

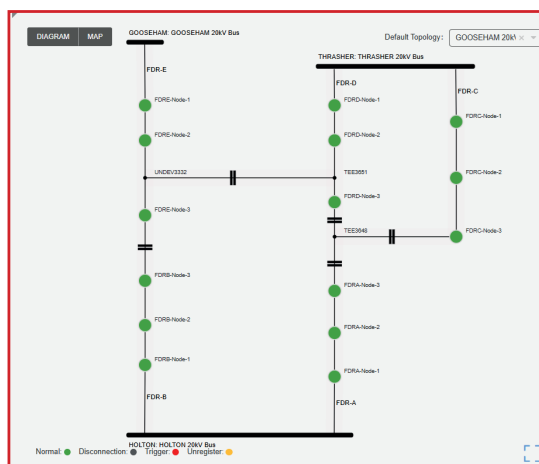
INSIGHT L700 (NODE)

Overview

The INSIGHT L700 system is a distributed network of advanced overhead line sensors designed to improve the safety, reliability and efficiency of the distribution network. Fast and reliable fault localisation adds an expert resource to the fault response team and helps maximise continuity of supply (SAIFI and SAIDI) - in a reliable and cost-effective way.

At a glance

- Very high earth fault sensitivity ($> 10\text{ k}\Omega$) exploiting multiple algorithms
- Reliable localisation of faults regardless of neutral treatment
- Direct to operator's smartphone with additional Local (LED) indication
- Fault localisation via Google maps with utility network GIS overlaid
- Intuitive graphical user interface (GUI)
- Distance to fault
- Integration with SCADA, ADMS, OMS
- Synchronised data monitoring to $1\mu\text{s}$ supports DER management



- High sensitivity earth fault detection improves safety performance with dangerous faults
- Fast, reliable fault location reduces the safety risk associated with faulted network.
- Ensures continuity of supply to customers can be maximised (both SAIFI and SAIDI)
- Provides excellent visibility of the operational conditions on the network
- Supports the optimised integration of DER, in particular renewables
- Simple plug and play installation
- Cost effective and dependable

The Distribution Network historically has had issues due to a fundamental lack of visibility. In response to this lack of visibility, the market has developed many forms of monitoring from the simple fault passage indicators to more complex communicating devices. In general, the market available solutions fail to deliver on high resistance earth faults and due to the complexity of installation and setup, become yet another system for time pressed Network Engineers to learn, deploy and when eventually operational, interpret the fault that is reported. This notion of a complex isolated and limited system for fault visibility has been resolved by the INSIGHT L700 system – thanks to the input of Utility Network Engineers who were a key part of the design process.

The L700 Design Process

The team at AIQ are experienced Network specialists but their first step in the design process was to engage with Utility Engineers from around the globe to deepen their understanding of the primary question; how can we best provide a solution to resolve modern day network problems?

Once informed, it became clear that more advanced network data was required, and the team set about defining the precise nature of this data. In addition to its accuracy, the team determined that the data should be enriched by accurate time coherence, using the best reference available - network wide GPS timing.

The development brief prioritised the functional requirements but also gave the AIQ team their number one priority, which was the need for an ultra-high level of reliability. The reliability that was demanded should be comparable to a protection device and every component of the INSIGHT L700 System has been designed accordingly. This system wide reliability extends beyond the equipment to communications and fault analysis techniques that are effective across multiple earthing methods - from solidly earthed networks to compensated. As a result of this end-user engagement, the INSIGHT L700 System has been designed to be a reliable and accurate resource for the network team.



System Architecture

The L700 User Experience

The INSIGHT L700 System comes with a Graphic User Interface and also has a simple process for SCADA, DMS and ADMS Integration. The detail of each fault, whether it be permanent, transient or insipient are easily accessible to the operator at the level of detail desired – simple details of the fault site with DTF or an upload of the sinusoidal characteristic of the data. The INSIGHT L700 Systems unique ability to detect high resistance earth faults, up to 10 k Ω , and display their location on a Google map. This ensures that public safety due to downed conductors in poor grounding conditions for example, is greatly reduced. The accurate location of faults ensures meaningful reductions in CAIDI and SAIDI.



L700 System Architecture

The L700 NODE consists of distributed devices reporting GPS time stamped near real time data to a central server. At the front end of this chain are the L701 Line Sensors and a local L700 Data Concentrator. Each Line Sensor communicates wirelessly with its local L700, and this in turn communicates with the Server. A substation installed device provides neutral displacement voltage which captures time stamped V0 in a compensated Network. This device is called the S700 which is also an excellent high impedance earth fault relay.

L700 Operation and Integration

The L700 System has multiple options for fault or disturbance capture. For example, when a distributed sensor or a substation S700 captures an overcurrent/ undercurrent condition or an increase in V0 at the substation, it notifies the server of the precise time of event. The server in turn polls for data at the time of event from all distributed devices thereby receiving a precise, distributed data picture of the disturbance.



Once processed by the server, the fault or disturbance is displayed in the GUI, or if integrated, to SCADA, DMS or ADMS. This means that in a matter of seconds, the operator will know where a fault has occurred, its cause and effect, and its potential to create a safety issue irrespective of grounding treatment.

Line Data Capture

The INSIGHT L01 line sensor has been designed to be lightweight, reliable and accurate. It has hybrid power sources; H Field harvesting, Solar Supply and battery, ensuring it will always be operable. It records current values, of amplitude and phase, and stores them into its buffer memory. The sensors are installed in minutes on a live line (where live installation is permitted), and once installed it is ready to go – plug and play.



L01 Line Sensor

The INSIGHT L700 Data Concentrator

Each set of line sensors has a pole mounted L700 Data Concentrator that captures line data and maintains time synchronisation via its GPS Transceiver. The L700 is powered by a solar power supply, and it forwards its data payload to the secure server via an embedded 4G/5G modem. In addition to remote fault notification, it has an optional visual fault indicator module and an integrated travelling wave module for highly accurate fault location (within a pole span).

L700 Data Concentrator



The INSIGHT S700 Relay and Fault Detector

The third hardware component of the L700 System is the S700 relay and fault detector. It is a multifunctional device that aggregates the feeder neutral Voltage with the distributed currents delivered by the line sensors via their local L700 data concentrators. Uniquely, the S700 is also a high impedance earth fault relay with the ability to capture high earth fault sensitivity ($> 10 \text{ k}\Omega$). The architecture of the L700 system supports both a centralised and decentralised approach to fault detection and location.

The L700 System is designed for integration to SCADA but also has its own HMI. The level of detail delivered by the system is configured by the user, and can be as simple as - where is the fault, when did it happen and what is the likely cause. Sub-cycle data can also be viewed for deeper analysis. The system requires minimal configuration and has been designed to be plug and play. The network model is automatically generated, as the named location of each node is input by the customer. It automatically adjusts its network models when the network feeding arrangements are adjusted bringing an Applied Intelligence approach to the system.



S700 Data Concentrator

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Item	Specification
Equipment Supplied	3 x L01 Line Sensors, 1 x L700 Data Concentrator, 1 x Battery Charger, 1 x Solar panel
GUI	Web accessible INSIGHT 7000 User Interface
Sensor installation	Electrically operated hot stick attachment
Rated Frequency	50/60 Hz
Cyber Security	End to End Encrypted
Current Range	0-2 kA
Max Sensor ConductorØ	~ 30 mm (CSA 250 mm ²)
Fault Indication & Notification	Via GUI and local visual LED Module
Sensor Powering	Electromagnetic harvesting supported by battery and solar
L700 Powering	Battery (30 Days)
Rated line Voltage Level	Up to 35 kV Ph to Ph
Recording of data	Stores 30 minutes at sampling 1.6kHz and 5 minutes at 6kHz (Raw Data)
Protocols Supported	IEC 61850/DNP 3.0/IEC 60870-5-104
IP Rating	IP67
Operating Temperature Range	- 40 oC to +70 oC
Accuracy	1A – 1 kA + 5% 1 kA – 20 kA + 5%
Recording of V and I data	Magnitude and phase 3-2 kHz 10 cycles pre fault, 30 cycles post fault
Recording of Waveforms	3.2 kHz 1 cycle pre fault, 3 cycles post fault
Local Communications	2.4GHz radio

If you have a question on any aspect of network protection, control or monitoring, please visit the 'Ask the Expert' section on our website, where our network engineers will provide you with an experts view of your particular issue. Each problem will be answered in the form of a video posted to the site without disclosing the source of the question if so requested.

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