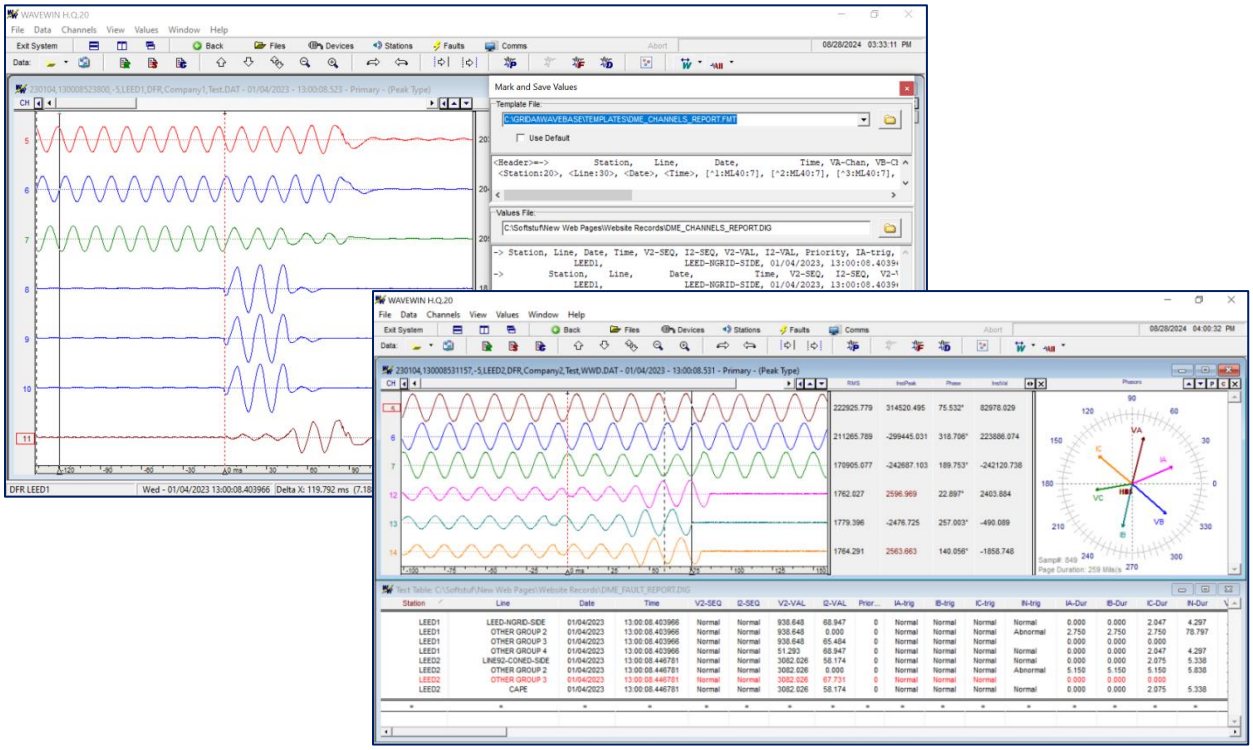


Product Description

Wavewin Process is an advanced software system that is designed to automate the process of analyzing transient data files. The Wavewin Process system includes data collection, data preparation, the extraction of key parameters, data analysis/classification, and event reporting.

Data Collection

Data Collection is the first component in the Wavewin Process system. Our data collection applications are user friendly, non-intrusive, and universal. By universal we mean that our data collection supports almost all communication protocols used in the modern substation, such as SFTP, IEC61850 MMS, and FTP/FTPS. We also support a wide array of proprietary protocols and serial protocols allowing our software to communicate with both legacy and modern disturbance monitoring equipment (DME).

Data Preparation

The main purpose of the Wavewin Process system is to automatically calculate and extract key parameters from transient data files. For this process to work generically the analog and digital channels of a line in any DME such as Digital Fault Recorders (DFRs), meters, or digital relays need to be specified in a standard format. This is where Line Groups come in. Line Groups are Softstuf's solution to preparing DME data for analysis in a standardized format.

Extraction of Key Parameters

Wavewin Process uses template files to determine what key parameters to calculate and extract from transient data files. These template files can either be pre-created by Softstuf, or user defined. The pre-created templates offered by Softstuf include but are not limited to the following:

1. Fault Report Template
2. Prefault Report Template
3. Postfault Report Template
4. Channel Health Report Template
5. Harmonic Analysis Report Template
6. Voltage Monitoring Report Template
7. Power Quality Report Template

Data Analysis and Classification

The key parameters extracted by Wavewin Process can be used to perform the following functionality:

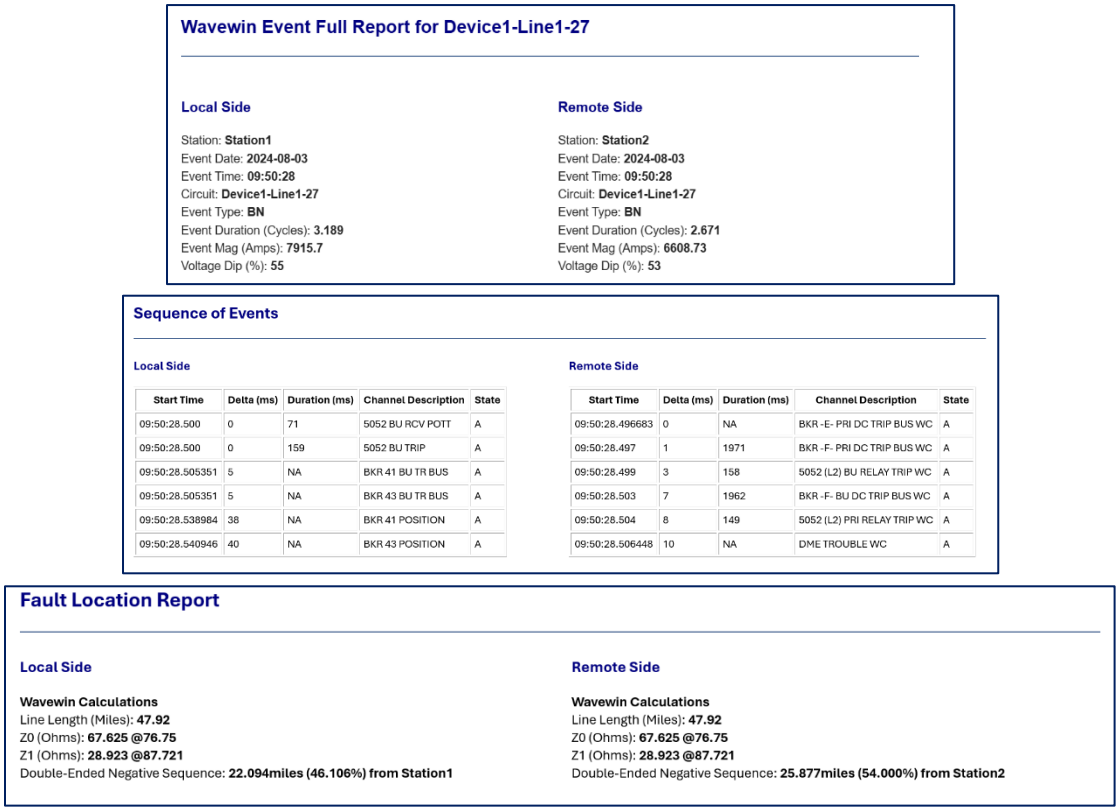
- Classify each transient data file as a System event, equipment event or a nonevent.
- Classify each system event: Single phase, multi-phase, or double ended.
- Classify each equipment event: Testing record, DME wiring, or bad channels issue.
- Classify bad channel issues: pegged channels, channel polarity, or channel imbalance.
- Classify voltage deviations from nominal as Sag or Swell events.
- Identify root causes of power quality issues such as voltage source or harmonic distortion.
- Analyze sequence of events (SOEs) to identify possible settings issues.
- Enhance system reliability by facilitating regulatory compliance.
- Assess the real time performance of the power system and associated devices.

Event Reporting

Once the events have been detected and classified the Wavewin Process system creates reports describing the events in detail within 15 minutes of the event occurring. Templates for event reporting include but are not limited to:

- Fault event reporting.
- Equipment event reporting.
- Regulatory compliance reporting.
- Voltage deviation reporting.
- SOE tracking and trending.

Examples of report templates are displayed on the following pages:



Wavewin Event Full Report for Device1-Line1-27

Local Side

Station: **Station1**
Event Date: **2024-08-03**
Event Time: **09:50:28**
Circuit: **Device1-Line1-27**
Event Type: **BN**
Event Duration (Cycles): **3.189**
Event Mag (Amps): **7915.7**
Voltage Dip (%): **55**

Remote Side

Station: **Station2**
Event Date: **2024-08-03**
Event Time: **09:50:28**
Circuit: **Device1-Line1-27**
Event Type: **BN**
Event Duration (Cycles): **2.671**
Event Mag (Amps): **6608.73**
Voltage Dip (%): **53**

Sequence of Events

Local Side

Start Time	Delta (ms)	Duration (ms)	Channel Description	State
09:50:28.500	0	71	5052 BU RCV POTT	A
09:50:28.500	0	159	5052 BU TRIP	A
09:50:28.505351	5	NA	BKR 41 BU TR BUS	A
09:50:28.505351	5	NA	BKR 43 BU TR BUS	A
09:50:28.538984	38	NA	BKR 41 POSITION	A
09:50:28.540946	40	NA	BKR 43 POSITION	A

Remote Side

Start Time	Delta (ms)	Duration (ms)	Channel Description	State
09:50:28.496683	0	NA	BKR -E- PRI DC TRIP BUS WC	A
09:50:28.497	1	1971	BKR -F- PRI DC TRIP BUS WC	A
09:50:28.499	3	158	5052 (L2) BU RELAY TRIP WC	A
09:50:28.503	7	1962	BKR -F- BU DC TRIP BUS WC	A
09:50:28.504	8	149	5052 (L2) PRI RELAY TRIP WC	A
09:50:28.506448	10	NA	DME TROUBLE WC	A

Fault Location Report

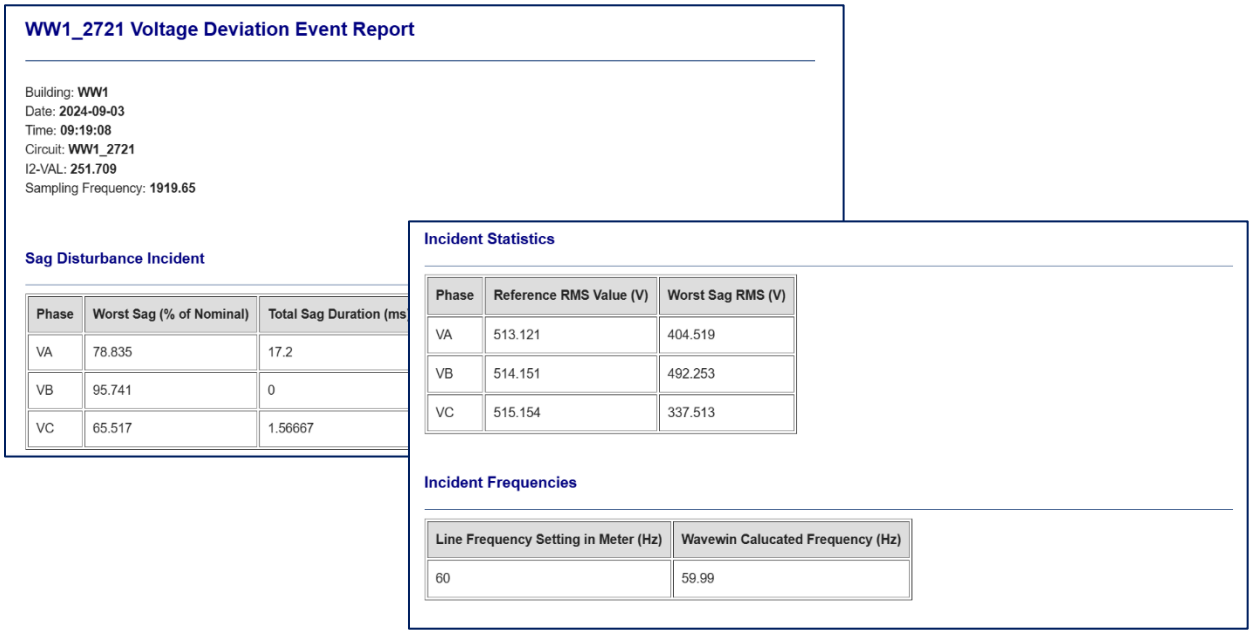
Local Side

Wavewin Calculations
Line Length (Miles): **47.92**
Z0 (Ohms): **67.625 @76.75**
Z1 (Ohms): **28.923 @87.721**
Double-Ended Negative Sequence: **22.094miles (46.106%) from Station1**

Remote Side

Wavewin Calculations
Line Length (Miles): **47.92**
Z0 (Ohms): **67.625 @76.75**
Z1 (Ohms): **28.923 @87.721**
Double-Ended Negative Sequence: **25.877miles (54.000%) from Station2**

Figure 1: System fault event email notifications include sections for prefault and fault phase measurements, associated sequence of events, and fault location.



WW1_2721 Voltage Deviation Event Report

Building: **WW1**
Date: **2024-09-03**
Time: **09:19:08**
Circuit: **WW1_2721**
I2-VAL: **251.709**
Sampling Frequency: **1919.65**

Sag Disturbance Incident

Phase	Worst Sag (% of Nominal)	Total Sag Duration (ms
VA	78.835	17.2
VB	95.741	0
VC	65.517	1.56667

Incident Statistics

Phase	Reference RMS Value (V)	Worst Sag RMS (V)
VA	513.121	404.519
VB	514.151	492.253
VC	515.154	337.513

Incident Frequencies

Line Frequency Setting in Meter (Hz)	Wavewin Calucated Frequency (Hz)
60	59.99

Figure 2: Voltage deviation event email notifications include sections for voltage sag disturbance statistics, and incident frequencies.

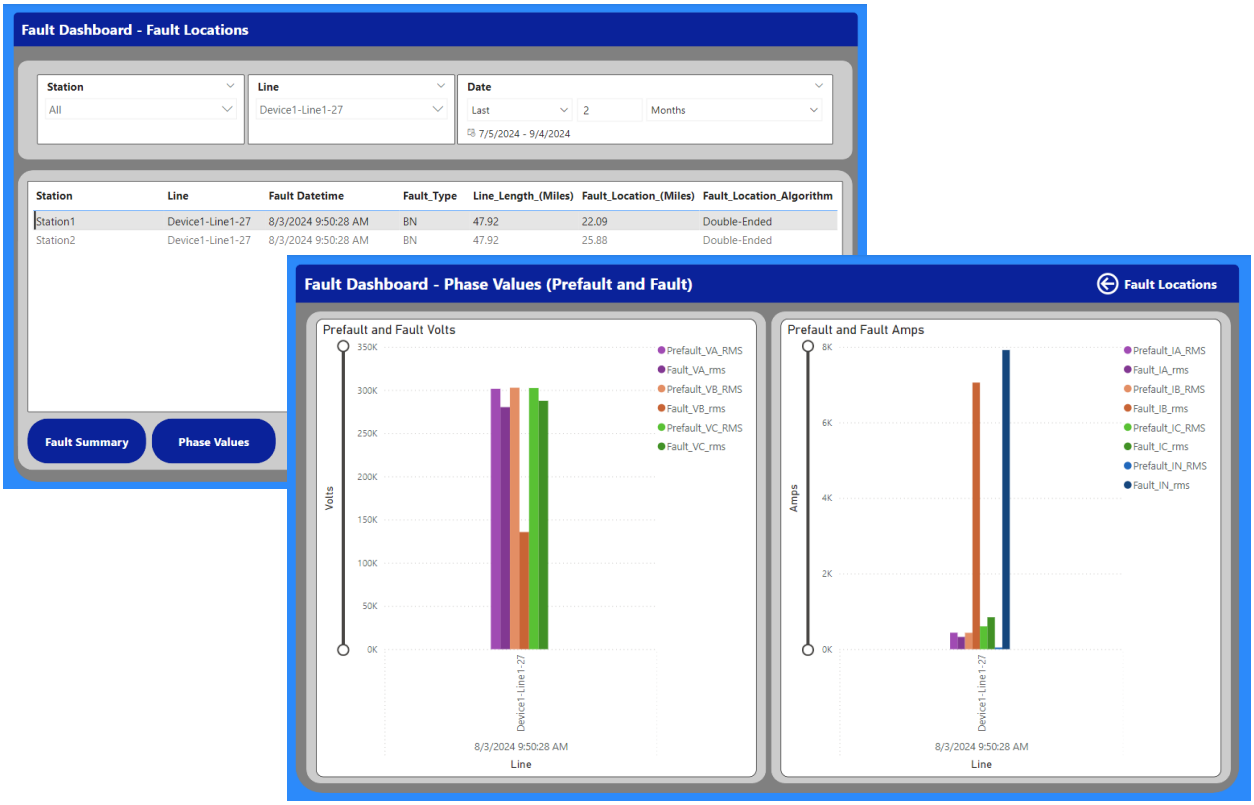


Figure 3: System fault event reporting can also be done via dashboard, with dedicated sections for fault location, prefault and fault phase measurements, as well as associated sequence of events.

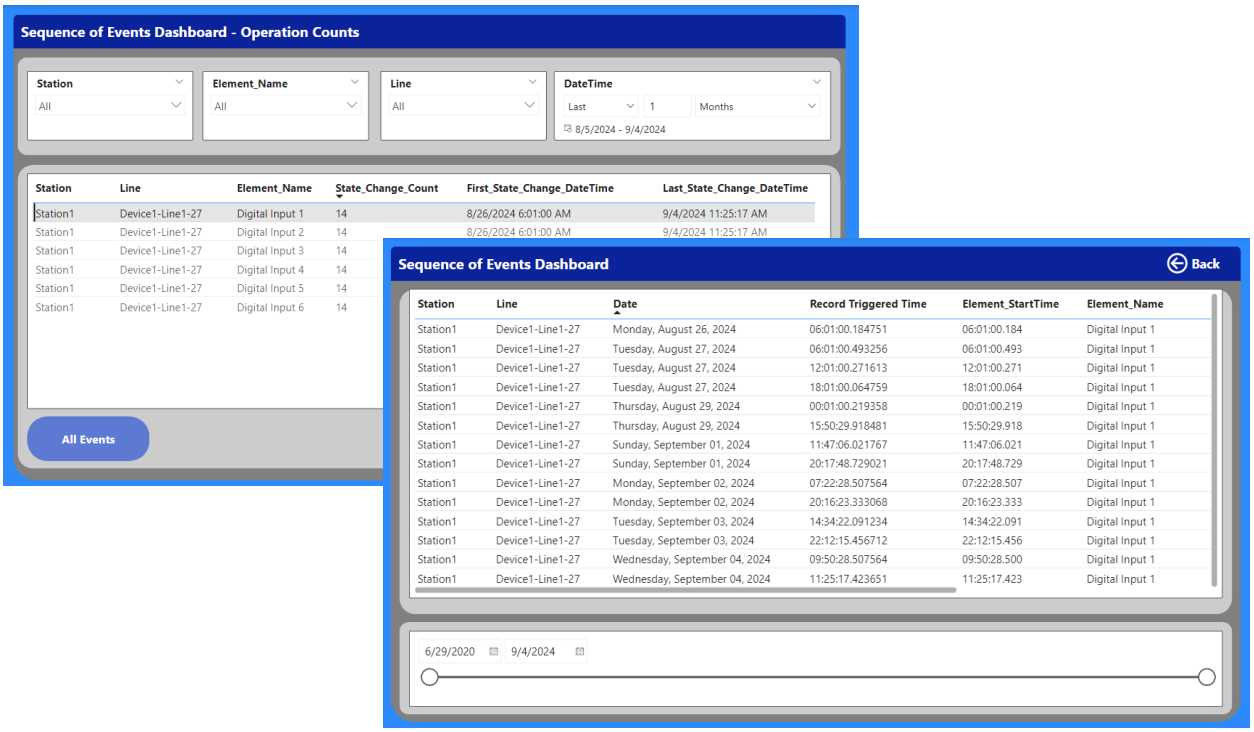


Figure 4: SOEs dashboard allows user to easily track and trend chattering digital elements

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