrument and communicating with it. The CableData Collector is supplied with a split USB Cable that allows more power to be drawn from an additional USB port if the USB port of a laptop cannot provide sufficient power.

On the right of the USB connector is the Ethernet Socket. Currently this is unsupported and is not functional - please do not insert a network cable into this socket.

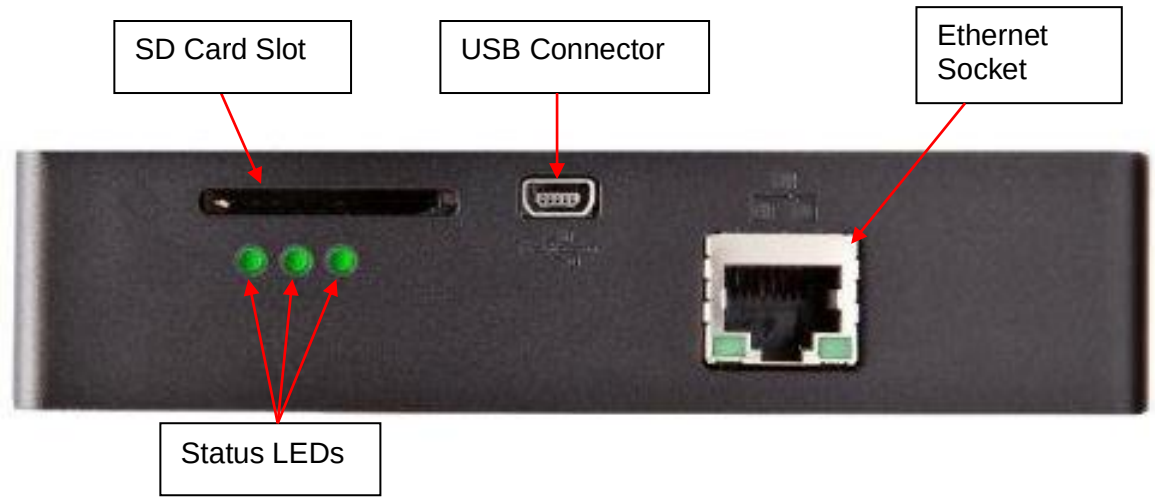

Figure 2 - CableData Collector Rear

9.2 Status LED Definition

The left hand two status LEDs indicate the status of the firmware. When the unit is powered up but not collecting data, they should remain a solid green. When collecting data, the left (outermost) LED should briefly flash whilst collecting event data. The centre LED will flicker when collecting waveform data. As the waveform collection is a slower process, this will flash for a longer period.

The right most LED is the phase reference indicator. When a phase reference is present, the LED should remain solid green. In the event that the phase reference is lost, it will turn orange.

In the event that any of the Status LEDs turns red, try power cycling the unit to see if this alleviates the problem. If the red status light remains illuminated, this may indicate a possible hardware issue with the unit. If this occurs then please contact EA Technology Product Support Team for further instructions.

9.3 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 via the phase reference transformer or the connected RFCTs. A phase reference on the Auxiliary channel from the phase reference transformer is the preferred source for the phase reference, but if the instrument detects it is not present it will attempt to locate a phase reference from the connected RFCT's.

9.3.1 Transformer Reference

The supplied phase reference transformer is the preferred source for a phase reference signal, as it will provide better results than using the RFCT's. Because of this, it should be used wherever possible. To use the Transformer Reference, plug the BNC connector from the end of the transformer cable into the **Aux** input.

If the attached cable is too short, it is possible to use either a mains extension lead or a longer BNC terminated coaxial cable from the phase reference transformer to the instrument. EA Technology can supply the recommended parts, please contact EA Technology Product Support for further information. For contact details please see section 19 of this manual.

The phase reference transformer input is in the form of an IEC320-C7 power cable, which can be swapped for an off the shelf version of the cable with a local plug. If this is not possible, the transformer will work with basic travel adapters. The more complex travel adapters that also convert the voltage may not work and should be avoided. The transformer is designed to work with an input voltage between 100V and 240V.

9.3.2 RFCT Reference

The CableData Collector will attempt to obtain a phase reference from the sheath current flowing through the RFCTs. This 50Hz or 60Hz current is due to the cable capacitance, or in some circumstances may be down to induction from the phase conductors. A current of approximately 200mA is required to give a reliable reference - if the current is lower, the reference may be intermittent and unreliable. If the current is around the lower limit, the phase reference LED may occasionally change between green and orange. If this occurs then it is recommended to use the phase reference transformer. If the instrument is being used in Single Phase mode it will only attempt to detect the phase reference on channel 1, but if it is being used in three phase mode all three input channels will be attempted. This information is logged in the capture reports and can be viewed at the end of the data capture process.

9.4 Calibration

It is recommended that the CableData Collector be calibrated annually. The calibration date and due date can be viewed through the CableData Collector software by looking at the instrument information screen.

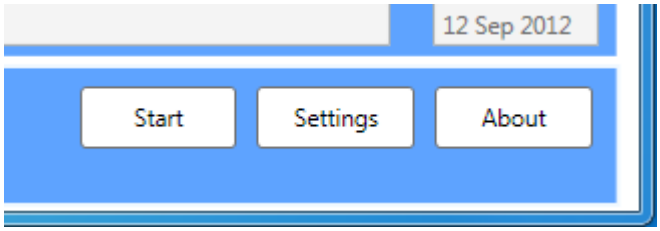

Figure 3 - About button in CableData Collector Software

Clicking the About **button will display the instrument information window shown in** Figure 4. **Calibration Due Date** will give an indication of the remaining time left until calibration is recommended.

Figure 4 - About CableData Collector

When attempting to use the software with a CableData Collector whose calibration period has expired, a warning will be displayed as shown in
Figure 5. Clicking **OK** will allow the software to continue and it will still be possible to collect data, however it is recommended that you return the device for calibration at the earliest convenience.

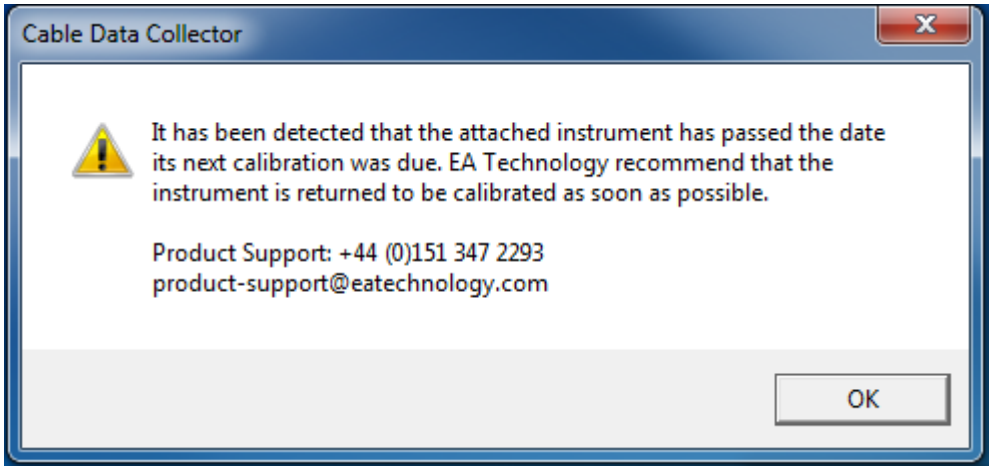

Figure 5 - Warning about calibration expiry

10 CableData Collector Software

10.1 Software Installation

Before starting the installation process, any other older version of the CableData Collector software should be uninstalled including the accompanying Virtual COM Port driver.

The CableData Collector software requires Microsoft's .Net 3.5 framework to be installed, for which a separate installer included with the setup files. If you are unsure, whether you have this installed then it is advisable to run and install this before starting with the installation of the CableData Collector.

To start the installation, locate the install files supplied. Run the exe file to start the installation process. Windows administrator privileges are required to install the CableData Collector software. The installer applications are shown in Figure 6.

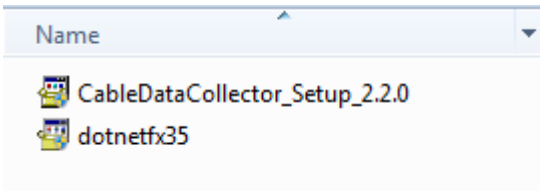

Figure 6 - Setup Files

Running the **CableDataCollector_Setup_xxx** file will ask for confirmation before installation proceeds. The confirmation screen is shown in Figure 7. To start the installation, click **Yes**.

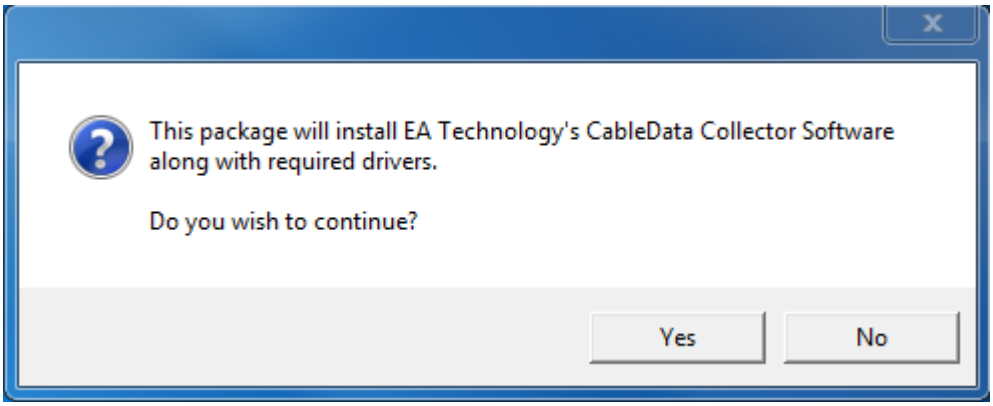

Figure 7 - Installer Confirmation

The CableData Collector Setup Wizard runs, and has several installation steps. As part of the installation process, a Virtual COM Port driver is installed. This is necessary to communicate with the CableData Collector.

During the installation, a preparation window will appear first as shown in Figure 8.

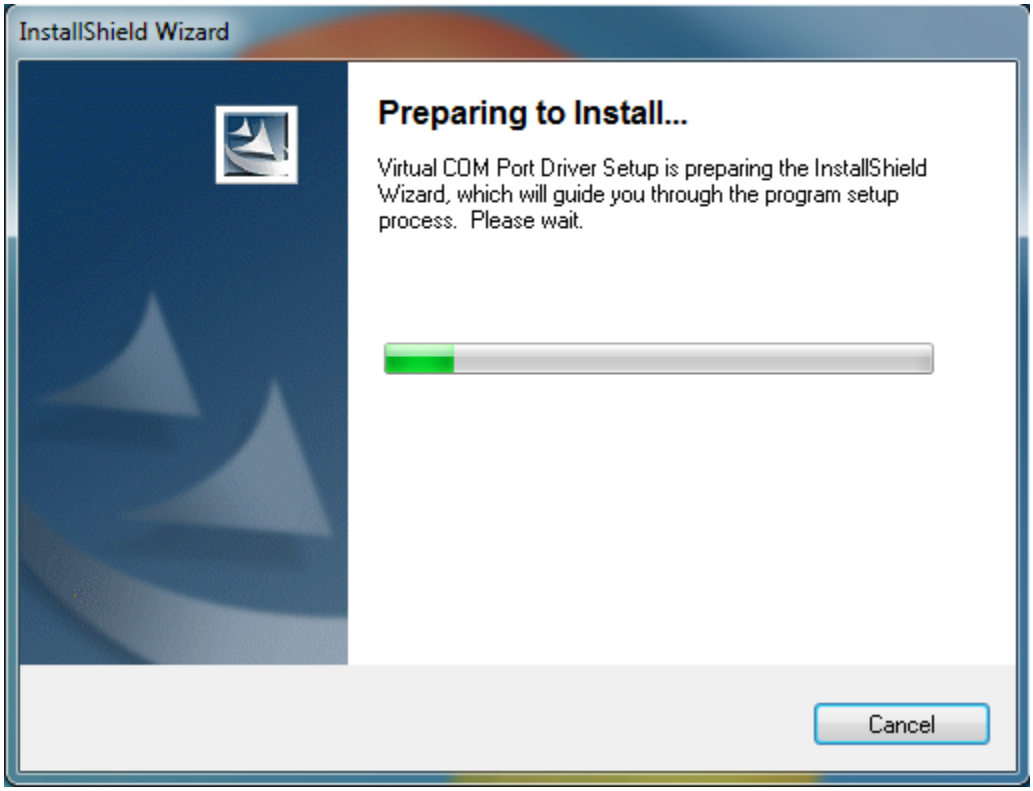

Figure 8 - Virtual COM Port Driver Installation Preparation

Once the preparation is completed, the installer will wait to start as shown in Figure 9. To start the driver install, click **Next**.

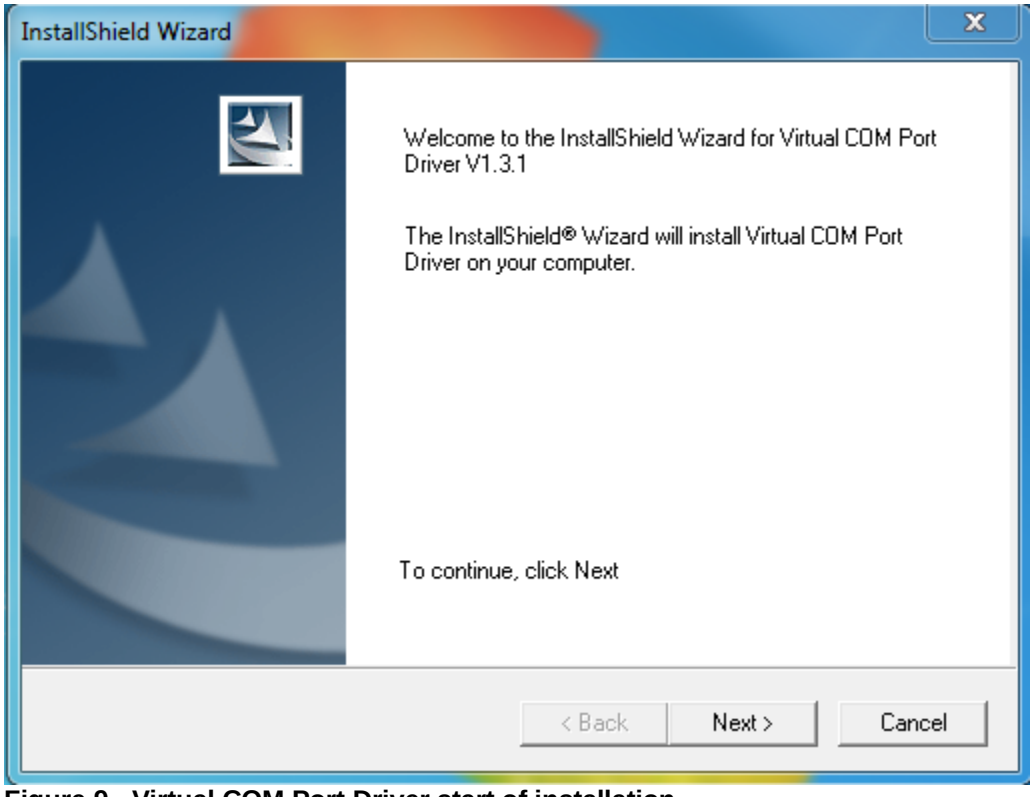

Figure 9 - Virtual COM Port Driver start of installation

This installer will copy across the required files, shown in Figure 10.

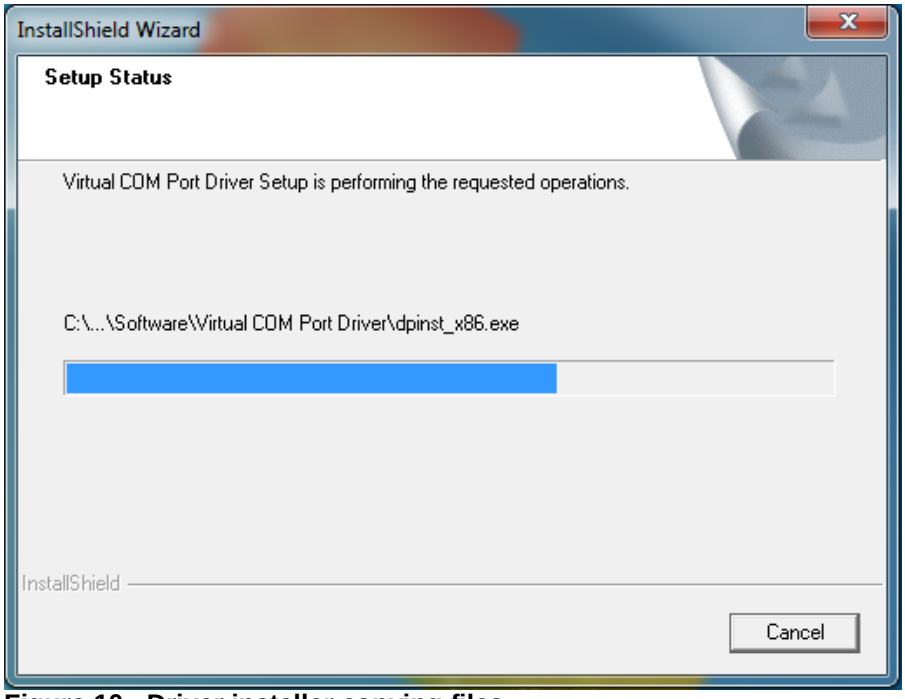

Figure 10 - Driver installer copying files

Once the required files have been copied across, the Windows Device Driver Installation Wizard will run, shown in Figure 11. To install the driver click **Next**.

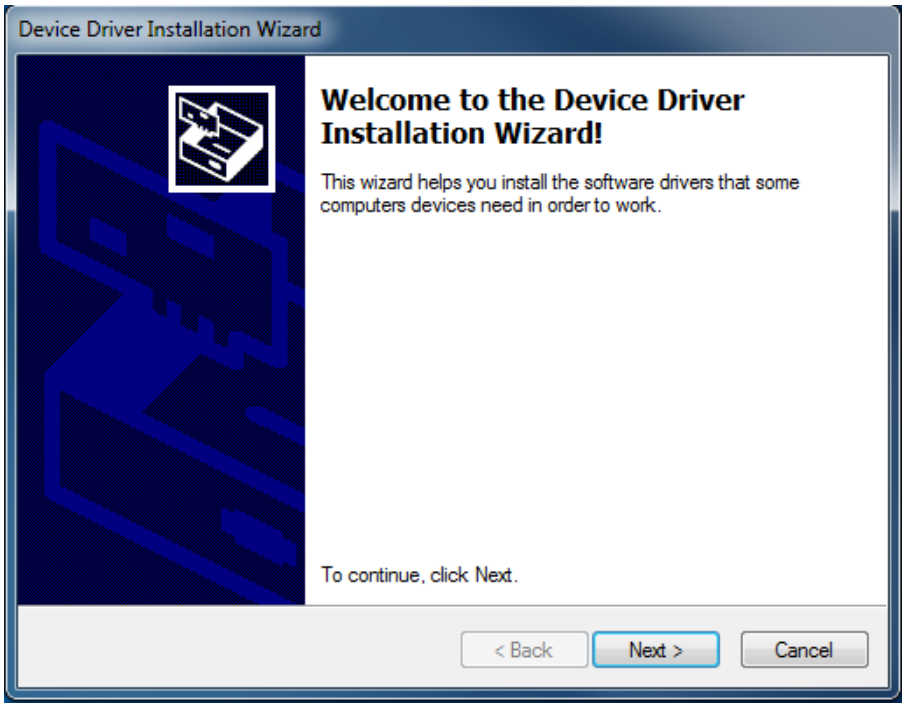

Figure 11 - Windows device driver installation wizard

Windows will now install the driver, and once completed will show a confirmation screen. Once completed, click the **Finish** button to close the Device Driver Installation Wizard and proceeded to the next stage, as shown in Figure 12.

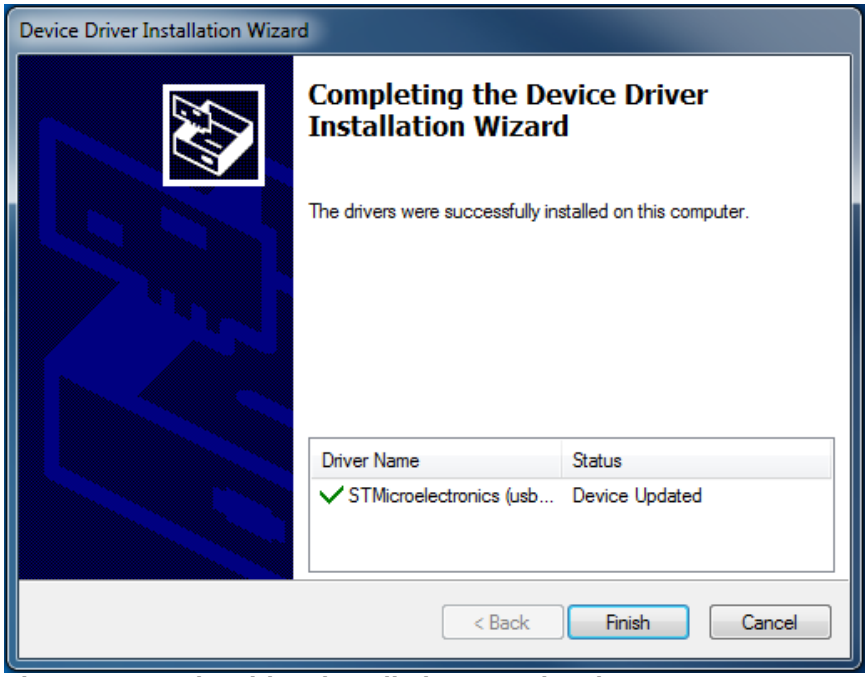

Figure 12 - Device driver installation completed

The next set up screen, shown in Figure 13, installs the CableData Collector Software. Click **Next** in the bottom right hand corner.

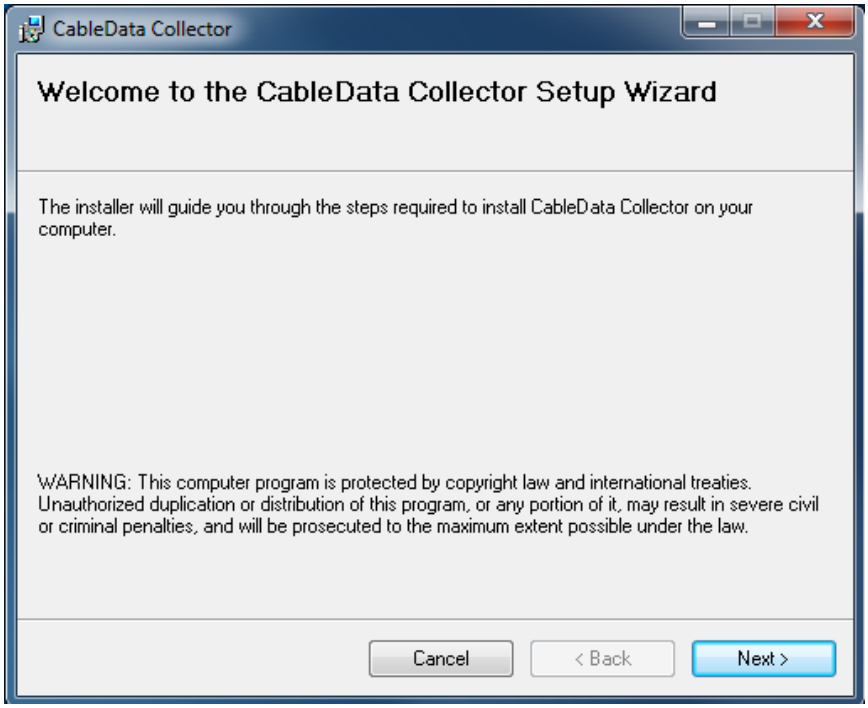

Figure 13 - CableData Collector Setup Wizard

On the next screen, the license agreement shown in Figure 14 is displayed. Please read this. If you do not agree to the license agreement, installation of the Desktop collector software is not possible. If you agree, click the **I Agree** button, and then click **Next**.

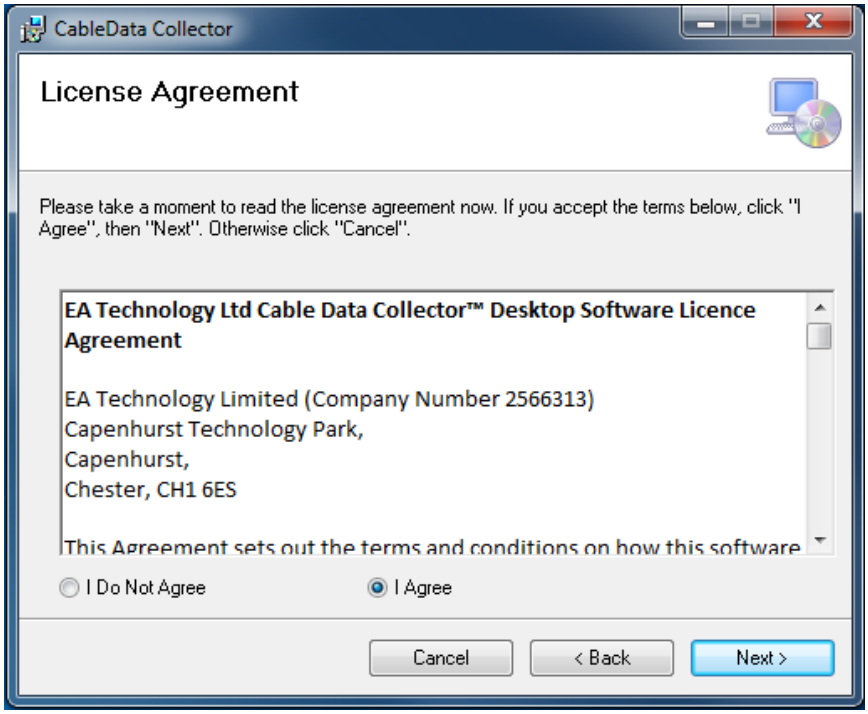

Figure 14 - License Agreement

The next screen, shown in Figure 15 allows you to select the installation folder. It is recommended that this be left as the default. You can select whether the software is installed for all users, or just the current logged in user.

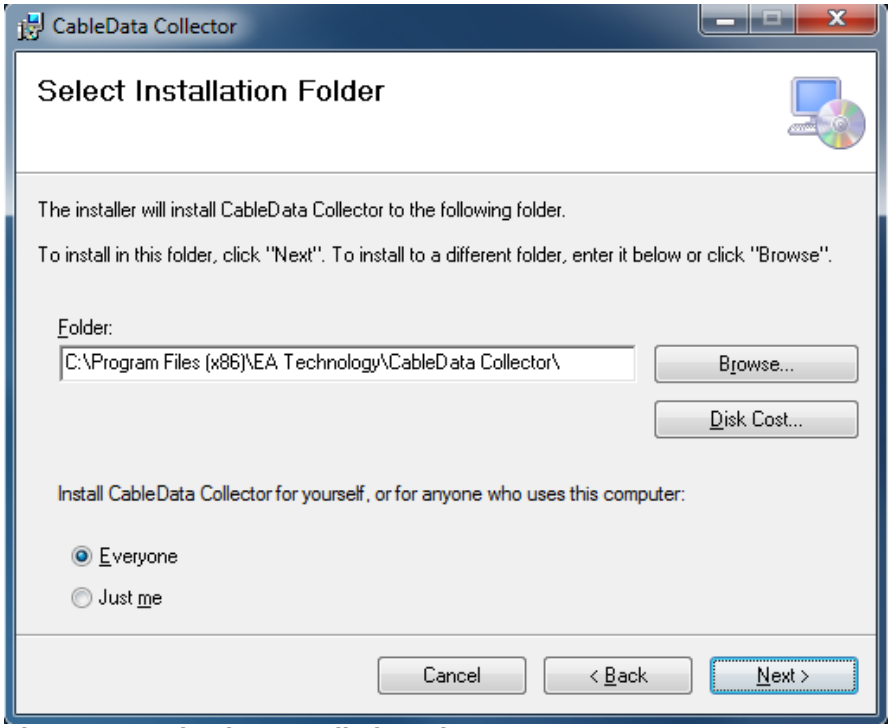

Figure 15 - Selecting Installation Directory

After clicking **Next**, the installation process will begin. A progress bar will keep you updated with the installation progress, shown in Figure 16.

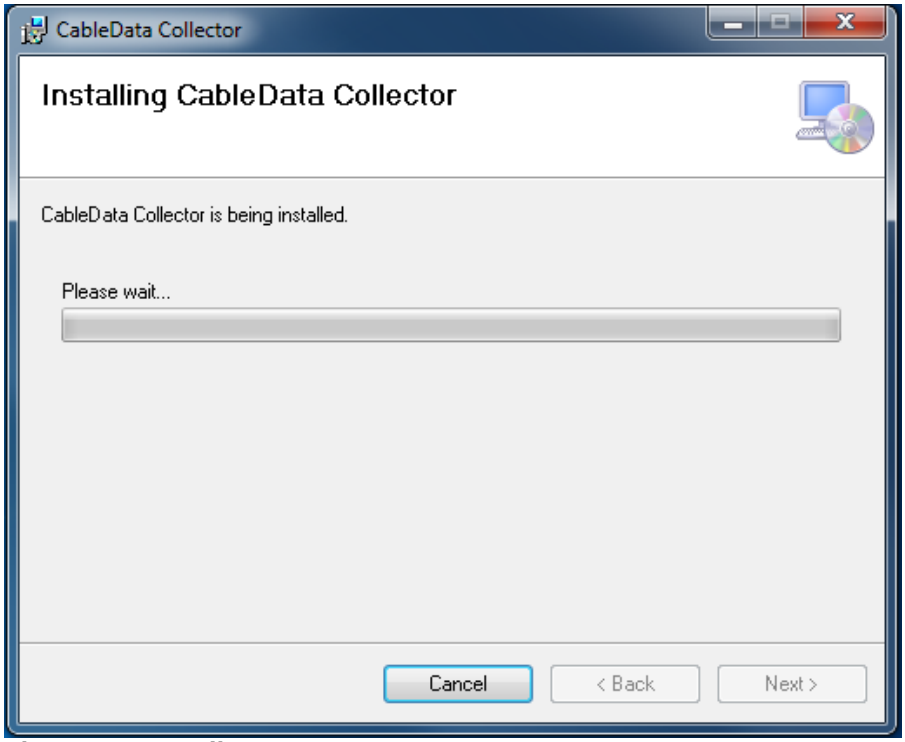

Figure 16 - Installer Progress

Once installation is completed, the screen shown in Figure 17 will be visible. Click **Close** to finish the installation process.

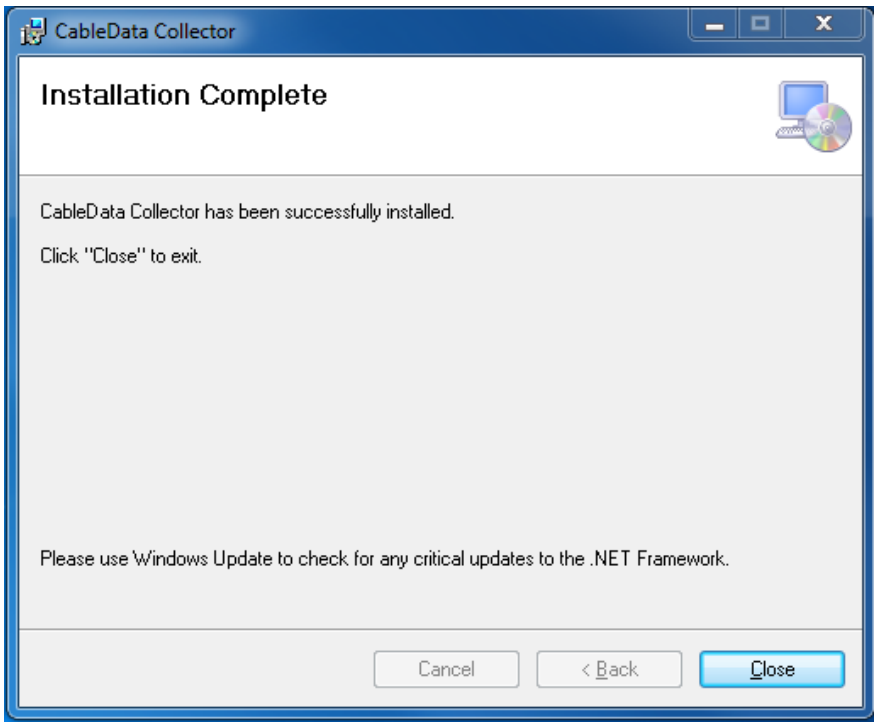

Figure 17 - CableData Collector Wizard Completion Screen

10.2 Connecting the CableData Collector

Before the application can be run for the first time, it is important to make sure that the correct drivers are installed. To do this, connect the CableData Collector unit to the laptop by the USB cable.

The device will automatically power on once connected. If a CableData Collector has not been connected before, Windows should take a few moments whilst it installs the driver for the unit. Windows will notify you when the driver is successfully installed.

Once the driver has been installed, the software can be started. For Windows XP, this will be located in **Start > Programs > EA Technology > CableDataCollector**

For Windows Vista and 7, this will be located in
Start > All Programs > EA Technology > CableDataCollector

10.3 First Run

The first time the software runs, a configuration settings screen is displayed. A populated setup screen is shown in Figure 18.

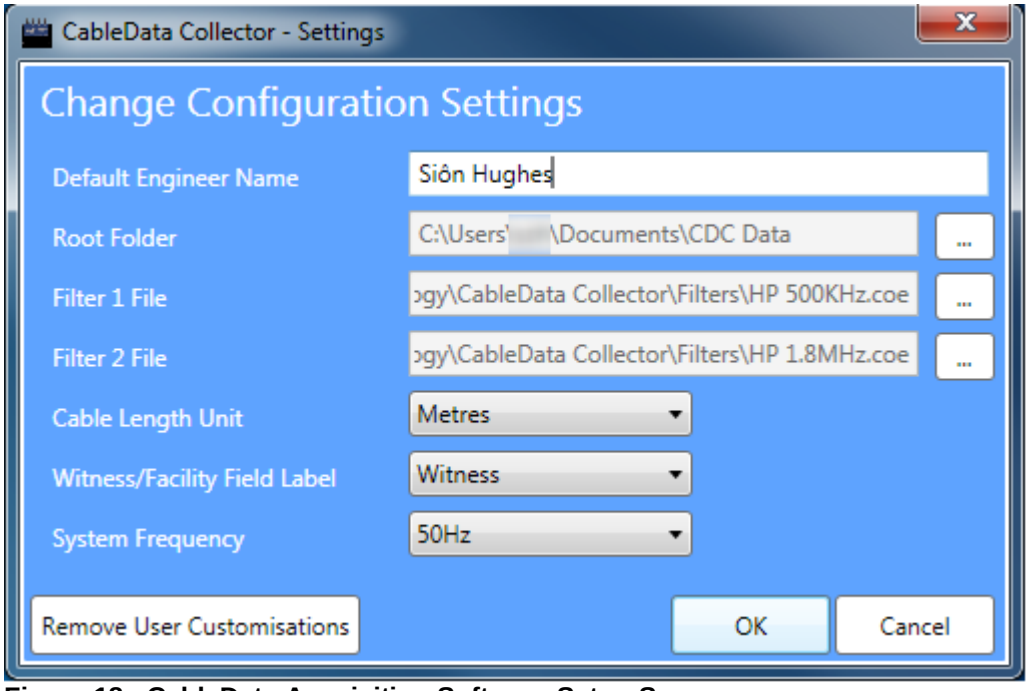

Figure 18 - CableData Acquisition Software Setup Screen

The **Default Engineer Name** is the name that will automatically populate the **Engineer Name** field on the main screen. This can be changed during testing if the operator changes. The **Root Folder** is the folder in which the collected data files will be saved to. For this installation, the folder has been set to **C:\Users\szh\Documents\CDC Data**

Note: When setting a root folder it is recommended to choose, a folder in the **My Documents** folder in Windows for the logged on user, as attempting to set the root folder in another directory, such as the root of C Drive may cause problems due to restricted permissions, dependant on the settings of the computer.

There are two filter files; **Filter 1** and **Filter 2**. These are copied across automatically during the installation. These generally should not need to be changed. In the event that they do need changing, this can be done by first copying the COE files to the local hard drive. Then click the **"…"** button for Filter 1, and navigate to where you have copied the file. Select the file, and then repeat this process for the second COE file for Filter 2. The button is highlighted in Figure 19.

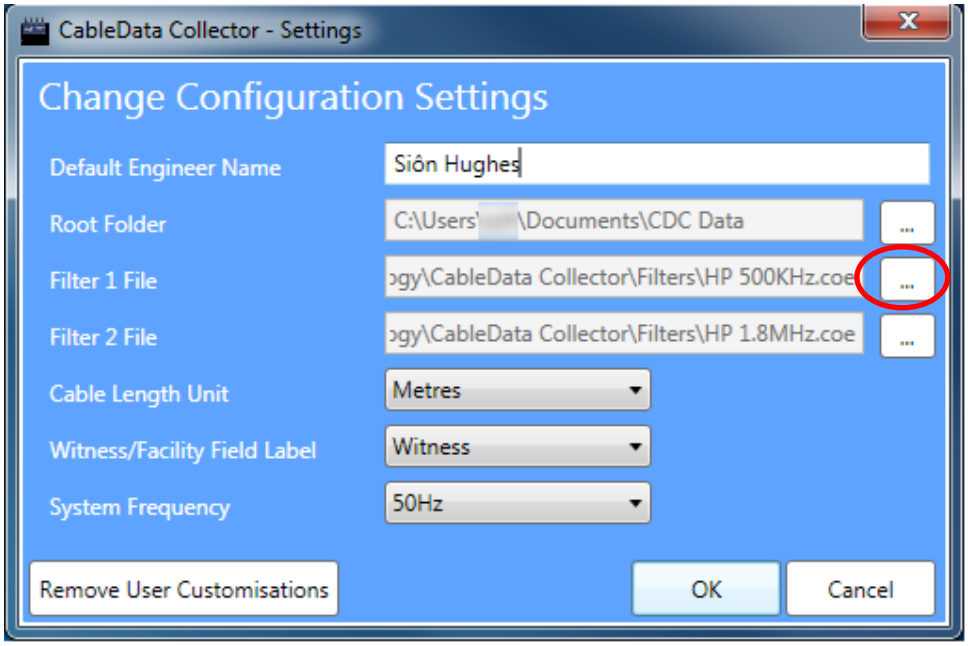

Figure 19 - Setting Filter 1 File

The default filters generally **should not** need to be changed unless advised by EA Technology. The default filters are as follows:
Filter 1: **HP 500kHz**
Filter 2: **HP 1.8MHz**

If updating the selected filters, they should always be set so that the more restrictive filter is set to Filter 2. For the supplied filters, the High Pass 500kHz filter will block frequencies from DC up to 500kHz. The High Pass 1.8MHz will block frequencies from DC up to 1.8MHz. As the High Pass 500kHz filter will let through a wider range of frequencies, this should be set to Filter 1, with the High Pass 1.8MHz set to Filter 2.

The **Cable Length Unit** has two options that can be selected from the drop down list, these are **Metres** and **Feet**. Select the unit that you wish to use for entering cable lengths.

The **Witness/Facility Field Label** is for a field on the main screen. This can be set to **Witness** if there will be a witness observing work, then the witness's name can be entered. It can be set to **Facility Name** in the event that it is desired to record the facility name separately.

System Frequency is the operating frequency of the cable that is being measured. This should be either **50Hz** or **60Hz**. This value is used by the CableData Collector to detect the correct phase reference. Set the correct frequency for your location in this list.

If you wish to change any of these settings at a later date, this window can be brought up again by clicking **Settings** from the main screen.

When all of the settings have been entered, click the **OK** button to save the settings and close the window. The main interface will now be loaded.

If the **Cancel** button is clicked instead, the prompt shown in Figure 20 will appear. Clicking **Yes** will close the settings screen and all changes will be lost. Clicking **No** will return you to the settings screen where it is possible to click **OK** to save the changes.

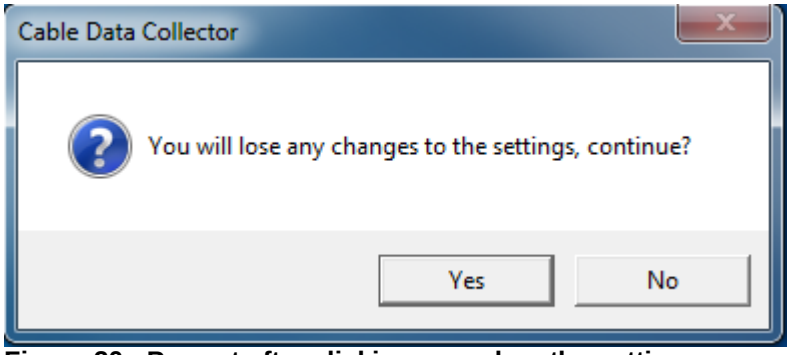

Figure 20 - Prompt after clicking cancel on the settings screen without saving any changes

10.4 Operating the Software

First, connect the CableData Collector and power on the device. To run the software the shortcut will be located in **Start > Programs > EA Technology > CableData Collector**

10.4.1 Software Initialisation

When the main interface is run, the software will start by attempting to find the attached CableData Collector device. During this process, the window shown in Figure 21 will be present. The window will close once the instrument has been found.

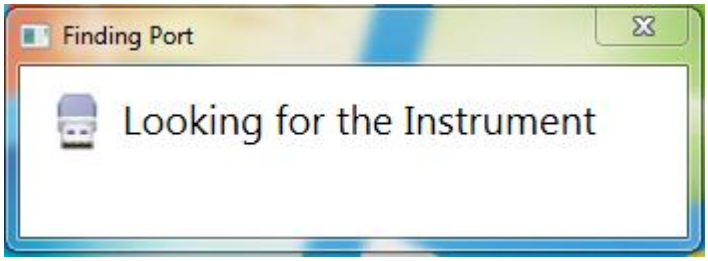

Figure 21 - Searching for instrument at software start-up

This should take no more than 5 seconds. If there is a problem detecting the instrument, a warning message will appear as shown in Figure 22. This error should only occur if the unit is not connected correctly. In such case, please check that the USB cable is securely connected, and click **Yes**. On some laptops, not all of the USB ports will function correctly, so it is advisable to attempt connecting the CableData Collector to a different USB port if this error occurs. If the error message persists and the cable and laptop have been ruled out as the source of the problem, then please contact EA Technology for further assistance. **The CableData Collector must not be connected through a USB hub as this may cause intermittent errors during data capture.**

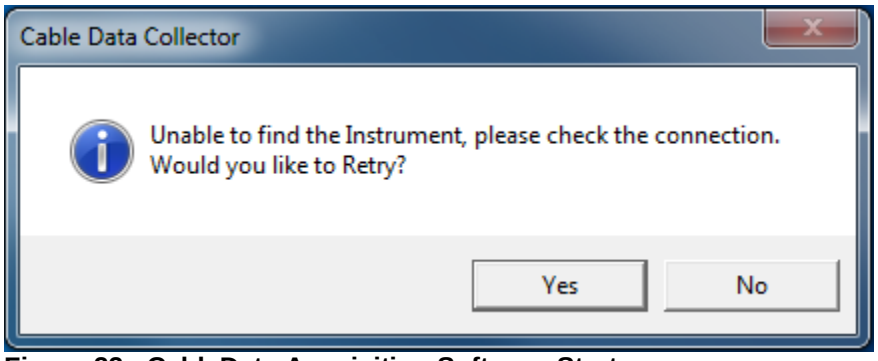

Figure 22 - CableData Acquisition Software Start-up

If during the loading procedures, it has not been possible to read the asset data, the warning shown in Figure 23 will be displayed. If this warning is displayed, first try unplugging the unit and closing the software. Then re-connect the unit and start the software again. If the warning message persists, please contact product support.

It is still possible to capture data without the asset data, however this is not advised as the results of the analysis may have reduced accuracy.

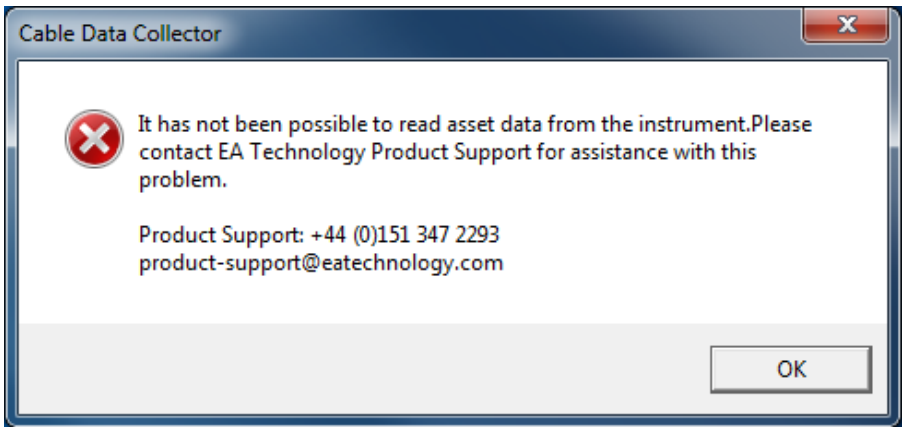

Figure 23 - Error whilst reading asset data

10.4.2 Main Screen

Providing the software has initialised correctly and found the connected CableData Collector, the main screen will now be shown which is the screen used to perform surveys. The screen is shown below in Figure 24.

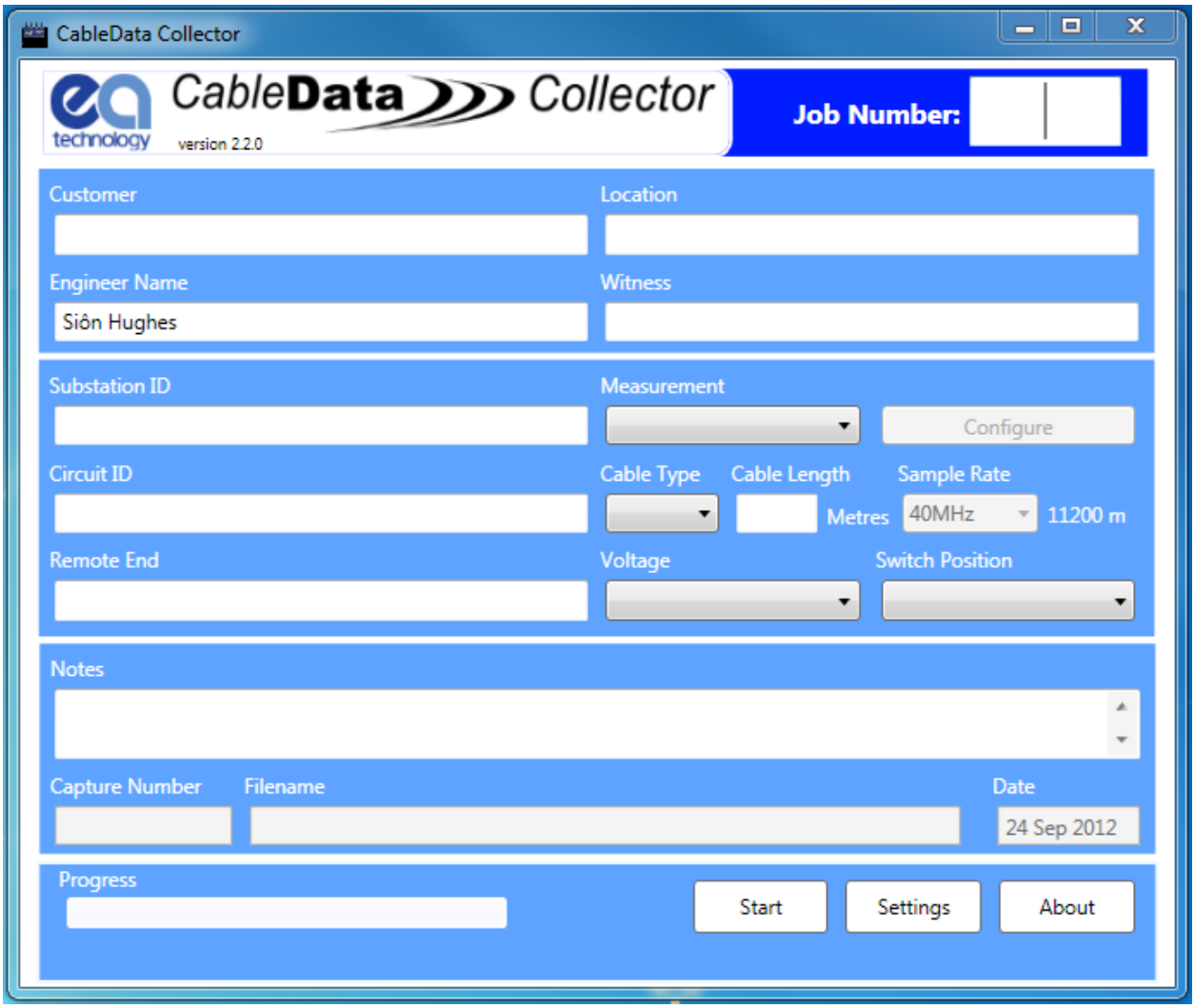

Figure 24 - CableData Acquisition Software Main Screen

10.4.3 Data Entry

Some of the input fields are required and must be completed before data collection can begin. The required fields are as follows:

- **Job Number**
- **Customer**
- **Location**
- **Engineer Name**
- **Substation ID**
- **Circuit ID**
- **Cable Type**
- **Voltage**
- **Switch Position**
- **Phase**

Attempting to start recording data without completing the required fields will give a prompt as shown in Figure 25.

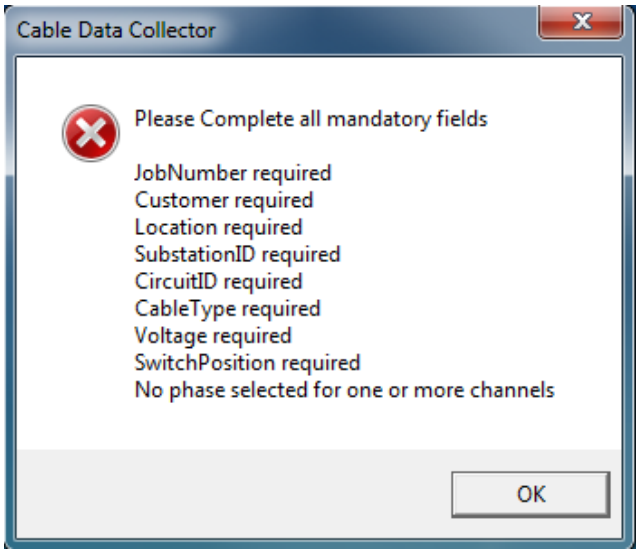

Figure 25 - Error message when starting a capture with incomplete information

Required fields that are incomplete when attempting to start a capture will be highlighted in red. An example of this is shown below Figure 26.

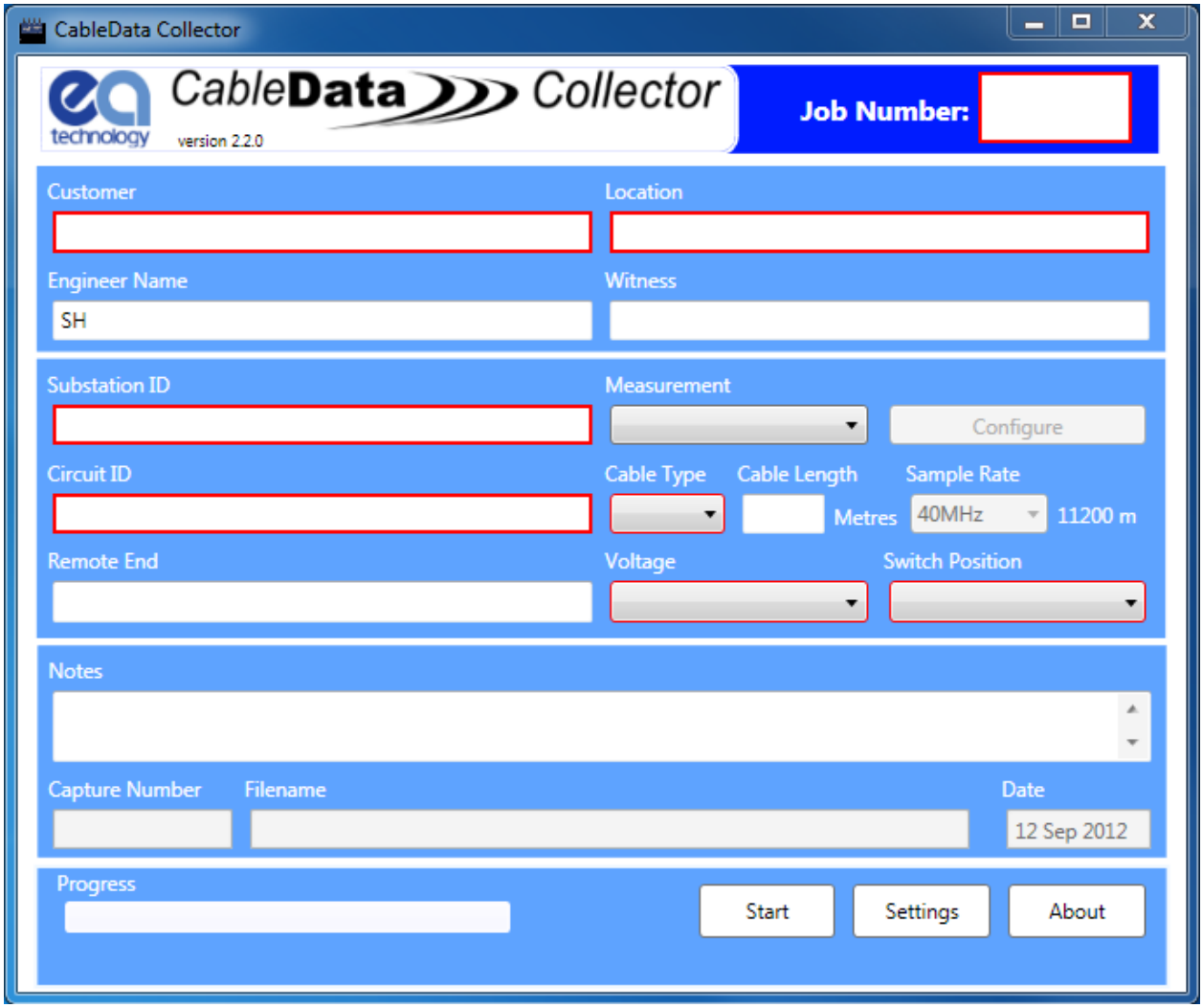

Figure 26 - CableData Acquisition Software with incomplete data

The first set of fields are free text, and can have any values entered. These are **Job Number**, **Customer**, **Location**, **Engineer Name** and **Facility Name**.

The second set of fields relate to the circuit that is currently under test. **Substation ID** and **Circuit ID** are free text and must be populated.

10.4.4 Phase Information

Under the **Measurement** title, there is a drop down list, which allows you to select the measurement type. This can be **Single Phase**, **Three Phase** or **Belted Cable** (also known as three core cable with one accessible earth). The **Single Phase** option should be selected when each phase is tested separately. For single phase measurements, only channel 1 is used. **Three Phase** should be selected when all three channels are used simultaneously with separate RFCTs. **Belted Cable** should be selected when the earth conductor surrounds all three cores and it is not possible to attach an RFCT to a separate earth conductor for each core. The drop down list is shown in Figure 27.

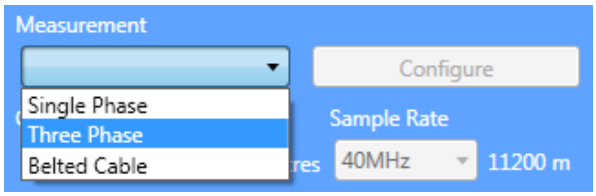

Figure 27 - Measurement selection

For **Belted Cable**, no phase information is required and so the configure window is not needed as the phase setting is locked to belted. For **Single Phase** and **Three Phase**, once the option for the measurement type has been selected, the **Configure** button to the right must be clicked to set the phase for the measurement.

For single-phase configuration, first, select the phase naming convention from the drop down list as shown in Figure 28.

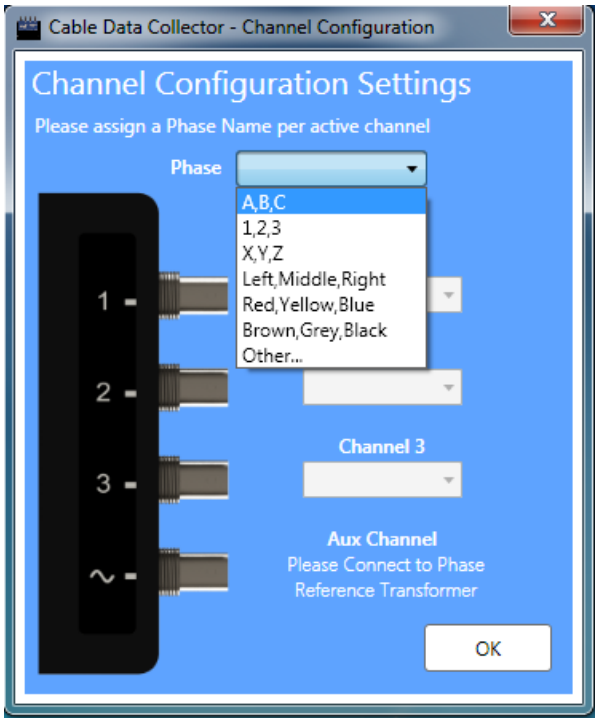

Figure 28 - Selecting phase naming convention

This will then populate the drop down list under **Channel 1**, with the selected options. From this drop down list, then select the appropriate option for the phase being tested and click **OK**, as shown in Figure 29.

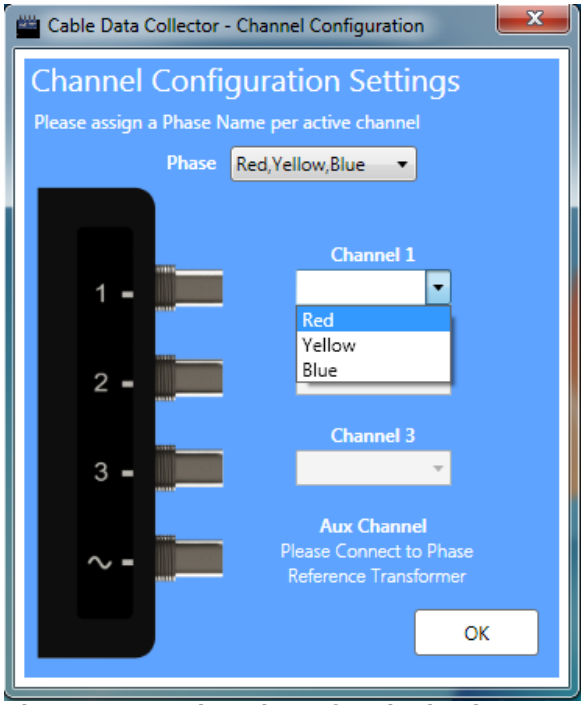

Figure 29 - Setting phase for single phase measurement

For a three phase measurement, the phase naming convention must be set in the same way. All three drop down lists for the channels will now be activated, and each drop down list must have an option selected. The drop down list for channel 3 is shown in Figure 30.

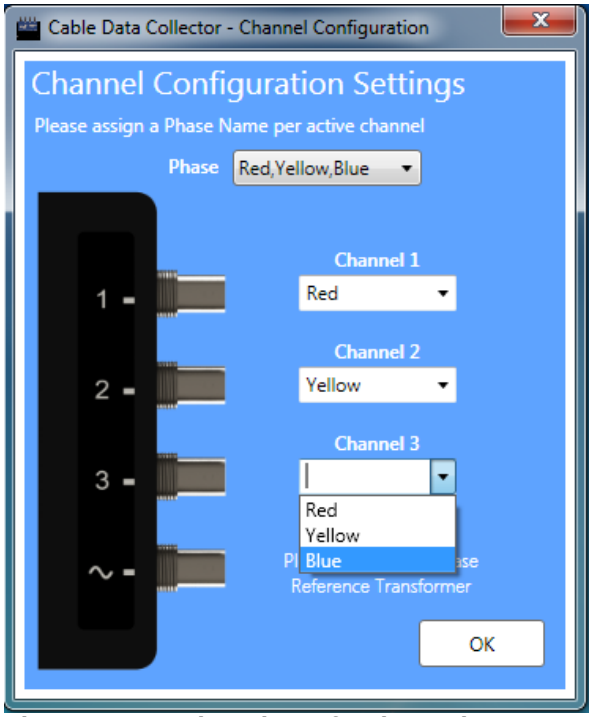

Figure 30 - Setting phase for three phase measurement

Once the phase for each channel has been set, click **OK**. Figure 31 shows the channel phase data entered correctly. It is not possible to select the same phase label for multiple channels.

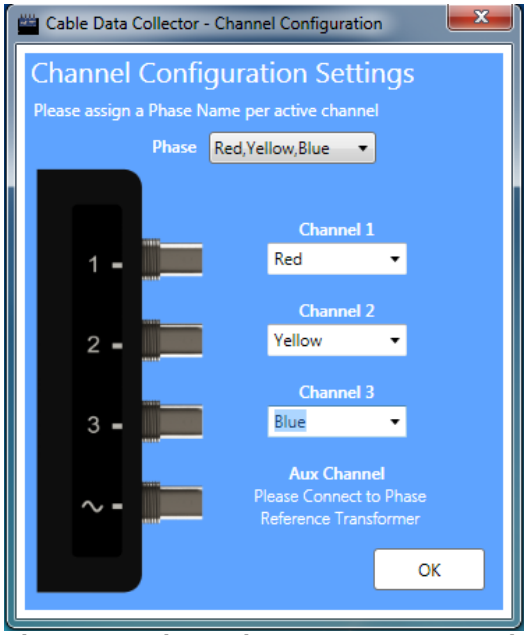

Figure 31 - Three phase measurement phase data entered

10.4.5 Cable Type

The **Cable Type** must now be set. There is a drop down list for this field. There are several of the most common cable types listed by default. Figure 32 shows the drop down list with the default options.

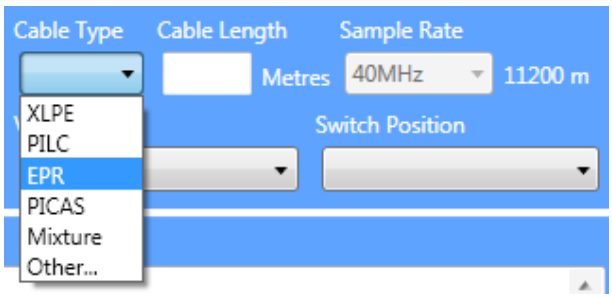

Figure 32 - Selecting cable type

If the cable under test does not have a type listed in the available options, then a new option can be added. To do this, select the **Other…** option. A window will open with a field to enter the new Cable Type. Only the first 7 to 8 characters will be visible in the **Cable Type** drop down list. The window is shown in Figure 33. Enter the Cable Type, and click **Add**. This will add the newly entered cable type to the list of available options, and will save it so that it can be selected again in the future.

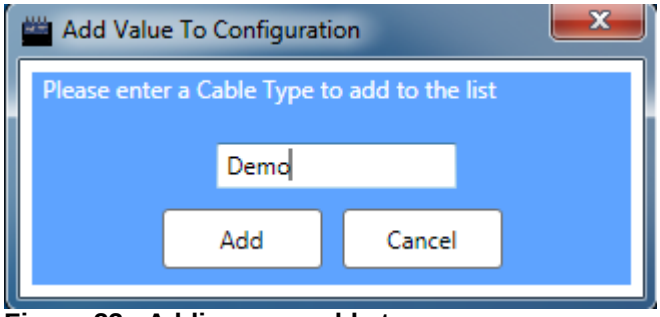

Figure 33 - Adding new cable type

The newly entered option will be automatically selected for the data capture and will available for selection in any future assessments, as shown in Figure 34.

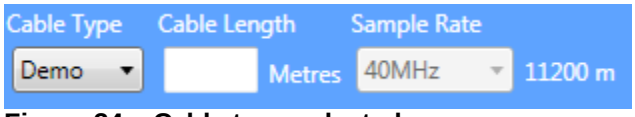

Figure 34 – Cable type selected

For cables where there is a join part way down the cable, **Mixture** must be selected, and a comment must be added in the **Notes** field. If data capture is attempted with the Mixture Cable Type selected, and no text in the **Notes** field, the error message in Figure 35 will be displayed.

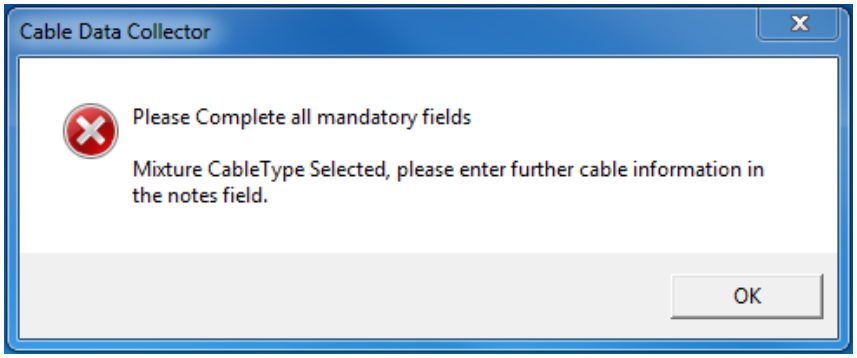

Figure 35 - Error when selecting mixture for cable type without entering any notes

10.4.6 Cable Length

The next field is for **Cable Length**. The units for this were set during the first run of the software. The **Cable Length** field is not required, however if cable mapping is performed then an accurate cable length is of great help.

Figure 36 shows the cable length and sample rate fields. When the cable length is blank, it is not possible to alter the sample rate, and the sample rate will always be set to 40MHz.

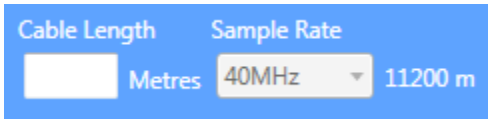

Figure 36 - Cable length and sample rate fields

The software attempts to select the best **Sample Rate** for the entered cable length. The sample rate is the sampling interval used to capture the measured waveform. A higher

sampling rate provides a better resolution of the waveform being captured; however, this limits the maximum length of the cable that can be tested.

A lower sampling rate allows longer cables to be tested; however, the high frequency resolution will be reduced. If the cable length is an estimate, and the length is thought to be near to a length limit for the sampling rate, it is recommended to choose a slower sampling rate to ensure that mapping is possible.

The theoretical maximum cable lengths for each sample rate are shown in Table 1.

Sample Rate	Maximum Cable Length (m)	Maximum Cable Length (Feet)
160MHz	2,800	9,186
80MHz	5,600	18,372
40MHz	11,200	36,745

Table 1 – Theoretical Maximum cable lengths for each sample rate

Caution: If the cable being tested is longer than allowed by the selected sampling rate, then cable mapping will not be possible from the data set. The maximum cable length is 11,200m. If this is exceeded then the warning message shown in Figure 37 will be displayed.

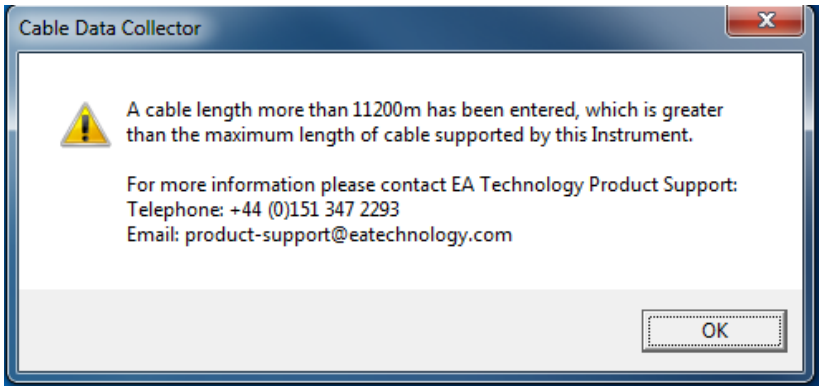

Figure 37 - Warning when entering a cable length of over 11,200m

10.4.7 Voltage

The next field, visible in Figure 38, is the **Voltage** of the cable under test. Several common voltages for the UK distribution network are available by default.

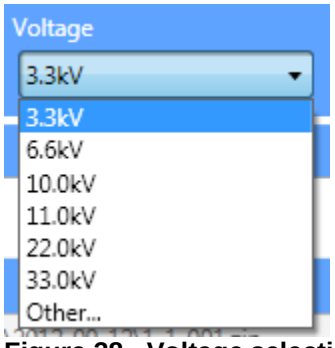

Figure 38 - Voltage selection

If the cable under test operates at an unlisted voltage, it is possible to add further options. To do this, select the **Other…** option at the bottom of the list. The window, shown in Figure 39 will then be displayed, which will allow you to enter a new voltage. Only the numeric value of the voltage needs adding, as the software automatically adds the unit.

Figure 39 shows an example of a correctly entered voltage option. With the new value entered, click **Add**.

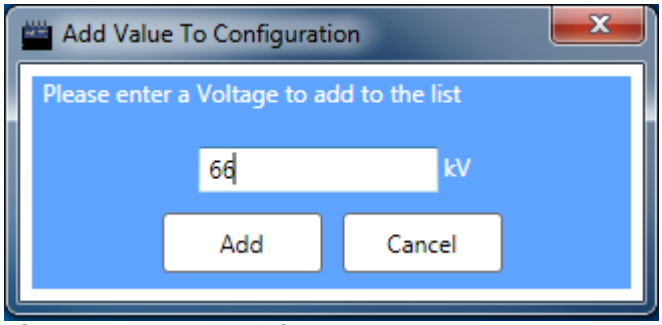

Figure 39 - Correct voltage entry

10.4.8 Switch Position

The **Switch Position** option is to enter the status of any switch that may be present on the cable at the point of measurement. If there is no switch present, then **Absent** should be selected. The **Open** option would be for cases when the switch is open, and the cable is energised but with no load. The **Closed** option is for when the switch is closed and the cable is energised and carrying a load. It is only possible to perform testing on energised cables. The options are shown in Figure 41Figure 40.

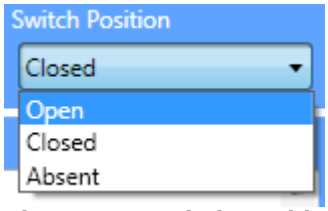

Figure 40 - Switch position selection

10.4.9 Commencing Data Capture

With all of the required fields filled in, it is now possible to start the data capture. Press the start button shown in Figure 41 to start the capture process. Once data capture is started, all of the data entry fields will be locked and it will not be possible to modify any of the fields until the capture is complete.

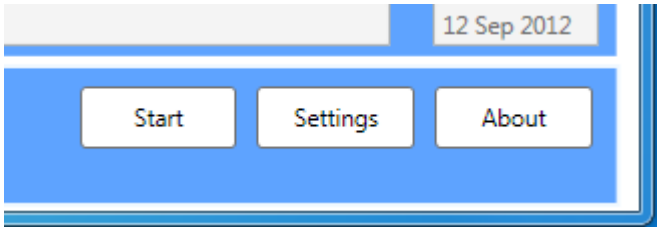

Figure 41 - Start button

10.4.10 Aborting Data Capture

If the data capture process is taking a very long time, or needs to be halted for any other reason it is possible to cancel the data capture at any time. Some stages of the data capture may be skipped to allow progression to later stages of the capture progress.

It is recommended that if, after 5 minutes on a waveform capture stage, the bar is not showing any signs of moving then the data capture should be skipped to the next stage

using the **Skip** button. The **Skip** button will only be active during waveform capture, as raw data capture cannot be skipped.

During the data capture, the **Settings** button on the main screen will change to the **Cancel** button and at some stages; the **Skip** button will become active.

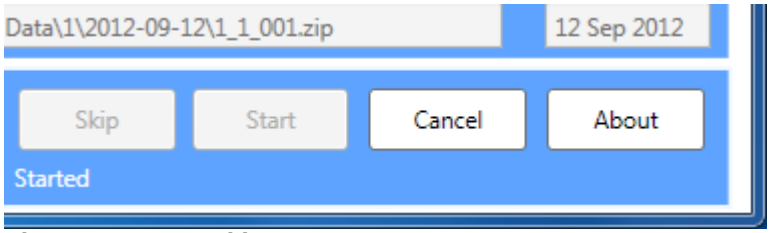

Figure 42 - Cancel button

Clicking the cancel button will immediately cancel data collection. A message box will ask if the output should be saved. If the data capture has been halted because of very little activity on the cable, then the **Yes** button should be clicked which will save the data. If the data is not needed, then clicking the **No** button will discard the data and return to the main screen. The prompt is visible in Figure 43.

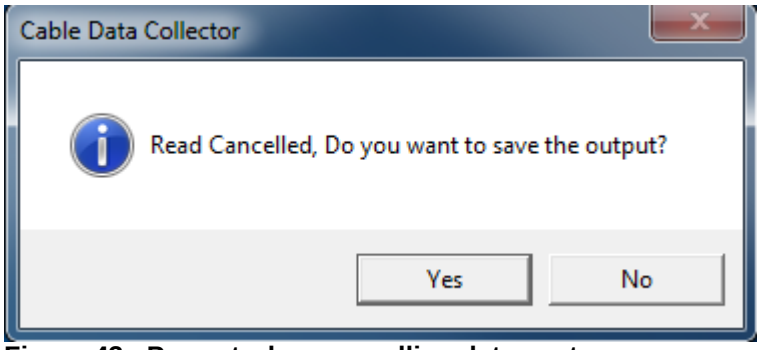

Figure 43 - Prompt when cancelling data capture

If the **Yes** button has been clicked then the data will be automatically saved into the same directory as the other captured data files, with the word **Cancelled** appended to the file name. The data file location will be displayed in a message as shown in Figure 44. To close this window, click **OK**.

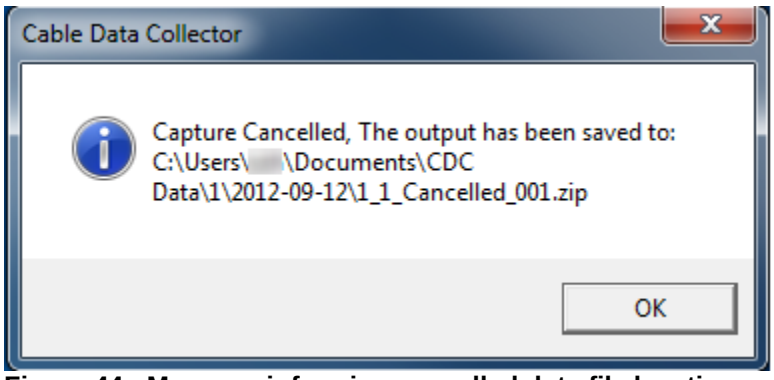

Figure 44 - Message informing cancelled data file location

10.4.11 Repeating Data Capture

If a data capture has been performed with the same settings, a warning will appear stating that the capture is the same as a previous capture. If this is correct and the same cable is being tested, then the **Yes** button should be pressed to repeat the measurement. If this is not correct then the **No** button should be clicked and the cable details updated accordingly.

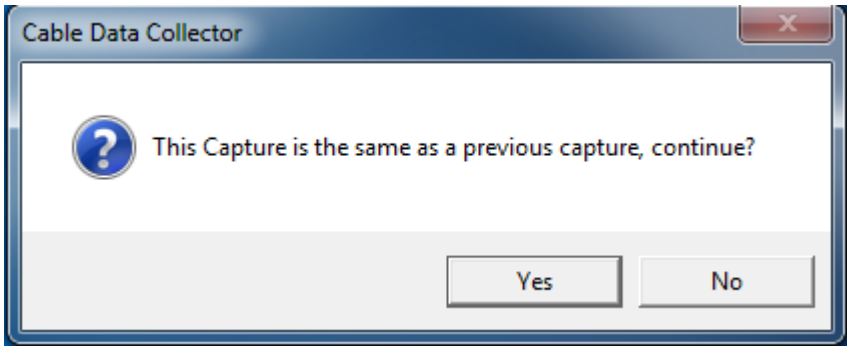

Figure 45 - Warning when repeating data capture

10.4.12 Data Capture Process

There are different sequences for single and three phase capture. The data capture process collects two types of data; Raw data and waveforms. Raw data is used to generate the phase plots. The raw data capture is a 15 second run where all of the events detected are recorded. This stage will always take 15 seconds for each filter.

Waveform data is used to map the location of the fault on the cable. During the data capture process, the data collection will switch between the two. In addition to this, the filter that is in use will also be changed to remove as much noise as possible from the collected data. The waveform capture time is dependent on the levels of partial discharge on the cable, and also depends on the level of background noise. If there is a quiet cable with very little activity and very little background noise, each waveform stage may take several minutes. For a cable with lots of partial discharge activity occurring, the waveform capture stages will be quicker.

10.4.13 Single Phase Data Capture Sequence

For a single phase data capture, only the data from channel 1 will be recorded, so the data capture will only trigger on channel 1. 100 waveforms are captured with each filter for a total of 300 waveforms.

The single-phase capture sequence is shown in Table 2.

Stage	Filter	Data Type	Trigger Channel
1	Unfiltered	Raw	1
2	Unfiltered	Waveforms	1
3	Filter 1	Raw	1
4	Filter 1	Waveforms	1
5	Filter 2	Raw	1
6	Filter 2	Waveforms	1

Table 2 - Single-phase capture sequence

10.4.14 Three Phase Data Capture Sequence

For the three-phase data capture, events for all phases will be captured, and then for each filter a waveform capture will be done triggering from each of the channels. This is shown in Table 3.

Sets of 100 waveforms are captured with each filter, for each trigger channel. As the unit is in three-phase mode, each set of waveforms will contain a waveform from each channel. This gives a total of 2,700 waveforms or 900 waveforms per channel.

As there are more data capture stages, for cables with the same levels of activity the three-phase data capture will take longer than for single-phase captures.

Stage	Filter	Data Type	Trigger Channel
1	Unfiltered	Raw	All
2	Unfiltered	Waveforms	1
3	Unfiltered	Waveforms	2
4	Unfiltered	Waveforms	3
5	Filter 1	Raw	All
6	Filter 1	Waveforms	1
7	Filter 1	Waveforms	2
8	Filter 1	Waveforms	3
9	Filter 2	Raw	All
10	Filter 2	Waveforms	1
11	Filter 2	Waveforms	2
12	Filter 2	Waveforms	3

Table 3 - Three-phase capture sequence

10.4.15 Progress Indication

When the data capture process is started, an additional progress bar will appear beneath the top visible bar. The top bar indicates the progress through the different data capture stages as shown in the previous section. The lower status bar indicates the progress though the current stage. To the right of the lower progress bar is a text field indicating the current data capture stage.

In Figure 46, the data capture process has just started and the second bar is visible.

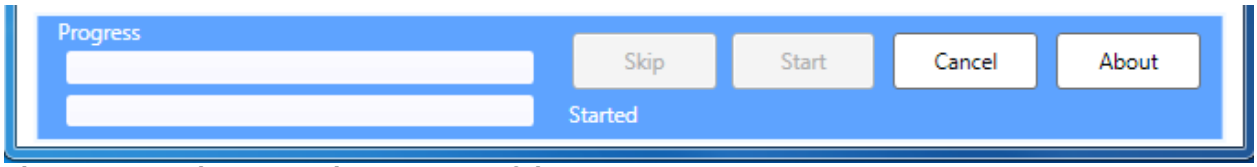

Figure 46 - Dual progress bars at start of data capture

In Figure 47, the data capture is part way through stage 1. As this is the raw data, this stage will take approximately 15 seconds.

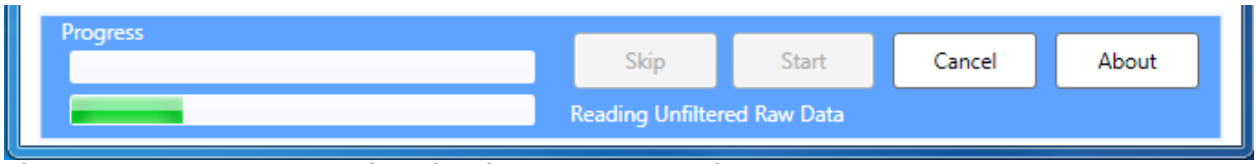

Figure 47 - Bottom progress bar showing current operation progress

Figure 48 shows the software in the unfiltered waveform capture stage. As this is a waveform stage, the length of time taken will depend on the PD activity present on the cable.

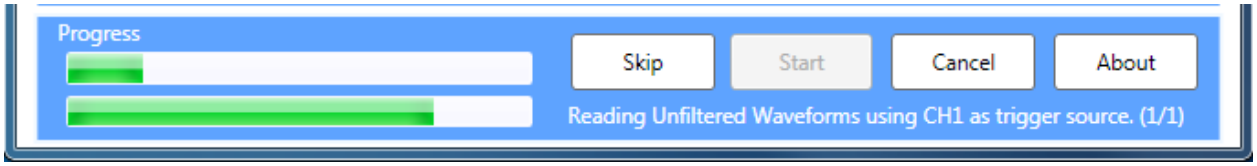

Figure 48- Top progress bar showing data capture sequence progress, bottom progress bar showing current operation progress

Once the data capture is completed, both bars should be fully green as shown in Figure 49.

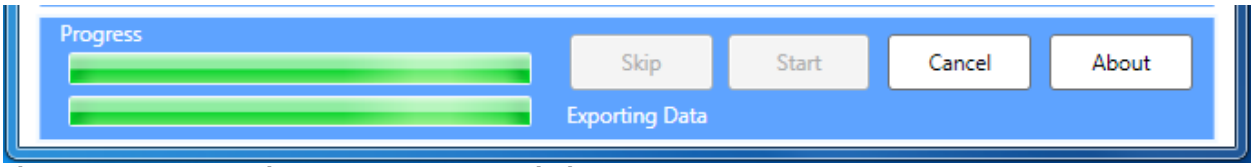

Figure 49 - Progress bars at capture completion

If data capture is cancelled part way through the data collection process, then both bars will appear full and remain green similar to when data capture complete as shown in Figure 49.

If the phase reference source is lost or interrupted during data capture, both progress bars will turn orange. This is shown below in Figure 50. This change in bar colour is latching to serve as an indication of the phase reference status over the capture in comparison to the live status indicated by the LED on the instrument.

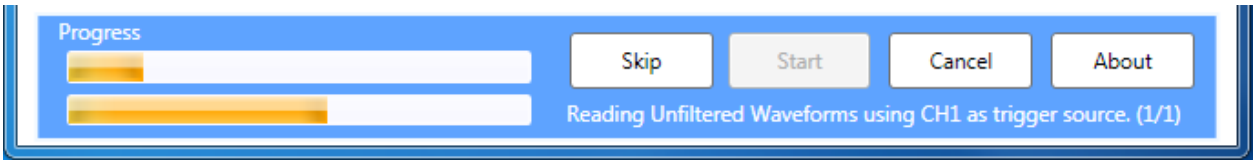

Figure 50 - Progress bar latched orange after losing phase reference source

If there is an error with the device during the data capture, then the status bar will turn red. This is shown in Figure 51. If this occurs, unplug the device and close the software. Then plug in the device and start the software again. If this occurs regularly then please contact EA Technology Product Support for further assistance.

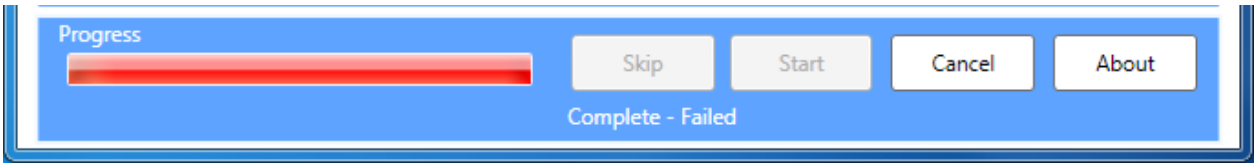

Figure 51 - Progress bar after a capture has failed

10.4.16 Invalid Phase Reference

When starting the data capture, if a phase reference is not detected, the error message shown in Figure 52 will be shown. It is not possible to capture data without a phase reference present. If this error occurs, please address the issue by using an alternative phase reference source. A phase reference is necessary for data analysis as it allows classification of events based on the phase position.

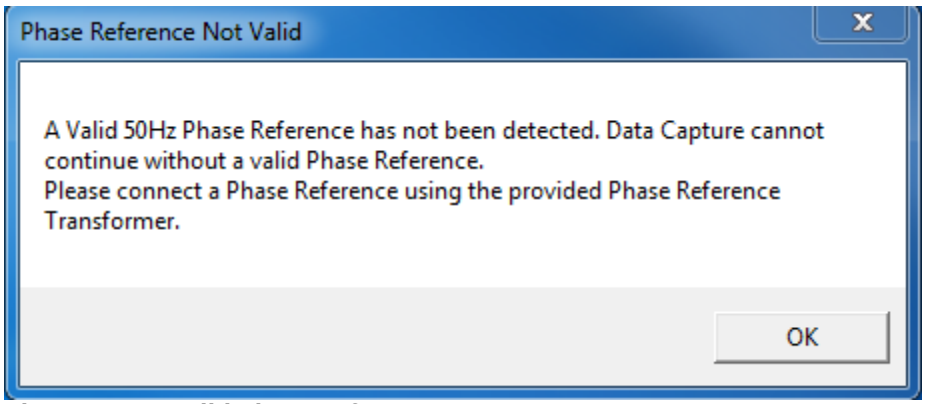

Figure 52 - Invalid phase reference message

10.4.17 Capture Reports

A capture report is a brief summary of the data captured, to allow an overview of the data capture process. The capture reports allow determining of the Data Capture Duration, Number of Events Captured, Number of Waveforms captured on each channel, and the number of phase reference errors. It also allows checking of the phase reference quality.

Figure 53 shows the capture report for a successful three-phase capture with a good phase reference. There are a large number of events, 900 waveforms per channel and 0 phase reference errors. This is what a Capture Report should ideally look like.

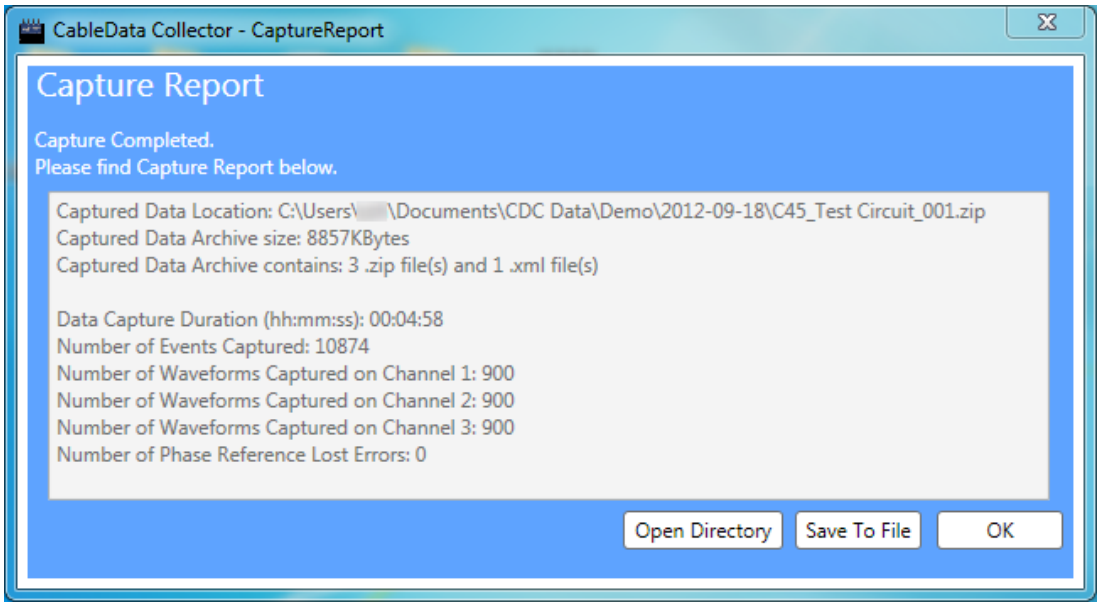

Figure 53 - Capture Report for successful three-phase capture with constant phase reference

Figure 54 shows the capture report for a successful single-phase capture with a good phase reference. Again, there are a large number of events captured, and there are 300 waveforms for channel 1, with zero phase reference errors.

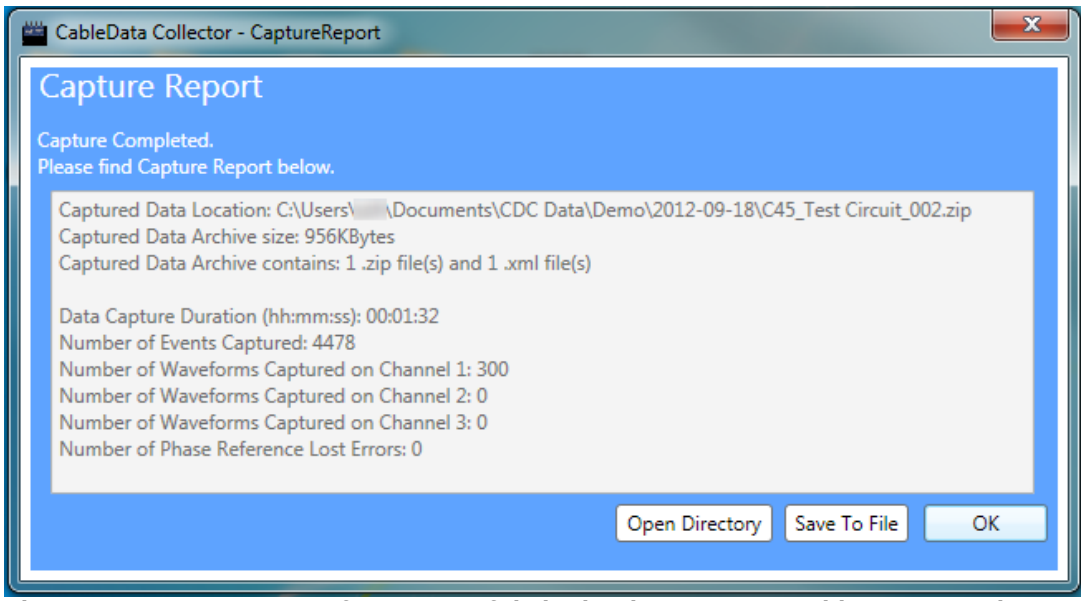

Figure 54 - Capture report for successful single-phase capture with constant phase reference

If a valid phase reference is found at the start of the data capture, but is lost part way through, then this will be shown in the Capture Report at the end of the capture. In Figure 55, the last line of the Capture Report states **Number of Phase Reference Lost Errors: 1530**. This number may vary but generally for a good phase reference should be zero. If this number is anything other than zero then the phase reference transformer should be considered as an alternative source for the phase reference.

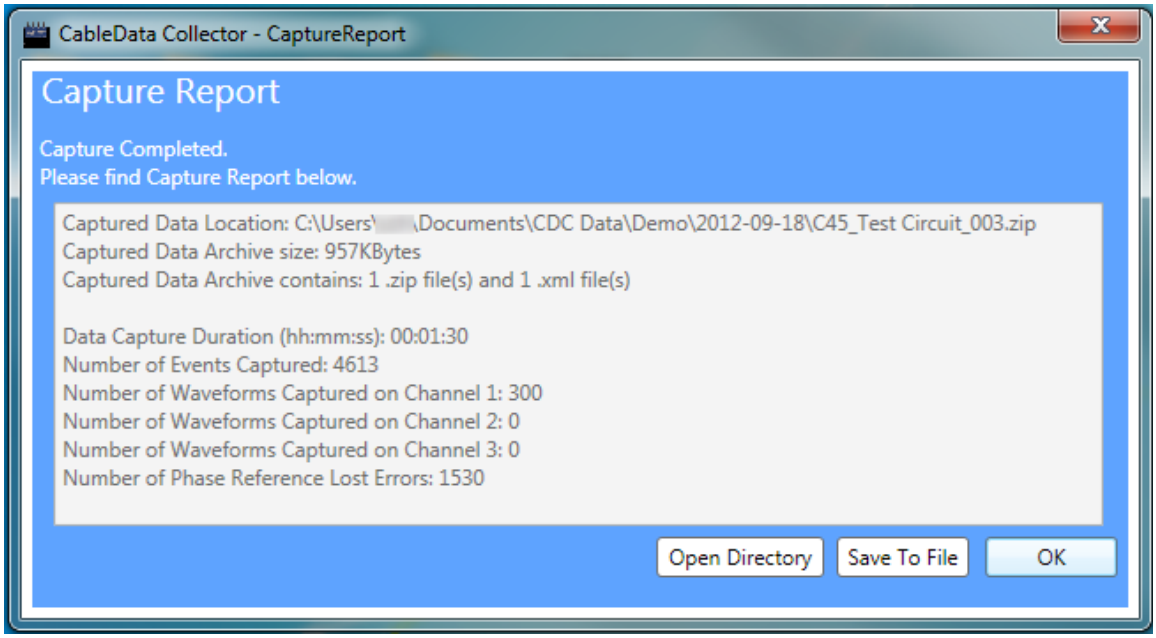

Figure 55 - Status report for data with missing phase reference

The capture reports can be saved by clicking the **Save To File** button. This will bring up the **Save As** dialogue box, which can be seen in Figure 56. The destination for the capture report to be saved to should be selected, and the **Save** button pressed to save the file.

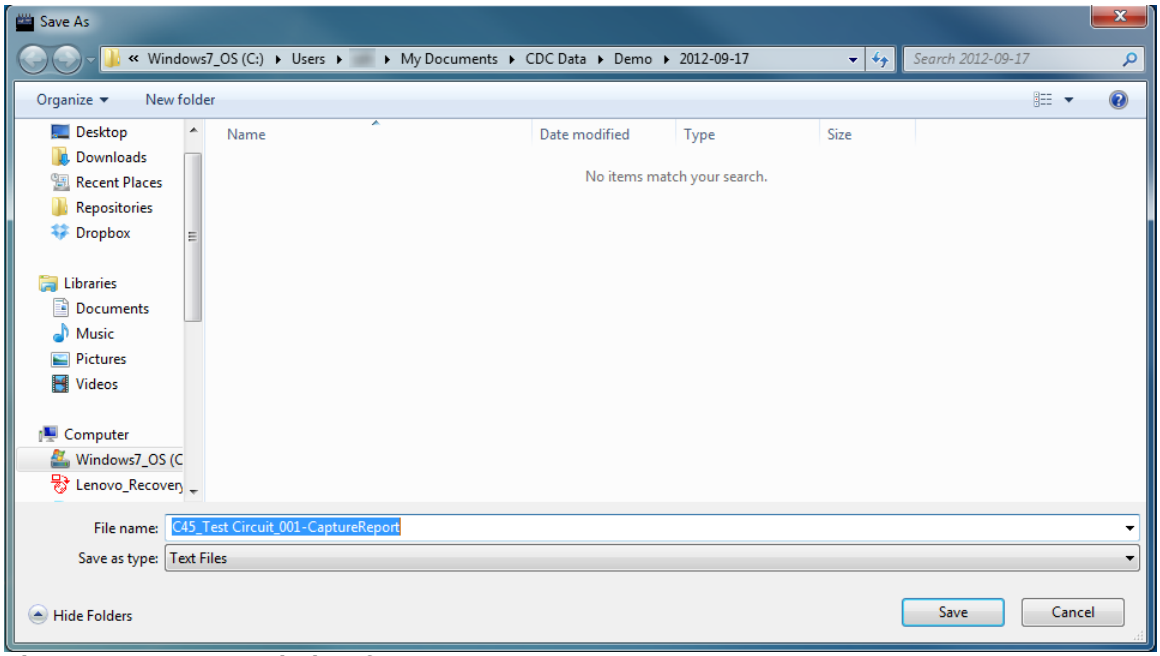

Figure 56 - Save As window for capture report

After the file has been saved, a message will be displayed to confirm the successful writing of the file, as can be seen in Figure 57.

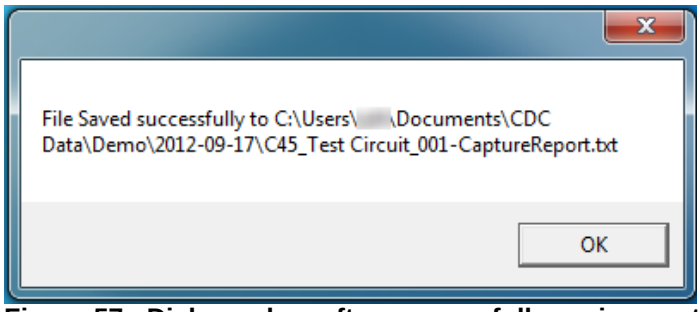

Figure 57 - Dialogue box after successfully saving capture report

10.4.18 File Output Location

The captured data files will be saved in a file with an automatically generated name. All of the data will be saved into the **Root Folder**, as set on the **Settings** window. Within this directory, a new directory will be created with the **Job Number**. In this directory, there will be a directory for each day that collection was performed. In this directory will be the individual data files. The **Substation ID** and **Circuit ID** fields are used to generate the file name for the data set. The file name also includes a run number, so if for any reason the test is to be run again, the run number will be increased and the data will be saved into a new file.

The Filename is displayed at the bottom of the window, as shown in Figure 58, and is automatically updated when any of the fields are modified.

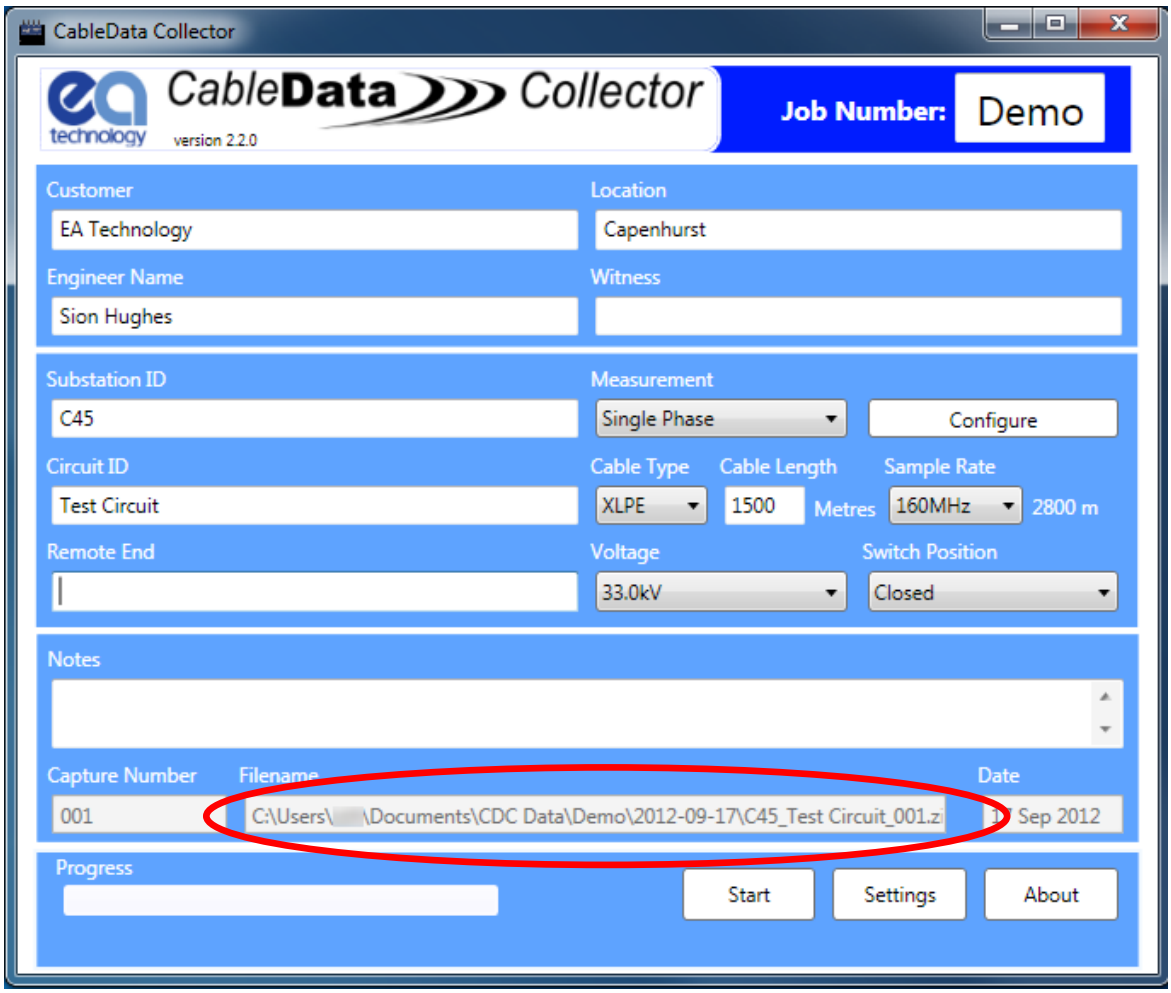

Figure 58 - Output file name

10.5 Data Analysis

Once testing is complete, collect all of the ZIP files that have been created during testing and supply these files to EA Technology for analysis. EA Technology will produce a report with a top level overview and more detail for each cable tested.

10.6 Restoring Software Default Options

It is possible to make changes to the options that appear in the CableData Collector software. The list of **Voltages** and **Cable Types** can have user options added, as shown in sections 10.4.5 and 10.4.7. If the additional options need to be removed, they can be using the **Remove User Customisations** button. This removes all added options and will only show the default ones.

From the software screen, click the **Settings** button, shown in Figure 59.

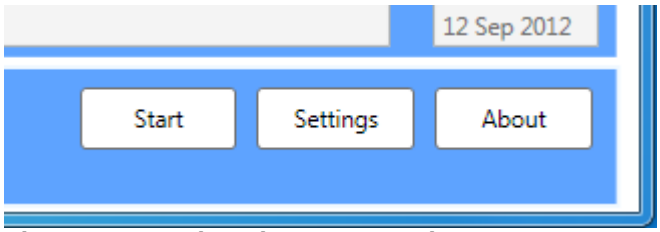

Figure 59 - Settings button on main screen

On the Settings screen, there is a button in the bottom left corner labelled **Remove User Customisations**, visible in Figure 60.

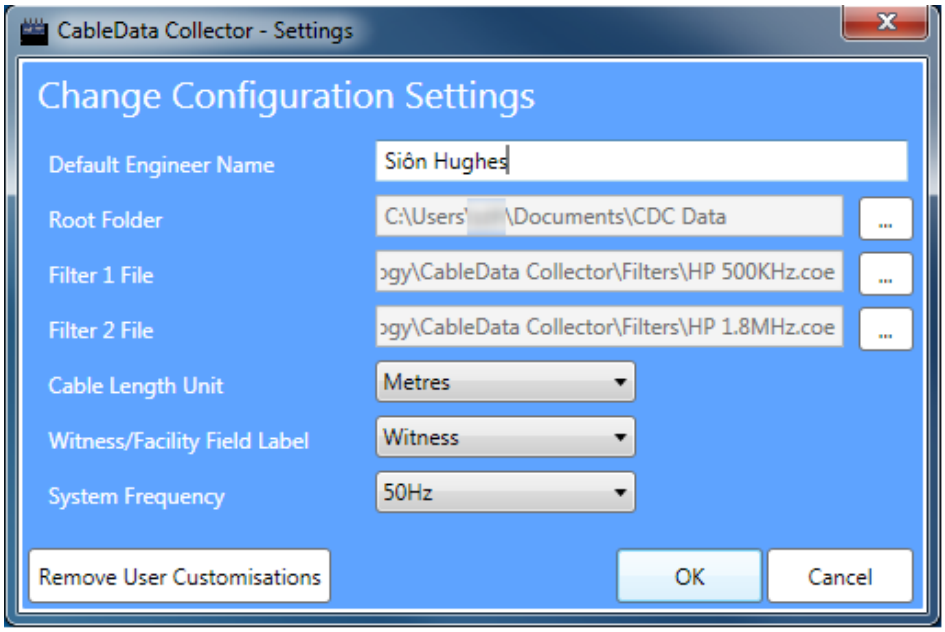

Figure 60 - Remove User Customisations button

The confirmation shown in Figure 61 will be displayed, warning that all of the customisations will be lost. Clicking the **Yes** button will continue with the removal. Clicking the **No** button will return to the Settings screen.

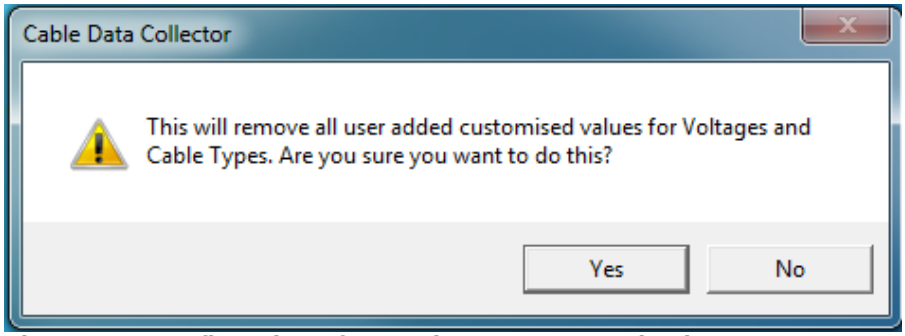

Figure 61 - Confirmation of removing user customisations

After confirming deletion, once this has been carried out the message shown in Figure 62 will be displayed.

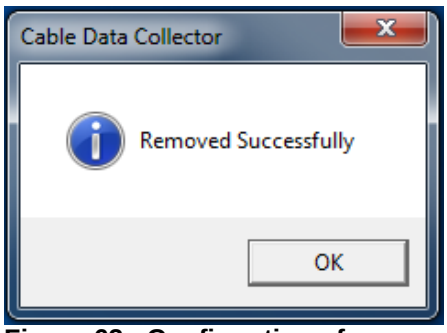

Figure 62 - Confirmation of removal

10.7 Updating Software

If version 1.x of the CableData Collector software is already installed, this must be uninstalled before installing the updated version 2.x.x software. From version 2.x.x onwards, any updates will automatically upgrade the installed software, meaning the old software will not need to be removed beforehand.

Uninstalling the software will cause the user customisations to be lost, for example custom cable voltages, and cable types. After uninstalling the software, navigate to the installer application and follow the previous instructions on installing the software in section 10.1.After installation is completed, the first time that the software is ran, the following warning message might appear:

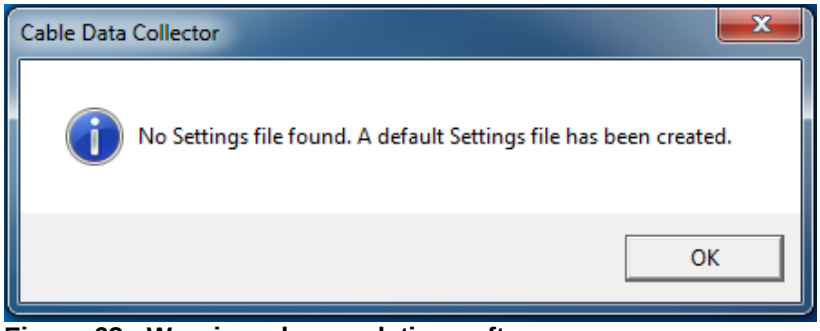

Figure 63 - Warning when updating software

Pressing the **OK** button will allow the software to continue and the user customisations will need to be re-entered.

10.8 Uninstalling the CableData Collector Software

The CableData Collector software must be uninstalled through the Add or Remove Programs interface. To open the interface, click **Start** > **Settings** > **Control Panel**. In the Control Panel, double click on **Add or Remove Programs.** The CableData Collector software will be in the list. This can be seen in Figure 64 where it has been selected. Click the **Remove** button.

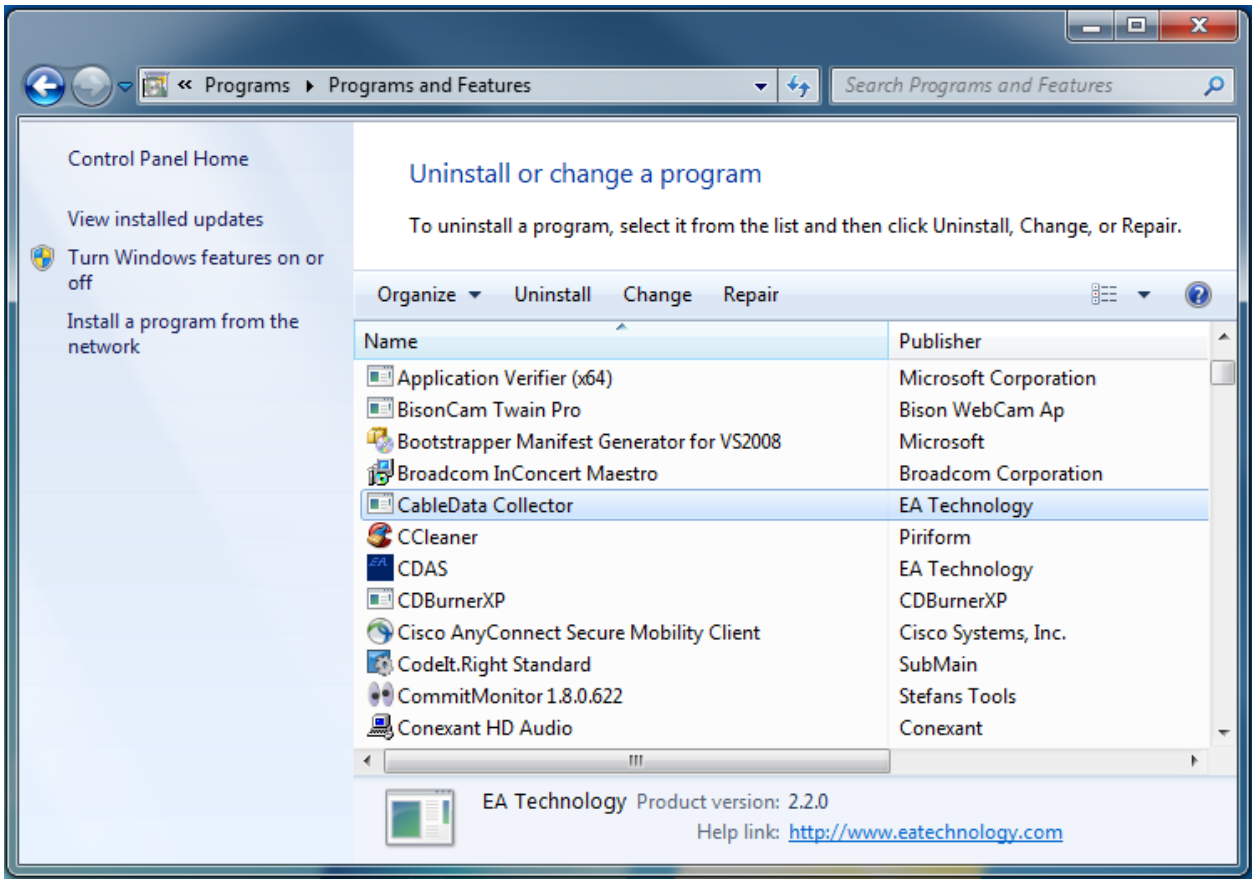

Figure 64 - CableData Collector software in Add or Remove Programs interface

A screen will be displayed asking for confirmation on the removal, as shown in Figure 65. Click **Yes**.

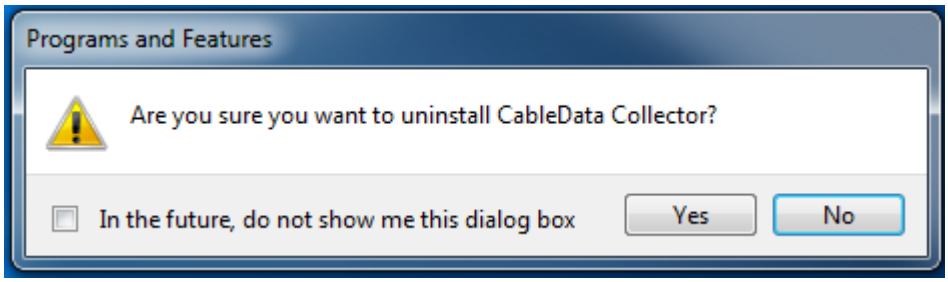

Figure 65 - Confirmation of uninstalling software

The rest of the installation process will happen automatically. The uninstaller will display a progress bar as can be seen in Figure 66. Once completed, the uninstaller will close automatically.

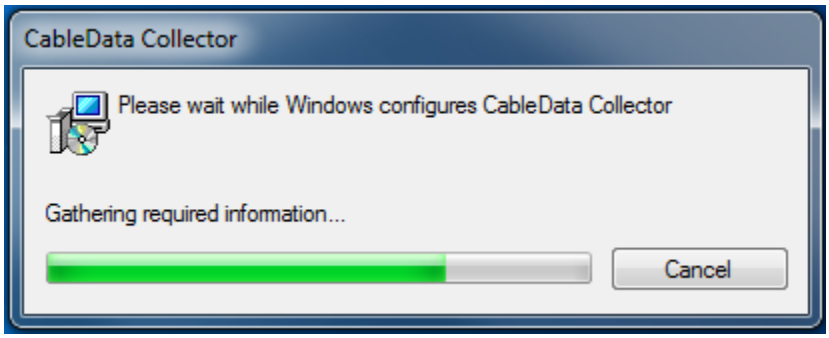

Figure 66 - Progress during removal process

11 Using the CableData Collector

Using the RFCT for online Partial Discharge (PD) tests on medium voltage power cables is relatively straightforward and very safe, as the current transformer is simply clamped around the earth cable using its split core as illustrated in Figure 67. This method can be used on-line without disconnecting cables or switching off supplies to customers.

11.1 Connecting the RFCTs

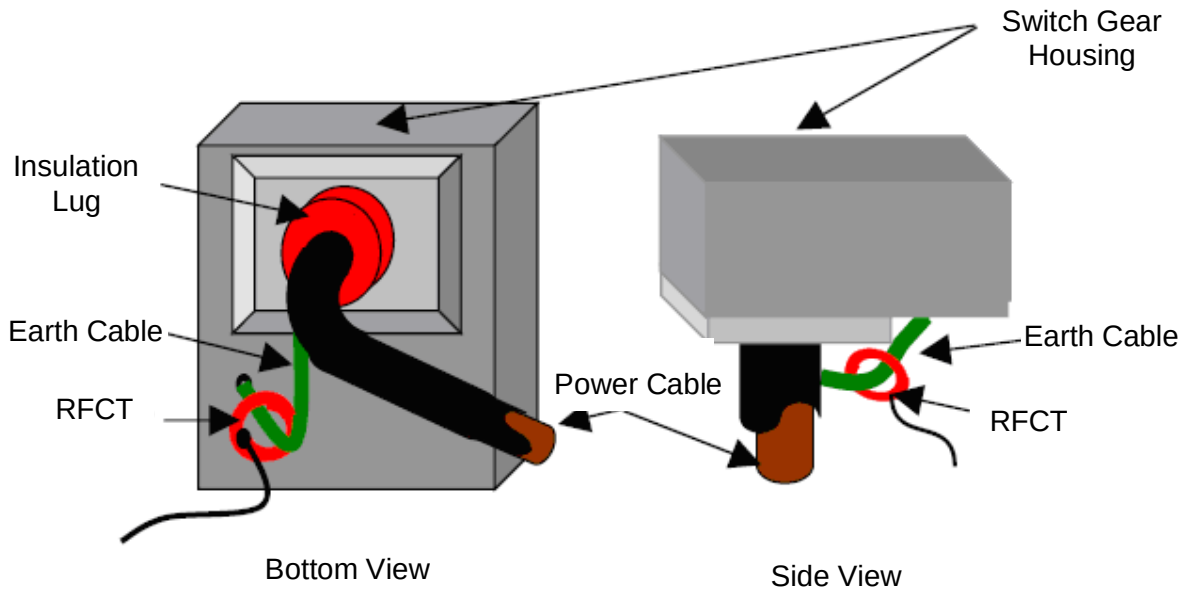

Figure 67 - RFCT Connection

11.1.1 Practical RFCT Connection Requirements

When completing an online PD test, the plant item must allow access to the 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 PILC (Paper Insulated Lead Covered) cables difficulty may arise attaching the RFCT unit as the cable earth and switchgear earth can be bonded together. This is more usual on older PILC cables using compound filled cable boxes. The placement of the RFCT is then not possible until an insulated gland has been installed with an earth strap bridging the gland in order to earth the cable and the switchgear earth together, so as to allow a PD test.

11.1.2 Testing Three Phase Cables

When using the CableData Collector to test three phase cables with three RFCT's, the arrows on the RFCT must all point in the same direction. This ensures that the polarity of the RFCT's are all the same which means that any PD pulses captured which are common across the three cables will all be in the same polarity aiding in detection and classification of the discharge.


Model: UTL1-RFCT1
Serial Number:
product-support@eatechnology.com
Tel: +44 (0) 151 347 2293
www.eatechnology.com
Made in the UK
Model: UTL1-RFCT1
Serial Number:
product-support@eatechnology.com
Tel: +44 (0) 151 347 2293
www.eatechnology.com
Made in the UK
Model: UTL1-RFCT1
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product-support@eatechnology.com
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Made in the UK

11.1.3 Cable Partial Discharge (PD)

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 and it is unlikely that a phase-to-phase PD will occur within the cable itself. Conversely, on PILC cables the PD effect can occur more often (than on XLPE types) between phase and phase, and the PD events can also be seen on the cables terminations.

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

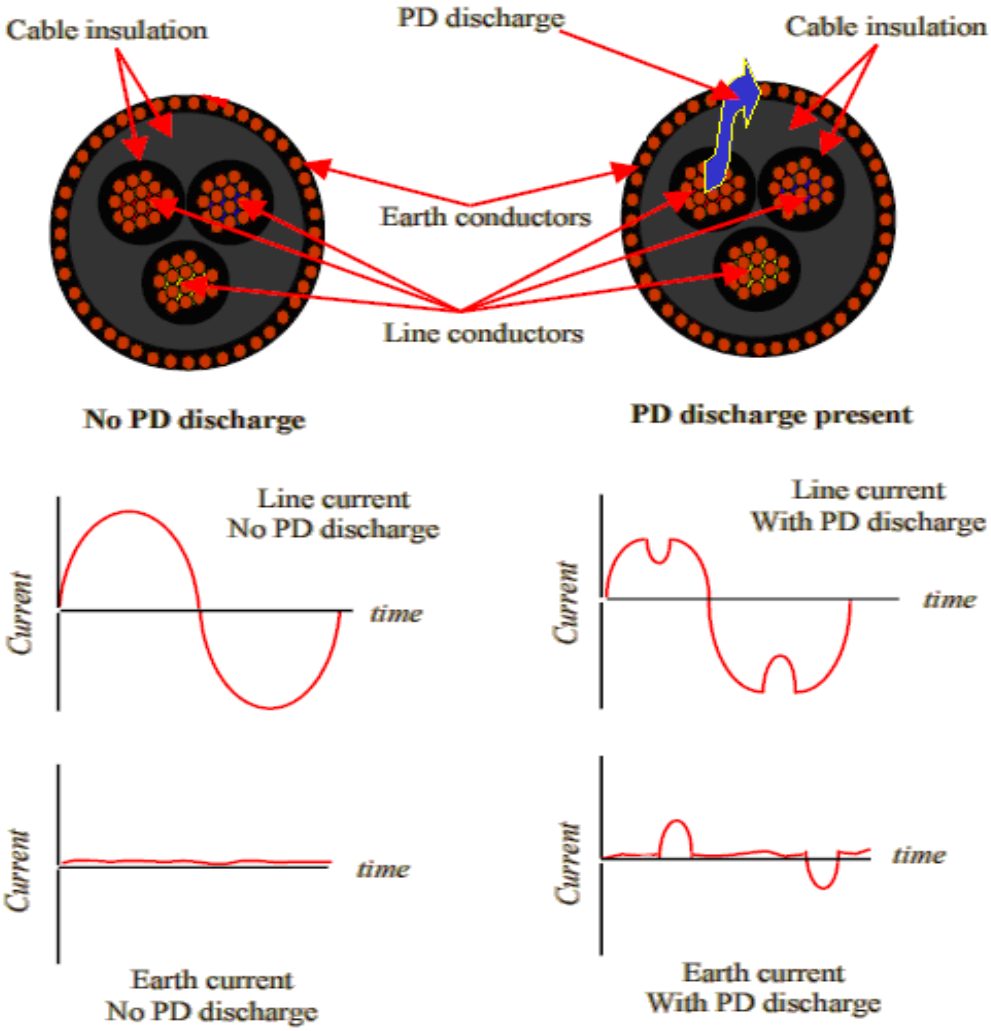

Figure 68 - Effect of Partial Discharge on a cable

11.1.4 RFCT Connection Requirements

The RFCT detects the occurrence of a partial discharge between the line conductor and earth by monitoring the condition of either of the three connection methods mentioned below. The connection methods are shown in Figure 69. Connections can be made:

By monitoring the earth cable only (figure C), this is the preferred connection method.
By monitoring the line conductor without the earth (figure D) or,
By monitoring the line conductor and earth within the sheathing and the earth cable external to the sheathing when passed back through the RFCT (figure F, close up Figure 70).

If the RFCT is placed over both the line conductor and earth cable at the same time the discharge currents are cancelled. This is illustrated in figure E, the method to counter this effect is shown in figure F, and figure G. Figure C 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.

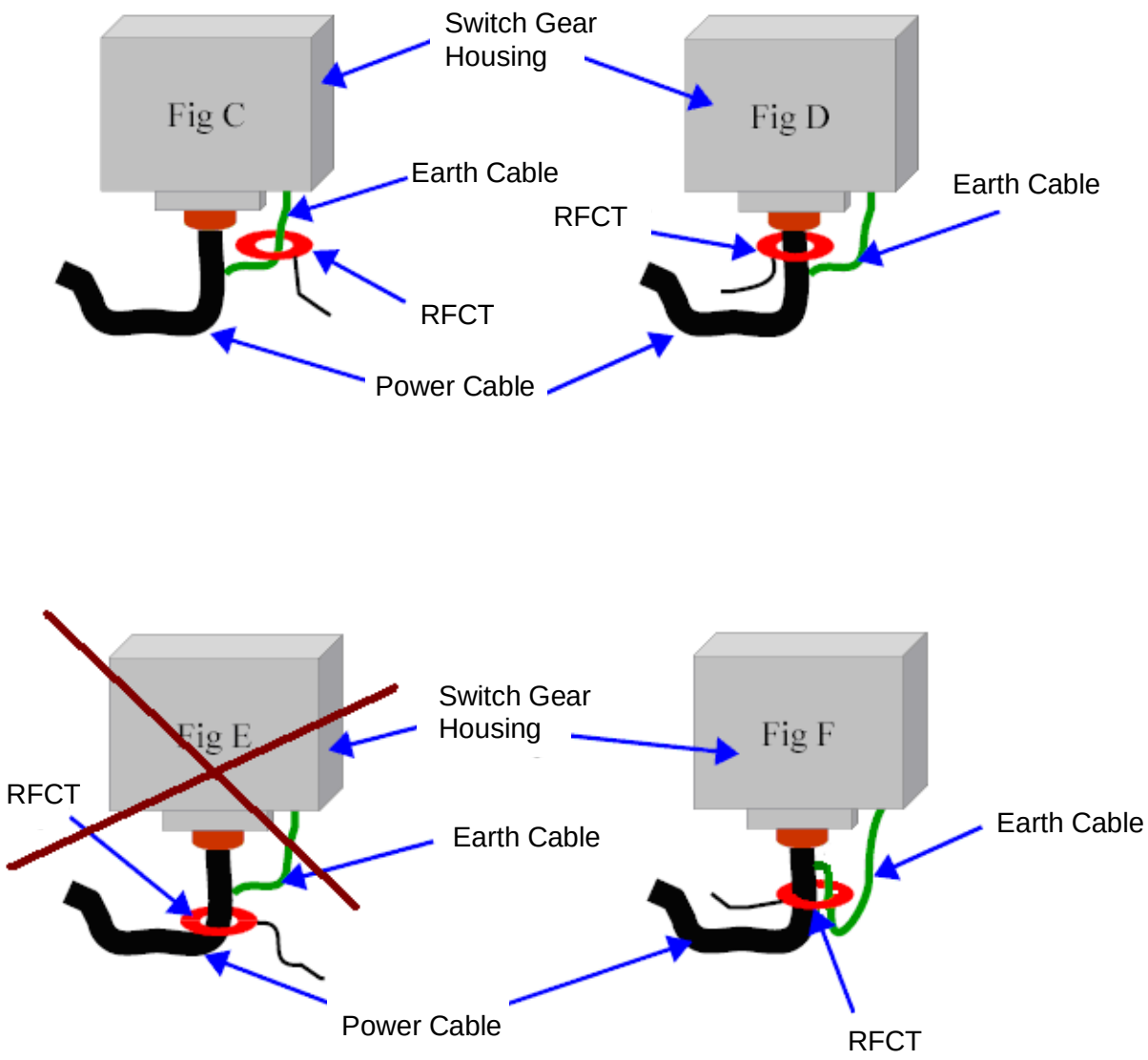

Figure 69 - Cable Connection Methods

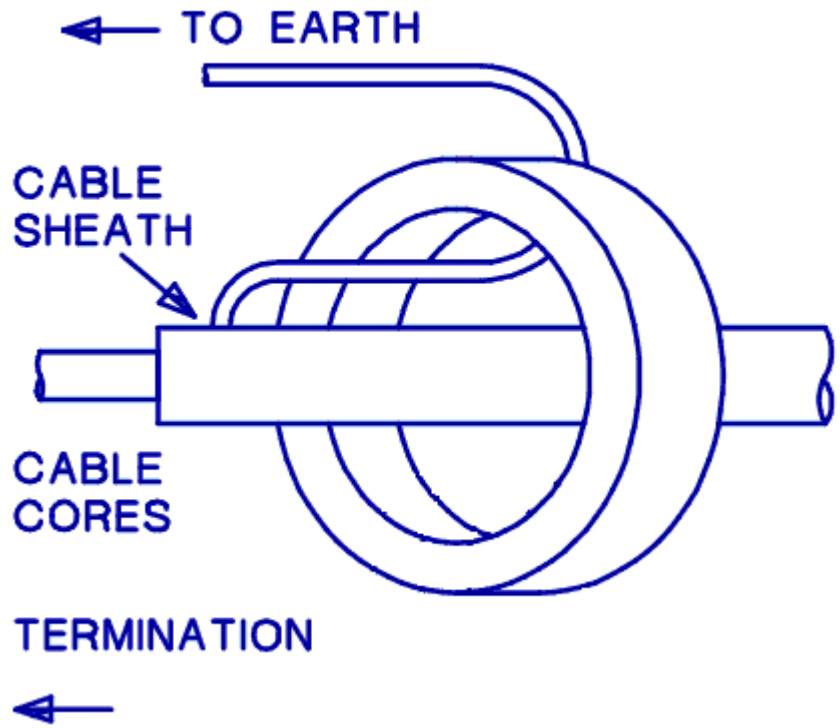

Figure 70 - Overcoming cancellation of discharge currents by looping back earth strap

11.1.5 Cable Type Restrictions

In cable types like the XLPE, the phase cores are separately screened. On belted cables, there is a common screen around the three phases. This is important because on belted cables phase-to-phase voltages exist, whereas on XLPE cables this is not the case.

On the 3-phase 6.6kV – 11kV belted cable types, the RFCT 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 for 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.

12 Specification

12.1 Cable PD Inputs

Sensor Type:	RFCT
Number of Channels:	3
Max Conversion Rate:	160 MSPs
Conversion Resolution:	12 Bit
Max Cable Length:	Cable Construction Dependent
Unfiltered Frequency Range:	0-80MHz
Filter 1 Frequency Range:	500kHz-80MHz
Filter 2 Frequency Range:	1.8MHz-80MHz
Gain Settings:	4 (Auto Ranging)
Measurement Range:	Range Dependent (25,000pC, 50,000pC, 100,00pC, 200,000pC)
Resolution:	Range Dependent (14pC, 28pC, 56pC, 112pC)
Capture Windows:	153µs, 76µs or 38µs

12.2 Hardware

Enclosure:	Machined Aluminium
Indicators:	3 x Dual Colour LEDs
Expansion Connections:	USB, SD Card, Ethernet

12.3 Environmental

Operating Temperature:	0 – 60 degrees C
Humidity:	0 – 90 % RH non-condensing
IP Rating:	31

12.4 Dimensions

Size:	177mm x 119mm x 28mm
Weight:	0.6kg

12.5 Power Supplies

Power Source:	Powered over USB connection from laptop, requires laptop with 2 x USB ports.

12.6 Recommended PC Specification

Processor:	1 GHz or faster x86 or x64 processor
Memory:	1GB RAM for 32 bit systems, 2GB for 64 bit systems
Storage:	100MB free disk space for application and driver installation plus additional space for storing captured data
Operating System:	Windows XP or above with Microsoft .Net 3.5
Connectivity:	Two free USB 2.0 ports

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.

There are no user-serviceable parts.

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.

14 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.

For warranty repair, please contact EA Technology Product Support:

Email: product-support@eatechnology.com

Telephone: +44 (0)151 347 2293

15 Calibration

Calibration Interval: 12 Months

Your application may require a different calibration interval dependant on the frequency of use. The calibration interval should begin on the date the instrument is placed in service.

16 Repair

For information on our repair procedure, please contact EA Technology Product Support:

Email: product-support@eatechnology.com

17 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.

18 Note

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

19 Contact Us

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20 Notes

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Improving Network Performance | Facilitating Low Carbon Energy | Delivering New Technology | Developing Your Team | Communicating the Message

Delivering Innovation in **Power Engineering**