



T-P23 Low Voltage Fault Locator User Manual

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Safety Instructions

Safety Note: This user manual is the basic commissioning and on-site operation guide for the T-P23. All operators who will use the T-P23 should read the entire contents of this manual in advance. The manufacturer of this product is not responsible for any loss caused by the operator's failure to comply with the operating procedures of this manual or for violation of the safe working procedures of the operator.

Meaning of the manual symbols Important instructions concerning personal safety, operating procedures, technical safety, etc., are marked with the following symbols:

Symbol	Meaning
	Indicates a potential hazard that could result in fatal or serious injury
	Indicates a potential hazard which, if not avoided, may result in minor personal injury or property damage.
	Indicates that it contains important information and useful guidance for using this product. Failure to heed this information will result in the test not functioning properly.
	Indicates that this is a useful guideline based on field practice.

Use of accessories: Please be sure to use Kehui's spare parts to ensure the safe and reliable use of this instrument. Using accessories made by other companies will make any warranty null and void.

Repair and maintenance: This instrument must be repaired and maintained by Kehui or an agent authorised by Kehui. If you have any questions such as maintenance, cable fault detection, on-site test consultation etc., please contact info@kehui.com

1. Introduction

The T-P23 is a sophisticated low voltage cable fault locator, capable of finding permanent, intermittent and transient faults. The instrument is operated through a PC interface either directly through a Bluetooth® serial port, or remotely through a GSM/GPRS modem. The latter method allows the fault to be monitored and interrogated without having to return to site and therefore, is also not intrusive as far as users are concerned.

1.1 Types of LV cable fault

LV cable faults can be separated into 4 categories:

- Transient Irregular, short duration voltage depressions which do not result in any fuse operations
- Intermittent Irregular operation of fuses at long intervals
- Persistent Repeated operation of fuses at short intervals
- Permanent Open circuits and 'solid' short circuits

1.2 Characteristics of LV cable faults

Many LV cable faults change from transient to permanent over time ("flickering lights" are a possible sign of a transient fault). In addition, LV cable faults are often unstable and non-linear and can therefore only be located when the cable is energised. Only once a fault has become permanent can it be located using conventional techniques and then the cable often needs to be de-energised. All unstable LV cable faults require a change in their condition in order to be located. The only way of doing this – with consumer loads connected – is to reconnect the supply voltage. Connecting a T-P23 at the main supply fuse, will monitor the cable and capture data when the fault ignites.

1.3 Application

The T-P23 is suitable for the detection of transient faults on any system where:

- i. the suspect cable cannot be isolated for fault-finding using a surge generator due to the topology of the network. An example of this is a system where individual consumers are fed from underground tee-joints, such as the example in Figure 1.1.

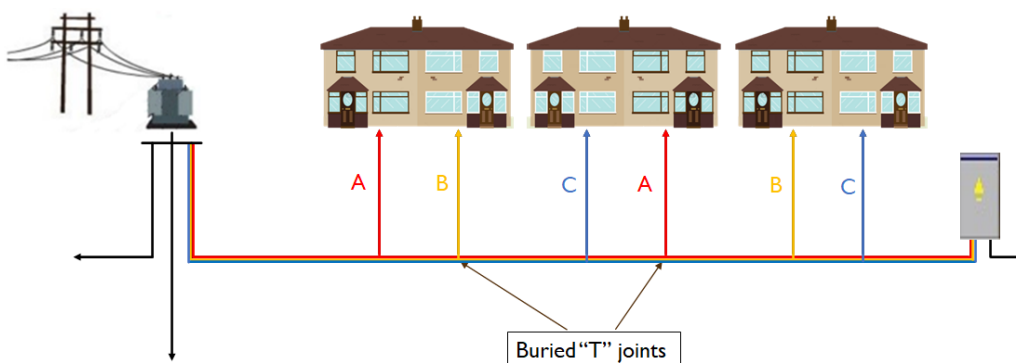


Figure 1.1: Network with consumers fed from underground Tee-joints

- ii. Applications where there are concerns about potential damage from the use of a surge generator.
- iii. Applications where isolation of the supply is difficult due to the importance of the load.

1.4 Product overview

The device has been designed for the location of all types of low voltage cable faults but especially the difficult and troublesome intermittent fault. Its main feature is that it is used on a live cable, so that consumers can remain on-line whilst the cable is being monitored. Additionally, it can capture faults, which may not necessarily blow a fuse and the information can be retrieved without further site visits after the initial installation. It can store up to 20 separate voltage triggered events in internal memory, which can be downloaded as required.

A very powerful feature of the T-P23 is the ability to continuously monitor the three-phase voltage and to capture two cycles immediately before and eight after the point of trigger.

The pre-trigger data includes sixteen TDR traces with a further forty-eight saved after the trigger point. This gives the operator a view of the actual fault condition that initiated the trigger and allows the T-P23 to be armed in the most appropriate manner.



Figure 1.2: T-P23 Low Voltage Cable Fault



Figure 1.3: T-P23 & Accessories

Through the T-P2X Master software, the T-P23 can be configured/re-configured to meet the needs of the application. This can be done locally from a laptop or tablet, using a Bluetooth connection, or remotely through GPRS communication.

The acquisition of the transient fault locations remotely, provides a major benefit in both reducing the cost of locating the fault and to improving customer service. However, it does lead to the possibility of confusion due to dispersed data. An internet-based system has been developed on the *iHost*® platform (similar systems may be usable in different locations). This keeps a register of all the units' current locations; it automatically polls the devices at regular intervals and stores the records on its own database and will automatically report events to designated users. Connection to individual devices can be made through *iHost*® without the need to know the connection details. Data can be downloaded from the units to allow it to be analysed in the T-P2X Master software.

By providing control from a remote location, the T-P23 can be connected to a faulty cable by field staff who are not necessarily familiar with the analysis of the waveforms. The expertise in adjustment and interpretation, being provided by a centrally located specialist. This becomes particularly beneficial when the equipment has to be left on-site awaiting the occurrence or reoccurrence of an intermittent fault.



Care should be taken to keep *iHost*® updated, to ensure data relating to a particular fault location refers to the current position of the unit on the network and not an earlier installation, otherwise results will be incorrectly archived, leading to confusion.

2. Technical Data

Parameter	Value
Operational voltage / Power supply	230 V ±10% AC, 50 Hz
Interfaces	Bluetooth®, GPRS
Transient recorder	3 Voltage channels
Data storage	20 Events with 10 cycles of AC voltage 64 TDR-Traces, 16 pre-trigger events 48 post-trigger events
Environmental protection	IP65
Operating temperature	-10 °C to +50 °C
Dimensions (W x H x D)	240 x 120 x 60 mm
Weight	1.0 kg

3. T-P23 System Overview

3.1 T-P23 Hardware

The T-P23 hardware is shown in Figure 3.1, showing the user interface and connectors;

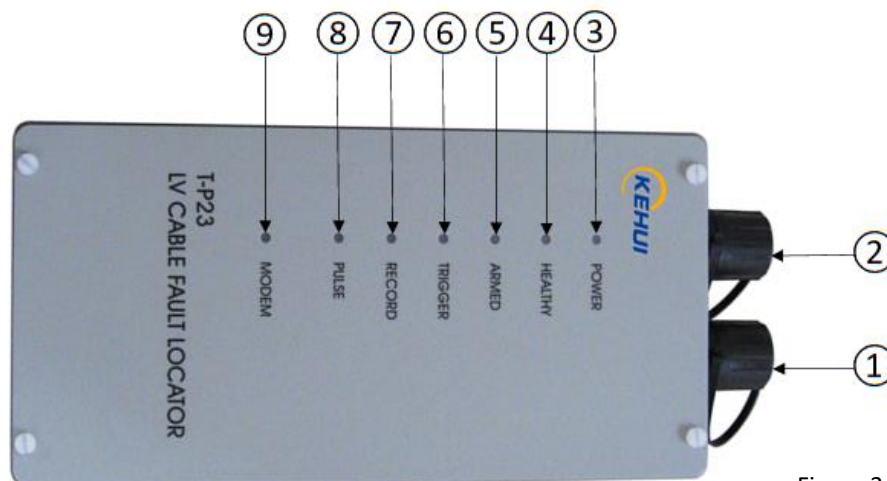


Figure 3.1: T-P23

Element	Description
①	3-phase (4 core) voltage connector
②	Aerial connector
③	Power LED (internal power supply) On = Operating Off = Unit unenergised
④	Healthy LED (standby status) Flashing: Fast = not active Slow = ready for testing Constant: On = data transfer active Off = re-initialising modem
⑤	Armed LED (test armed) (Armed means that the test system is ready to record trigger events) On = armed (waiting for trigger) Off = not armed (not ready for recording)
⑥	Trigger LED On = at least one event has been recorded since the last arming Off = no new events recorded
⑦	Record LED (test) On = TRS mode active Off = TDR mode active
⑧	Pulse LED (test type) On = TDR mode or TRS master Off = TRS slave
⑨	Modem status indicator Flashing: Every 1 sec. = registering Every 3 secs. = registered Flickering: Remote communications in progress Off = re-initialising modem

3.2 Software main display

The device is controlled from the T-P2X Master software which provides the display shown in Figure 3.2. A detailed explanation of which, is made in section 7.2.



Figure 3.2: Software Main Display

3.3 Record Types

The T-P23 has three different record types. In each case the file name is in the format: YYYY-MM-DD-HH-MM-SS (see “Triggered events” in the bottom left of Figure 3.2) i.e. the date and time at which the record was captured, however, the name extension is dependent on the type of record.

3.3.1 .vlt

This record type is generated from a manual trigger and is a snapshot of the voltage at the time of the trigger and contains 64 TDR pulses. They are listed and viewed in the events window and are labelled in the events list as (MT) also in “Triggered events” in Figure 3.2.

3.3.2 .tdr

These are generated from the test button and capture a single TDR waveform and are viewed in the TDR viewer and the Manual Tests window (Top centre and right Figure 3.2). Up to three waveforms can be selected at any one time and can be switched on and off via the check box on the left-hand side of the window. This allows comparison of all three Phase-to-Earth or Phase-to-Phase waveforms simultaneously for comparison purposes.

3.3.3 .trg

These are the records that are automatically captured when the T-P23 senses a change in the voltage waveform beyond the configured threshold. The trigger point should be the twelfth of the sixty-four TDR pulses in the events windows (bottom Figure 3.2), ensuring the operator has twelve healthy waveforms for comparison with those after the trigger point. They are listed in the “Triggered events” window and have an associated number (e.g. (04) in Figure 3.2) which is the memory cell it was stored in. These are numbered from 01 through to 20 and the oldest are overwritten as the number of records recovered increases.

4. TDR Application

4.1 Description

The basic principle of operation is time-domain reflectometry (TDR). In this process, a pulse is launched in to a cable at one end. The pulse is completely or partially reflected by the impedance mismatch created by the fault. By measuring the time taken for the pulse to return to the source the distance to the fault can be calculated using this time, multiplied by the velocity of the pulse (vop). The vop in the cable can be considered a constant and typical values are available for different cable types.

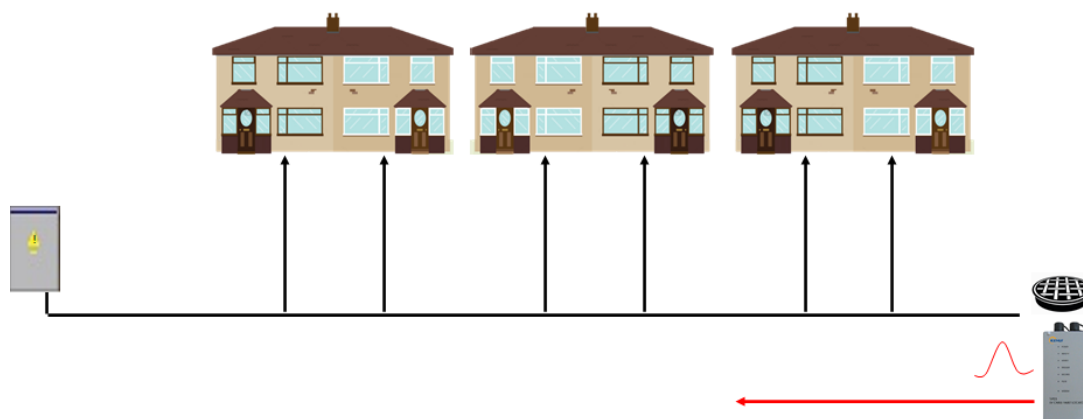


Figure 4.1 TDR measuring system with T-P23 located in underground link box

In Time-Domain Reflectometry (TDR) mode, a triggered TDR test can be made using one device, which will provide effective fault location for most cables. The device will monitor the system and continually inject TDR pulses in to it. If an event triggers the device, the voltage waveforms and TDR traces before and after the trigger points are saved and can be analysed to identify the fault's characteristics and its position.

The range of the fault location using the TDR method, is limited by the length of the cable and the number of branches due to the attenuation of the TDR signals. This is caused by the properties of the cable itself and by the installed joints. With the TDR method, the test pulse must have sufficient energy to travel to the fault location and be partially reflected and return along the same path. Adjustments can be made to increase the distance of propagation by balancing the device to match the cable's characteristic impedance and adjusting the pulse width through the "range" control. The TDR mode requires an "open end" such that the pulses are directed in to the suspect cable (section 4.3.1) and not in other directions, which will confuse their interpretation.

4.2 T-P23 Application as a triggered TDR device

Unlike conventional TDR fault locators, the T-P23 is connected simultaneously to all 3 phases of an energised LV cable to allow the local, or remote, operator to perform TDR testing on any combination of phases. Power for the unit is taken through the 3 phase test lead and so the unit requires at least 1 phase to be energised.

The T-P23 includes a 3 channel transient recorder which is used to acquire information about the exact nature and behaviour of intermittent faults. The signals acquired by the transient recorder are also used to detect "trigger" conditions for the TDR system based on voltage distortion.

A limitation of the basic single-unit system is that in order to avoid confusion from multiple TDR reflections from “behind” the unit (e.g. a local busbar), it is necessary to install it at an “open end” (e.g. a link box with the links left open) or with a blocking coil which prevents the passage of high frequency pulses but does not interrupt the supply of power. In this way the TDR pulses are only directed in to the suspect cable. Using the T-P23 in TDR mode is a very effective way of detecting transient faults on low voltage cables but there are some disadvantages which can limit its application under certain circumstances.

- The device must be connected at an ‘open’ end
- The range is limited by cable attenuation and the number of branches
- There may be ambiguous results on branched networks
- Fault reflection may be obscured by branch joints and ‘noise’ from the fault arc
- Non-linear loads may produce confusing ‘voltage dependent’ reflections

By applying two units this restriction can be avoided. In this configuration, recordings from both devices are used for fault location through the detection of the transient travelling waves created by ignition of the fault itself and a special internal synchronising feature (TRS mode see section 5).

4.3 Marker unit in TDR mode

The optional marker unit (T-MU1 Figure 4.2) is primarily for use with the TRS mode (see section 5.3), but it can also perform a useful function in the TDR mode. For this application the crocodile clip connectors need to be fitted.

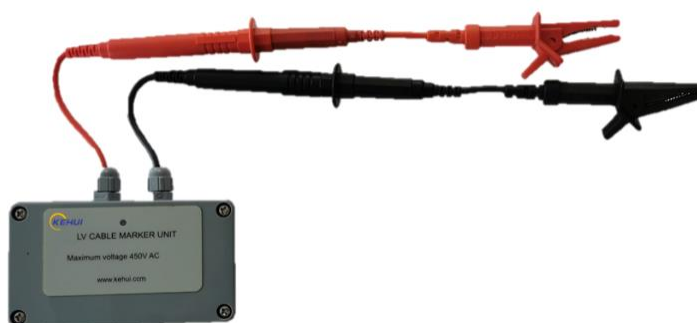


Figure 4.2 T-MU1 Marker unit with crocodile clip connectors

A possible source of inaccuracy with the T-P23 is incorrect information about the cable length, due to inaccurate cable records or excess cable being put in to the ground to save it being cut. The marker unit can be applied at a known, accessible position on the cable (e.g. a lamp post).

Note the circuit will be live at the access point and normal high voltage safety precautions should be taken.

With the T-P23 connected to the circuit, the access point to a live terminal on the cable is exposed. The black terminal of the marker unit is connected to a suitable earth point and the red one is then attached to a live terminal. The T-P23 is then manually triggered allowing a fault location measurement to be made. This value is compared to the physical straight-line distance from the location of the T-P23 to the measuring point. If there is a significant difference, the propagation velocity (vop) can be adjusted to calibrate the T-P23 to the specific cable being tested.



5. TRS Application

5.1 Operating principle

The TRS mode requires two recording devices (plus an optional portable Marker unit) the system uses a quasi-synchronous Travelling Wave Fault Location system. Such a system is shown in Figure 5.1 with T-P23 units located in accessible points in the substation fuse pillar and an underground link box. When the cable fault ignites it will create travelling waves, which will be detected by the two T-P23 units.



Figure 5.1 TRS measuring system

TRS is a two ended method using travelling wave fault location technology. It will locate a fault on the direct cable route between the two T-P23's. The system offers a number of advantages, but the main one is that the units can be connected at any accessible point on the feeder and are not dependent on open ends.

The system works by measuring the time of arrival of the travelling waves which emanate from the fault when it ignites. From these times the travel time for the wave from the fault point to each line end can be deduced and the distance to the fault determined using the propagation velocity (vop) of the wave in the cable.

5.2 Synchronising the measurements

Synchronisation is achieved by sending pulses from the Master unit at one end to the Slave unit at the other. It is possible to have both ends set as Master units with both sending and receiving pulses; however, it is easier to explain the system as Master/Slave.

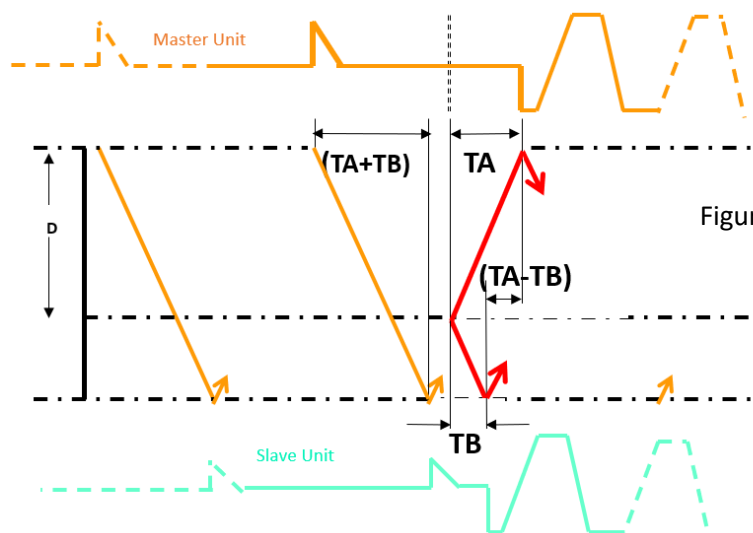


Figure 5.2 TRS Synchronisation

In Figure 5.2 the pulses are sent out from the Master at regular intervals, these take a time $T_A + T_B$ to reach the far end. T_A is the time to reach the notional fault point, a distance D away, and T_B the time for the wave to continue from that point to the far end. When the fault occurs, it initiates travelling waves that are detected at the Master after time T_A and at the Slave after time T_B . The difference in the two arrival times can be denoted as $T_A - T_B$.

The fault is a common point seen at both ends and so can be used to compare the waveforms as shown in Figure 5.2 and the difference between the sending of the pulse from the master and the receipt of that pulse at the slave is T_{diff} (figure 5.3).

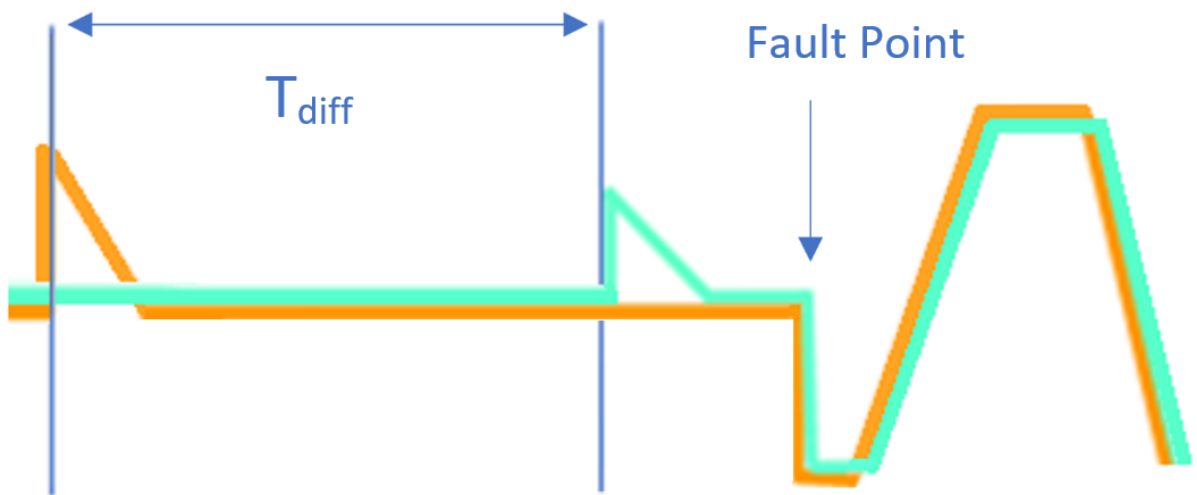


Figure 5.3 pulses synchronised on the time of arrival of fault generated transients

It can be seen from Figure 5.2 that T_{diff} is the sum of the time it takes for a wave to travel the length of the line, plus the difference in the arrival time of the travelling wave at each end:

$$\begin{aligned}
 T_{diff} &= (T_A + T_B) + (T_A - T_B) \\
 &= 2T_A + T_B - T_B \\
 &= 2T_A \\
 \frac{T_{diff}}{2} &= T_A \quad \text{Therefore } T_A \text{ can be determined by the T-P23}
 \end{aligned}$$

T_A is the time taken for the wave to travel distance D , therefore:

$$D = T_A \nu$$

Where ν is the velocity of propagation

Therefore, the distance to the fault can be calculated. A similar measurement can be made from both ends allowing verification of the result.

5.3 Marker Unit in TRS mode

The marker unit for the TRS mode is the same as that for TDR mode except the crocodile clips are exchanged for the probes (figure 5.4).



Figure 5.4 T-MU1 Marker Unit with probes



The purpose, as before, is to allow compensation where there is incomplete or incorrect knowledge of the cable length. The marker unit is used at a known, accessible position on the cable (e.g. a lamp post). The signal created by the marker unit differs from the behaviour of a real fault and the T-P23 unit's internal filter would normally reject it. To overcome this, the mode of the units should be changed to 'Filter OFF' on the control panel (Figure 5.5) before the test is carried out. It is important to reapply the filters before the units are put back in service using the control panel, as described in detail in section 7.3.

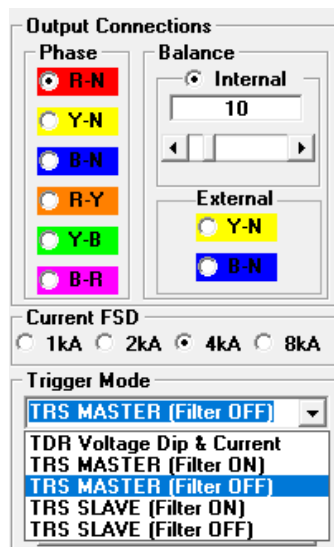


Figure 5.5 Mode selection on the control panel



Note the circuit will be live at the access point and normal high voltage safety precautions should be taken.

With the two T-P23 units connected to the circuit and armed, the access point to a live terminal on the cable is exposed. The black probe is held so it touches on a suitable earth point and the red one is then momentarily applied to the live terminal. The T-P23 units at each end will then receive a simulated travelling wave causing them to trigger, allowing fault location measurements to be made at each end. This value is compared to the physical straight-line distance from the locations of the units to the measuring point. If there is a significant difference, the propagation velocity can be adjusted accordingly to compensate.

5.4 Synchroniser unit

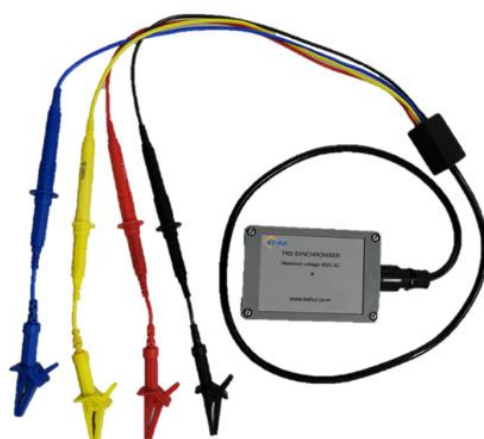


Figure 5.6 T-SU1 Signal booster

The range of the T-P23 in TRS mode is limited by the ability of the synchronising pulse to reach the other end of the cable. Normally the range is around 800m, but this may be adversely affected by the number of branches or other discontinuities on the cable. To overcome this problem, and significantly increase the range, the T-SU1 synchronising module (Figure 5.6) can be used.

The T-SU1 is connected to the cable at an intermediate point using the same connectors as the T-P23 and is also powered in the same way. It injects synchronising pulses into the cable, which travel to both ends of the line. In this case the T-P23 units are both set as slaves – with the filter on - using the selection in the control panel (Figure 5.5). Typically, the unit can be connected in a lamp pillar or link box (as shown Figure 5.7). The T-SU1 has the same lead arrangement as the T-P23. It is then necessary to wait for a fault to trigger the unit.

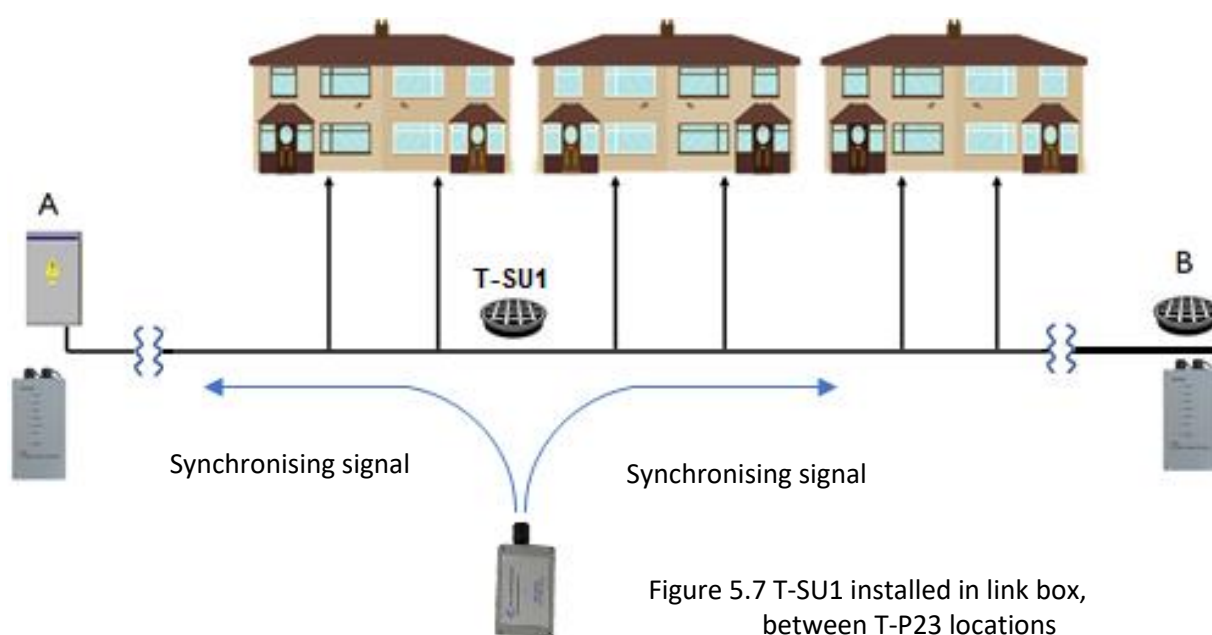


Figure 5.7 T-SU1 installed in link box, between T-P23 locations

6. Physical Connection to a Suspect Cable

6.1 General



The T-P23 is attached to the live electricity network, only authorised personnel, trained in working on such systems should undertake this work. It must be ensured that all the correct live-line working precautions are taken before connecting the unit.

The T-P23 is connected to and monitors all phases of the cable under test. There are several options for connecting the device to the faulty cable and the chosen connection point can impact on the chances of a successful location.

6.2 Selecting the point of connection for the T-P23 in TDR mode

To obtain the clearest waveform when using the T-P23, it is important to prevent spurious reflections by restricting the injected TDR pulse to the faulty cable. To do this, the connection point should be chosen with care, the different options are listed in order of preference.

6.2.1 Open end

The first choice is an open end, which is a part of the network where the only available path for the TDR pulse is towards the fault. This may be a branch, a substation with the relevant fuses removed or a link box with the relevant links removed. It is essential that the circuit remains energised (back-fed) from the far end (figures 6.1 and 6.2).

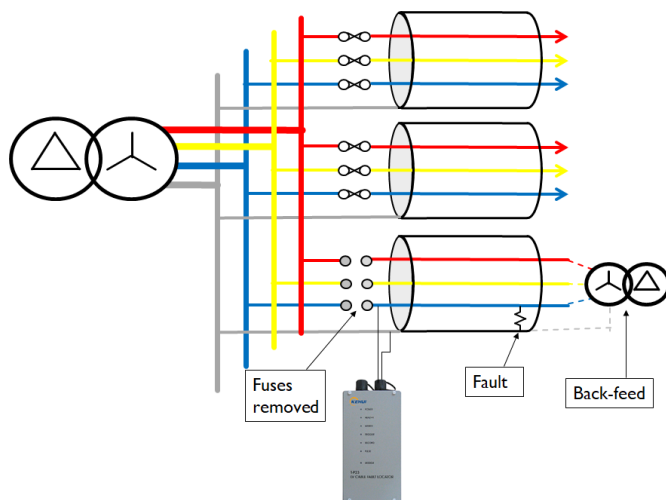


Figure 6.1: Open end connection at the substation on a back-fed cable. Red (A) and yellow (B) phase connections are omitted for clarity

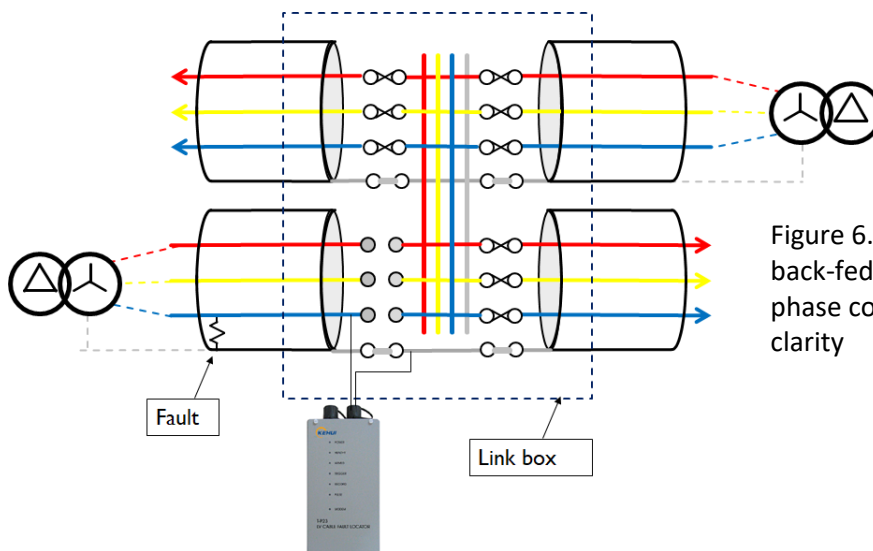


Figure 6.2: Link box connection on a back-fed cable. Red (A) and yellow (B) phase connections are omitted for clarity

6.2.2 Blocking coil

If an open end is not available, the second choice is to connect the T-P23 at the feeding end of the suspect phase, in series with a blocking coil and a fault re-energising device. The blocking coil must have the same rating as the cable to which it is connected. The load current at power system frequency, will flow through the coil, whilst the high frequency TDR pulse is blocked from travelling in to the busbar. The coil is available as a T-P23 accessory, although the re-energiser must be provided by the customer.

It is only necessary to use one blocking coil, as the TDR pulse will be blocked for any fault involving the phase to which it is attached. In the example shown in Figure 6.3, the blocking coil is on the blue (C/L3) phase, which will allow blue phase to earth, blue phase to red (A/L1) phase and blue phase to yellow (B/L2) phase faults to be located. It will not detect red to yellow phase faults.

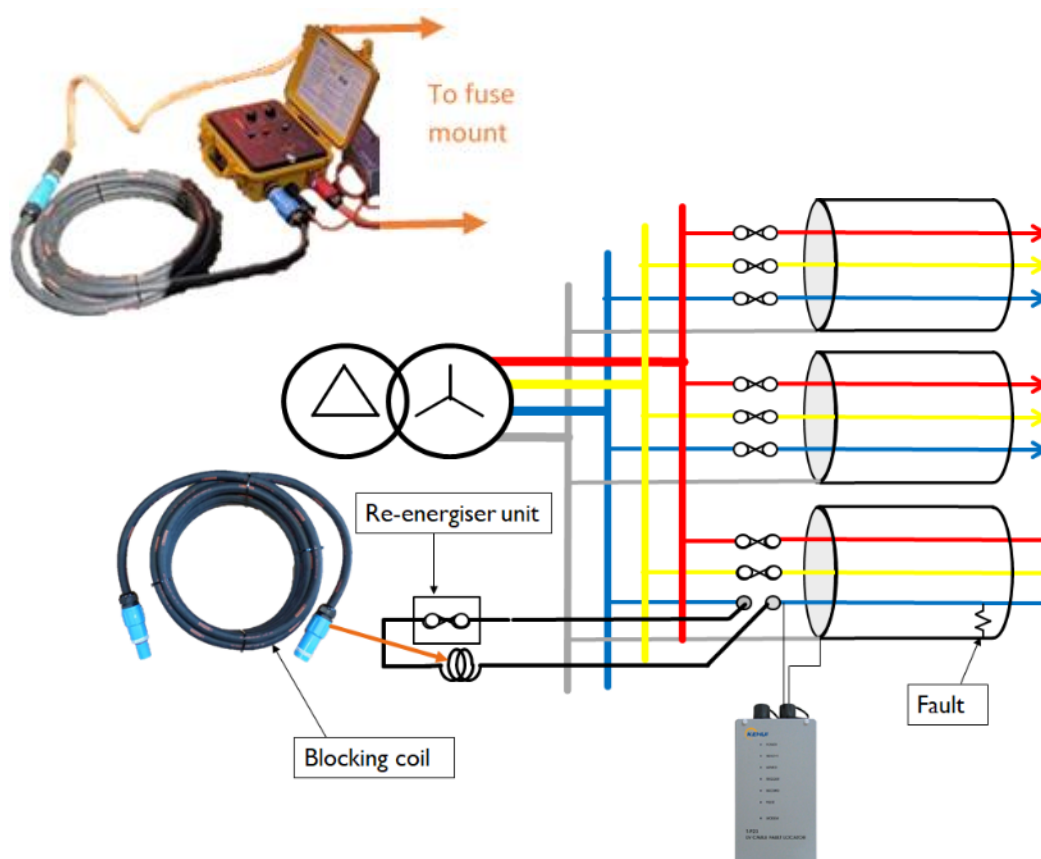


Figure 6.3: Connection using a re-energising device (inset) and a blocking coil. Red (A) and yellow (B) phase connections are omitted for clarity

6.2.3 Other possibilities

It is possible to attach the T-P23 at the feeding end with a fault re-energising device in series, but this will allow the TDR pulse to pass in to the busbar and reflect off the network elements behind the measuring point, such as the busbar and other attached cables. This will lead to more reflections and cause the trace to become harder to interpret.

The last possibility is to connect at the feeding end with a replacement fuse, this has the same disadvantages as the previous connection and has the added complication of having to insert a fuse on to a live network instead of using a re-energising device.

6.3 Connecting the T-P23

The electrical connections of the T-P23 are located on the front of the device as shown below (figure 6.4), the electrical connection is on the left (the right-hand connector is for the aerial). The connector has red, yellow and blue cables for the phases and a black neutral lead. Figure 6.5 shows crocodile clips, 4mm plugs are also provided.



Figure 6.4: T-P23 terminals



Figure 6.5: T-P23 crocodile connection lead

The crocodile clips, allow the unit to be connected to any exposed metallic part of the circuit such as the busbar or the fuse carrier, such as in Figure 6.6

Regardless of the point of connection the sequence is always the same:

- With the test lead disconnected from the T-P23, first connect the black voltage lead to the neutral/earth conductor of the test object
- Connect the red, yellow and blue leads to the phases of the test object utilising any exposed metal on the appropriate phases using the crocodile clips
- Unscrew the dust-cap and connect the GSM antenna (Figure 6.7) to the T-P23 by inserting the plug in to the terminal socket on the right and tighten the screw cover on the plug to secure it.
- Unscrew the dust-cap and insert the four-core cable in to the left-hand socket on the T-P23 (figure 6.4) and tighten the screw cover on the socket to secure it.



Figure 6.6: T-P23 installation in utility fuse cubicle using clip connectors



The connection and disconnection instructions are printed on the underside of the T-P23 (figure 6.8). Always ensure that the dust-caps are replaced when the cables are not connected.



Figure 6.7: Aerial and connector

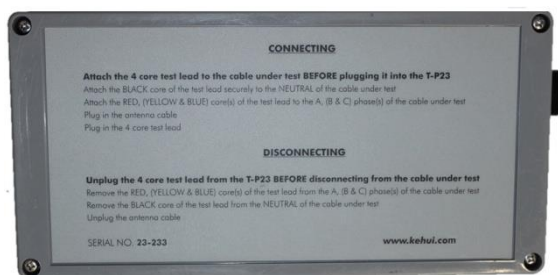


Figure 6.8: Connection and disconnection instructions on the underside of the T-P23

- As an alternative to the crocodile clips, specially adapted fuse handle assemblies are available with integral 4mm sockets (figure 6.9), which can be used in place of the conventional mounts (alternatives are available for 83mm and 92mm centres). The neutral busbar can be connected to the T-P23 using an insulated G Clamp with integral 4mm socket (figure 6.10).



Figure 6.9: Adapted fuse mount with 4mm connection socket



Figure 6.10: Adapted fuse mount with 4mm connection socket



The output socket on the fuse handle assemblies supplied by Kehui, is not provided with a fuse and should only be used with fused leads, such as those supplied with the T-P23

- If it is more convenient, the T-P23 can be installed in an underground link box, as shown in Figure 6.11.



Figure 6.11a: T-P23 connections in the utility link box using clip connectors



Figure 6.11b: T-P23 laid on top of the link-box bell housing



Note: The T-P23 is powered via the voltage leads and there may be a small spark if a voltage lead is disconnected or reconnected. In the event of a loss of supply to one phase the T-P23 will automatically draw from one of the two remaining live phases. Should a second phase lose supply then the T-P23 will be powered from the remaining phase. If all three fail then the unit will power down.



6.4 Switching on the T-P23

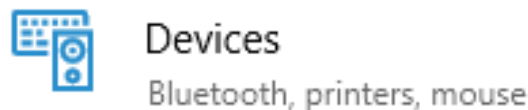
The Power LED shows that at least one of the conductors is live (including any back-feeds). If so, the LV-Monitor behaves as follows:

- The Healthy LED starts flashing after a few seconds.
- The Pulse LED is on.
- The Armed LED switches on automatically after 2 minutes.
- The Record LED lights up (when in TRS mode).

6.5 Connecting a PC to the T-P23

The T-P23 can be controlled directly on site or from a remote location. For local operation, the device has a Bluetooth interface via which it can be connected to a nearby PC. The following will explain how to connect the T-P23 to a local Bluetooth-capable computer. The instructions have been compiled based on a MS Windows 10™ operating system, other systems may vary slightly.

With the T-P23 energised go to Windows , then settings  and under “Devices” the Bluetooth & other devices page is brought up:



Ensure Bluetooth is switched on by moving the virtual switch to the right so it reads “on” (Figure 6.12).

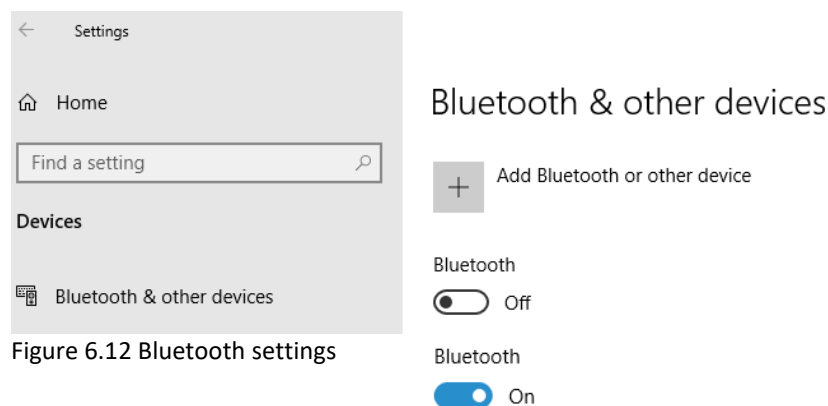


Figure 6.12 Bluetooth settings



The T-P23 units utilise a Bluetooth modem called Ezurio blu2i, the identifier (ID) of the unit should have been saved in the system configuration in the T-P2X Master software. However, if the PC is already paired with one or more T-P23 units, it may be confusing as to which is the one being connected. In this case it may be clearer if all the existing paired Ezurio units are removed by pressing on the icon and then “Remove device” (Figure 6.13) followed by a confirmation.

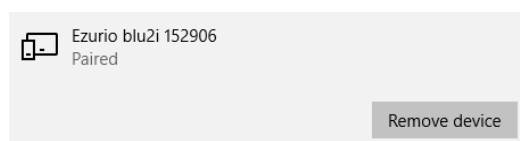


Figure 6.13 Bluetooth settings – device removal

Then click “Add Bluetooth or other devices”, this is followed by clicking “Bluetooth” and then clicking the Ezurio blu2i device that appears. A pin will be requested and entered (the default is 1234), followed by pressing “connect”. The screen will then state that the unit is paired and pressing “Done” confirms this.

Before running the T-P2X Master software, a Bluetooth connection must be established via a virtual COM port on the laptop. Click on the Ezurio blu2i device and under “Related settings” (top right of the page), select “More Bluetooth options”. Click on the “COM ports” tab and make a note of the outgoing port (Figure 6.14).

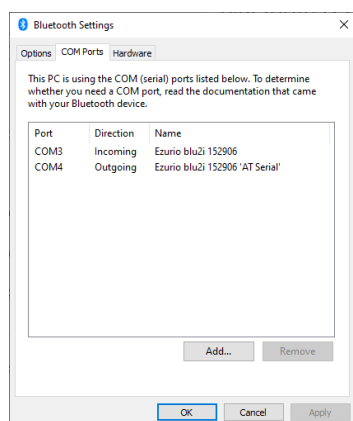


Figure 6.14 Virtual COM ports

The next step is to communicate with the T-P2X Master software. One important point to note is that when a PC is connected to the T-P23, it will disarm and change into communications mode. During this time, it will not monitor any cable activity until it is re-armed at the end of the session. To ensure that the T-P23 is not inadvertently left in an unarmed state, which would prevent it from detecting a fault condition, the Bluetooth connection will be terminated after three minutes of inactivity, with a warning appearing to prompt the user to renew the connection, the warning gives the user ten seconds to press the “Stay On” button (Figure 6.15).

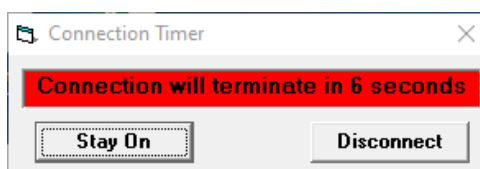


Figure 6.15 Bluetooth disconnection warning

6.6 Disconnecting the T-P23



The T-P23 is connected to the live electricity network, only authorised personnel, trained in working on such systems should undertake this work. It must be ensured that all the correct live-line working precautions are taken before connecting the unit.

If the TRIGGER LED is illuminated, at least one trigger event has been recorded. It is recommended that the event is downloaded before disconnecting the unit. The unit should be disconnected in the following order:

- Disconnect the red, yellow and blue leads
- Disconnect the black lead
- Disconnect the GSM antenna

The connection and disconnection instructions are printed on the underside of the T-P23 (figure 6.8).

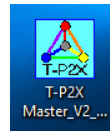
7. T-P2X Master Software

7.1 Preparation on a PC / laptop

To install the T-P2X Master software, follow these steps:

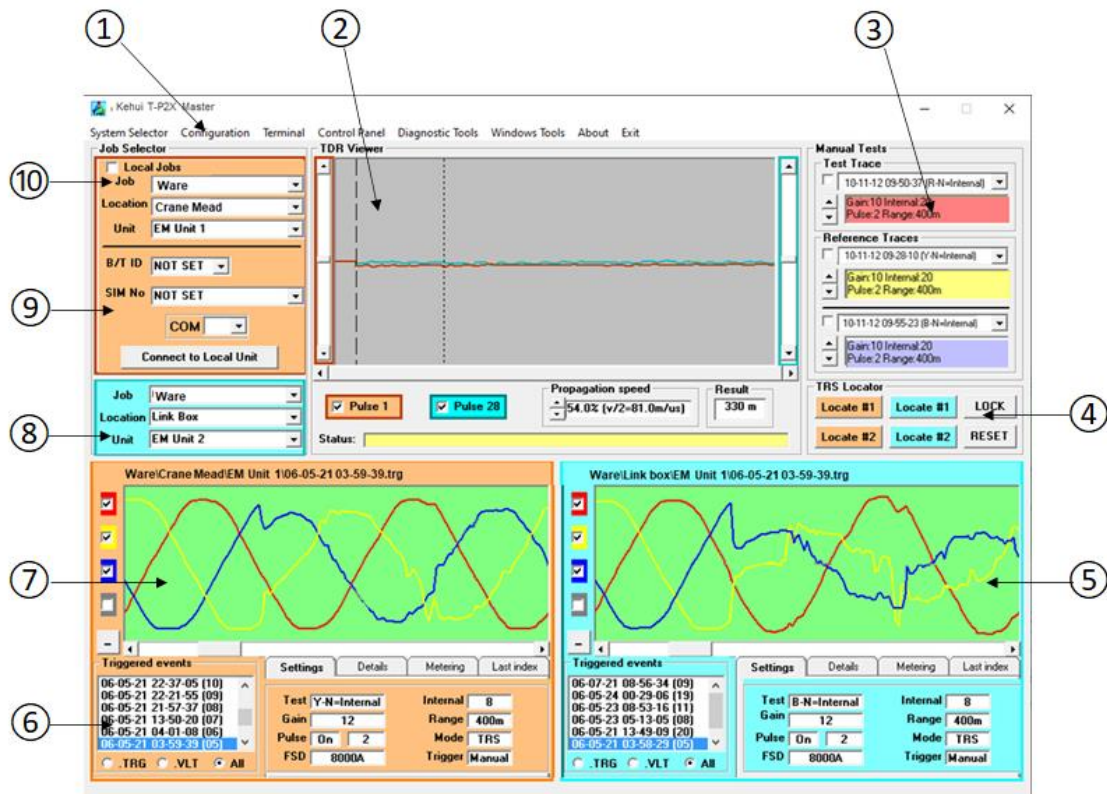
- Download the T-P2X Master software from the Kehui Website www.kehui.com
- Copy the software files to the C drive of the PC. (**C:\T-P2X Master** folder)
- Double-click *T-P2X Master.exe* (this program does not need to be installed)

For a quick start, a link can be made to the PC desktop.



7.2 Software Main Display

The display of the T-P2X Master is loaded on to the laptop or tablet PC. This is the main interface to the T-P23 and displays the results obtained from the device.

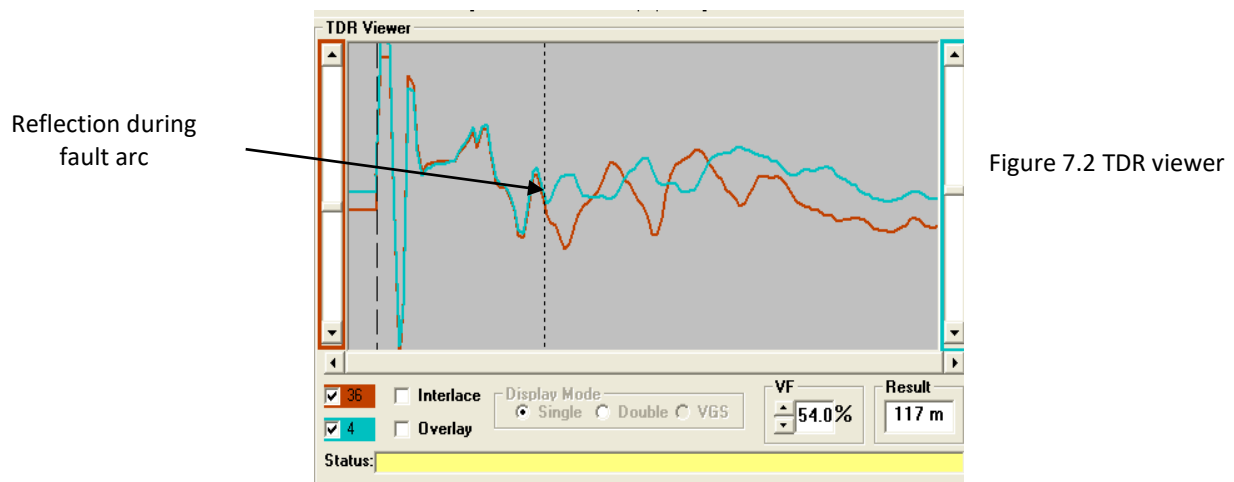


- ① Menu bar
- ② TDR/TRS viewer
- ③ Manual test records
- ④ TRS Locator
- ⑤ Second event viewer
- ⑥ Triggered events list
- ⑦ AC waveform viewer
- ⑧ Second unit selector
- ⑨ Unit and Comport selector
- ⑩ Job selector

Figure 7.1 T-P2X Master display

7.2.1 TDR viewer

This area will display the TDR pulses selected from a triggered record. It allows post-fault traces to be superimposed on pre-fault traces to permit the fault point to be identified and measured.



7.2.2 Menu bar

The elements of the menu bar (figure 7.3) are explained below:

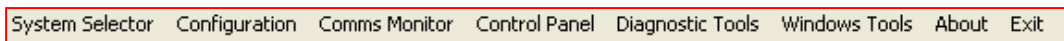


Figure 7.3 Menu bar

- System selector: displays the different systems with which the software has been used. Selecting the system allows the different locations to be selected in the Job selector (section 7.2.3)

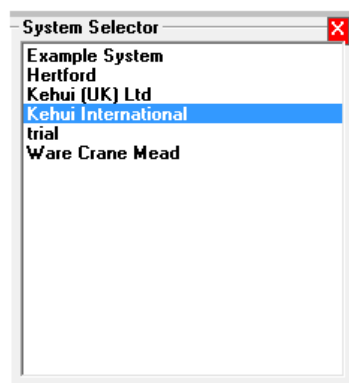


Figure 7.4 system selector

It is possible to have more than one system in use on one PC. It may be that an operator has more than one area to cover e.g. area 1 and area2. Rather than have a large list of recorders, they can be contained in two systems designated Area 1 and Area 2, in order that the recorders can also be kept in the area that they are assigned to. Clicking on System Selector in the Menu Bar will show the systems available in a drop-down box (figure 7.4).

- Configuration: defines the location and identity of T-P23 units on a network, allowing the user to create a group of related installations to allow ready access. New systems are created under “Configuration”. If a unit is to be relocated, the job can be edited by clicking on the “Move a unit” button.

Example System Configuration

Serial No	B/T ID	Version	Current Job	Current Location	Sim No
23-391	152907	T-P23	Ware	High Street	8944110098765432109876
23-299	152900	T-P23	Hertford	Ware Road	8944110078901234098765
23-356	152976	T-P23	Stanstead Abbots	Station Road	8944110075310864284798
23-566	152864	T-P23	Ware	Crane Mead	8944110086460832465711

Figure 7.5 System configuration table

- Add a unit: allows a new T-P23 to be added to the system. The user will be presented with a succession of windows to define:
 - Name of the new unit
 - Bluetooth ID of the new unit (B/T ID)
 - Version (In addition to the T-P23 there are other TP units in existence)
 - Current job (user defined)
 - Current location (where the unit is installed)
 - SIM cardnumber (Can be obtained from the supplier or from the diagnostics (n.b. it is not obligitory to complete this section))
- Delete a unit: Select the unit ID in the configuration file. A left click on the delete box prompts a confirmation, following which the unit is deleted (at least one unit must remain in the group)
- Move a unit: Allows the job name and location to be changed. It is important to do this as remote receipt of data will be compromised if the location is incorrect.
- Set B/T ID: Change the Bluetooth ID
- Set SIM No: Allows the SIM number to be added or changed
- Save as: Allows the set of units to be saved as a new user-defined system
- Save: Saves changes in the existing system
- Control Panel: Causes the control panel to appear even with no unit connected. It should be noted that the control panel is not operative unless the controller is actually connected to the T-P23 (see section 7.3)

- Diagnostic Tools: This displays a set of sub-displays summarising the settings on the unit:
 - Unit settings
 - Display settings
 - Misc.
 - Memo. Window

These commands are only used during troubleshooting and are not utilised during the normal operation of the equipment.

- Windows tools: Provides ready access to Windows Explorer, Notepad and Calculator, which may be useful during the testing process.
- About: Provides data about the T-P2X Master software such as the version number.
- Exit: Allows the user to exit the T-P2X Master software.

7.2.3 Job Selector

The job selector allows the user to either select the device they want to connect to or to analyse existing records. It displays the information as follows:

- Local Jobs: When checked the Job drop-down list will only show the jobs currently held in the configuration; when unchecked, the list will show all the jobs that the T-P23 units have been connected to in the selected System.

This allows a historical view of faults, which may also be useful for training purposes.

- Job: The location of last job where the unit was used is, in this example Hertford. To change it, scroll down the list until the required location is highlighted in a blue background (Figure 7.7 shows Stanstead Abbots). A left click on will select it.

Figure 7.6 Job selector - i

Figure 7.7 Job selector - ii

Figure 7.8 Job selector – iii

Figure 7.9 Job selector – iv

- Location: Where a job has only one location in the configuration file, the Location menu will use it, otherwise it will allow the user to select the one they wish to work on Figure 7.8. The unit number will be extracted from the configuration file and the data displayed in full. This is repeated in the second job selector (blue area) unless there are two locations associated with the job (e.g. a TRS scheme), in which case, both locations will be displayed Figure 7.9.

7.2.4 Manual Tests – Test Traces

Every manual test made from the Control Panel is saved to a file but is displayed in the test trace window rather than the event window. These waveforms are the same as those from a traditional TDR. Test traces are normally acquired when configuring optimum settings on the T-P23 after connection at a new job. They can be used to locate a permanent fault but can also be overlaid on a triggered record to extract additional information. The records show the settings of the gain, pulse width, internal balance (if used) and the range for the test trace and the reference traces.

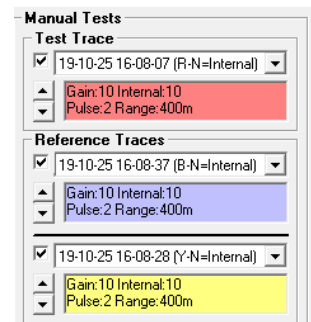


Figure 7.10 Manual test settings

7.3 Control Panel

7.3.1 Overview

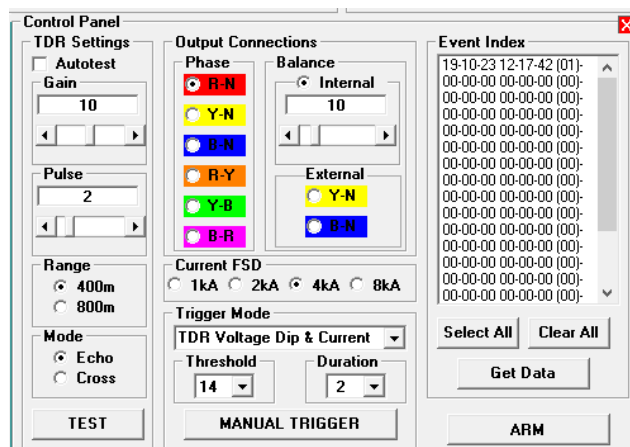


Figure 7.11 Control Panel

When the T-P23 is connected to the PC, the control Panel (figure 5.10) will appear in the bottom left, replacing the Second Event viewer. Note if it is selected from the menu bar (section 5.2.2) it is non-operational.

The control panel is the interface between the operator and the T-P23 and is used to:

- Select range
- Select cores for pulse injection
- Condition the pulse through testing:
 - Gain
 - Pulse (width)
 - Balance
- Select both operating and trigger modes
- Recover records from T-P23 and store them on the computer

7.3.2 Range

The range should initially be set to a value that is longer than the length of the cable under test. There are two ranges available 400m or 800m, which are selected by clicking the appropriate button.

7.3.3 Output Connections

- i. Phase: The test lead is connected to all three phases and neutral and therefore, there are six possibilities of phase-earth and phase-phase available for pulse injection. Normally the most active pair are selected, although the fault condition can change, making it necessary to choose a different combination. This selection is made in the phase panel.
- ii. Balance: The objective of balancing is to try and match the unit to the characteristic impedance of the cable and, as far as possible, to achieve a flat line at the start of the graph by minimising the injected pulse in the TDR viewer. This can be done in two ways:
 - Internal balance: This is a numerical value between 0 and 60 and is based on an internal model of the cable. To set the value, pulses are sent manually in to the cable the create an optimised waveform. If the balance is set to zero, the waveform will resemble Figure 7.11, with a large positive spike representing the injected signal. Conversely, a value of 60 will produce a corresponding negative spike. The starting point is normally a low value, rather than zero. If the waveform is clipped the gain should be reduced until it is fully visible.



Figure 7.11 TDR Viewer; Balance = 0 Gain

Increasing the value of the balance will gradually reduce the amplitude of the outgoing pulse, until the point is reached where the pulse starts to go negative, which will look similar to Figure 7.12. The optimum setting will normally be between 10 and 25



Figure 7.12 TDR Viewer; Optimum

The Gain control can now be increased to maximise the waveform to make the reflection clearer, ensuring it is not clipped as shown in Figure 7.13.

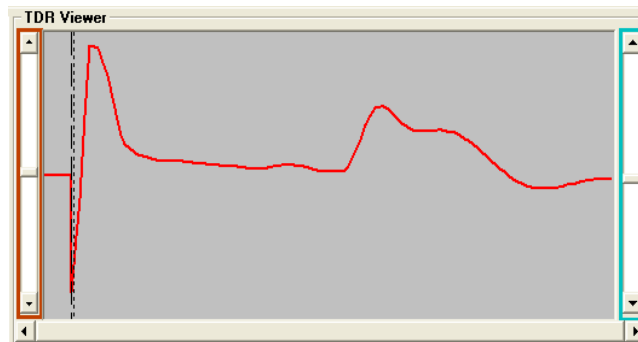


Figure 7.13 TDR Viewer; previous wave-shape with higher gain

- **External balance:** This method uses an adjacent core of the cable to balance against the one being investigated. It produces better balancing than the internal approach as it considers all of the factors, such as the test leads and the electrical connections. However, it cannot be used for single core cables, where branches from the individual cores are unequally spread or in applications where blocking coils have been used to create the open end.

The available configurations for the external balance are indicated automatically when the phase is selected. Figure 7.14 shows that R-Y has been selected as the output connection phase setting, which presents Y-N and B-N as the available external balances. The following options are available:

Phase	External balances
R-N	Y-N , B-N
Y-N	B-N , R-N
B-N	R-N , Y-N
R-Y	B-Y , R-B
Y-B	R-B , Y-R
B-R	Y-R , B-Y

Figure 7.14 External balance options

7.3.4 Current FSD (Full Scale Deflection)

This setting relates to the use of the T-P22 device. As the T-P23 does not have a current input, it can be ignored in this application.

7.3.5 TDR Settings

- Test:** This button injects a single pulse into the cable and displays the result on the TDR viewer, it can be used to check whether the chosen settings produce a suitable trace.
- Autotest:** If this is ticked, whenever a setting change is made a single pulse injection will be performed (as with the Test button), using the new setting and the result will be displayed on the TDR viewer. This will allow the user to see the effect of the new setting so the optimum value is selected.

- iii. Gain: The gain refers to the factor by which the waveform is amplified for display in the TDR Viewer. The gain is adjusted using the slider bar and can be set at a value between 0 and 20. The selected value is displayed on the control panel.
- iv. Pulse: This setting determines the pulse width and can be set from 1 and 8. The pulse width will set to a default value for the selected range but can be increased to inject more energy into the cable. A wider pulse width will travel further but may obscure detail of the fault if it has occurred close to the terminal. Additionally, its leading edge will be less well defined, affecting the accuracy of the measurement.
- v. Mode: this is included to allow the use of the equipment on different sorts of cable. For power cables, it should always be set to Echo.

7.3.6 Trigger Mode

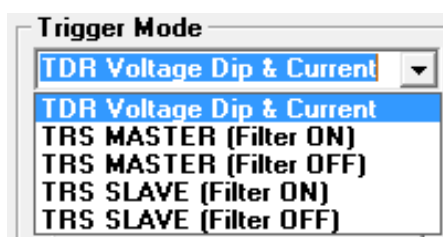


Figure 7.15 Trigger selection

The Trigger mode is selected from a drop-down menu (Figure 7.15).

- TDR mode: There is only one TDR option entitled TDR Voltage Dip and Current. The reference to current relates to the T-P22 device. The T-P23 has no current monitoring available and so this setting refers only to triggering due to a voltage dip.
- TRS mode: The trigger can be set as either a Master or Slave and with or without a filter. The filter analyses the AC data for evidence of fault activity to reject spurious operations and is normally selected to be on. However, with the filter off, the unit will trigger on spikes which will be necessary if it is to be used with Kehui's Marker Unit (TMU-1, see section 8.3). In TRS mode the units are usually configured as Masters. The Slave mode is normally used if a synchroniser unit(T-SU1) is employed to extend the range (section 8.4).

The voltage threshold and the duration of the signal required to trigger the T-P23, have to be selected to make the system as sensitive as possible, without spurious triggers occurring due to noise and other system conditions.

7.3.7 Manual Trigger

The manual trigger button allows the user to simulate a system trigger, injecting 64 pulses into the network and displaying the pre- and post-trigger waveform on the event viewer.

7.3.8 Event index

This will populate when a connection is made to the T-P23 and will list the last twenty records that have been captured. Records that are marked "+" have already been downloaded and saved to the host computer. Those that are marked "-" are new and need downloading. Selected records have a blue background and can be chosen by clicking on them individually or by using the "select all" button, if they are selected incorrectly the "clear all" button will deselect them. The records are downloaded by left-clicking "Get Data".

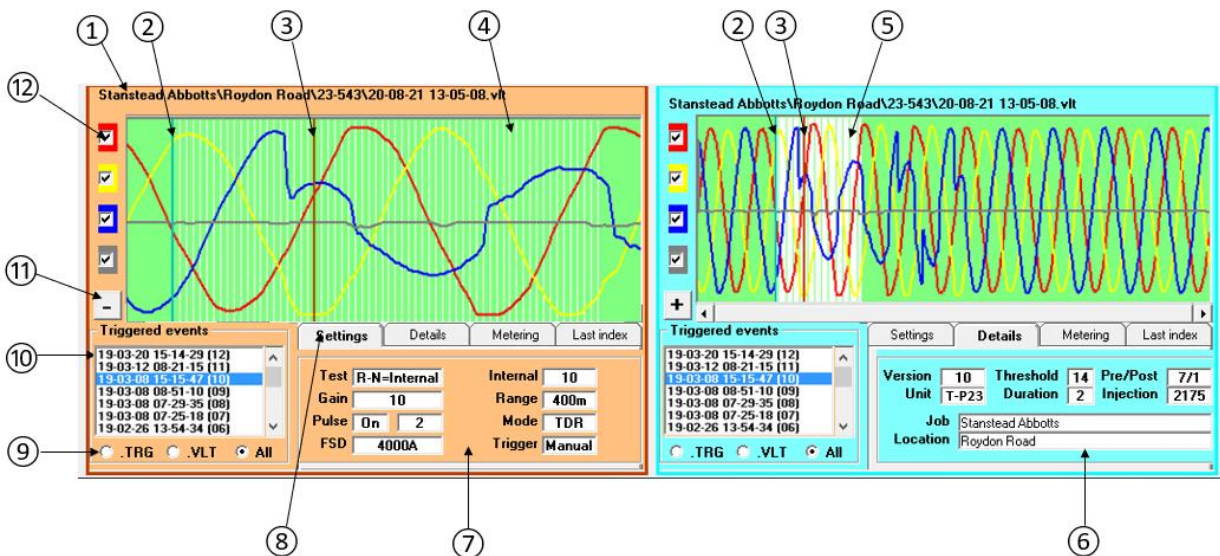
7.3.9 Arming the device



After successfully connecting to the T-P2X Master all six phase to neutral and phase to phase traces should be recorded. When recording phase to phase, the Balance should be reset as the parameters are different for phase to earth connections. This helps when finding the distance to the fault as all the possible combinations of healthy wave forms are available for comparison with traces obtained under fault conditions.

To put the device into service, click the Arm button on the control panel. A message will appear asking if the device should be armed using the current settings and whether they are correct. Clicking 'Yes' will arm the device.

7.4 A.C. Event Viewer



- ① File name including location
- ② Moveable blue cursor
- ③ Moveable brown cursor
- ④ White lines representing TDR pulses
- ⑤ TDR trace area
- ⑥ Details tab
- ⑦ Settings Tab
- ⑧ Tab selection
- ⑨ File type selection
- ⑩ Triggered event list
- ⑪ Trace contraction/expansion button
- ⑫ Trace show/hide selection

Figure 7.16 AC Event Viewer

The AC waveform window gives a visual indication of the event. In the example shown in Figure 7.16 the two A.C. waveform viewers are displaying the same waveform.

The title bar ① details the job/location/unit/record date time, indicating where the unit is situated and when the event took place. The record being viewed is highlighted in blue in the Triggered Event list situated in the bottom right of the view ⑨. Different records can be selected for display and analysis in this list by left-clicking on the date/time.

In Figure 7.16 the right-hand window shows the full ten cycles of the event while the left-hand viewer has zoomed in to the trigger point ⑤, which is normally the area of interest. In this case, the event is a fault on the Blue (L3) phase. Note that the waveforms on the left can be expanded by clicking on the '-' symbol ⑪ in the bottom left of the trace, which will then change to the '+' symbol, as can be seen on the right-hand trace. This can be reversed by clicking on the '+', which will revert to '-' increase the number of cycles visible.

The left-hand window shows the trigger point in detail and includes sixty-four vertical white lines (3). Each of these lines represents a TDR record with the change in voltage occurring at approximately, the twelfth TDR record. The blue cursor (4) is positioned in the healthy part of the waveform but can be moved by right-clicking it in the brown (left) viewer or manipulating directly it in the blue viewer on the right (the cursor will move in both windows). The brown cursor (2) is moved to the faulty section of the waveform in the brown viewer or by right-clicking it in the blue viewer. Both cursors can be moved within the window to compare the healthy and faulty sections of the waveform. The associated TDR waveforms are then displayed in the TDR viewer for analysis.

The coloured check boxes on the left-hand side of each of the viewers (11) allow individual phases to be switched on or off, which can assist the analysis by bringing more clarity to the view of the phases under investigation. When using the T-P23, it is good practice to disable the grey current trace, as no current is being measured.

The settings tab (6) adjacent to the triggered events list, shows the control panel settings for this record.

7.5 TDR / TRS Viewer

The TDR viewer displays the waveforms. It can be used to analyse all TDR waveforms whether they are obtained manually, through the test button, or automatically from triggered records.

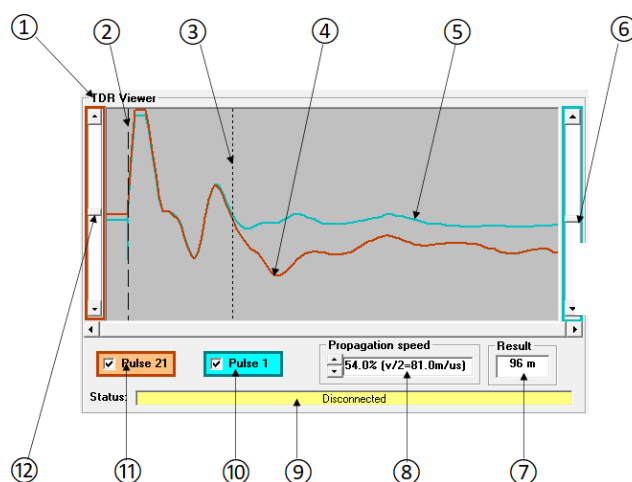


Figure 7.17 TDR/TRS Viewer

- | | |
|---|--|
| ① Title (changes to TRS when alternative mode selected) | ⑦ Distance to fault in metres |
| ② Dashed cursor | ⑧ Propagation speed (m/μs and % of the speed of light) |
| ③ Dotted cursor | ⑨ Status of connection to T-P23 unit |
| ④ Brown trace (corresponds to brown cursor in event viewer) | ⑩ Blue pulse number and enable |
| ⑤ Blue trace (corresponds to blue cursor in event viewer) | ⑪ Brown pulse number and enable |
| ⑥ Blue trace vertical shift | ⑫ Brown trace vertical shift |

The traces are selected in the event viewer by moving the brown and blue cursors (figure 7.4) to appropriate places on the event waveform, the number of the TDR pulses with which the traces are associated are in the blue and orange boxes (10) and (11). The ticks in the boxes can be deselected to hide the corresponding trace.

The corresponding TDR traces ④ and ⑤ will appear on the TDR viewer. There are two vertical cursors that can be moved. The dashed cursor ② is normally fixed at the start of the waveform, whilst the dotted cursor ③ can then be moved to the point where the waveforms diverge to determine the distance from the start-point. In order to get the best alignment for comparison purposes, the two traces can be moved vertically using the sliders ⑥ and ⑫.

Where a point on a waveform represents a known point on the cable it can be useful to move the first cursor to use as a reference. This is done by moving the dotted cursor to the required point and right clicking the mouse, which will move the dashed cursor to the same point. The horizontal axis of the trace represents time, which is automatically converted in to the distance to fault ⑦ by multiplying the time by the propagation speed ⑧. This speed can be adjusted by using the arrow buttons to the left of the box.

Combinations of manual and fault records can be displayed simultaneously if required, which may provide a clearer reference than that obtained automatically.

8. TDR Testing Examples

8.1 Earth fault

The following steps illustrate the fault investigation process using an example where a transient fault between the red phase and neutral, triggers the device.

Connect a PC to the device and then, using the Event Index (figure 8.1), select the most recent event. The T-P2X can hold up to 20 records on its internal memory. The (-) in front of the record shows that the record has not been down-loaded to the PC. The (+) in front of the record shows that it has.

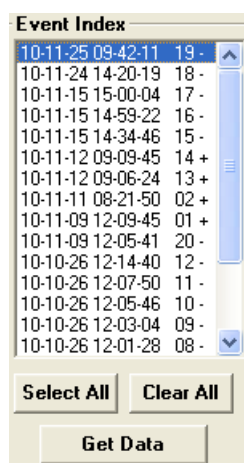


Figure 8.1 Event Index

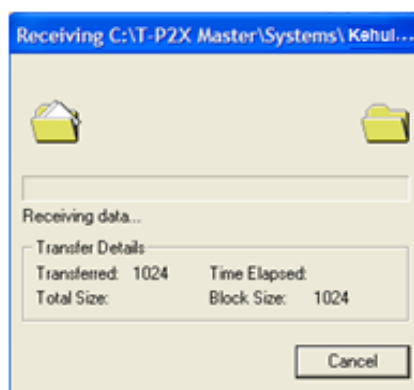


Figure 8.2 Data transfer

To download a record, click on it followed by Get Data (figure 8.2), alternatively double-click it. The software will then start to download the record on to the PC. After the record finishes downloading the (-) will change to a (+), showing that the record has already been extracted.

Using the Main Event Viewer, click to select the latest record on the Triggered Events record list. This will bring up a trace on the Event Viewer (figure 8.3).

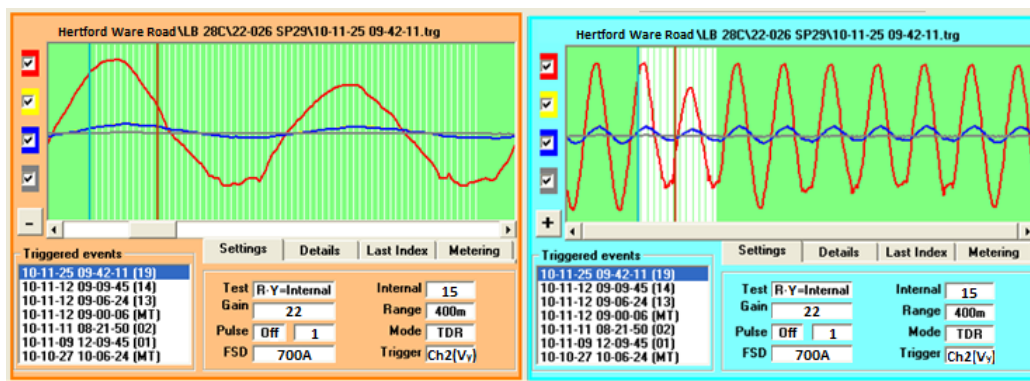


Figure 8.3 Event viewer

On the brown viewer (left), the cursor can be moved by left-clicking it and moving the mouse. Alternatively, left-clicking at any point on the trace moves the cursor to that point, the brown cursor on the blue event viewer (right) will move proportionally. As the cursor moves, the traces on the TDR viewer will also change, reflecting the records represented by the white lines on the event viewer. The cursor can be moved to any one of 64 pulses injected into the cable shortly before and during the fault.

The blue cursor can be moved in a similar way on the brown viewer but with right-clicks, it is normally kept at a point on the graph where the circuit was still healthy. When operating in the blue event window, the controls are reversed. Note that moving a cursor in either window, will move the corresponding cursor in the other one.

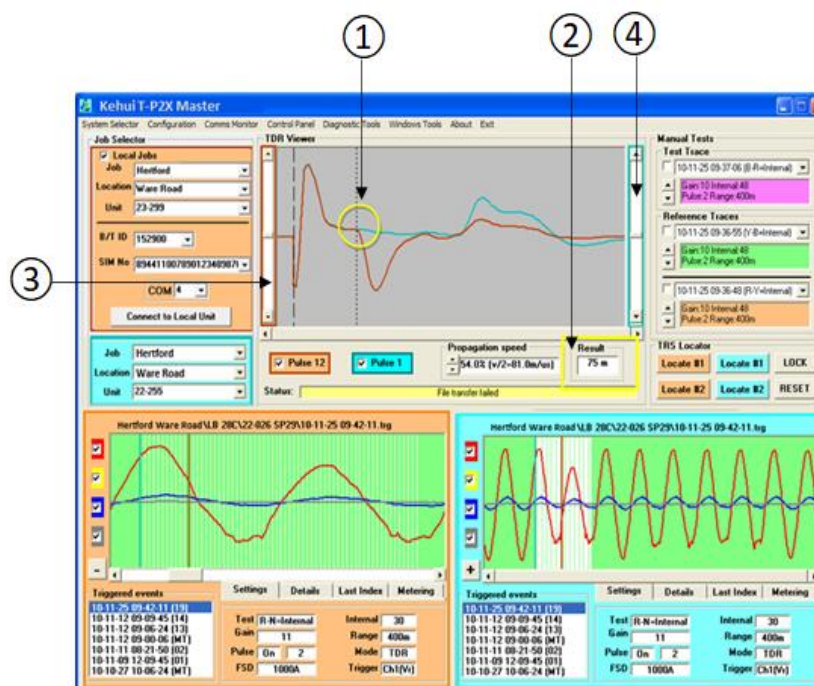


Figure 8.4 Fault investigation

- ① Both traces can be viewed together to find the point where the waves start to separate. This is the start of the fault.
- ② The distance to fault from the fault locator is displayed in the Result box in meters.
- ③ and ④ If the traces do not align, they can be moved vertically using the two scrollbars highlighted in brown and blue.

The location of the fault can be confirmed by going through the following steps:

- i. Observing the traces corresponding to each pulse to confirm the point that the two traces start to separate.
- ii. By using one of the traces recorded before arming the device and comparing it to the trace obtained under fault conditions. A zoomed-out version of the trace is shown on the second (blue) event viewer. In this case, observing the waveform shows how the voltage dropped during the fault and then recovered afterwards.

8.2 Branched Networks

Where the network splits, it introduces additional routes for the TDR pulse to travel before it is reflected back to the device. In addition to the actual fault the TDR signal will also reflect from the end of each branch. In view of this care must be taken to interpret the recorded waveform.

In the example shown, the most suitable open end is at a Mini-Pillar which is on a branch, situated 87m from the substation source (Figure 8.5).

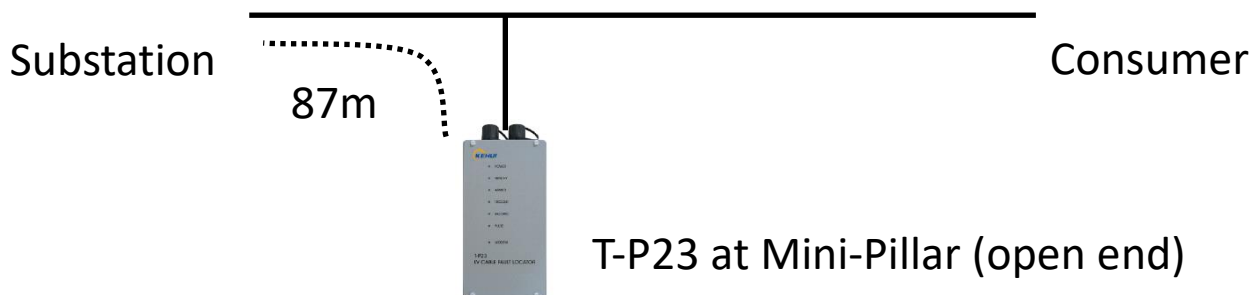


Figure 8.5 Branched network

When a fault occurs on the system it triggers the T-P23, during the recording period the fuse at the substation ruptures in response to the fault and both events appear on the recorded waveform. Moving the cursor to the first part of the disturbance allows the comparison of the TDR trace under fault conditions, with a healthy trace. Moving the cursor further to the right, brings it to the point that the fuse blows, again the TDR trace can be compared to a healthy condition. Manipulating the cursor on the trace reveals both the distance to the fault and the distance to the substation. As the distance to the substation is known, it can be ignored, leaving the other Figure as the distance to the fault. (Figure 8.6).

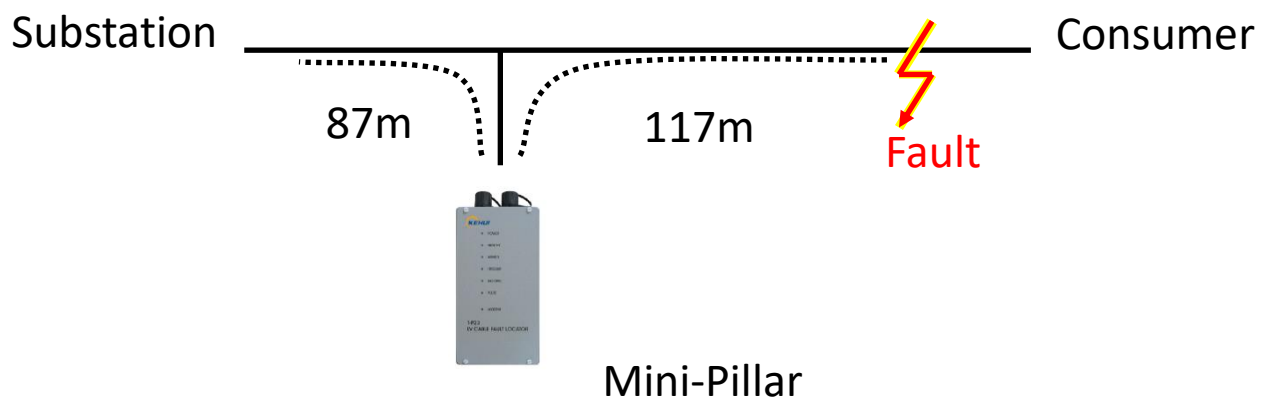


Figure 8.6 Branched network during fault

The resulting waveforms and TDR traces are shown in Figure 8.7.

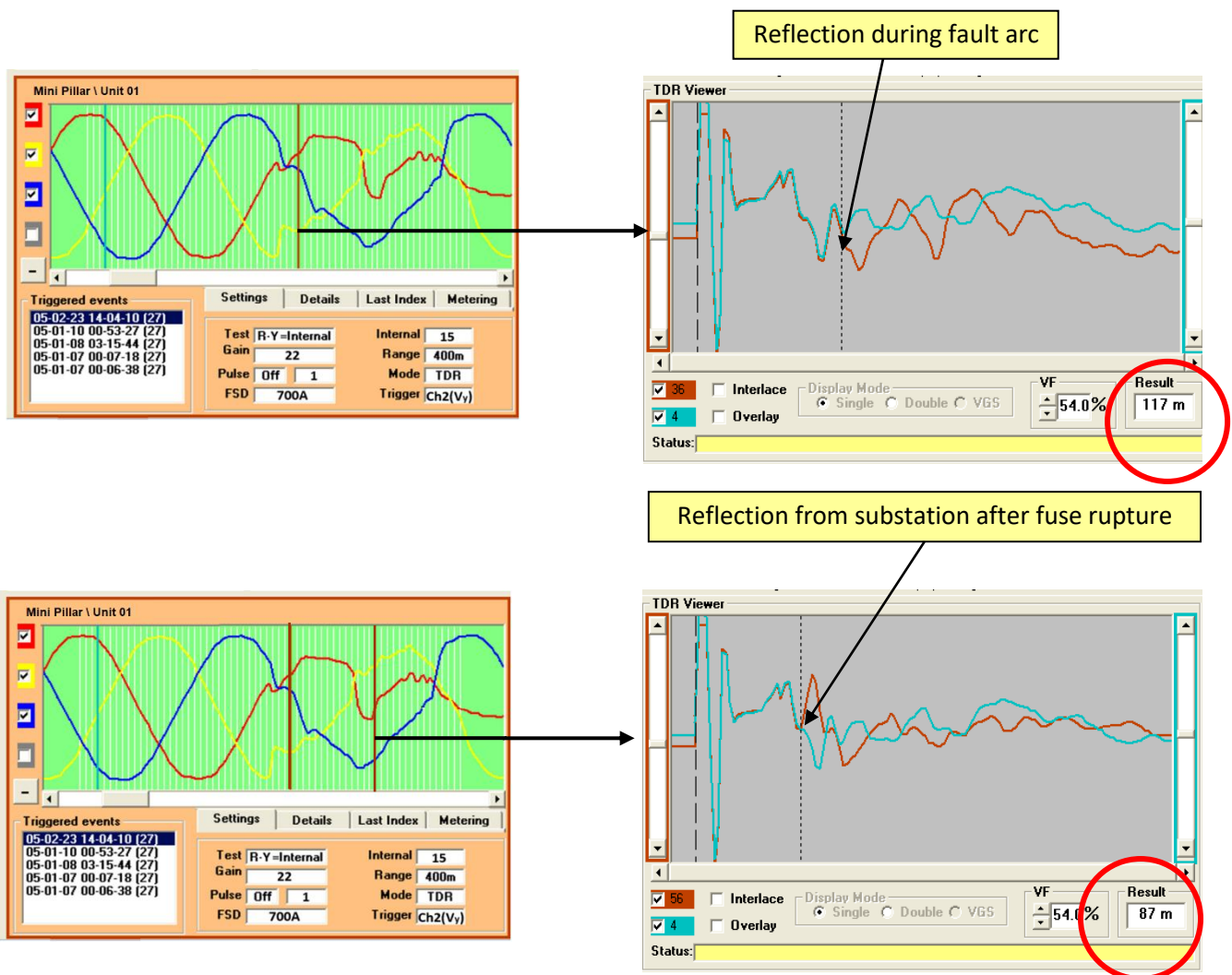


Figure 8.7 Disturbance caused by fault

9. TRS Testing Examples

The example below (Figure 9.1) shows a suspect cable with one T-P23 units connected at a link box (end A) and one at the substation (end B). The distance between the two ends is D_{AB}

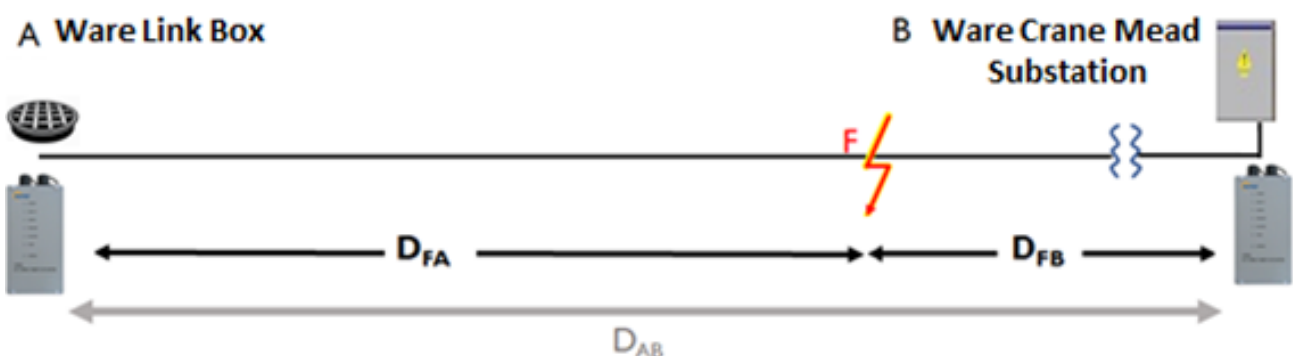


Figure 9.1 TRS system

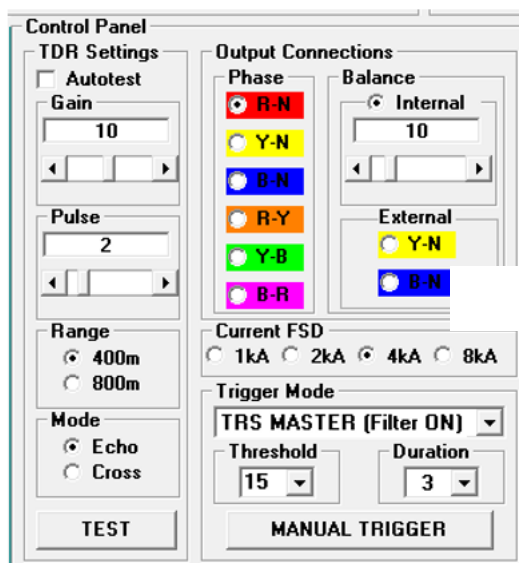


Figure 9.2 Control Panel

To set the unit for TRS Mode, the appropriate Trigger Mode is selected. Figure 9.2 shows the unit in TRS Master mode with the filter on. The options are:

- TRS Master mode with the filter on: The normal setting for TRS mode
- TRS Master mode with the filter off: Used when the T-P23 is used in conjunction with a marker unit T-MU1 (see section 5.3)
- TRS Slave mode with the filter on: Normally used when the T-P23 is used in conjunction with a synchroniser unit T-SU-1 (see section 5.4)
- TRS Slave mode with the filter off: Normally used when the T-P23 is used in conjunction with a synchroniser unit and a marker unit

When the fault ignites, travelling waves will be sent to the two ends with the waveforms at the substation and link box being recorded as in Figures 9.5a and 9.5b respectively. These can be downloaded manually, using a Bluetooth connection, or accessed remotely.

The user can then examine the waveforms from the two ends by selecting the appropriate traces from the Triggered events lists in the bottom right of the two event viewers.

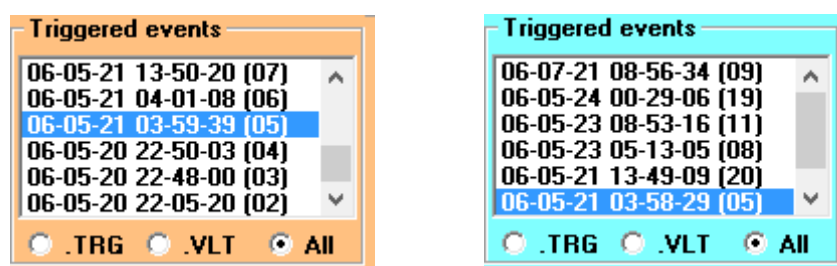


Figure 9.3 Event viewers showing “Triggered events” record lists

As the traces resulted from the same event the date and time of corresponding events should be the same. However, as can be seen in Figure 9.3, because the clocks in each unit are not synchronised (or are synchronised infrequently by remote signals) there may be a slight mismatch. Comparing the traces will confirm that the events are the same, as they will share similar characteristics (e.g. the “notch” out of the blue phase in Figure 9.4).

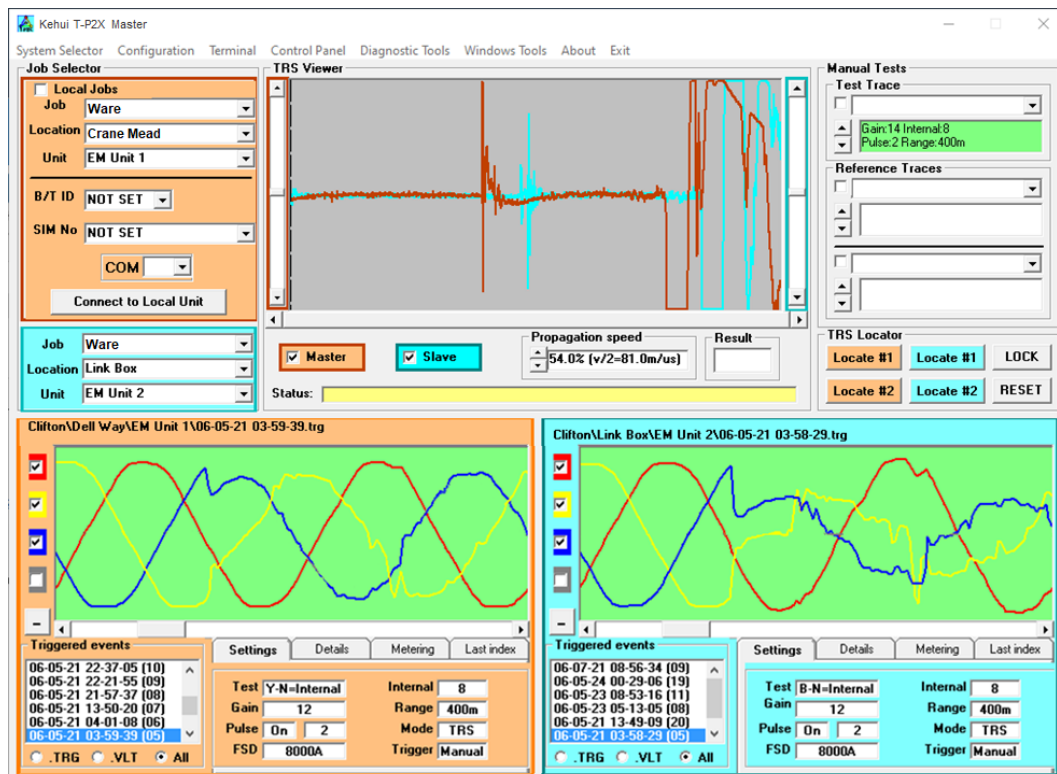


Figure 9.4 T-P2X Master showing disturbance records from the T-P23 units at each line end

The display differs from that on the TDR in a number of ways; the TDR viewer is renamed TRS viewer. The white lines representing the TDR pulses are no longer visible on the waveform viewer, as they are not relevant and their associated pulse numbers in the central orange and blue boxes are replaced with the label Master or Slave, depending on the setting. The traces at each end are shown in Figures 9.5a and 9.5b.



Figure 9.5a TRS Trace end A



Figure 9.5b TRS Trace end B

By ticking both the orange and blue boxes, the two traces are combined (Figure 9.5C)



Figure 9.5c TRS Traces end A and B combined

The next step is to synchronise the two ends. This is achieved by dragging the dotted cursor to an identifiable feature on the brown waveform (Figure 9.6a) as indicated with the red arrow.

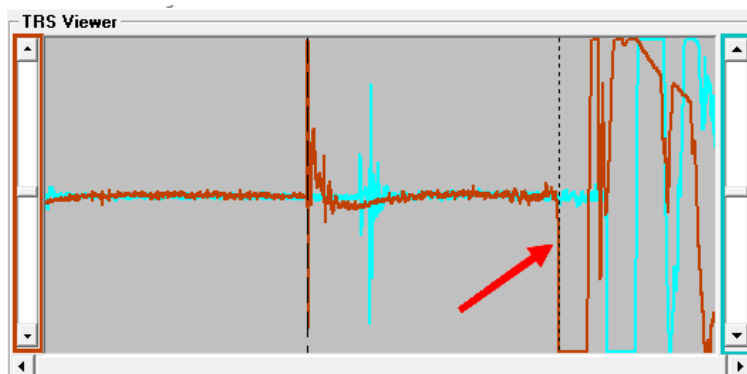


Figure 9.6a cursor positioned on brown trace feature



With the cursor is in line with the feature, right click the mouse. This fixes the cursor on to the feature and changes its form to a dashed line. It also releases a second dotted cursor which is positioned over the corresponding feature on the blue trace (Figure 9.6b)

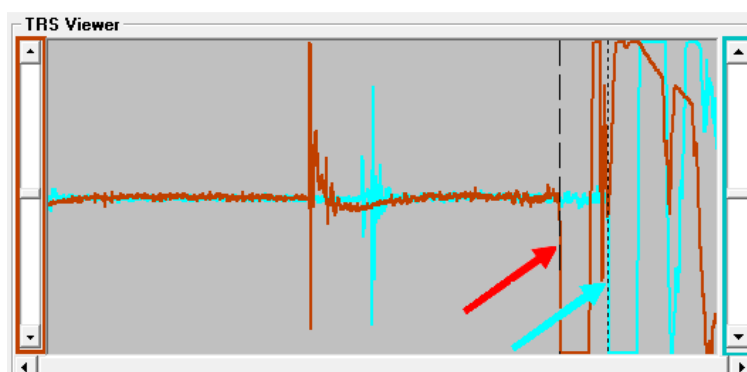


Figure 9.6b cursors positioned on corresponding features on the two traces

Once the cursors are positioned press 'LOCK' on the TRS Locator (figure 9.7), which causes the two traces to move together (Figure 9.8).

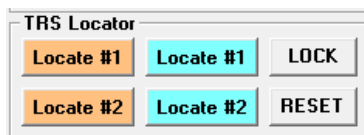


Figure 9.7 TRS Locator

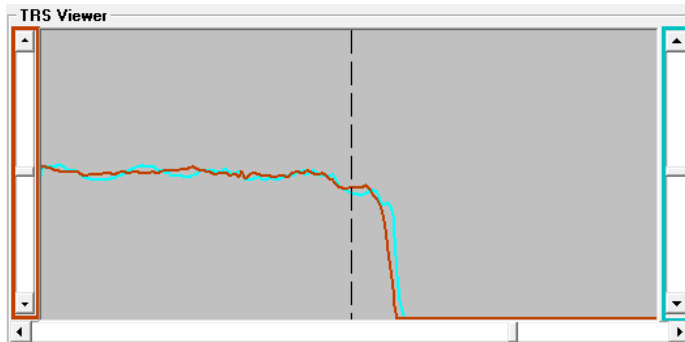


Figure 9.8: Synchronised traces

If the traces are poorly synchronised, they can be adjusted by moving the cursor and pressing 'LOCK' again. Alternatively, 'RESET' will return the screen to Figure 9.6A for the process to be repeated.

Now the two traces are synchronised, pressing 'Locate #1' in the orange window will expand the trace to show the arrival of the travelling wave from the Slave end. The dotted cursor is moved to the start of the rise in the blue trace as shown in Figure 8.9a. The corresponding distance-to-fault is displayed in metres in the 'Result' window. The result is calculated from the time measured at the point the cursor is positioned and the propagation speed.

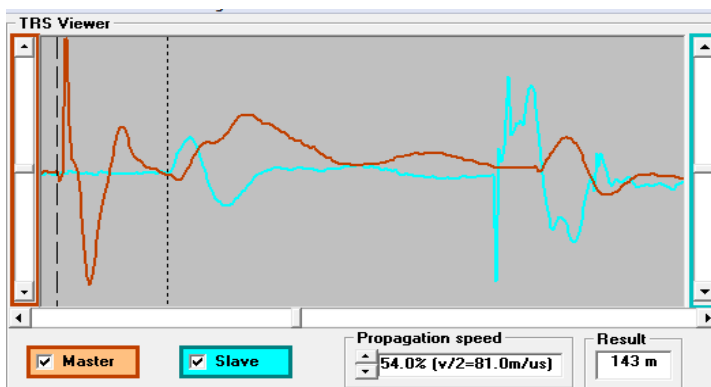


Figure 9.9a: fault location from the 'Master' end

When both units are set as Masters a confirmatory location can be obtained from the Slave end by selecting Locate #1 in the blue window (figure 9.9b)



Figure 9.9b fault location from the 'Slave' end

10. Voltage Gradient

Three or more Kehui T-P23 units can be used for Fault Location using the Voltage Gradient method. They are connected at appropriate locations, in the same way as when used in TDR mode and set to trigger on the fault.

In this approach the T-P23 is used as a meter to capture the instantaneous voltage at particular measurement points. The measurement must be taken at exactly the same instant in time, as selected using the cursor. In the section of cable between the source and the fault the voltage will decrease in a linear fashion, whereas past the fault point, the voltage will be at a minimum and constant. By plotting the instantaneous voltages at a specific time, against the known resistance between the measuring points, a gradient is formed. By relating the resistance to the physical distance, the approximate position of the fault can be found from the intersection of this line with a horizontal line drawn at the voltage level beyond the fault point, as seen in Figure 10.1.

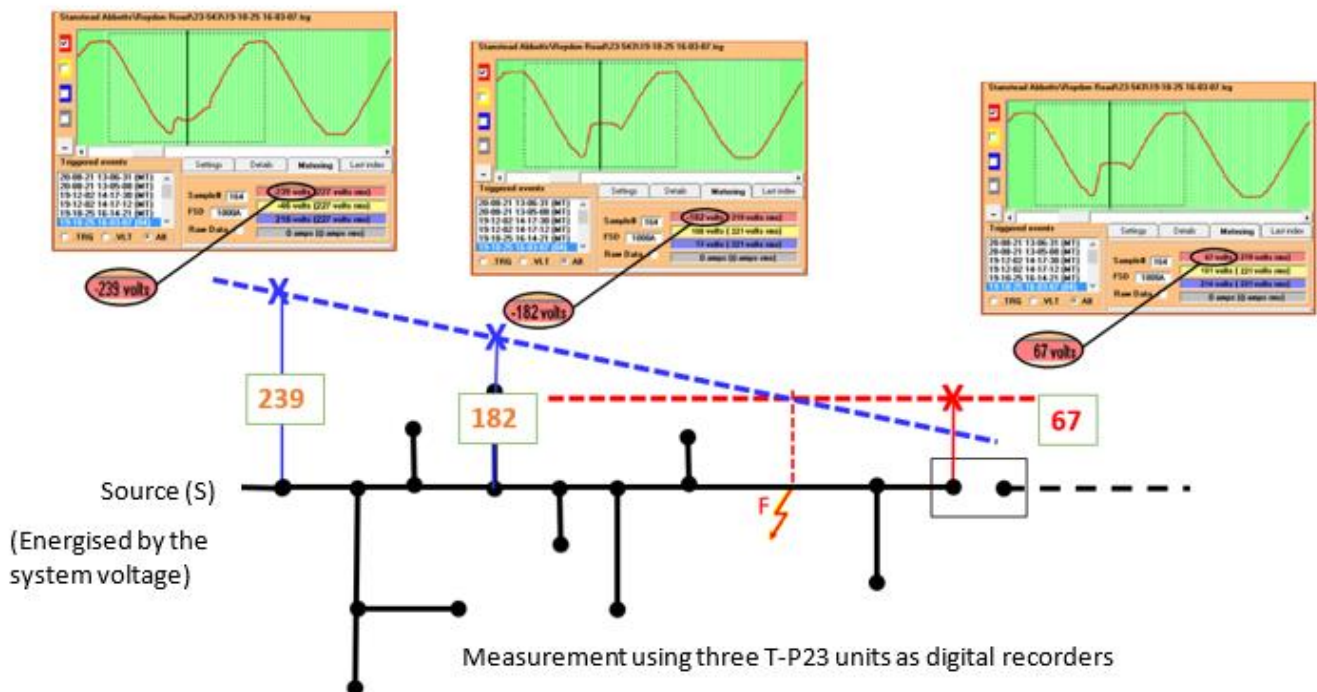


Figure 10.1 Voltage gradient location of arcing faults

The calculation to find the distance is:

$$D_{SF} = \frac{V_S - V_f}{V_S - V_r} D_{S1}$$

Where: D_{SF} is the distance from the source to the fault
 D_{S1} is the distance from the source to measurement point 1
 V_S, V_r, V_f are the voltages at the three measurement points

This method only works if the resistance of the cable is proportional to its length. If there is a mixture of cables of known length, a calculation aid (VGS Master) is available from Kehui to calculate the fault position.

11. Faulted Branch Identification from Voltage Analysis

Positioning T-P23 units at different points on a branched network allows the user to analyse the triggered waveforms and identify on which branch the fault has occurred. Figure 11.1 shows a branched network with TDR1 connected at the source and three other T-P23 units connected to the branches.

A transient red (L1) phase to earth fault occurs on one of the branches which results in the waveforms shown. Note that the displays for the yellow (L2) and blue (L3) phases have been turned off by unchecking the tick-boxes to the left of the display. As these are T-P23 units there is no current input and so the current trace tick-box is also unchecked. As no current is being measured the reading in the grey meter box should be disregarded.

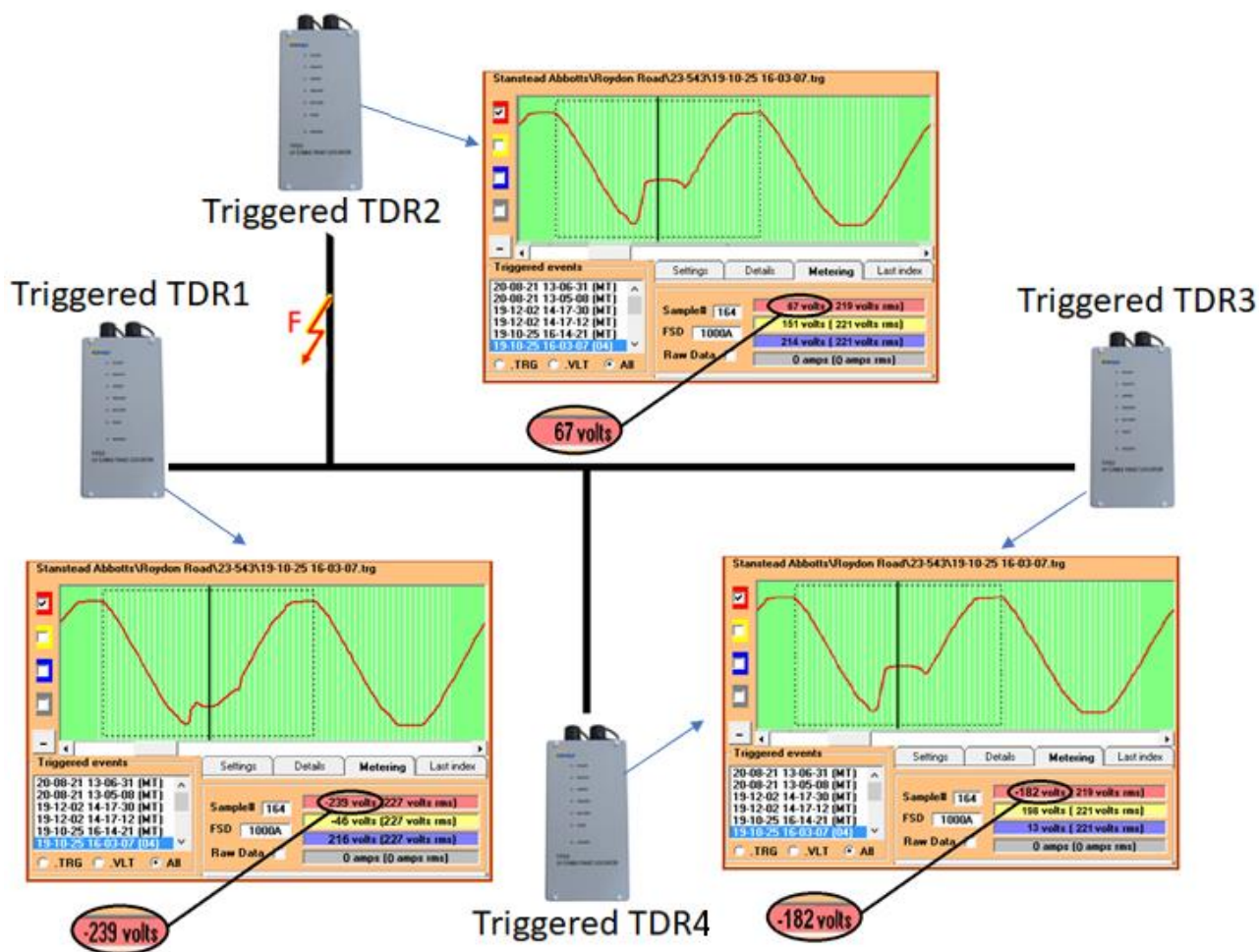


Figure 11.1 Branch analysis

On each the waveforms captured by the TDRs, the cursor has been positioned at the same point during the arcing period of the fault. As can be seen in this example, the voltage in this instance, varies between the locations. At the source (TDR1), the voltage is -239V whereas positions TDR 3 and TDR4, the traces are identical and the instantaneous voltage on the red phase is -182V (The lower figure is due to the voltage drop caused by the flow of fault current in the first section of cable). However, the voltage on the other branch (TDR2) is much lower at -67, indicating that this is the branch containing the fault.

12. Remote communications



T-P23 is provided with remote GPRS communications through the insertion of an appropriate SIM card in the internal modem. The SIM card will normally be added during the manufacturing process. If a specific type is required (e.g. to work with a customer's favoured network), the cards would need to be supplied to Kehui, prior to delivery. Retrospective fitting of SIM cards is possible, but this process would be subject to a separate instruction.

The provision of the SIM card and the aerial with the T-P23, allows it to be interrogated and set remotely. In addition, the device can provide auto-reporting whenever an event occurs, allowing the server to alert the user through text message or email. The system also polls the equipment on a regular basis to obtain data for the period since the previous poll.

The SIM card allows the equipment to communicate with any suitable GPRS enabled server but, in practice, most units in service utilise the *iHost*® system available from Nortech of the UK, although the service is available internationally.

The following is a description of how the T-P23 can be set and interrogated using *iHost*®. To have access to *iHost*®, the user has to purchase a time-limited licence for each unit, either from Kehui or directly from Nortech. The *iHost*® software has its own help system, whereby the user can hover over elements with the cursor and, after a short delay, a short description will appear.

12.1 Logging In

The address of *iHost*® is <http://www.nortechonline.net/iHost/>. The account is set up by Kehui or Nortech using user names and passwords supplied by the user. Passwords can subsequently be changed by the local administrator

The user names are not case sensitive; however, passwords are.

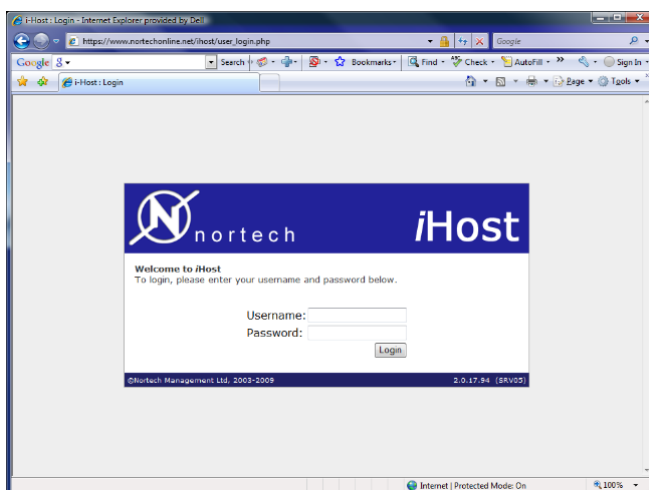


Figure 12.1 Login page

When the user accesses the system, the layout is as shown in Figure 12.1 (section 12.2). It should be noted that this is a standard *iHost*® interface, applicable to equipment from numerous manufacturers, and there are a number of features which are not applicable to the T-P23.

12.2 System Overview

The screenshot shows the iHost System Overview page. The browser address bar displays 'nortechonline.net/ihost/index.php'. The page title is 'System Overview, T-P2X Units'. The left sidebar shows a file tree under 'All Units' with folders for 'Herts. Units', 'Essex Units', and 'Harlow'. The main table lists units with columns for Serial No., Job, Location, Last Communication, and Communication Status. Callouts 1-16 identify specific UI features: 1 (File list), 2 (Print icon), 3 (Column editing), 4 (Acknowledge icon), 5 (Export icon), 6 (Serial No. header), 7 (Job header), 8 (Location header), 9 (Quick access menu), 10 (Last Communication header), 11 (View dropdown), 12 (Communication Status header), 13 (Unacknowledged message), 14 (Acknowledged message), 15 (Unit out of use), and 16 (Total RTUs).

Serial No.	Job	Location	Last Communication	Communication Status
89441000301632900000	Stanstead Abbots	Roydon Road	16/10/2020 11:04:00	Successful
89441000302420124201	Harlow	1st Avenue	15/10/2020 23:14:05	Successful
89441000302420138944	St Margarets	Station Rd.	15/10/2020 23:12:26	Successful
89441201202420124201	Bengeo	Hertford Rd	29/09/2020 18:07:52	Successful
89441000302420135089	Wadesmill	Ware Rd.	28/09/2020 11:09:22	Ring Back Requested
89441013502420135089	Sacombe Green	Office	28/09/2020 10:06:32	Comms Failed
8931089318118891611	Ware	Mill Studio	No Contact	Timed Out: No Response
7 RTUs				

- ① File list to organise devices
- ② Print view select icon
- ③ Column editing button
- ④ Tick to acknowledge all unread messages
- ⑤ Export to .csv file (compatible with Excel™)
- ⑥ Serial number (SIM cards)
- ⑦ Job name
- ⑧ Location of unit
- ⑨ Quick access menu
- ⑩ Time of last communication from unit
- ⑪ Result filter (not used in T-P23 application)
- ⑫ Communication status column
- ⑬ Unacknowledged message (bold type)
- ⑭ Acknowledged message (non-bold type)
- ⑮ Unit out of use (grey type)
- ⑯ Total number of T-P23 units (designated as RTUs in iHost®)

Figure 12.2 System Overview

The System Overview can be configured by the user, Figure 12.2 shows a typical layout. The file structure ① allows the location of the units to be stored in a logical way to allow easy access. It is important that specific units (identified by their serial numbers) have the correct locations allocated, otherwise the records will be misleading.

The event status of the unit can be determined by the font of its entry in the table. Bold, blue type indicates an event has occurred and data is available to be accessed, normal blue type indicates that there is no data to be accessed or unread data has been acknowledged using the ✓ symbol ④. Grey print indicates that the unit has been parked and is not currently available.

The order of the events can be amended by clicking on the header of the column the user wants to sort by. For example, clicking on the “Last Communication” column will put the events in time order.

By clicking on the column editing button (③ in Figure 12.2), the screen shown in Figure 12.3 appears which allows the display to be customised. Most of the available columns are not relevant to the T-P23, however if the user does want to add one, it is highlighted in the “Available Columns” list.

Clicking on the right-facing arrow in the middle of the display will move the chosen heading to the “Selected Columns” and delete it from the “Available Columns” list. The new column can then be moved relative to the other columns by use of the “Move Up” and “Move Down” buttons on the right-hand side of the screen. Conversely, selecting a column using the “Selected Columns” list and pressing the left-facing arrow, will remove that column. The Selected Columns list can then be confirmed by pressing “Save”, which will return the user to the main screen. Alternatively pressing “x Cancel”, will return the user to the main screen without making any changes.

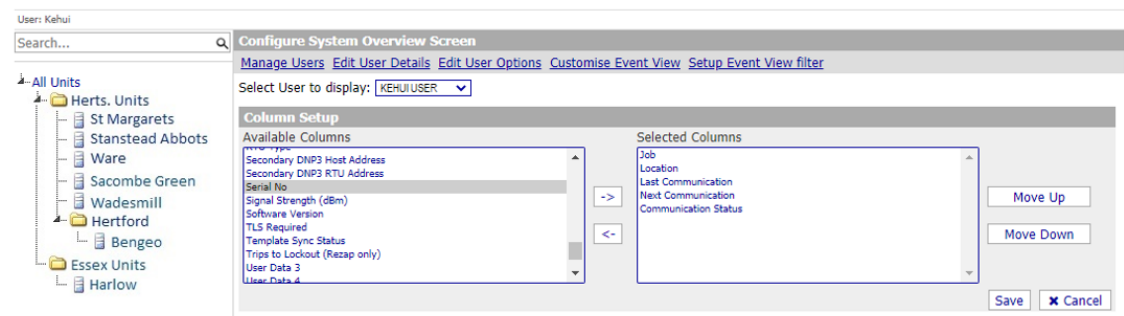


Figure 12.3 Column editing screen

Right-clicking any one of the units listed in the Systems Overview will bring up a sub-menu (Figure 12.4)



Figure 12.4 Systems Overview sub-menu

On this menu “View events” takes the user to the Event Log view (Figure 12.26), for that unit; “Acknowledge All Events” and “Delete” are self-explanatory. “View Unit Overview” allows a particular unit to be inspected, bringing up the Unit Overview screen (Section 12.6) which allows access to several key functions.

12.3 Configuration

Setting up the system can be achieved by clicking on the “Configuration” tab in the Quick Access Menu ⑨, which brings up the System Configuration menu (Figure 12.5).

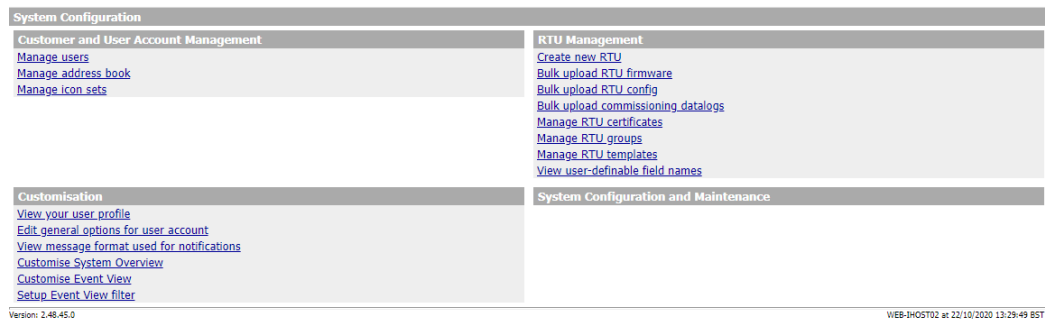


Figure 12.5 System Configuration menu

There are a number of links on this page, some of which are not relevant for the T-P23 or duplicate commands available elsewhere in the menu.

Key links include:

- Customer and User Account Management:
 - Manage Users: allows the administrator to add the details of people who are to have access to the T-P23 units. Within the tab, clicking on the “New User” button allows the individual’s credentials to be added, this process requires the creation of a password with greater than 12 characters. Once the new user is created, the name will appear on the user list, from where its details can be examined or the user can be deleted. Manage address book: provides a list of users and their emails. The edit function allows their email to be changed and gives the option for the administrator to enable or disable their access.
 - Manage address book: gives an overview of the users on the system, with an edit function available
- RTU (Device) Management
 - Create new RTU: The format of the set up is based on a template selected from a list. The templates can be edited through the “Manage Templates” link at the top of the “Create RTU” page or directly from the configuration menu. It should be noted that in the template “Serial Number” refers to the number of the SIM card used in the T-P23. The other reference “Serial No” is not essential but can be used for the serial number of the T-P23 device.
 - Manage RTU Groups: This allows the file list (① in Figure 12.2) to be reorganised so that the group folders are renamed

12.4 Unit Overview

The Unit overview screen is shown in Figure 12.6. Each of the coloured sections is described in the following sections.

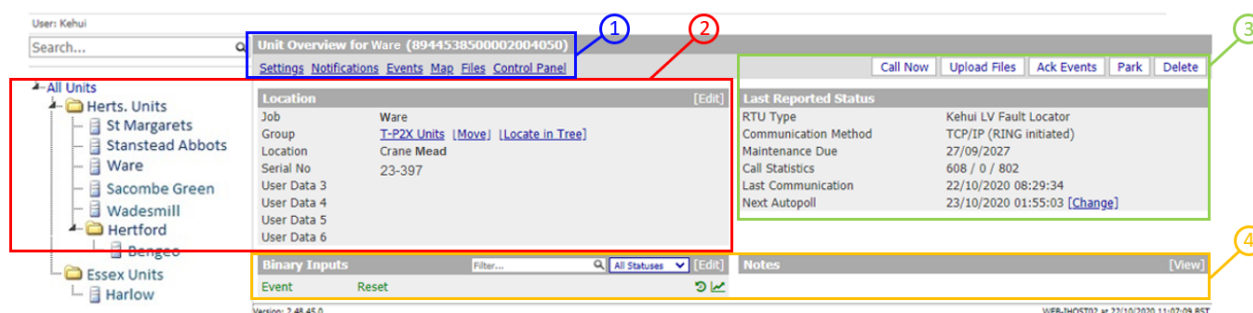


Figure 12.6 Unit overview

12.4.1 Unit Overview Section 1

The Unit Overview refers to a single device identified by its current location and SIM serial number. For example, in Figure 12.6 the unit is Ware 8944538500002004050.

i. Settings

The settings of a unit can be changed from the “Settings” tab in the top-left menu of Figure 12.6. This brings up the screen shown in Figures 12.7, 12.8 and 12.9. Any changes in this data will be recorded by *iHost*®:

Figure 12.7 Unit Setup tab

Figure 12.8 Auto Poll tab

The settings in Figure 12.7 define the set-up of the T-P23 (RTU) in the network. Care should be taken that this group is correct, to ensure data received from the unit refers to the geographical location expected.

The RTU SIM settings provide the phone number needed for the *iHost*® server to connect to the T-P23 and the SIM's serial number which defines the unit; both of these will be provided by the supplier of the SIM card fitted to the device. Normally, the "Call Hold Time" should be set to 100 Seconds and "Comms Method" to TCP/IP (ring initiated) as shown. The RTU IP Address or the RTU Listen Port will be set depending on the type of SIM card being used, this information is normally available from the SIM card provider. This section also allows a maintenance alarm to be set-up, with a time interval in accordance with the organisation's regulations.

Figure 12.8 shows the Auto Poll tab on which the auto poll feature is set. In the example shown, the *iHost*® server will poll the unit once a day at a time between midnight and 6am.

The third tab "User Data" (Figure 12.9) allows additional information to be added, notably the location. It is important that this is updated if the T-P23 is moved.

Figure 12.9 User Data tab

The Limits tab controls the number of notifications sent, with an alarm being provided when the number is exceeded. The Binary Input tab refers to the event trigger, which should not normally be amended for the T-P23.

ii. Notifications

The *iHost*® system allows the user to be notified when an event occurs, the notification can be sent as an email or an SMS message, whichever is preferred. Click on "Notifications" in the Unit Overview page, which will give the RTU Notification Setup page (Figure 12.10), this shows any existing notifications that have been set.

RTU Notification Setup - Serial Number: 8944538500002004050, Ware

[Unit Overview](#) [Unit Settings](#) [Address Book](#) [Notification Format](#) [Add New Notifications](#) [Copy All](#)

Enabled	Point	Event	Custom SMS Text	Notification Restriction	Select
	John Smith (john.smith@kehui.com)	Copy Change Person			.
✓	Event	Triggered		None	<input type="checkbox"/>
	John Smith (+447800285060)	Copy Change Person			.
✓	Event	Triggered		None	<input type="checkbox"/>

With selected: [Delete](#) [Go](#) [Cancel](#)

Version: 2.48.54.0 WEB-IHOST02 at 29/10/2020 17:29:08 GMT

Figure 12.10 RTU Notification Setup page

The following actions are available:

- Select the entry by clicking on the box under “Select” on the right
 - Select “Delete” and click “Go” to delete the entry
 - Select “Enable” from the drop-down menu and click “Go” enables the notification
 - Select “Disable” from the drop-down menu and click “Go” disables the notification
- Select “Change Person” to show the address book with a drop down menu, allowing the correct person to be selected; clicking on “Save” will amend the notification recipient.
- Select “Copy” to add an additional person as a notification recipient. The address book with a drop down menu will appear, allowing the required person to be selected; clicking on “Save” will confirm the choice.

Clicking “Add New Notifications” shows the address book allowing a recipient to be selected. Clicking “Next” brings up the screen in Figure 12.11; for the T-P23, this should already be selected as “Event” and “Triggered” as shown. Clicking “Finish” creates the notification.

Create Notifications

[Back](#) [Finish](#) [Cancel](#)

Available Events

Please select from the Points below:

RTU Event Source

Available Events for Event:

Triggered ☒

Event ☐

Binary Input Closed (Manual Override) ☐

Binary Input Open (Manual Override) ☐

Binary Logic Buffer overrun ☐

Flutter Detection Auto-Disable ☐

Flutter Detection Auto-Enable ☐

PQ Event ☐

PQ Incomplete Event ☐

PQ Pending Event ☐

Selected Events

Events to be notified about:

Event -> Triggered

(Hold Ctrl to select more than one)

[Remove](#)

[Finish](#) [Cancel](#)

Version: 2.48.54.0 WEB-IHOST02 at 29/10/2020 17:22:04 GMT

Figure 12.11 Create Notification

The standard notifications format is shown in Figures 12.12 for email and 12.13 for SMS text messages. This can be modified under the “Notification Format” link in Figure 12.10.

From: iHost <ihost@nortechonline.net>
 Sent: 30 October 2020 02:09
 To: John Smith <john.smith@kehui.com>
 Subject: iHost Event Notification - Ware

You have received a new event on the i-Host System....
 Ware Crane Mead, Event, Triggered at 30/10/2020 02:03:18 To view the current status of this site follow the link below:
http://www.nortechonline.net/ihost/index.php?redir=rtu_overview.php?rtu_serial_no=8944538500002014050

Figure 12.12 Email Notification

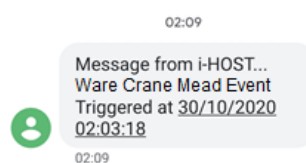


Figure 12.13 SMS Text Message Notification

iii. Events

This will take the user to the Events overview for this unit. The format and functionality are the same as the Event Log View (see section 12.5) filtered for this particular device.

iv. Map

If the coordinates of the T-P23 are added to the user data when the unit is set up (Figure 12.9) its position will be shown as a marker on a global map (Figure 12.14).



Figure 12.14 Unit location

v. Files

This section gives access to files sent to *iHost*® from the unit (Figure 12.15).

Job	Location	File Extension	Folder	Description	Job	Location	File Size	Date Added
[View] [Delete]	20-10-30 02-09-29.vlt	vlt			Ware	Crane Mead	11.3 KB	30/10/2020 02:09:29
[View] [Delete]	20-10-30 02-03-18.trg	trg			Ware	Crane Mead	11.3 KB	30/10/2020 02:09:03
[Delete]	8944538500002004050.IDX	idx			Ware	Crane Mead	384 bytes	30/10/2020 02:08:43
[View] [Edit] [Delete]	8944538500002004050.Settings.txt	txt			Ware	Crane Mead	141 bytes	30/10/2020 02:08:40
[View] [Delete]	20-10-30 01-50-16.vlt	vlt			Ware	Crane Mead	11.3 KB	30/10/2020 01:50:16
[View] [Delete]	20-10-29 14-51-36(Y-N=Model).tdr	tdr			Ware	Crane Mead	640 bytes	29/10/2020 14:51:36
[View] [Delete]	20-10-29 14-50-57(Y-N=Model).tdr	tdr			Ware	Crane Mead	640 bytes	29/10/2020 14:50:57
[View] [Delete]	20-10-29 14-41-22.trg	trg			Ware	Crane Mead	11.3 KB	29/10/2020 14:46:57
[View] [Delete]	20-10-28 02-30-52.vlt	vlt			Ware	Crane Mead	11.3 KB	28/10/2020 02:30:52
[View] [Delete]	20-10-27 22-47-12.vlt	vlt			Ware	Crane Mead	11.3 KB	27/10/2020 22:47:12
[View] [Delete]	20-10-27 22-39-49.trg	trg			Ware	Crane Mead	11.3 KB	27/10/2020 22:46:18
[View] [Delete]	20-10-27 14-39-09.vlt	vlt			Ware	Crane Mead	11.3 KB	27/10/2020 14:39:09
[View] [Delete]	20-10-27 14-33-16.trg	trg			Ware	Crane Mead	11.3 KB	27/10/2020 14:38:44
[View] [Delete]	20-10-27 05-29-35.vlt	vlt			Ware	Crane Mead	11.3 KB	27/10/2020 05:29:35
[View] [Delete]	20-10-27 00-16-15.vlt	vlt			Ware	Crane Mead	11.3 KB	27/10/2020 00:16:15
[View] [Delete]	20-10-27 00-10-23.trg	trg			Ware	Crane Mead	11.3 KB	27/10/2020 00:15:48
[View] [Delete]	20-10-26 16-45-47.vlt	vlt			Ware	Crane Mead	11.3 KB	27/10/2020 00:15:48

Figure 12.15 File list

Clicking on “View” shows the waveform (Figure 12.16), whilst Delete will remove the file. Clicking on the file name will download the file to the user’s computer, where it can be accessed in Windows Explorer. Once downloaded, .vlt, .trg and .tdr files can be opened in the T-P2X Master software for full analysis and fault location.

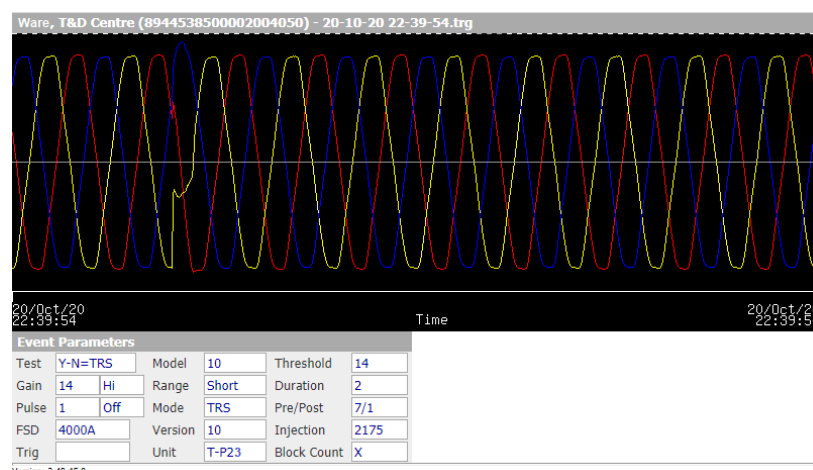


Figure 12.16
Waveform viewed in
iHost®

To download multiple files, check all of the required records can be on the right-hand side. The selection can be modified by clicking the “Select” choices (top right); “All” will check all the records, “None” will clear the selection and “Invert” checks all the unselected records and clears those previously checked. At the bottom right of Figure 12.17, the command “With selected:” should be set to “compress and download”, then pressing “Go” will download the files in “Zip” format.

After the download is complete the zip file will appear at the bottom of the user’s PC screen Figure 12.17as “iHost_Files.zip” which can be opened in Windows Explorer by clicking on it. Windows Explorer will now show the ‘system folder’ to which the selected unit belongs and this can then be dragged over to the appropriate place in the file list, normally C:\T-P2X Master\System\.

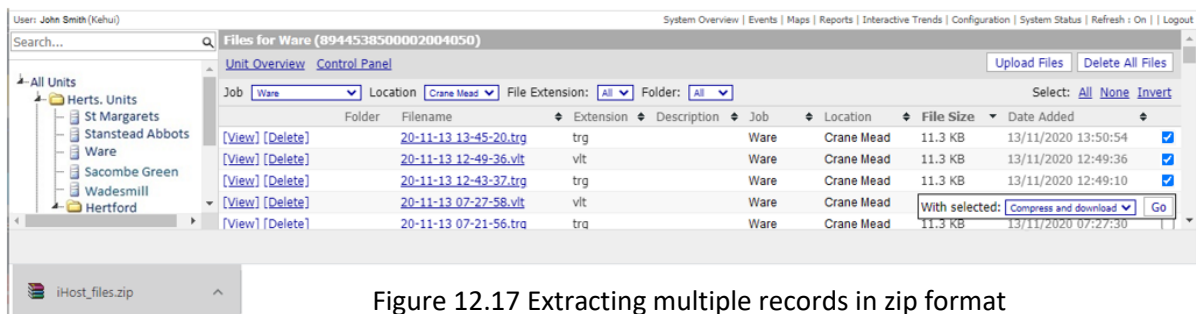


Figure 12.17 Extracting multiple records in zip format



Once the files are in this location, they can be accessed from T-P2X Master, as described in section 8.1. It will be necessary to uncheck “Local jobs” in the Job selector shown in Figure 7.1 (item ⑩).

The “Upload Files” button in the top right of Figure 12.17, allows files to be added to the iHost® record. This may be needed if files have been obtained locally through the Bluetooth connection when the unit was not communicating remotely, and the user wants to ensure the iHost® record is complete. Clicking on this button will prompt the user to select a file from Windows Explorer and also add a descriptive note if required (n.b. this may be required as the file will not be added at the top of the file list and not in the correct chronological order), see Figures 12.18 and 12.19. Duplicate file names can be selected to be either rejected or to overwrite the previous file.

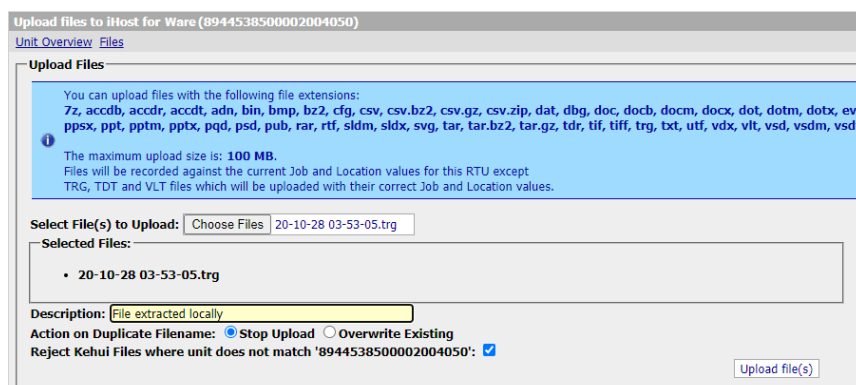


Figure 12.18 (left) File upload

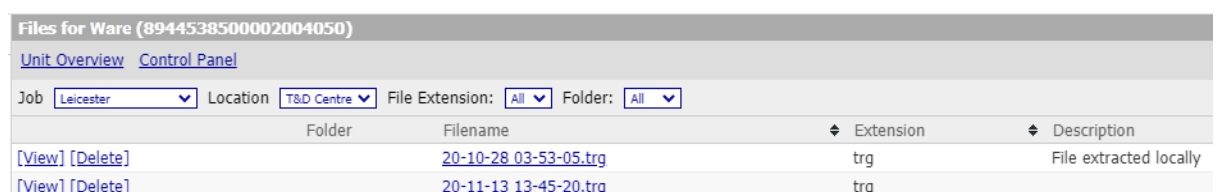


Figure 12.19 (below) File list with uploaded file and note

vi. Control Panel

Control panel (Figure 12.20) emulates the control panel on the T-P2X Master software and allows the settings on the T-P23 to be made remotely.

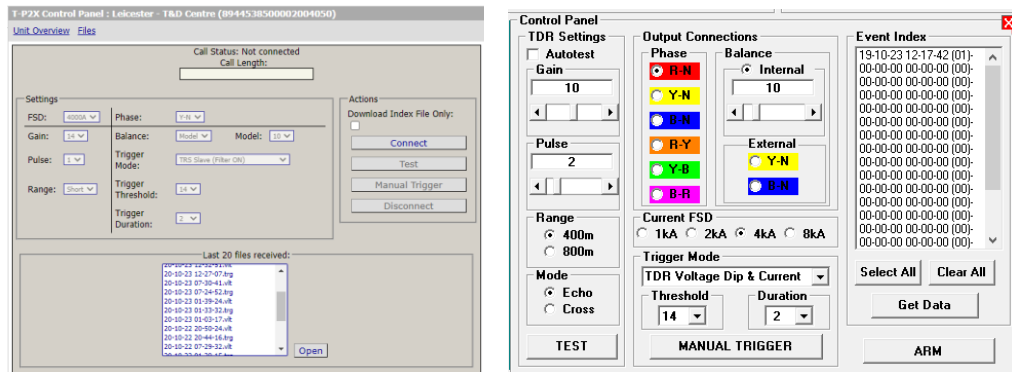


Figure 12.20 Control Panel emulation in *iHost*® (Left) compared to the standard panel (right)

The Control Panel is connected to the T-P23 by pressing connect and waiting for the “Call Status” to change to “connected”, a clock recording the length of the call will appear next to “call length”. Most of the settings are replicated, although the range settings are renamed as short/long and the mode is not selectable. The Event index is omitted and is replaced by a list of the latest files extracted from the unit.

12.4.2 Unit Overview, Section 2 Location

i. T-P2X Units

The link “T-P2X Units” will return the user to the System Overview (Figure 12.3).

ii. Move

“Move” allows the unit to be relocated to another group, clicking will give the screen in Figure 12.21 allowing a new group to be selected, but keeping all of the parameters as previously set.

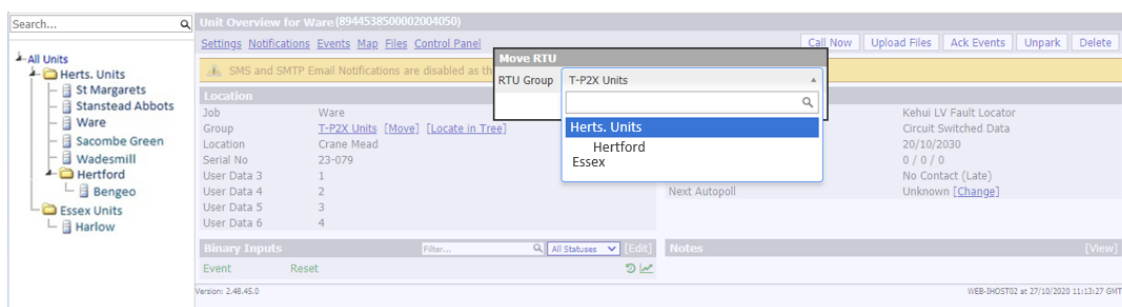


Figure 12.21 Move unit

The new group is selected from the drop-down menu and the action is confirmed by clicking save or it can be cancelled. It is important to ensure that units are always allocated to the correct location or incorrect results may occur.

iii. Locate in Tree

To confirm which unit is being examined, clicking on “Locate in Tree” will highlight the appropriate unit on the “All Units” tree (Figure 12.22)

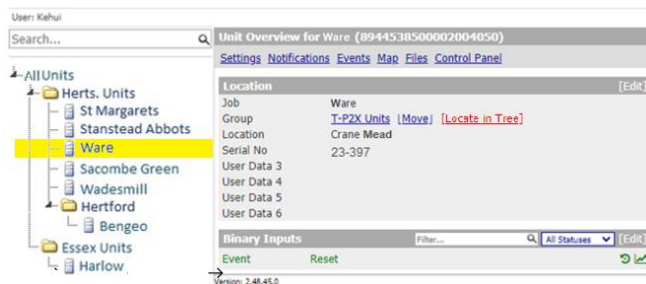


Figure 12.22 Locate in Tree

12.4.3 Unit Overview, Section 3 Communications



Figure 12.23 Communications panel

The generic name for equipment connected to *iHost*® is RTU, the particular type in this application is defined in the first line (Kehui LV fault locator), with the method of communication listed below as TCP/IP (RING initiated), the maintenance due date is derived from section 12.4.1i

The call statistics refer to the number of times the unit has been polled. The first number indicates how many times the T-P23 has initiated a message, the second represents calls initiated by *iHost*® and the last is the total number including those initiated by the user. The dates of the last and next communication are self-explanatory. “Change” allows the polling time to be amended.

When installed remotely with the antenna connected, the T-P23 will normally be polled on a daily basis at the time indicated in the “Next Autopoll” section, which is set as in section 12.4.1i.

An immediate poll can be instigated by clicking on “Call Now” which will poll the unit resulting in the screens in Figure 12.24. The retrieved files will appear in section 12.4.1v. It should be noted that this method of communication is not recommended as it does not allow the unit to be controlled. Normally the device should be accessed by using the control panel see section 12.4.1 vi.

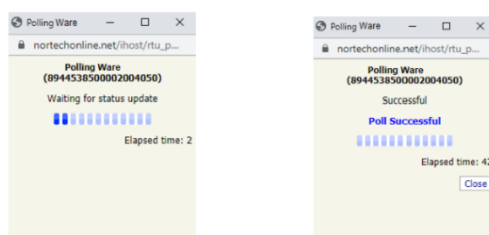


Figure 12.24 Device polling

The other buttons are:

- “Upload files” will upload files from the unit to *iHost*®
- “Ack events” will acknowledge all of the events on this unit
- “Park” will disable the unit, such that it cannot be polled and will not provide any notifications.
- “Delete” will remove the unit from the system, following a confirmatory message.

12.4.4 Unit Overview, Section 4 Binary inputs and Notes

“Binary inputs” is a generic term used by *iHost*®, for the signal initiating the event. For the T-P23, this will always be the triggering of the unit as set in section 7.3.6 and will not need to be changed.

Notes can be added to the record to provide any additional information which the user considers to be useful, such as a description of the cable being monitored. Notes can be added by clicking “view” in the notes segment of Figure 12.6 section ④. This brings up the page in Figure 12.25a, clicking on “+Add Note” allows the note to be written (Figure 12.25b), which will then appear in the unit overview (Figure 12.25c).

Notes for Ware (894453850002004050)

Unit Overview

Expand All Collapse All View Deleted Notes + Add Note

Version: 2.48.54.0 WEB-IHOST02 - Last Refresh: 04/11/2020 16:04:16 GMT

Figure 12.25a Notes access page

Notes for Ware (89441000301632900000, Kehui)

Unit Overview

Title: Equipment installed in Crane Mead

Note: Located in indoor substation, fed from a reclosing device and blocking coil

+ Add Cancel

Version: 2.48.54.0 WEB-IHOST02 - Last Refresh: 05/11/2020 15:39:06 GMT

Figure 12.25b Notes page with note added

Notes [View]

Equipment installed in Crane Mead

Located in indoor substation, fed from a reclosing device and blocking coil

Version: 2.48.54.0 WEB-IHOST02 at 05/11/2020 15:46:41 GMT

Figure 12.25c Note in Unit Overview

12.5 Event Log View

Selecting “Events” in the quick access menu (⑨ in Figure 12.2) will produce an overview of the events which have been reported to *iHost*®. The resulting view is shown in Figure 12.26.

The screenshot shows the 'Event Overview' page for user 'Kohui'. It features a sidebar with a unit hierarchy, a main table of events, and a top navigation bar. Numbered callouts point to specific UI elements: 1 (Column editing button), 2 (Black entries with normal type), 3 (Blue entries with bold type), 4 (Start date/time filter), 5 (End date/time filter), 6 (Event filter), 7 (Today button), 8 (Refresh button), 9 (View event types dropdown), and 10 (View event status dropdown).

Serial No	Job	Location	Event Time	Event Description
8944538500002004050	Ware	Crane Mead	21/10/2020 15:10:56.454	RTU Initiated Call
8944538500002004050	Ware	Crane Mead	21/10/2020 15:10:35.229	Ring Back Requested
8944538500002004050	Ware	Crane Mead	21/10/2020 15:10:26.505	Ring Back Initiated
8944538500002004050	Ware	Crane Mead	21/10/2020 14:00:32.721	RTU Initiated Call
8944538500002004050	Ware	Crane Mead	21/10/2020 13:55:32.000	Event - Reset
8944538500002004050	Ware	Crane Mead	21/10/2020 13:55:31.000	Event - Triggered
8944538500002004050	Ware	Crane Mead	21/10/2020 07:27:33.000	Event - Reset
8944538500002004050	Ware	Crane Mead	21/10/2020 07:27:32.000	Event - Triggered
8944538500002004050	Ware	Crane Mead	21/10/2020 04:27:20.000	Event - Reset
8944538500002004050	Ware	Crane Mead	21/10/2020 04:27:19.000	Event - Triggered
8944538500002004050	Ware	Crane Mead	21/10/2020 03:59:16.523	Auto Poll Call - Failed
8944101350242013589	Sacombe Green	Office	21/10/2020 03:47:41.000	Ring Back Response Timer elapsed
8944101350242013589	Sacombe Green	Office	21/10/2020 03:44:31.858	Ring Back Requested
8944101350242013589	Sacombe Green	Office	21/10/2020 03:44:11.920	Ring Back Initiated
8944101350242013589	Sacombe Green	Office	21/10/2020 03:24:31.956	Auto Poll Call - Failed
8944538500002004050	Ware	Crane Mead	21/10/2020 03:12:26.000	Ring Back Response Timer elapsed
8944538500002004050	Ware	Crane Mead	21/10/2020 03:09:21.642	Ring Back Requested
8944538500002004050	Ware	Crane Mead	21/10/2020 03:09:21.157	Ring Back Initiated
8944538500002004050	Ware	Crane Mead	21/10/2020 02:49:37.957	Auto Poll Call - Failed
8944100030163290000	Stanstead Abbots	Roydon Road	21/10/2020 02:38:02.000	Ring Back Response Timer elapsed
8944100030163290000	Stanstead Abbots	Roydon Road	21/10/2020 02:34:50.587	Ring Back Requested
8944100030163290000	Stanstead Abbots	Roydon Road	21/10/2020 02:34:30.704	Ring Back Initiated

Total number of events: 22
Version: 2.48.45.0
WEB-IHOST01 at 21/10/2020 16:13:47 BST

- ① Column editing button
- ② Black entries with normal type: acknowledged records
- ③ Blue entries with bold type: unacknowledged records
- ④ Select start date and time of record filter
- ⑤ Select end date and time of record filter
- ⑥ Event filter (not applicable for T-P23)
- ⑦ Today button; adjusts start and end dates to show only today's records
- ⑧ Refresh button; allows the records to be refreshed (e.g. after start/end date change)
- ⑨ View event types (not applicable to T-P23)
- ⑩ View event status; select all events, or just acknowledged or unacknowledged events

Figure 12.26 Event Log view

The table can be customised in a similar way to the System overview table, by clicking on the configure view button ①.

A pair of events representing the device's triggering and resetting is created every time a disturbance is detected. Each pair has a trigger file associated with it that may be used to locate the cable fault position.

If configured to do so, the system will send an email and/or text message to users, to advise them there is data that needs to be checked. Selecting a record and right-clicking it will bring up the menu shown in Figure 12.27 allowing the various commands listed to be carried out.

Event Overview, Kehui			
Event Filter: off			
Start Date:		<input type="text" value="20/10/2020 00:00:00"/>	End Date: <input type="text" value="21/10/2020 23:59:59"/>
Serial No	Job	Location	Event Time
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Ware	Crane Mead	21/10/2020
8944538500002004050	Unacknowledged	Crane Mead	21/10/2020
8944538500002004050	Acknowledged	Crane Mead	21/10/2020
8944538500002004050	Unit Overview	Crane Mead	21/10/2020
8944538500002004050	View Additional Data	Crane Mead	21/10/2020
8944538500002004050	View Comments	Crane Mead	21/10/2020
8944101350242C	View File	combie Green Office	21/10/2020
8944101350242C	Download File	combie Green Office	21/10/2020
8944101350242C	Download Waveform Data	combie Green Office	21/10/2020
8944101350242C	Show Map	ire Crane Mead	21/10/2020
894453850000200	Show Status History	ire Crane Mead	21/10/2020
894453850000200	Show Notification History	ire Crane Mead	21/10/2020
894453850000200	Delete	are Crane Mead	21/10/2020
8944100030163290000	Standard Aborts	Bovine Road	21/10/2020

Figure 12.27 Event overview sub-menu

12.6 Technical Support

Technical support can be accessed at:

- Phone: +44 1920 444050 (9am – 5pm UK time, Monday to Friday)
- E-mail: info@kehui.com

Support pertaining specifically to *iHost*[®] can be obtained from Nortech:

- Phone: +44 8700 111992 (9am – 5pm UK time, Monday to Friday)
- E-mail: info@nortechonline.co.uk

13. Transportation and Storage

13.1 Transportation considerations

Use the soft case and transport box provided, and observe the environmental conditions specified in the technical data sheet.

13.2 Storage conditions, storage period and precautions

Observe the environmental conditions specified in the technical data sheet when storing the instrument. The instrument should be stored in a dry environment providing suitable protection against mechanical damage and dust. Where the instrument is not used on a regular basis, it should be stored indoors using the original packaging, and should not be exposed to the sun or rain. The room should be air-conditioned and should not be susceptible to corrosive gas. The instrument should not be subjected to severe mechanical vibration or shock and there must not be a strong electromagnetic field.






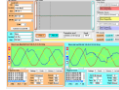

13.3 Unpacking and Inspection

Before unpacking for the first time, follow the steps below.

- i) Take out the document bag containing the instructions and packing list.
- ii) Check the packing list to ensure that the contents are complete and intact.
- iii) Check that the serial number is consistent with the instrument and the factory number of the warranty card.



14. Packing List and Accessories

14.1 T-P23 standard packing list



No.	Materials	Picture	Quantity
1	T-P23 Unit		1
2	Carry case		1
3	Antenna		1
4	Fused test cable (with crocodile clips)		1 set
5	4mm plugs (for use with fused test cables)		1 set
8	T-P2X master software (free website download)		1
9	User Manual (free website download)		1

14.2 Accessories



14.2.1 Remote communication (ordered separately)

No.	Materials	Picture	Quantity
1	<i>iHost</i> [®] licence (<i>iHost</i> [®] is a trademark of Nortech Management Ltd.)		1
2	Sim Card		1



14.2.2 T-MU1 Marker unit (ordered separately)

No.	Materials	Picture	Quantity
1	T-MU1 Marker unit with fused leads and crocodile clips		1
2	Probes for use with fused leads		1 set



14.2.3 T-SU1 Signal booster (ordered separately)

No.	Materials	Picture	Quantity
1	T-SU1 Signal booster (with crocodile clips)		1
2	4mm plugs (for use with fused test cables)		1 set


14.2.4 4mm plug connection accessories 1 (ordered separately)

No.	Materials	Picture	Quantity
1	Adapted fuse handle assembly 83mm centre, with 4mm connection socket (single phase, three required for most applications)		1
2	Insulated G-clamp with 4mm socket		1

14.2.5 4mm plug connection accessories 2 (ordered separately)

No.	Materials	Picture	Quantity
1	Adapted fuse handle assembly 92mm centre, with 4mm connection socket (single phase, three required for most applications)		1
2	Insulated G-clamp with 4mm socket		1

14.2.6 Blocking coil (ordered separately)

No.	Materials	Picture	Quantity
1	400A blocking coil		1