

# LineScope<sup>®</sup>

Voltage and Current Sensor  
with Fault Indication

US Patent Nos. 9664710B2, 9746498B2, and 9810720B2

# LineScope®

## Overview

The LineScope® is a three-phase power monitoring system for use on circuits from 4kV to 138kV that is capable of 0.5% voltage and current measurement. The system consists of three conductor-mounted LineProbe sensors and a data consolidating remote terminal unit (RTU3212) that can be housed in any enclosure. **The LineScope® system can function properly on systems with or without a ground.**

The LineProbe does not have the limitation of current-powered sensors, as it is powered by line voltage. The unit is battery-free, which removes the need for regular maintenance, and contains a supercapacitor for last-gasp functionality.

## Data Reporting

Using a patented synchronization scheme, the sensors are precisely synchronized to the RTU, enabling the calculation of neutral currents and phase-to-phase voltages. COMTRADE files capture the current and voltage waveforms during overcurrent events.

The system utilizes a 915MHz spread spectrum radio link to stream data at a rate of 32 samples per cycle from each phase. All available data is digital, preserving full resolution and accuracy of all measured parameters. Data is transmitted automatically in event of user-defined exceptions and can be retrieved on demand or on a specified schedule. The LineScope® system does not require server-side software; it integrates directly into DNP 3.0 SCADA and smart-grid systems.

The LineScope® system reports:

- RMS voltages
- Load currents to 1,600A RMS
- Neutral current
- Fault currents to 32kA peak
- Fault direction
- Watts/VARs
- Total Harmonic Distortion
- Power angle
- Power factor
- LineScope® system radio signal strength

## RTU3212

The RTU3212 is a full-featured RTU capable of supplementing—or even replacing—an existing RTU. The device features fifteen digital inputs, four digital outputs, and provides two RS232 ports, an RS485 port, and an Ethernet port. The RTU has a small footprint (4.18" x 6") and minimal power requirements (<1W at 9-30VDC). The RTU3212 can be installed in any enclosure and retrofit applications are provided with an antenna kit.



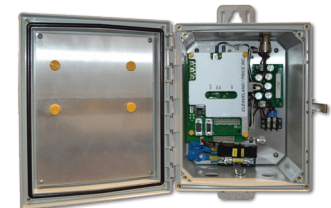
# CommBridge

The CommBridge contains all of the components necessary to receive LineScope® data and report it to the SCADA system. The CommBridge is available in two models, the CommBridge-B and the CommBridge-S, with the latter having reduced backup functionality and a smaller form factor.

|                | CommBridge-B    | CommBridge-S   |
|----------------|-----------------|----------------|
| Power Source   | 120VAC or Solar | 120VAC         |
| Backup Power   | 8Ah Battery     | Supercapacitor |
| Communications | RTU and Radio   | External Radio |



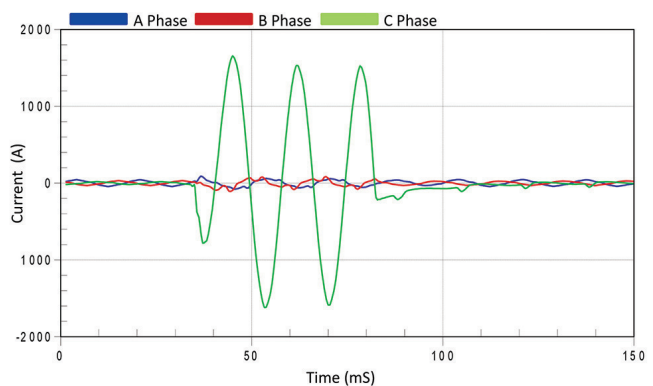
CommBridge-B



CommBridge-S

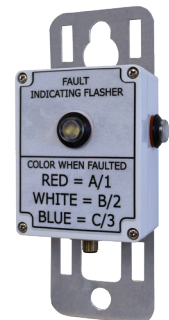
## Fault Reporting

In the event of a fault, the LineScope® automatically reports the event and generates a COMTRADE file. The RTU stores up to 64 COMTRADES locally that are 30 cycles in length. The waveforms below show COMTRADE examples.



## Local Fault Indication

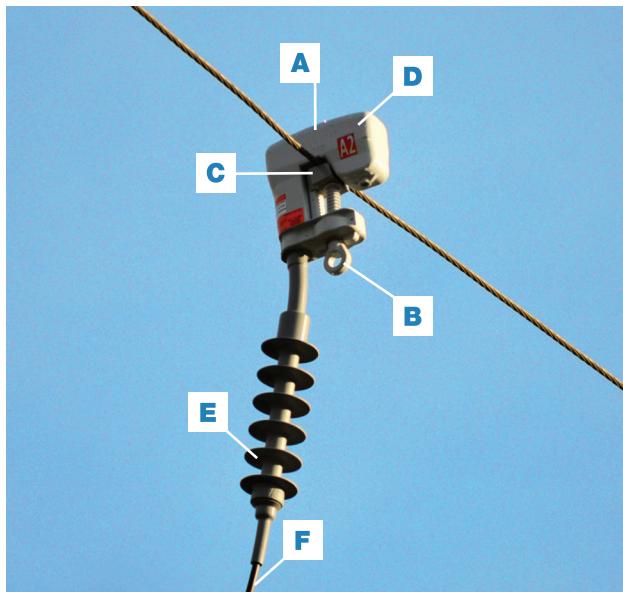
An optional indicating light box can be installed above the enclosure with any battery-powered enclosure to provide daylight visible local fault indication.



# LineScope® LineProbe

The LineProbe is a lightweight sensor that can be attached to an energized conductor with a hotstick. The sensor continuously streams current and voltage data to the RTU3212.

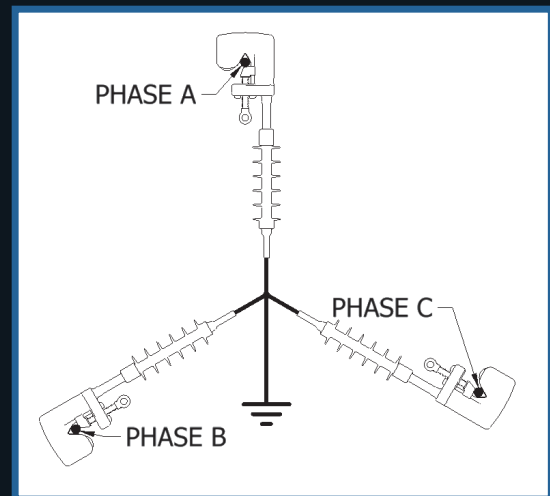
A resistance voltage reference cable connection is used to obtain extremely accurate voltage measurements without the need of current flow in the overhead line. It has the flexibility to be applied on any circuit configuration – delta or Wye – with or without a ground (refer to Easy Installation for any Circuit Configuration).



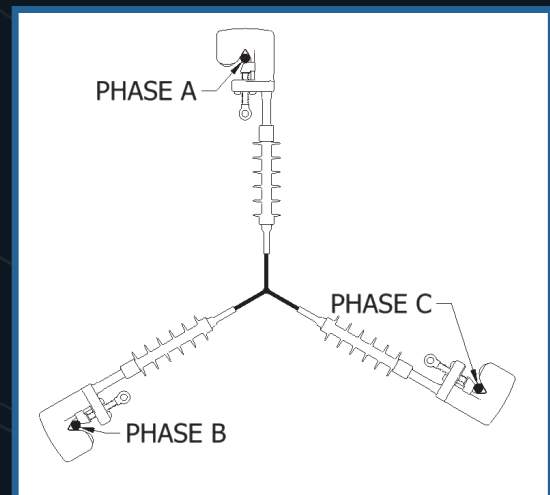
- A** The sensor head contains the sensing modules, a power-harvesting module, spread spectrum radio, and supercapacitor reserve power supply.
- B** A hotstick mounting screw clamp is used to attach the sensor to the line. The screw clamp incorporates a slip clutch mechanism to prevent over-tightening.
- C** The LineProbe head accommodates conductor cable diameters from 0.1" - 1.2".
- D** Line and load-side identifiers are molded into the sensor head.
- E** The leakage distance of the LineProbe exceeds IEEE Standard C57.19.100 requirement for very high pollution level at most voltages.
- F** The voltage reference cable is insulated to 55kV for distribution and 70kV for transmission and has UV-resistant insulation.

## Easy Installation for any Circuit Configuration

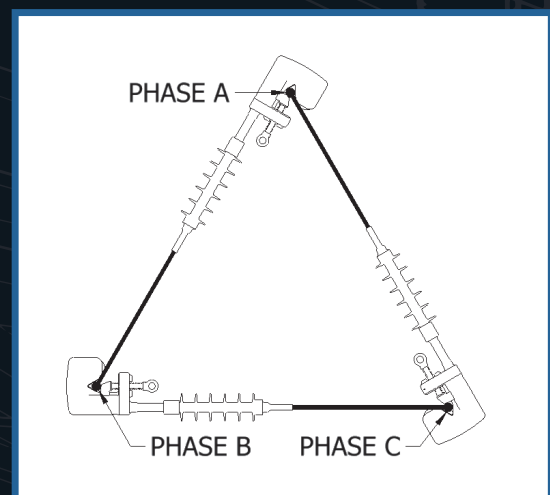
### Phase to ground/neutral



### Ungrounded Wye



### Phase to Phase



# LineScope® Technical Specifications

## Measurement Specifications

|                                   |  |
|-----------------------------------|--|
| Available system voltages (60Hz)  | 4kV, 8kV, 15kV, 23kV, 34.5kV, 46kV, 69kV, 115kV, 138kV                                       |
| Voltage accuracy                  | +/- 0.5%   |
| Nominal current measurement range | 0 - 1600A  |
| Current accuracy                  | +/- 1A up to 200A, +/- 0.5% 200 – 1600A  |
| Fault current measurement         | Up to 32kA peak  |
| Fault current tolerance           | 100kA peak   |
| Fault detection response time     | Adjustable - 2 or more cycles  |
| Fault direction                   | Yes  |
| Sampling rate                     | 32 samples/cycle/phase   |
| Power measurement                 | Watts, VARs, Power Angle, Power Factor   |
| Power angle accuracy              | +/-1°  |
| Neutral current calculated        | Yes  |
| Voltage/current THD               | Yes - to the 11th harmonic   |
| Waveform capture                  | 4 cycles before inception of an event and 30 cycles total with storage for 64 COMTRADE files |

## Operational Specifications

|                                   |                               |
|-----------------------------------|-------------------------------|
| LineProbe powering method         | Voltage based line harvesting |
| Line temperature range            | -40°C to 125°C                |
| Conductor diameter range          | 0.1" - 1.2"                   |
| LineProbe housing material        | UV-stabilized plastic         |
| LineProbe ingress protection      | IP68 - 3' for 33 hours        |
| CommBridge ingress protection     | NEMA 4                        |
| Design life                       | >20 years                     |
| LineProbe to RTU communications   | 915MHz spread spectrum radio  |
| Grid communication protocol       | DNP 3.0, MODBUS               |
| Sensor to RTU communication range | 150' line of sight            |
| Maximum co-located installations  | Four LineScope® sets          |

| LineProbe Characteristics                      | 4kV/8kV       |               | 15kV          |                | 23kV           |                | 34.5kV         |                | 46kV           |               | 69kV          |               | 115kV         |                | 138kV          |                |
|--|---------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|
|  | 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"<br>(65) | 25.4"<br>(65) | 25.4"<br>(65) | 42.9"<br>(109) | 42.9"<br>(109) | 65.3"<br>(166) | 65.3"<br>(166) | 82.8"<br>(210) | 65.3"<br>(166) | 123"<br>(311) | 105"<br>(267) | 162"<br>(413) | 145"<br>(368) | 242"<br>(615)  | 208"<br>(527)  | 316"<br>(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 lbs/(kg)                                | 4.8<br>(2.2)  | 4.8<br>(2.2)  | 4.8<br>(2.2)  | 6<br>(2.7)     | 6<br>(2.7)     | 7.4<br>(3.4)   | 7.4<br>(3.4)   | 8.6<br>(3.9)   | 7.4<br>(3.4)   | 11.2<br>(5.1) | 14.1<br>(6.4) | 18.2<br>(8.3) | 19.8<br>(9.0) | 26.8<br>(12.2) | 22.7<br>(10.3) | 29.7<br>(13.5) |

\* LineProbe connected from Line to Ground

\*\* LineProbe connected from Line to Line

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