TESLA Recorder

PMU Capabilities

Krish Narendra
GM- Technology & Quality
ERLPhase Power Technologies Ltd
www.erlphase.com
Contents

• About ERLPhase

• TESLA Power System Recorder

• TESLA Recorder PMU Capabilities

• TESLA 4000 PMU & IEC 61850

• Conclusions
About ERLPhase

Charles Legeyt Fortescue

- Inventor of SYMMETRICAL COMPONENTS
About ERLPhase

- ERLPhase was formed in 2007 as the next generation of APT Power Technologies and the Relay and Recorder division of NxtPhase T&D Corp.

- ERLPhase is formed as a division of Easun Reyrolle Ltd., a growing international company.
## Protection Relays

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-PRO 2100 / 4000</td>
<td>line relay</td>
</tr>
<tr>
<td>T-PRO 8700 / 4000</td>
<td>transformer relay</td>
</tr>
<tr>
<td>B-PRO 8700 / 4000</td>
<td>bus relay</td>
</tr>
<tr>
<td>F-PRO 5100 / 3000</td>
<td>feeder relay</td>
</tr>
</tbody>
</table>

## Disturbance Recorders

**ALL 4000 Series Products and**
- F-PRO 3000 Support
- IEC 61850 Communication protocol

**TESLA 3000 / 4000 Recorders**

**RecordBase**
- (central station)

**TESLA LITE**
- New!
TESLA Power System Recorder

TESLA 3000 Power System Recorder

- **DFR** (Digital Fault Recorder): 0 - 30 sec
- **DSR** (Digital Swing Recorder): 1 - 30 min
- **SER** (Sequence of Event Recorder)
- **PQR** (Power Quality Recorder)
- **LTR** (Trend Recorder): 1 - 90 day
- **CDR** (Continuous Disturbance Recorder): 4-140 day
- **PMU** (Synchrophasors): Real Time
TESLA Overview

The TESLA is a complete, state of the art, user friendly multi timeframe dynamic power system recorder with advanced PMU and Continuous Disturbance Recording capabilities

- 36A (64 DI) and 18A (32 DI) Channels; cooperative mode: 144A (256 DI)
- Sampling: 32, 64, 96, 128, 256 & 384 samples/cycle
- NERC Compliant Continuous Disturbance Recording Capabilities
- Multiple Time-Frame Recording Device
  - Transient (Fault) Recording
  - Extended Disturbance (Swing) Recorder
  - Event Logger (SOE)
  - Long term Trend Recorder
  - Continuous Disturbance Recording (FIFO)
- PMU – Phasor Measurement Unit (IEEE C37.118)
- Fault Location (10 devices)
OVER 120 CALCULATED CHANNELS PER RECORDER:

- Summation: (30 channels) High & Low Magnitude; + & - ROC triggers
- Sequence: (12 channels) +, -, 0 sequence triggers
- Watts/Vars: (18 channels) high & low magnitude; + & - ROC triggers
- Impedance: (18 channels) ROC within defined impedance circle around origin
- Logic: (30 channels) AND, OR, etc triggers on transition to ON or OFF state
- Power Factor: (18 channels) separate triggers for lagging (inductive) and leading (capacitive)
- Fault Locator: (10 channels) creates event message
- Frequency: (2 channels) High & Low Magnitude; + & - ROC triggers
TESLA Recorder
PMU (IEEE C37.118) Capabilities

Digital I/O
Status O/P
IRIG-B

TESLA Power System Recorder

PMU Module (Software)

LAN, Modem or Serial Link

Phasor Data Concentrator (PDC)

Analog Input (Va, Vb, Vc, Ia, Ib, Ic)

Primary signals through station CTs/PTs
TESLA PMU Module

- Complies with IEEE C37.118
- Field upgradeable
- Exists simultaneously with the other recording features
- Superior communication capabilities
- Wide range frequency response
- Easy to configure and use
- Excellent time synchronization accuracy (± 1.5 μS)
TESLA PMU Capabilities

• All Triggers are based on PMU measurements
  – Voltage and Current Phasor Trigger
  – Sequence Components Trigger
  – Summation Trigger
  – Impedance Trigger
  (Triggers: high, low, positive, negative, rate of change etc.,..)
TESLA PMU Capabilities…

• Synchronized sampling with IRIG signal (1 PPS)
TESLA PMU Capabilities…

- PMU Recording in Swing Domain (1 - 30 minutes)
  - PMU Magnitude and Phase angle recording available based on different trigger event
  - Frequency channels are also available
TESLA PMU Capabilities…

- Trend PMU Data over 90 days (10 – 3600 sec interval)
  - PMU Phase Angle Trending over 90 days
  - PMU Phasor Magnitude Trending over 90 days
  - Frequency channels trending
TESLA PMU Capabilities…

• Continuous Storage of PMU data from 10 – 60 Frames / sec on a 4GB on board flash disc (mini PDC)
  – Voltage and Current Phasors can be stored as per NERC’s requirement ranging from 3 – 140 days on the local storage memory
  – Recording can be made based using continuous data
### TESLA PMU Capabilities...

### NERC CDR Compliance:

<table>
<thead>
<tr>
<th>Number of channels *</th>
<th>Sample rate (RMS records per second per channel)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>24</td>
<td>56</td>
</tr>
<tr>
<td>18</td>
<td>73</td>
</tr>
<tr>
<td>12</td>
<td>106</td>
</tr>
<tr>
<td>9</td>
<td>136</td>
</tr>
</tbody>
</table>

No. of days the continuous data can be stored on the TESLA 3000 DFR

6 records per sample is the requirement from NERC and TESLA 3000 DFR can store depending on the number of channels up to 136 days of data.

Sample rate – RMS records per second per channel
TESLA PMU Capabilities…

Installation Benefits:

• Best retrofit recorder solution to the industry
  – Can use existing wiring (split core CTs)
  – Smallest footprint among recorders allows easy retrofit and installation

• Remote input modules up to 1200 meters (4000 feet) away save on costly CT and PT wiring runs

• Flexible Installation : Centralized, distributed, or hybrid installation
  – PMU and CDR recording capability are field upgradable on existing TESLA 3000 installations

Utilities can save nearly $250k in installation cost for synchrophasor applications
TESLA PMU Capabilities...
TESLA 4000 PMU
Cross Triggering
Conclusions:

- TESLA PMUs are field upgradable through firmware update, easy to install, and cost effective.

- Provides built-in redundancy to PMU Phasor Data and supports event-based recording capabilities at 60Hz sample rate.

- Still need to establish interoperability for wide area monitoring and control.

- IEC 61850 and PMU standards are implemented in small scale (especially in North America) and hence the limitations are not fully understood.

- Number of challenges for both vendors and utilities ahead to adopt to the rapid changing standards and regulations.
QUESTIONS ??