TFS 2100E

Traveling Wave Fault Location System

- The all-in-one solution for the HV network fault location.
- Minimizes the line outage time.
- It applies to any type of network: AC or DC.
- Fast: the fault is located in few milliseconds.
- Accurate: location error less than 150 m (less than one tower).
- The location is performed directly on the network map.
- Unaffected by fault resistance.
- One TDU-100E covers up to eight lines.
- The GPS synchronization is embedded into TDU 100E.
- Huge fault memory: 8 Gbyte.
- 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 also via the IEC61850-8 interface.

OVERVIEW

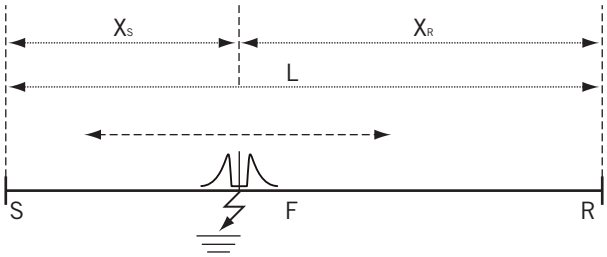
The transmission line is an important part for the electrical network, but since it needs to cross long distances, it is easy to have faults. Sometimes, it is very difficult to patrol the lines because of the weather and the field condition, so it is vital to have an equipment capable to locate the fault with the accuracy of one tower. It is also important to have a system capable of locating recurrent intermittent faults, 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, lines with T branches, series compensated transmission lines, non-earthed distribution lines, and also DC lines.

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 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.

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

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

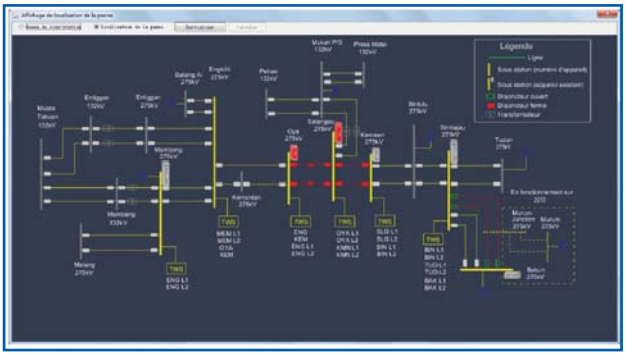
- T_S and T_R are the absolute times of sensing of the fault generated surges at the two ends of the line.
- v is the velocity of the travelling wave, which is close to light velocity in overhead lines.
- L is total length of the line.

FAULT LOCATION RESULTS

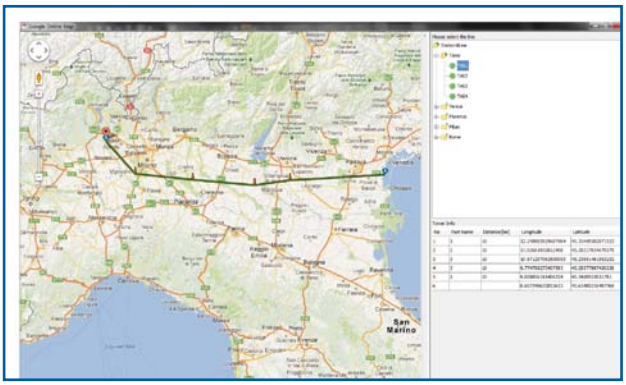
The fault recorder TDU 100E is provided with a very high frequency circuit, capable of recording the fault impulse and tagging the metering event absolute time, which is generated inside the device starting by a GPS built-in detector, or from and IRIG-B connection.

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 a window like the following one.

After the user has drawn and open the network schematic, the starting screen looks like the following one: the faulty line is immediately identified.



The wide area fault locator provides the following screen.



It displays the faulty tower; it can also be a satellite map.

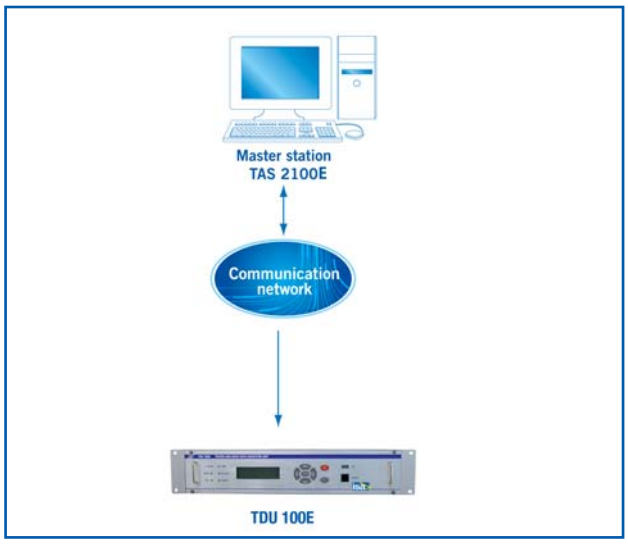
SYSTEM DESCRIPTION

The fault location system TFS 2100E is made of:

- The travelling wave data acquisition unit **TDU 100E**, which is installed at the substations, and can monitor up to 8 lines.
- The travelling wave analysis **software TAS 2100E**, which runs on the Master Station PC (not included in the supply), and the communication network.

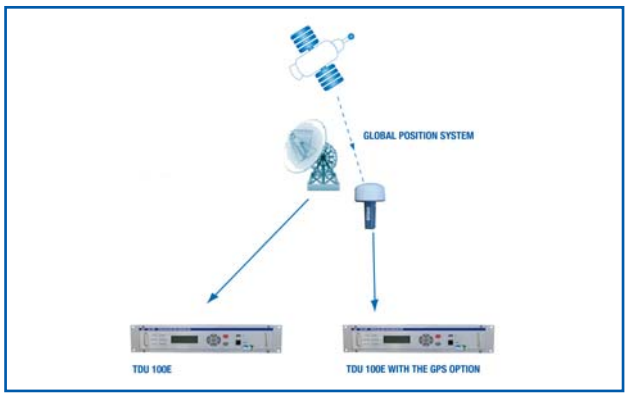
The whole system includes therefore the following:

- TDU 100E Travelling Wave Data Acquisition Unit.
- TAS 2100E Master Station Software.



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. This time reference can come from the Substation via the IRIG-B interface, or via a direct connection to the GPS systems or by the built-in GPS time synchronizer.



COMMUNICATION

Three communication means are available: TCP/IP network, point to point, dial-up MODEM.

TCP/IP network

TDU 100E and the Master Station are connected to a TCP/IP network via their Ethernet ports.

Point-to-point connection

TDU 100E and the Master Station are linked together through a dedicated point-to-point data transmission channel provided with optical fiber or microwave communication network. Both of them are interfaced to the communication channel via an RS-232 port. The baud rate of communication is 1,200 to 56kbps, selectable depending on the channel conditions.

Dial-up MODEM

TDU 100E and the Master Station are connected to the utility or to the public telephone network using modems connected to their RS-232 port. The transient data acquired by TDU 100E are sent to Master Station by dialing up communication.

TRAVELLING WAVE DATA ACQUISITION UNIT TDU100E

TDU 100E is the travelling wave data acquisition unit designed to acquire the fault travelling waves and 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, i.e. the deviation of any input signals exceeds the pre-set threshold level, the embedded super high speed Data Acquisition Unit (DAU), which is independent of the Master Control 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.

Special interface control techniques make the time interval between two travelling wave records less than 200 µs. Thanks to this approach, we can guarantee the seamless recording of transient signals, avoiding the loss of fault waves. The configuration of TDU-100E can be viewed and changed by 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 firmware of TDU 100E.

TDU 100E front and rear panel

The **front panel** hosts the following components:
• Six status lights. • 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 USB.
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.
• One communication module: two types available.
• One TIME SYNC module: five types available.
• One or two digital inputs modules.
• Analog modules: three types available, AD, AI, AV. A maximum 8 AI modules for 24 analog channels, or maximum 4 AD/AV modules for 12 analog channels, or a combination of them.
The following set-up parameters of TDU 100E can be viewed and programmed on the display, or from the PC: substation and line identification; line characteristics; type of connection; sampling frequency; length of records; ratio of CT and PT; gain of analog channels; trigger threshold.
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; triggered.

TDU 100E weight and dimensions:

• 2U, 19'' rack. • Dimensions 483mm×323mm×83mm.
• Weight: <4kg without modules: < 6 kg with modules.
• Power supply: 85 to 264 V AC or 90 to 260VDC.

MASTER STATION SOFTWARE TAS 2100E

On the Master Station runs the travelling wave analysis software TAS-2100E, in a PC with WINDOWS® environment. TAS 2100E collects the transient data acquired by the TDU 100E travelling wave data acquisition units installed at the substation, and

• **TFS performs automatic calculation of distance to fault using double-end and wide area fault location methods with the error being less than 150m**. 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 percentage of the total line length, or the tower of the line.
• The wide area fault location can identify the point of origin of traveling waves (the fault point) using the time tags of travelling wave surges 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 lightning strike on the line may also be able to trigger the TDU 100E, and **TFS can provide the lighting striking location,** based of time tags of lighting surges. The discrimination between lighting and fault is made by examining the magnitude of the power frequency current.
• **TAS 2100E automatically collects the remote substation fault data**, and stores them in the local Data Base, as soon as a fault is detected.
• TAS 2100E performs fault records management, report preview and printing. It also provides the history fault and calculation result statistics and query.
• The system can perform the complete 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.
• TAS 2100E can publish data to other systems using the table file of database, which provides the fault information, including name of the faulty line, fault occurrence time, fault distance. This allows these data to be written to another database, automatically after a fault.

TFS 2100E MAIN KEY POINTS

EXTREME ACCURATE FAULT LOCATION

- Automatic calculation of distance to fault.
- Location accuracy: better than ± 150 m.
- Maximum location resolution: ± 5 m.
- Software TAS2100E performs, collect, register and store the fault data.
- The fault location result is expressed in km, or in percentage of the total line length and the faulty tower of the line is accurately detected.
- Minimizes the line outage time.

NON INTRUSIVE SYSTEM FAST INSTALLATION

- The TFS 2100E system is extremely easy and fast to set up, not intrusive. The whole system includes therefore the following:
- TDU 100E Travelling Wave Data Acquisition Unit.
- TAS 2100E Master Station Software, provided with the TDU 100E Toolkit software, for the TDU set-up.

INTEGRATED SYSTEM

- TFS 2100E system is provided with a built-in GPS accurate time syncronizer and an integrated modem.
- Connection types available: INTERNET, MODEM and POINT TO POINT.
- Substation connection also via the IEC61850-8 communication interface.

TAS 2100E SOFTWARE

- TAS 2100E software is alway provided with the system and performs, collect, register and store the fault data.
- Huge data storage: protected in case of loss of supply and internal 8 GByte Flash disk.
- Recording lenght: 1-20ms, programmable; default 4 ms.

ORDERING INFORMATION

CODE	MODULE
40171	TFS2100E - 1 LINE DIRECT with software
41171	TFS2100E - 1 LINE INDIRECT with software
42171	TFS2100E - 2 LINES DIRECT with software
43171	TFS2100E - 2 LINES INDIRECT with software
44171	TFS2100E - 3 LINES DIRECT with software
45171	TFS2100E - 3 LINES INDIRECT with software
46171	TFS2100E - 4 LINES DIRECT with software
47171	TFS2100E - 4 LINES INDIRECT with software

CODE	MODULE
90171	CT MOUNTING PLATE
91171	ADDITIONAL ANALOG INPUT TYPE AI
92171	ADDITIONAL ANALOG INPUT TYPE AV
93171	ADDITIONAL ANALOG INPUT TYPE A-DIRECT
95171	OPTIONAL POWER SUPPLY 35 V to 65 V
96171	OPTIONAL POWER SUPPLY 35 V to 140 V

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