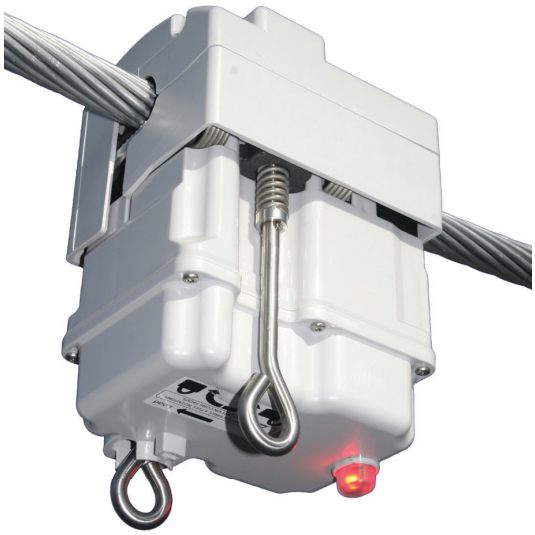
Sentient ENERGY®

MM3™ Line Sensor



Sentient Energy's MM3 intelligent line sensor is your gateway to improved grid reliability and reduced operations cost.

It combines fault and disturbance detection with load monitoring and high resolution waveform capture—a must-have capability for any Grid Analytics System. The MM3 is proven to be multi-communications capable; operating on RF Mesh (Itron) and cellular (4G/LTE) network.

Maintenance Free and Easy to Deploy
The MM3 uses Sentient Energy's patented IBOLT power harvesting technology to generate all the power it needs from the magnetic field surrounding the conductor it is installed on. Our flagship line sensor does not need battery changes or solar panel cleaning. Installation is done via hot-stick and takes just minutes.

Proven Multi-Communications Solution
Developed for flexible communication, tens of thousands of Sentient Energy's MM3 intelligent sensors are deployed across both mesh and cellular networks. The MM3 delivers rich analytics data to Ample and supports integration into SCADA using multiple protocols. Its edge processing reduces the burden on the communications network by transmitting only key event information, in real time and by exception.

Powerful Platform for Advanced Monitoring and Analytics
The MM3 device is equipped with sophisticated sensing and measurement capabilities including current, conductor temperature, voltage characteristics, GPS for location and a precision clock. It also features patent-pending communications software that efficiently enables uploads and downloads over constrained networks allowing data transfers, software upgrades and configuration changes remotely over the air from the utility's control center. Multiple embedded apps enabling fault detection, anomaly disturbance detection, auto-phase identification, waveform analysis, and load monitoring are supported by the MM3.

SAIDI: Fault Detection and Location
Sentient Energy's MM3 Fault Monitor app (cFCI®) uses advanced fault detection algorithms and works with the Ample® Analytics Platform, identifying ground faults to improve situational awareness. The MM3 wirelessly communicates fault information immediately to the utility control center, and operators can dispatch crews to the correct location based on an immediate alert notification, supported by a daylight-visible LED which enables crews to confirm that they have arrived at the proper site.

SAIFI: Waveform Analysis and Disturbance Management
Equipped with high resolution waveform capability at a rate of 130 samples per cycle, the MM3 captures and records waveforms of faults and line disturbances. The MM3 and Ample can also notify engineers when there is a high density of high amplitude load events. Complete current and E-field waveform data is stored locally on the MM3 and is available to download when needed.

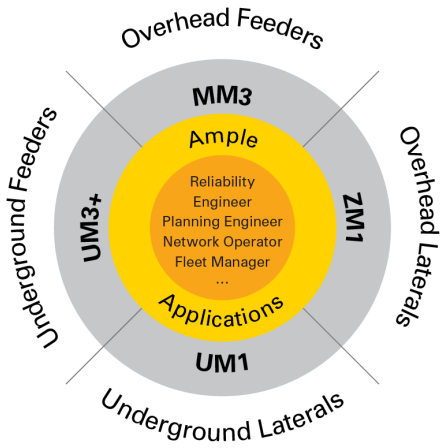
These high-definition waveforms captured by the Grid Analytics System enable utilities to shift from reacting to outages to preemptively tackling issues that may cause power interruptions in the future. Examples of such issues include insulator leakage, excessive arcing during capacitor switch operations, and loose connectors—causing anomalies that can be detected before an actual failure occurs.

Load Monitoring and Phase Balancing
The MM3 Log-I app continually measures current and temperature and derives the most useful values and averages for load monitoring purposes. This collected data is processed on the device itself to extract critical information and report accurate line conditions. Only average logging data and statistics (such as alerts and daily peaks) are reported back to Ample and the Grid Analytics System. The Sentient Energy Log-I app gives operators visibility into network loading conditions and allows maximized asset utilization by basing asset replacement and network operational decisions on accurate, real data rather than best-guess simulations or state estimations.

Auto-Phase Identification
Combining its current and E-field measurements, the MM3 automatically detects the phase it is installed on. Utilities can use this information not only to correct any database errors that affect all operations technology systems, but also for continuous connectivity tracking, as construction and restoration may lead to phase misconnection.

A Complete Grid Analytics System

Sentient Energy's Grid Analytics System consists of the MM3™, ZM1™, UM3+™, and UM1™ line sensors, and the Ample Analytics Platform. Each sensor features fault detection and load monitoring capabilities, an LED indicator, GPS, and integrated cellular or mesh communications. The MM3 is used for overhead feeders and the ZM1 monitors overhead laterals as well as low load feeder segments. The UM3+ addresses underground feeders while the UM1 monitors underground residential distribution. All four sensors are designed to maximize the amount of system data gathered while transmitting only the necessary information.



Ample® Analytics Platform

Sentient Energy's Ample Analytics Platform is a comprehensive set of software tools that turn sensor data into actionable insights for network operators, reliability engineers, and planning engineers. In addition to providing data visualization and analytics, Ample streamlines sensor fleet management and integration of sensor system data into existing OT systems.

Key Characteristics

The MM3 intelligent sensor is the key enabler to effectively turn raw field data into actionable intelligence. Its local computing capability greatly reduces the burden on the communications networks by communicating only processed and compressed event information — in real time and by exception.

Wireless Communications (WAN)	Cellular (4G LTE - AT&T, Verizon, SoLinc, Telus and additional International MVNO Mesh – Itron Protocols: DNP3/IEC 60870-5-104[1]
Current, Fault Measurement	0 to 800A RMS, up to 10kA peak current, fault type identification; 25kA RMS fault current tolerant
Waveform Capture (I & V)	130 samples/cycle (60 Hz) and 156 samples / cycle (50 Hz), 1st – 22nd harmonics
Sensing/Characteristics	Up to 44kV (L-L). Measures E-field and current presence, current direction, waveform
GPS	Lat/Long & precision time stamping, +/- 64 micro seconds
Operating Environment	-40°F to +185°F (-40C to +85C)
Off Peak Low Current Ride-Through (for 8 hrs @ 22°C)	50 Hz – 8A, 60 Hz – 7A
Current for Full Sensor and Communications Operations	50 Hz – 10A, 60 Hz – 10A
Conductor Size & Surface Area	0.375" to 1.030" (9.5 to 26.2 mm) (up to 795 AAC); 0.25" with armor rod; 71.3-538mm^2
Physical Size & Construction	8" x 4.5" x 5.5"; Weight: 6.5 lbs; Weather-proof; 10+ year lifespan
Qualifications	ANSI®/IEEE495-2007; FCC part 15 and IC; salt fog environmental
Event Notifications / LED	Immediate network messaging and local super-bright LED FCI-type indicator
Availability / Outage	60 min. cellular or 30 min. Itron sensor & communications at full operation
Installation	Standard hot stick; minimal installation time with no pole attachments required
Security	Transport Layer Security (TLS)
Clamping Mechanism	Metallic and mastic grippers available

[1]DNP3/IEC 60870-5-104 through concentrator

Sentient ENERGY®

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Visibility, Analytics, and Control for a Better Distribution Grid

Sentient Energy®, a Koch Engineered Solutions company, is the premier provider of intelligent sensing, data analytics, optimization, and control technologies for the distribution grid. Sentient Energy's hardware and software solutions help electric utilities make data-driven decisions to enhance the delivery of safe, reliable, and efficient power. With the industry's only Grid Analytics System™ that covers the entire distribution network, Sentient Energy leads the global market with the largest network of line sensor deployments in North America, gathering rich data in real time for predictive insights and strategic grid management. Sentient Energy's Grid Edge Control solutions enable utilities to reduce energy costs at the grid edge through Volt-VAR optimization, conservation voltage reduction, and peak demand reduction. Sentient Energy partners with leading communications network providers. For more information visit www.sentientenergy.com.

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