

TWS FL-8 and TWS FL-1

Traveling wave fault locators



Provides exact fault location to one tower - improved performance

- Reduce downtime by getting to the fault faster
- Track intermittent self clearing faults and focus maintenance at the right spot to prevent a major breakdown
- Accurate results from circuit trips automatically available in the dispatch center within minutes of the event
- Maintenance crews alerted by email notification
- Supersedes the successful TWS Mark VI and DSFL devices

Product Summary

Description A device that provides extremely precise fault location on multiple lines enabling operation and maintenance engineers to respond rapidly to events and correct defects at minimum cost and maximum efficiency

Application Fault location on interconnected overhead lines where high availability is important. Accurate, consistent results for all types of faults quickly displayed in a control room or engineering centre

where it is needed to direct maintenance teams and reduce downtime



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TWS FL-8 and TWS-FL-1 Traveling wave fault locators

Provides exact fault location to one tower - improved performance

- Best accuracy to ± 60 meters [± 195 feet] independent of impedance methods
- Returns quality results for all types of faults, including high resistance ground faults and open circuit
- Accuracy is independent of line length, remote end infeed, non uniform line construction, conductor asymmetry and mutual coupling
- Can be used on lines with series compensation and tapped loads
- It is possible to compensate for lengths of underground cable

Reduce downtime by getting to the fault site faster

- Consistent accuracy eliminates need to send out multiple line patrols and helicopters to identify the fault site
- Can save hours of search time and reduce costs
- Faster restoration time reduces system risk posed by the possibility of a second or third coincident fault
- Faster restoration time reduces the costs of running uneconomic generation needed to maintain system security during the line outage

Track intermittent self clearing faults and focus maintenance at the right spot to prevent a major breakdown

- Most overhead line faults are transient and can be successfully re-closed
- Multiple trips can occur at the same place over time due to a damaged insulator, growth of vegetation or conductor clashing
- Accurate fault location pinpoints these trouble spots
- Planned maintenance can be undertaken to fix the 'minor' transient problem before it becomes a 'major' permanent one
- Fewer line trips reduces the number of voltage dips and subsequent customer complaints

Accurate results from circuit trips automatically displayed in the dispatch centre within minutes of the event

- A line trip is recognized by a change of state on a digital input or a 61850 GOOSE message
- A request for poll is sent to the central dispatch centre immediately after a line trip. The central PC polls each end of the line to retrieve data, calculate results and display them in a simple list view on a single screen
- Alternatively, the central software can be set to routinely poll all devices to collect data and display results

Maintenance crews alerted by email notification

- Fast, automatic dissemination of results gets the information directly to the maintenance teams
- Results can be filtered to select only those associated with a line trip
- No need for intervention by protection engineers - saves time

Fast installation and set up on multiple lines - no line or substation outage required

- Most installations completed in one day
- FL-8 monitors up to 8 circuits. FL-1 limited to one circuit
- Split-core linear couplers are placed around the secondary wiring of the protection current transformers to capture the traveling waves
- Can be installed with the circuit still alive
- Device configuration via a web page - no special software required

Display, keypad and USB port allow more interaction with the device

- Device status is available from the display - no need for a PC
- Can view line module trigger time tags if remote communications have failed
- Data can be downloaded onto a memory stick plugged into the USB port
- A programmed memory stick can be used to upload device firmware and configurations

Modular, reliable hardware - flexible communications

- Integral dial-up modem and ethernet port. External GSM modem (optional)
- Solid state CompactFlash for data storage

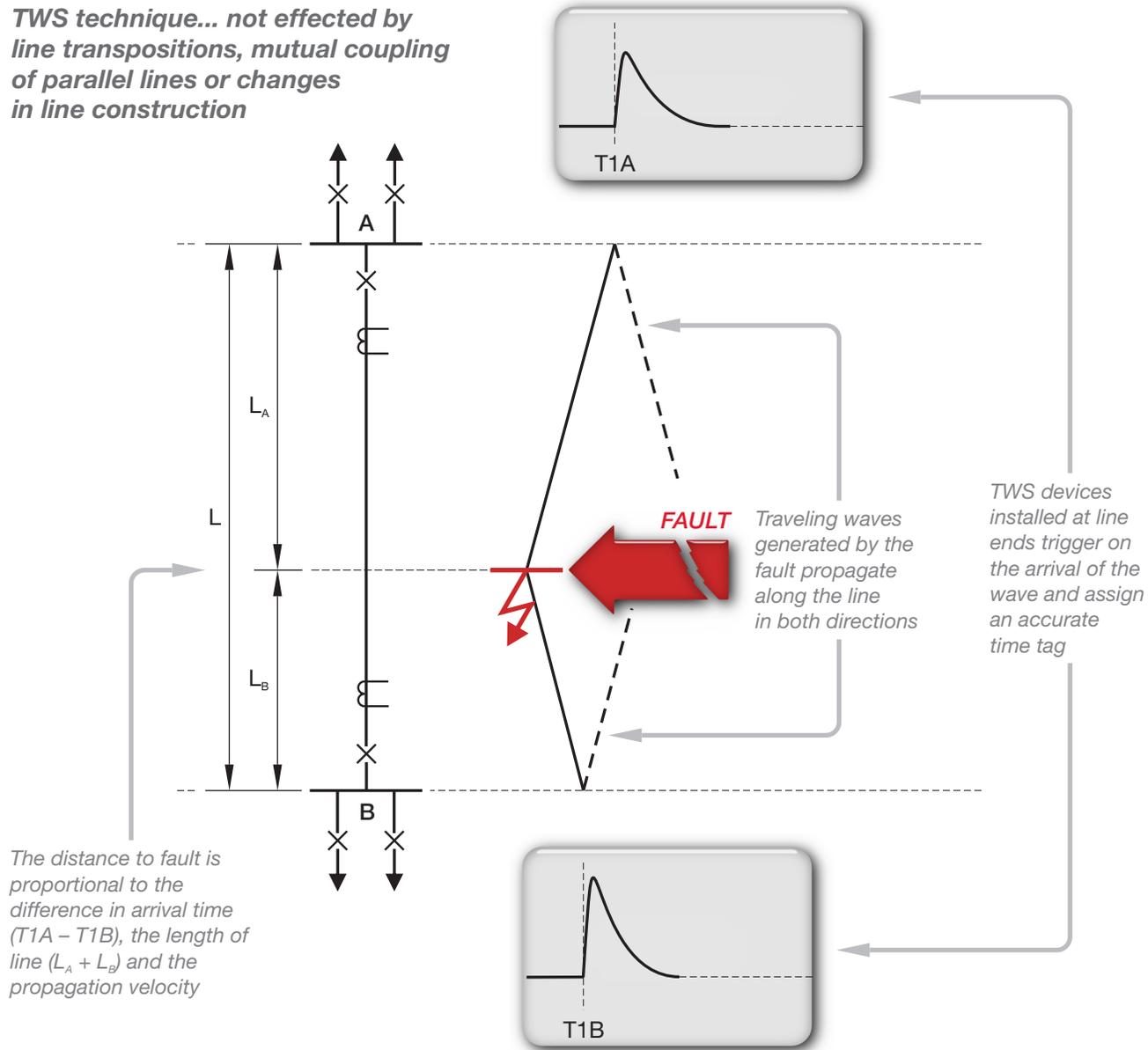


TWS - the traveling wave technique

General description

- The traveling wave uses the double ended method of fault location
- An accurate time reference is provided by GPS time synchronization

TWS technique... not effected by line transpositions, mutual coupling of parallel lines or changes in line construction



TWS FL-8 - modular - monitors 2, 4, 6, or 8 lines



TWS FL-1 - fixed format - monitors 1 line

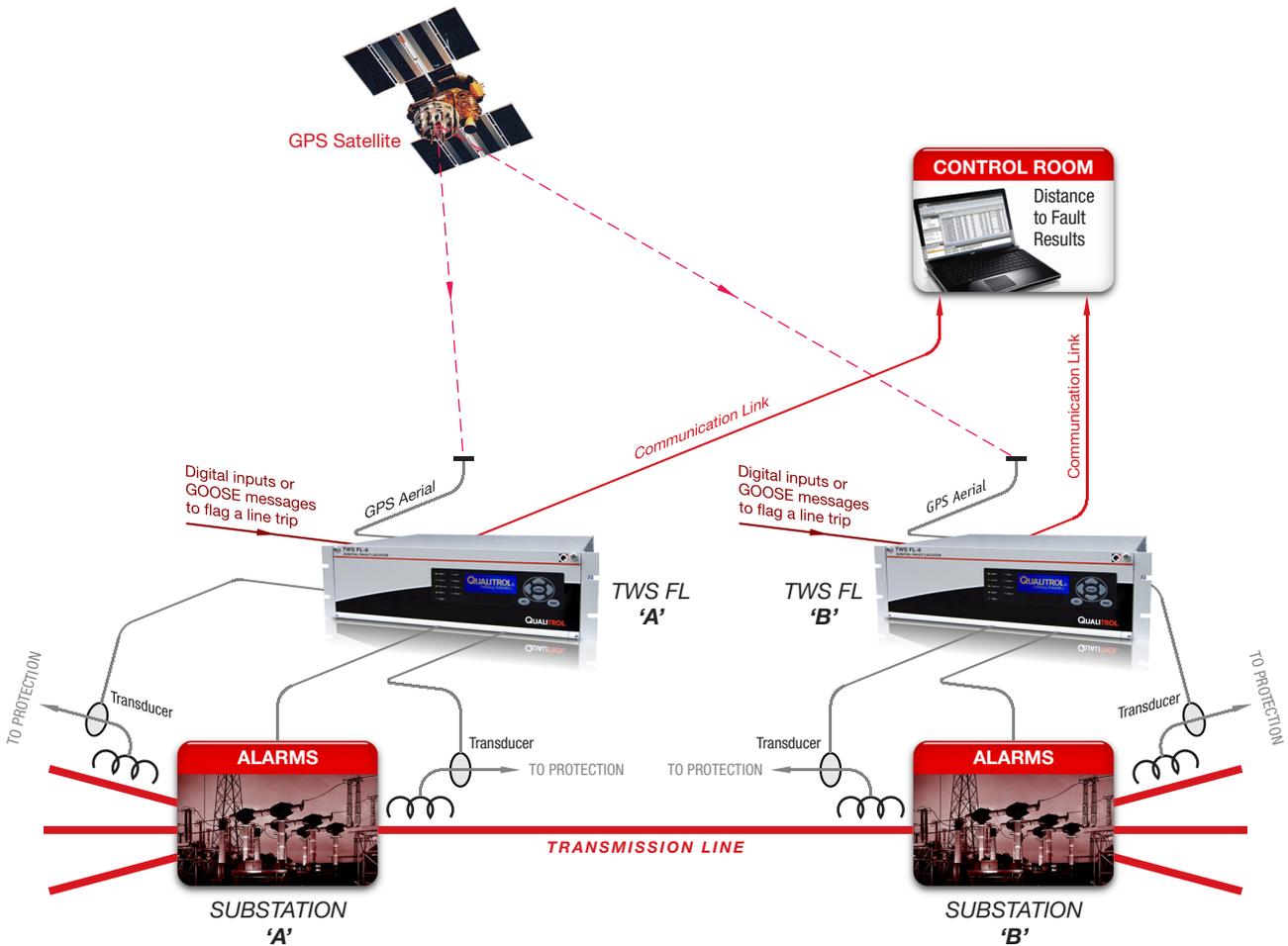


TWS FL-8 and TWS-FL-1 Traveling wave fault locators

TWS - Traveling wave application

General description

- Installation requires minimal cabling
- Mount GPS antenna with a clear view of the sky to ensure good GPS lock and time synchronization
- Fit linear coupler transducers to the secondary of the protection current transformer wiring
- Connect digital inputs or enable GOOSE messaging to detect line trips
- Connect communication channel to allow data to be processed at a central location - essential for correct double-ended operation
- Each TWS FL-8 can monitor up to 8 line ends - for use in centralized relay rooms
- Each TWS FL-1 can monitor one line end - for use in distributed substations



◀ GPS antenna and linear couplers ▼





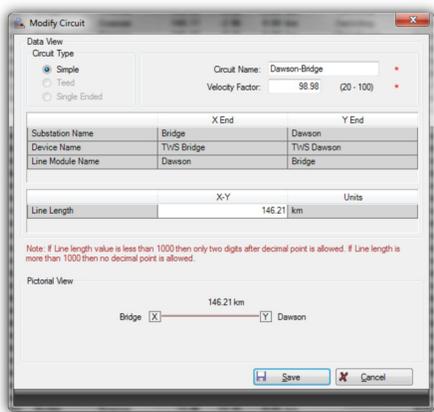
IQ+ - Configuration and analysis software

General description

- Full client-server architecture with separate communications manager module
- All data stored in an SQL database
- Ideal for large installations with a central server, remote clients and multiple communication managers to share the burden of collecting data from different types of devices

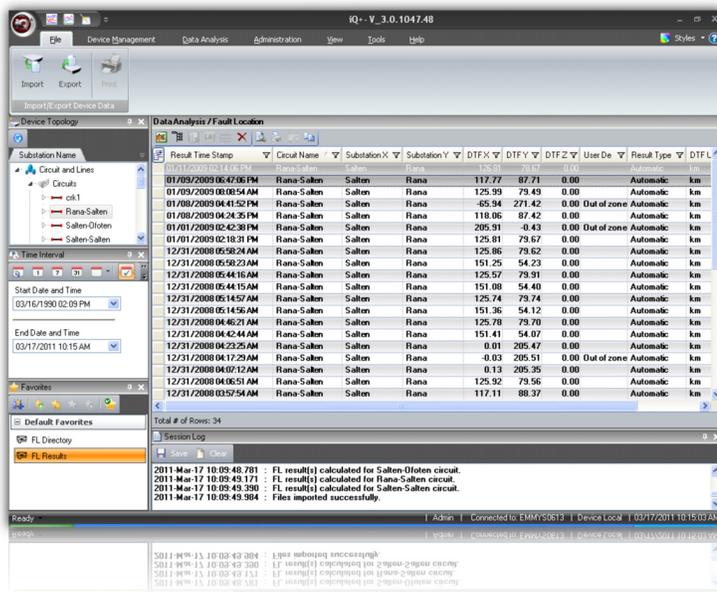
Features include

- Data download, storage and processing
- Device creation and configuration
- Comprehensive viewer for manual analysis of waveforms
- Health check overview to quickly identify any device or communication defects
- Full support for legacy TWS and DSFL (Linux and DOS versions)



Creation of a simple circuit

Circuits and results page for a defined time period



Viewer showing TWS waveforms from each end of the line for a line fault



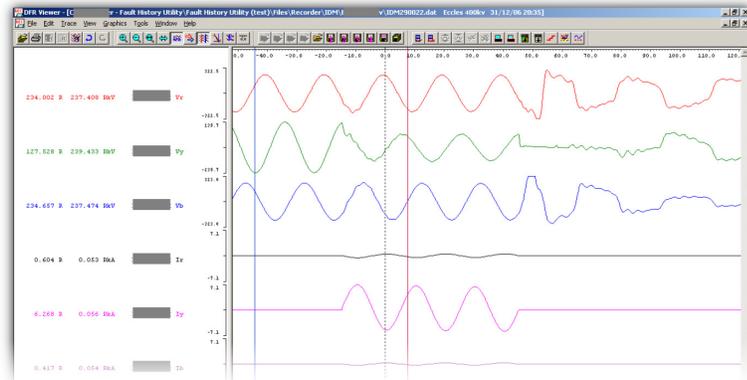
TWS FL-8 and TWS-FL-1 Traveling wave fault locators

TWS - Case study (from Europe). Tree contact on a 65.8 km 400 kV overhead line

Impedance distance to fault (DTF) versus traveling wave distance to fault (DTF)

Data From	Time	Voltage Retained	Fault Current	Clearance Time
	20:35:42:633	128 kV	6.24 kA	60.8 ms
	20:35:42:634	46.3 kV	3.984 kA	61.4 ms

◀ Details of the fault from each end of the line from DFR analysis (substation names blanked out due to confidentiality agreements)



◀ Single phase to ground fault. DFR record and impedance based distance to fault calculation from end X

Impedance method puts fault at **48.4 km** from end X

Result Time Stamp	Circuit Name	Substation X	Substation Y	DTF-X	DTF-Y	DTF Unit	Result Type	Record
30/03/2010 22:29:20				23.14	42.70 km		Automatic	-
30/03/2010 19:19:04				36.11	29.73 km		Automatic	-
21/06/2007 15:25:54				56.54	9.30 km		Automatic	-
31/12/2006 20:25:42				20.56	45.34 km		Automatic	-
05/07/2006 17:50:47				35.04	30.00 km		Automatic	-

◀ iQ+ software and traveling wave distance to fault calculation from end X

The traveling wave method employed by the TWS FL-8 automatically calculates the distance to fault from end X as **45.3 km**



Summary of results

DTF confirmed by line patrol	TWS FL-8 result	TWS FL-8 accuracy	Impedance based result	Impedance based accuracy
45.2 km [28.09 miles]	45.3 km [28.15 miles]	0.15% of line length or 100 m [328.08 feet]	48.4 km [30.07 miles]	4.7% of line length or 3200 m [1.98 miles]

Note: Even an accuracy of 4.7% produces an error of 3.2 km [2 miles] (approximately 11 tower spans) on a line length of 65.8 km [40.89 miles]. Impedance errors can be up to 20% of line length for certain types of fault equating to a 40km [24.85 mile] error on a 200 km [124.3 mile] line.



TECHNICAL SPECIFICATIONS

Power supply	Voltage range	88 - 300 VDC / VAC, 42.5 to 67.5 Hz (optional 36 - 72 VDC)
	Power	20 VA
	Auxiliary output	DC output 12 VDC at 750 mA
MMI	Display	Backlit LCD, 114 x 49mm - 240 x 80 dots
	Keypad	7 button membrane keypad
	Status	9 LEDs (healthy, alarm, trigger, clock sync, comms, status)
Line modules	TWS FL-1	Fixed format with one line module
	TWS FL-8	2 line modules expandable to 8 in steps of 2
	Channels	3 (one per phase) from external linear couplers - 12 bit ADC
	Gain	Programmable full scale deflection
	Triggering	Programmable threshold level
	Sample rate	20 MHz, 10 MHz, 5 MHz, 2.5 MHz or 1.25 MHz
	Diagnostics	Automatic test of channel front end to prove operation
Digital inputs	2 per line module	Wide ranging input from 48 to 250 VDC - selectable debounce
Storage	CompactFlash	4 GB allowing storage of 2100 records from 8 line modules at a sampling rate of 2.5 MHz (option for 8GB on request)
	Modes	Selectable locked or cyclic buffer
Clock	Internal	Synchronized by internal GPS module (master) or via NTP over LAN and a 1 pps (slave)
	Accuracy	Master 100 ns. Slave 1 microsecond
	Output	IRIG-B out to synchronize other IEDs
GPS antenna	Lead length	10 meters [33 feet] (optional extension leads available)
	Mounting	Via 25mm [1 inch] pipe mast
Comms	Modem (optional)	Internal PSTN (V.90) modem (optional on COM 4)
	Ethernet port	2 x 100 Mbits - one RJ45 for local connection at the front and one RJ45 (with option for fiber) on the rear port
	USB	One port to facilitate firmware upgrade and manual download of data
	Serial	3 x RS 232 provided (one front panel, two on rear). 1 x RS 485 on rear panel
Alarms	4 provided	1 (normally closed) for system healthy 3 (normally open) for lost lock, trigger and high priority trigger and fixed buffer 80% full
Configuration	iQ+ Master station	Edit configuration and view diagnostics
	Web page	Access via browser - edit settings, manual trigger, view last waveform
Environmental	Temperature	Operating: -5 to +50° C [23 to 122° F]. Storage: -30 to +70° C [-22 to 158° F]
	Humidity	0 to 95% non-condensing
Immunity	IEEE, EU and IEC	Conforms to relevant specifications for monitoring / control equipment in HV substations
Mechanical	Enclosure	IP 41, 19" rack-mountable
	TWS FL-8	3U device - H x W x D: 132.5 mm [5.2"] 487 mm [19.2"] x 362.2 mm [14.3"] Weight - 11 kg [24.2 lbs].
	TWS FL-1	2U device - H x W x D: 90 mm [3.25"] x 487 mm [19.2"] x 362.2 mm [14.3"]



TWS FL-8 / FL-1

Unrivalled accuracy



**minimize search time and reduce expensive downtime
...what is your time worth?**

QUALITROL® Field Services

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QUALITROL® Accelerated Delivery

QUALITROL® provides accelerated delivery on many products and services including replacements, spare parts and repairs.

About QUALITROL®

QUALITROL® manufactures substation and transformer monitoring and protection devices used by electric utilities and manufacturing companies. It is the global leader in sales and installations of transformer asset protection equipment, fault recorders and fault locators. Established in 1945, QUALITROL® produces thousands of different types of products on demand, each customized to customers' unique requirements.

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