Electrical Power Monitoring in Data Center
Typical Data Center One-Line Diagram?

Multiple Utility Feeds
Uninterruptible Power Supplies (UPS)
Dual Feed Substations
Coordination and Engineering Studies

- Performed with electrical analyses software
- Develop optimal settings for selectable breakers, protective relays, and fuse sizes
- Isolated faults and/or overload
- Provide protection to system components and personnel
- Double check electrical design
- Load flow study for transient stability
Why Monitor Power In a Data Center?

- Disaster Avoidance
  - Power Quality problems
  - Early warning of overloads and mechanical conditions leading to downtime
  - Correct root cause of problems, avoid future incidents

- Verify Energy Consumption, Bill to Users, and Verify up-time

- System Planning
  - Preparing for new equipment and change outs
  - Improve maintenance efficiency

- Overall Improved Customer Service

- Help Manage Energy Consumption and Integration w/ HVAC
Monitor to Assure Up-Time

- Take warning from electrical events that do not cause outages
  - Transients
  - Sag & Swell
  - Harmonics

- Information for forensic ‘root cause’ investigation

- Sequence of Events Recording

- Monitor non-electrical parameters that can cause problems
  - Rack Temperature
  - Air Flow
  - Generators
Transients in Power Systems

- Duration-less than a microsec to several millisec.
- Originate inside facility or out on the utility’s grid
- Stress electrical insulation
- 75% of IC failures may be due to voltage transients
Transients in Power Systems

Figure A: Event captured using the 64 Sample/Cycle Monitor (without a TVSS on the load)

Figure B: Event captured using the 64 sample/cycle monitor (with a TVSS on the load)

Figure C: Event captured using the 512 sample/cycle monitor (without a TVSS on the load)

Figure D: Event captured using the 512 sample/cycle monitor (with a TVSS on the load)
Transients in Power Systems

Figure E: Event Capture using high end meter
Facility Wide Power Monitoring

Monitor the following:
- Power Distribution Units
- UPS
- Diesel Generators
- Transformers
- Transfer Switches
- Switchgear and breaker trip units
- Surge Protection – TVSS
- Filters
Power Monitoring System Overview
## What to monitor?
### Service Entrance

<table>
<thead>
<tr>
<th>Monitored Parameters</th>
<th>Recorded Data Log</th>
<th>Waveform Capture</th>
<th>Alarm Relay</th>
<th>Software Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surge Protection</strong></td>
<td>Blown Fuse</td>
<td>Voltages</td>
<td>Min. 60 cycle Pretrigger 10cycles</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td><strong>Ground Fault</strong></td>
<td>Alarm and Trip Contacts</td>
<td>Ground I Neutral I Phase I Voltages</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td><strong>Trip Unit</strong></td>
<td>Trip Status</td>
<td>Instantaneous V,I</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td><strong>Feeder Transformer</strong></td>
<td>Fan Failure Coil Temp. Overtemp</td>
<td>Feeder Demand K-Factor Current THD</td>
<td></td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td><strong>Utility</strong></td>
<td>Synch Pulse Interruptible Rate</td>
<td>Demand Power Factor</td>
<td>4 cycle</td>
<td>To Generators and Transfer Switch</td>
</tr>
<tr>
<td><strong>Transfer Switch</strong></td>
<td>Position Status Test Position</td>
<td>Gen Demand Gen V,I,THD</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
</tbody>
</table>
## What to Monitor?
### Generator

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Forced Data Log</th>
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</thead>
<tbody>
<tr>
<td><strong>Battery Charger</strong></td>
<td>DC Bus Level</td>
<td></td>
<td>To Central Monitoring Station</td>
<td>DC Voltage History Log</td>
</tr>
<tr>
<td><strong>Ambient Temp.</strong></td>
<td></td>
<td></td>
<td></td>
<td>Priority Alarm</td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td>Water Temp</td>
<td>Generator</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td></td>
<td>OV / UV Fuel</td>
<td>Demand</td>
<td></td>
<td>Page Event Priority Alarm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V, I, THD, Hz</td>
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<tr>
<td></td>
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<td>Ambied</td>
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</tr>
<tr>
<td><strong>Generator Output</strong></td>
<td>Sag / Swell</td>
<td>Generator</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demand</td>
<td></td>
<td>Page Event Priority Alarm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V, I, THD, Hz</td>
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<td></td>
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<td>Ambient</td>
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<tr>
<td><strong>Protective Relays</strong></td>
<td>Reverse Power</td>
<td>Generator</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td></td>
<td>High / low Oil</td>
<td>Demand</td>
<td></td>
<td>Page Event Priority Alarm</td>
</tr>
<tr>
<td></td>
<td>Water Temp</td>
<td>V, I, THD</td>
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<tr>
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<td>OV / UV Fuel</td>
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<td>Overspeed</td>
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<tr>
<td></td>
<td>Fuel</td>
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<tr>
<td><strong>Parallel Switch Gear</strong></td>
<td>Status Change</td>
<td>Generator</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demand</td>
<td></td>
<td>Priority Alarm</td>
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<tr>
<td></td>
<td></td>
<td>V, I, THD</td>
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# What to Monitor?

## UPS

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<tr>
<td><strong>UPS Alarms</strong></td>
<td>UPS Output V,I Ambient</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
<td>Priority Alarm</td>
</tr>
<tr>
<td></td>
<td>UPS Input THD</td>
<td></td>
<td>To Generator</td>
<td>Page Event</td>
</tr>
<tr>
<td><strong>UPS Input</strong></td>
<td>Even Harmonics</td>
<td>Input THD</td>
<td>4 Cycle</td>
<td>Priority Alarm</td>
</tr>
<tr>
<td></td>
<td>UPS Input THD</td>
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<td>History Log of Harmonics</td>
</tr>
<tr>
<td><strong>UPS Output</strong></td>
<td>Sag Swell</td>
<td>UPS Demand V, I, THD</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td><strong>UPS Battery</strong></td>
<td>Ambient Temp. DC V,I</td>
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<td></td>
<td>History Log</td>
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<tr>
<td><strong>UPS Data</strong></td>
<td>Internal Alarms</td>
<td></td>
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<td>Custom Table Alarm Log</td>
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<tr>
<td></td>
<td>UPS Measures: Bypass V,I</td>
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<tr>
<td></td>
<td>UPS V,I</td>
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<tr>
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<td>Input V,I</td>
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<td>DC V,I</td>
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## What to Monitor?

**PDU**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Forced Data Log</th>
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<th>Alarm Relay</th>
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<tbody>
<tr>
<td><strong>PDU Alarms</strong></td>
<td>Transformer OT EPO</td>
<td>K-Factor Output Demand</td>
<td>60 Cycle</td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output V,I Ambient Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PDU Output</strong></td>
<td>Load Currents Overload Limits</td>
<td></td>
<td></td>
<td>To Central Monitoring Station</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Environmental Conditions</strong></td>
<td>Water Detection Temperature Humidity</td>
<td>Temperature</td>
<td></td>
<td>To Central Monitoring Station</td>
</tr>
</tbody>
</table>

Schneider Electric
High-End Circuit Monitor Features

- **Implusive Transient Detection**
  Capture extremely short duration events to find cause of problems

- **Sag/swell and disturbance detection**
  Detect the cause of equipment shutdown

- **Waveform capture to 255th harmonic**
  Find tough power quality problems

- **Adaptive waveform capture**
  Look at events up to 60 seconds long

- **0.04% typical accuracy, meets ANSI C12.20**
  Billing and auditing with confidence

- **Continuous fast sampling, meter to 255th harmonic**
  Accurate data in challenging electrical environments

- **Log at up to 10 times/second**
  Trend motor starts for predictive maintenance

- **16 Meg of on-board data logs**
  Capture all data and waveforms to find problems
Functionality Summary

Low-end Metering

**Metered parameters:**
- kWh, kW, kVA, VAR,
- Power factor (3ø + total), Amps (3ø + total), Volts L-L (3ø + total)

Mid-range metering option

**Metered parameters:**
- Basic Power Metering
- Basic Power Quality
- THD
- Alarm & event recording
- On board data logging
- Modbus, Jbus communications
Benefits of Branch Circuit Monitoring

- Eliminates labor and cost intensive system of manual measuring thousands of circuits each week.
- Instantly warns NOC before breakers are tripped due to overload.
- **Ability to bill customers** for actual energy used.
- Optimizes floor space and available power to cope with rising load densities = more customers in the same space!

*No more labor intensive manual monitoring*

*Per breaker monitor charts customer power use in detail, and avoids accidental circuit overloads*
Branch Circuit Monitor Components

PDU BREAKER PANEL
Branch Circuit
Current Monitoring System

CT’S

COM CARD

Panel "A" 42 POLES
Panel "B" 42 POLES

Scriptex Network
Local and Remote Monitoring and Control

Remote Monitoring Via WAN or Internet

Ethernet (Wide Area Network)

SNMP

PMM

UPS

Generator Monitoring

Or

Ethernet Gateway

Modbus Protocol

Local Monitoring

Ethernet (Local Area Network)

SNMP

SNMP

PMM Utility Monitoring
Web-Enable User Interface

- Real Time Data
- Multiple Alarm levels (1, 2, 3, etc.)
- Historical Reports - Trends, Tables, Graphs, Charts
- Events Analysis
- SQL 2000 Database
- Graphic Screens
- Data exportable to spreadsheet (ODBC)
- Crystal Report Capability
Fast Notification - Preempt Problems

- Automatic Paging via software
- E-mail
- Remote monitoring via intranet or internet using web browser
Power Disturbances Cause Computer Down Time

- Transients
- Harmonics
- Loss of power
- Disturbance direction (Upstream/Downstream)
Questions