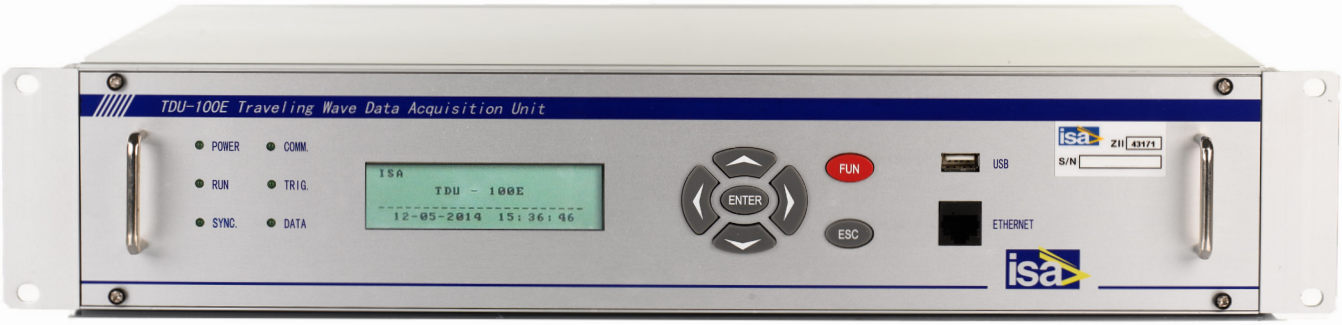
TFS 2100E

Travelling Wave Fault Location System



Travelling Wave Fault Location System

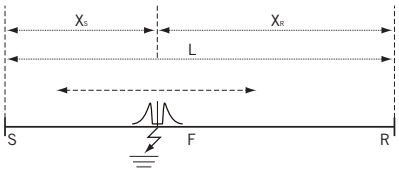
- The all-in-one solution for the HV network fault location
- The TFS 2100E system is composed from:
  - TDU 100E: the device (acquisition unit) installed at substations
  - TAS 2100E: the software installed into the PC Master Unit
- It minimizes the line outage time
- It applies to any type of network: AC or DC
- Automatic calculation of the fault distance
- Fast: the fault is located in few milliseconds
- Accurate: location error less than ± 50m (less than one tower)
- The Wide area fault location collects data from the whole network
- The location is performed directly on the network map
- Unaffected by fault resistance, line length, coupling capacitance, compensation
- One TDU 100E covers up to eight lines
- Nature of fault detection: actual fault or lightning or CB operation
- The GPS synchronization is embedded into TDU 100E
- Huge fault memory: 8 Gbyte
- Fast and non-intrusive installation
- Easy to set up
- Travelling wave recordings are collected by the Master Station software, which computes the fault distance
- Connection types available: INTERNET, MODEM and POINT TO POINT
- Substation connection: DNP 3.0 or optional IEC61850-8 interface
- Statistical analysis

Overview

The transmission line is an important part for the electrical network, but since it needs to cross long distances, it is easy to have faults. Sometimes, it is very difficult to patrol the lines because of the weather and the field condition, so it is vital to have an equipment capable to locate the fault with the accuracy of one tower. It is also important to have a system capable of locating recurrent intermittent faults, like swaying trees, with high impedance faults (up to several hundreds of Ohm), or breaking of conductor, which impair the reliability of the power line.
The traveling waves based fault locator is widely accepted as the best solution to the problem, thanks to its location accuracy and to the wide spectrum of line configurations, which include: mixed overhead and cable lines, parallel lines, lines with T branches, series compensated transmission lines, non-earthed distribution lines, and also DC lines.
It can apply in all line length.

Distance Measurement Method

The travelling wave fault locator determines the distance to fault by measuring the time for the surge to travel from the fault to the substation bus. The system provides a number of different fault location methods; the so-called D method is the one used in practice.



Type D (Double Ended) Method

Type D Method time tags the arrival of the fault generated surges (current and/or voltage) at the two time synchronized locations, at both ends of the line. The fault distance is determined measuring the difference of the arrival times, by the following formulas.

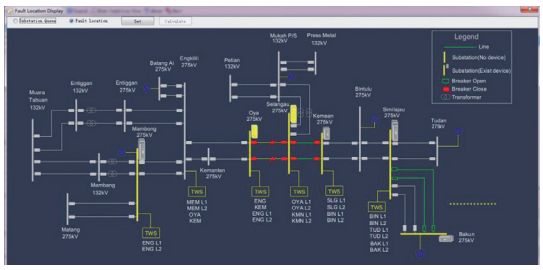
$$X_R = [(T_R - T_S) \cdot v + L]/2$$

$$X_S = [(T_S - T_R) \cdot v + L]/2$$

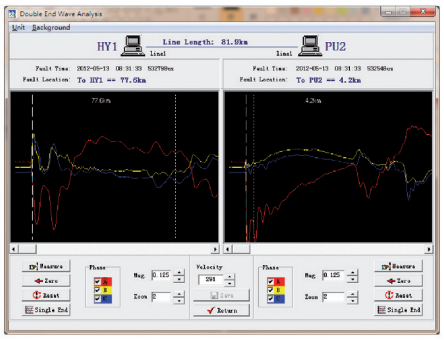
- TS and TR are the absolute times of sensing of the fault generated surges at the two ends of the line
- v is the velocity of the travelling wave, which is close to light velocity in overhead lines
- L is total length of the line

Fault Location Results

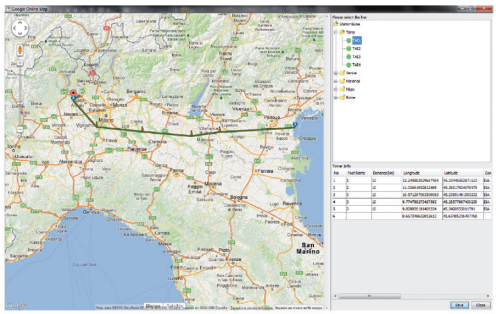
The fault recorder TDU 100E is provided with a very high frequency circuit, capable of recording the fault impulse and tagging the metering event absolute time, which is generated inside the device starting by a GPS built-in detector, or from and IRIG-B connection.
The time information is then sent to the Master Unit, provided with the TAS 2100E software, which computes the distances with the provided formulas, and displays to the operator the network diagram and the faulty line.



The operator can open the following window with actual fault recordings, for a further investigation.



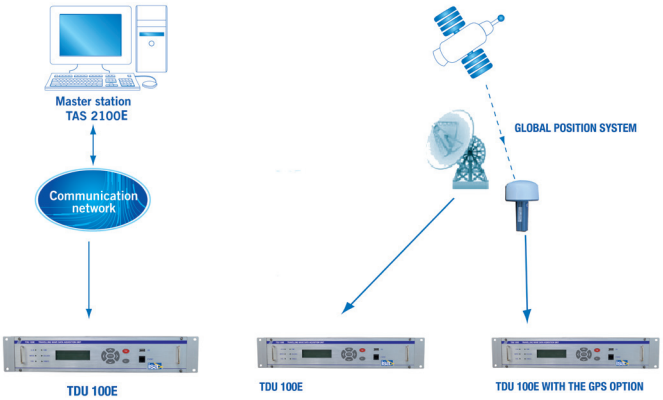
The operator can identify the faulty tower in a satellite map



Maintenance team can be fast informed about the position of the fault means SMS message.

System Description

The fault location system TFS 2100E is made of:
• The travelling wave data acquisition unit TDU 100E
• The travelling wave analysis software TAS 2100E



System Configuration

For the accurate timing of the devices involved, TDU 100E needs the time reference input, generated from the GPS Global Positioning System, to provide an accurate time reference. The time reference can come from the built-in GPS synchronizer, or from the substation, as an IRIG-B interface or as a connection to the GPS system.

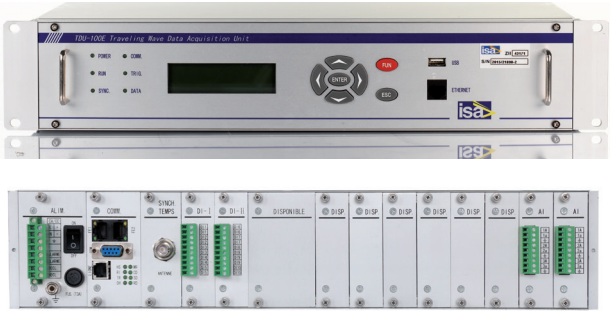
Communication

Three communication means are available:
• TCP-IP, via standard ETHERNET connections
• Point-to-point, via an RS-232 port (RS232 / USB converter included)
• Dial-up, via MODEM and the telephone network
• FTP,TELNET and HTTP protocols available for communication between TDU100E acquisition unit, TAS2100E master station software and TAS-web for setting and management

Data Acquisition Unit TDU 100E

TDU 100E is the travelling wave data acquisition unit designed to acquire the fault travelling waves and to transfer the data to the Master Station for fault location. It continuously samples the secondary outputs of CT's or VT's and stores the sampled data in a circular memory buffer. When the unit is triggered, the embedded super high speed Data Acquisition Unit records and saves in real time the transient travelling wave signals.

The acquired data are then sent to the Master Station via the communication network for further processing.
The configuration of TDU 100E can be viewed and changed by the TAS 2100E software. The software can also be used to export travelling wave records stored in TDU 100E and to display the waveforms, as well as to upgrade the TDU 100E firmware.



TDU 100E Front and Rear Panels

The front panel hosts the following components:
• Six status lights (seven lights optional)
• The LCD display
• Five push-buttons, to scroll the menu
• A Function button to select a menu item and an ESC button to exit the current menu
• Interface connectors: RJ45, for the local connections, and an USB memory connector

The rear panel gives access to a number of slots, where can be accommodated the modules which make TDU 100E. The choice has to be done at order. You can accommodate, left to right:
• One power supply module: three types available.
The power supply module has 2 dry contacts for: ALARM and TRIG TDU. Alternatively, as option, a digital ouput module with 4 dry contacts is available for: TDU synchronized (GPS ok), TRIG TDU, TDU error (SD card problem), spare.
• One communication module: two types available
• One TIME SYNC module: five types available. With the internal GPS module, a surge arrester and an antenna with support supplied. (Standard antenna cable lenghts: 30m. Optional: 40m, 50m, 60m, 100m)
• One opto coupler digital inputs modules (5 or 8 inputs each). As option, is possible to have a second digital input module the inputs can be dry or wet.
• Analog modules: three types available, AD, AI, AV. TDU-100E hosts 8 AI modules maximum for 24 analog channels, or 4 AD/AV modules maximum for 12 analog channels, or a combination of them. With the analog module AI, the signal by the field is got by a non-intrusive installation using clip-on CT's for 1 A or 5 A (Standard cable lenght: 5m. Optional cable lenght: 7m, 10m; 20m). The burden is negligible.

On the display it is possible to read the list both recordings and events, and to program the main line parameters, the ETHERNET addresses, and the time zone.
TDU 100E continuously performs the self-control of the equipment. The following alarm information are displayed: GPS signal lost; TDU 100E triggered; communication link broken.

TDU 100E Technical Data

- Dimensions: 2U, 19'' rack (483mm×323mm×83mm)
- Weight: <4kg without modules: < 6 kg with modules
- Power supply:
  - Basic module: 85 to 264V, 50/60 Hz AC or 90 to 260V DC
  - Option 1: 35 to 140 V DC
  - Option 2: 100 to 300 V DC
- Temperature: operating: -10°C to 55°C; storage: -40°C to 85°C
- Relative Humidity: 0 to 90% without condensation

Master Station Software TAS 2100E

The Travelling wave analysis software TAS-2100E runs in a PC (the Master Unit) with the WINDOWS(R) operating system. TAS 2100E collects the transient data acquired by the TDU 100E travelling wave data acquisition units installed at all substations and automatically calculates the distance to fault.

Main software features are the followings:

- TFS performs automatic calculation of the distance to fault using double-end and wide area fault location methods, with an error less than ± 50m. It also provides tools to allow the operator to analyze travelling wave time tags and waveforms
- The fault location result is the distance from the substation, in km, or in us, or the tower of the line
- The wide area fault location identifies the fault point using the time tags of multiple substation across the power network
- TAS 2100E can discriminate the nature of the recorded travelling wave disturbance, by examining the magnitude of power frequency currents and the CB open/closed logic input.
- The three possible causes of the travelling wave: actual fault, ligtning or CB operation are displayed in the fault summary
- TAS 2100E automatically collects the remote substation fault data, and stores them in the local Data Base, as soon as a fault is detected. The local Data Base is based on the standard SQL format
- TAS 2100E performs fault records management, report preview and printing. Fault records can export in COMTRADE format.
- The system performs the simulation of a fault
- The system has comprehensive self-diagnosis ability.
- TAS 2100E can remotely upload, view, change the configuration of TDU 100E, and reset the device. SOFTWARE & FIRMWARE are licence free, including their upgrade
- TAS 2100E can publish data to other systems using the table file of database, which provides all the fault informations, using DNP 3.0 protocol or optional IEC 61850. Data can be also seen by the TAS - web

Ordering Information

CODE	MODULE
40172	TFS2100E - 1 LINE DIRECT with software
41172	TFS2100E - 1 LINE INDIRECT with software
42172	TFS2100E - 2 LINES DIRECT with software
43172	TFS2100E - 2 LINES INDIRECT with software
44172	TFS2100E - 3 LINES DIRECT with software
45172	TFS2100E - 3 LINES INDIRECT with software
46172	TFS2100E - 4 LINES DIRECT with software
47172	TFS2100E - 4 LINES INDIRECT with software
90171	CT MOUNTING PLATE
91171	ADDITIONAL ANALOG INPUT TYPE AI
92171	ADDITIONAL ANALOG INPUT TYPE AV
93171	ADDITIONAL ANALOG INPUT TYPE A-DIRECT
96171	OPTIONAL POWER SUPPLY 35 V to 140 V
97161	OPTIONAL POWER SUPPLY 100 V to 300 V
32171	TSG-10 impulse generator

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