

# LineScope

## Smart Power Monitor

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# The LineScope®

## **Overview**

The LineScope<sup>®</sup> is a highly accurate three phase power monitoring system for use on circuits up to 138 kV. The system consists of three conductor-mount LineProbe sensors and a data consolidating RTU that can be housed in a CommBridge communication node, a customer's communication node, or integrated into a Cleaveland/Price ADMO or PTAD switch controller.

Applications for the LineScope<sup>®</sup> are numerous and include: Grid monitoring

- Fault detection, location, and system restoration
- PQ voltage, current, and power measurements
- Volt/Var optimization
- Power factor correction
- Line temperature monitoring
- DER (distributed energy resources) monitoring
- Metering for a mobile substation
- Calibrating the measurements of other metering equipment
- Remote switch operation when installed in a Cleaveland/Price motor operator

The LineScope<sup>®</sup> uses no proprietary software or communication format and will integrate seamlessly into DNP 3.0 SCADA and smart grid systems.

## **Data Reporting**

The CommBridge RTU module receives voltage, current, and conductor temperature data that streams from the LineProbe sensors via a 915 MHz spread spectrum radio. The data is received from each phase at a rate of 32 samples per cycle. All data downstream of the LineProbe is purely digital, preserving full resolution and accuracy of all measured parameters. This compact yet powerful device has low power demand and tremendous computing capabilities.

From the data provided by the LineProbe sensors, the LineScope<sup>®</sup> can report:

- Load current to 1,600A
- Fault current to 32kA peak
- Phase-to-phase RMS voltage value
- Ground current value
- Watts
- VAR
- Power angle
- Power factor
- Phase angle
- Fault direction
- Conductor temperature
- LineProbe-to-radio signal strength



CommBridge RTU

## **Exceptional Performance**

#### **Highly Accurate**

For accuracy, the Cleaveland/Price LineScope<sup>®</sup> goes to the head of the class of line sensors. The factory calibrated sensors have demonstrated an *accuracy of 0.5% for both voltage and current measurement*. The LineScope<sup>®</sup> has proven its ability to detect high impedance transient faults that were not detected by other sensors on a distribution line.

#### **Real-time Reporting**

LineProbe sensors stream data to the consolidating RTU at a rate of 32 samples per cycle from each phase. Data is automatically transmitted in event of user defined exceptions. Data can be retrieved on demand or on a specified schedule.

#### **Ultimate Grid Visibility**

The LineProbe sensor is powered by line voltage, which enables it to stream voltage, current, and conductor temperature data as long as there is voltage on the line. The system does not have the limitations of current based line harvesting sensors, making it *ideal for lightly loaded lines and end of line locations*. The unit is battery-free so maintenance is never an issue. The LineProbe contains a supercapacitor that will supply power for communication for 2 minutes after loss of voltage on the line.

#### **Sensor Synchronization**

Using a patented synchronization scheme, the sensors on each phase are precisely synchronized to the RTU processor clock, enabling the measurement of neutral/ ground current and phase-to-phase voltage, when connected phase to ground. COMTRADE files accurately illustrate the current and voltage waveform relationships between the phases.

#### System Signal Strength

The LineScope<sup>®</sup> system monitors the strength of the bi-directional radio signal between the LineProbe and the data consolidating RTU. The RSSI value can be read over DNP.

# CommBridge RTU

The CommBridge RTU is a full-featured RTU capable of supplementing or even replacing an existing RTU that utilizes DNP 3.0 protocol. The device features 15 DI contacts and 4 DO contacts and is provided with two RS232 ports, an RS485 port, and an Ethernet port. The RTU has a small 4.18" (106 mm) x 6" (153 mm) footprint and minimal power requirements. It has a maximum current requirement of 25mA. The RTU operates in an input voltage range of 9VDC to 30VDC.

The CommBridge RTU can be retrofitted in a Cleaveland/ Price ADMO or PTAD switch controller, a customer's communication node, or be supplied in a LineScope<sup>®</sup> CommBridge assembly. To communicate with the LineProbes in retrofit applications, a receiving antenna kit is supplied for installing with the controller or communication node enclosure. The antenna is gasketed to prevent the ingress of water into the enclosure. A coaxial cable is provided as part of the kit.

When installed in a switch controller, the RTU can be programmed to initiate auto-sectionalizing should voltage on the line drop below a user defined threshold.



CommBridge RTU retrofitted in a Cleaveland/Price PTAD switch controller

# LineScope<sup>®</sup> CommBridge

The CommBridge contains all of the components necessary to receive data from the LineProbes and transmit power measurements. The CommBridge is available in two models, the CommBridge-B and the CommBridge-S. Both are powered by a customer-supplied 120VAC source with solar charging available for the CommBridge-B.

The CommBridge-B contains an 8A-H battery to maintain communication for a long period of time after loss of AC. It also has provision for mounting a customer's choice of small footprint RTU and radio. When applicable, the CommBridge-B is supplied with an enclosure-mounted antenna.

The lower cost CommBridge-S contains super capacitors that enable a final transmission after loss of AC. Upon restoration of AC, the unit becomes immediately operable. It has provision for mounting a customer's choice of a small footprint radio, cell modem, fiber modem, or other communication device. For wireless communication, the CommBridge-S is available with an antenna kit that includes a polyphaser, coaxial cable, antenna, and antenna mounting bracket.



CommBridge-B



CommBridge-S

# **Fault Reporting**

In the event of a fault on the line, the LineScope<sup>®</sup> automatically reports the fault in real-time and generates a COMTRADE file. COMTRADE files are stored in non-volatile memory until retrieved and erased by the host system. When the memory buffer is full at 64 files, the oldest file is deleted when a new one is created.

The LineScope<sup>®</sup> detects transient and permanent faults, as well as anomalies on the line of very short duration. Because both voltage and current are closely monitored, false fault indications are prevented. The waveform to the right captures a short fault on B phase, then shows the effect of transformer inrush current on the current waveform.

The COMTRADE file waveforms below illustrate a threecycle fault captured by the LineScope<sup>®</sup>. The transient event on C phase was caused by a faulty lightning arrester. The waveforms clearly show fault magnitude and duration and how the system returned to normal after the event.







## **Local Fault Indication**

If local visual fault indication is desired, optional fault indicating lights can be installed on the CommBridge-B enclosure to provide a highly visible local fault alert. For installations where the CommBridge RTU will be retrofitted in a Cleaveland/Price overhead switch controller or customer's communication node, a separate faulted circuit indicating assembly is available.

The faulted circuit indicating assembly is connected to the motor operator or comm node enclosure by a 20-foot (6 m) long communication cable. Lights on the FCI box are powered by the battery in the controller (not available with the CommBridge-S).

The assembly features high-intensity, daylight-visible LED lights in a watertight housing. The lights are controlled by the CommBridge RTU. The LEDs will flash either red, white, or blue in a preset pattern depending upon which phase is faulted. A flashing light is clearly visible when approaching from any of three directions.



# LineScope<sup>®</sup> LineProbe



The voltage reference cables are joined at a common grounding point

The sensing portion of the LineScope<sup>®</sup> system is the LineProbe, a lightweight sensor that can be attached to the conductor with a hotstick or gloved hand. Powered by line voltage, the sensor continuously streams current, voltage, and line temperature data to the data consolidating RTU.

During installation, the voltage reference cable of the three LineProbes are joined together on a ground cable or grounded surface. The common grounding point enables the LineProbe to detect ground currents without the need for GPS coordination. Three wire systems, and four wire systems with geometries that are not conducive to phase-to-neutral connections, can be connected phase-to-phase.

After installation, the user can ping the LineProbes from the CommBridge RTU to verify that the sensors are installed on the correct conductors.



- A The sensor head contains the sensing module, a power harvesting module, spread spectrum radio, and supercap reserve power supply.
- **B** A hotstick driven screw clamp is used to lift and attach the sensor to the line. The screw clamp incorporates a clutch mechanism to prevent over-tightening.
- **C** The clamp head accommodates conductor sizes from 10 AWG to 1,000 MCM.
- D Line and load side identifiers are molded into the sensor head. Phase and serial number identifier labels are provided.
- E The voltage divider string has sheds of hydrophobic silicone polymer that are molded to the resistor string. The leakage distance of the string exceeds IEEE Standard C57.19.100 requirement for very high pollution level at most voltages.
- **F** The 15-foot-long voltage reference cable has UV resistant insulation.

LineProbe	4 kV / 8 kV		15 kV		23 kV		34.5 kV		46 kV		69 kV		115 kV		138 kV	
Characteristics	L-G	L-L	L-G	L-L	L-G	L-L	L-G	L-L	L-G	L-L	L-G	L-L	L-G	L-L	L-G	L-L
Basic Impulse Level (kV)	110	110	110	110	150	150	200	200	250	250	350	350	550	550	650	650
Resistor assembly leakage distance in/(cm)	25.4" (65)	25.4'' (65)	25.4'' (65)	42.9" (109)	42.9" (109)	65.3" (166)	65.3" (166)	82.8" (210)	65.3" (166)	123'' (311)	105'' (267)	162'' (413)	145'' (368)	242'' (615)	208'' (527)	316'' (802)
Power frequency dry withstand RMS voltage (kV)	50	50	50	50	70	70	95	95	120	120	175	175	280	280	335	335
Weight Ibs/(kg)	4.8 (2.2)	4.8 (2.2)	4.8 (2.2)	6 (2.7)	6 (2.7)	7.4 (3.4)	7.4 (3.4)	8.6 (3.9)	7.4 (3.4)	11.2 (5.1)	10.0 (4.5)	13.8 (6.3)	12.6 (5.7)	19 (8.6)	18.7 (8.5)	25.7 (11.7)

### **LineProbe Features**

# LineScope<sup>®</sup> Technical Specifications

#### **Measuring Specs**

Available system voltages (60 Hz)	4 kV, 8 kV, 15 kV, 23 kV, 34.5 kV, 46 kV, 69 kV, 115 kV, 138 kV
Phase-to-phase RMS voltage value	Yes
Voltage measuring accuracy*	0.5%
Load current measurement range	0 – 1,600A
Current measuring accuracy	+/- 0.5%, +/- 1A @ 200A or less
Fault current measurement Fault current tolerance Fault detection response time	to 32kA peak 100kA peak Adjustable – 1 or more cycles
Fault direction	Yes
Line temperature measuring range	-40°C to 100°C +/- 1°C accuracy
Sampling rate of data concentrator	32 samples/cycle/phase
Power measurement	Watts, VAR, Power Angle
Power factor	Yes
Phase angle resolution	0.1°
Ground current calculated	Yes
Voltage harmonics	THD is calculated to the 11th harmonic
Waveform capture	2 cycles before inception of an event and 16 cycles after. Storage for 64 COMTRADE files.

\*Voltage accuracy is 0.5% with phase-to-ground connection, and with phase-to-phase connection and a balanced voltage system. Contact the factory regarding non-balanced voltage situations with phase-to-phase connection.

#### **Operational Specs**

LineProbe powering method	Voltage based line harvesting with supercap backup
Operating temperature range	-40°C to 85°C
Conductor size range	10 AWG-1,000 MCM (0.1" - 1.15")
LineProbe housing material	UV stabilized plastic
Assembly ingress protection LineProbe CommBridge	IP66 NEMA 4
Design life	> 20 years
LineProbe to RTU communications	FCC compliant 915 MHz spread spectrum radio
Grid communication protocol	DNP 3.0
Sonsor to PTU communication range	150  ft (46  m)

This brochure describes a standard product and does not show variations in design that may be available. Contact the factory for additional details.

Cleaveland/Price reserves the right to make changes or improvements to the product shown in this brochure without notice or obligation.

Sensor to RTU communication range 150 ft. (46 m)



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