Distributech 2007 Tech Watch Report

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Beckwith Electric Autodaptive® Volt/VAr Management System

Beckwith

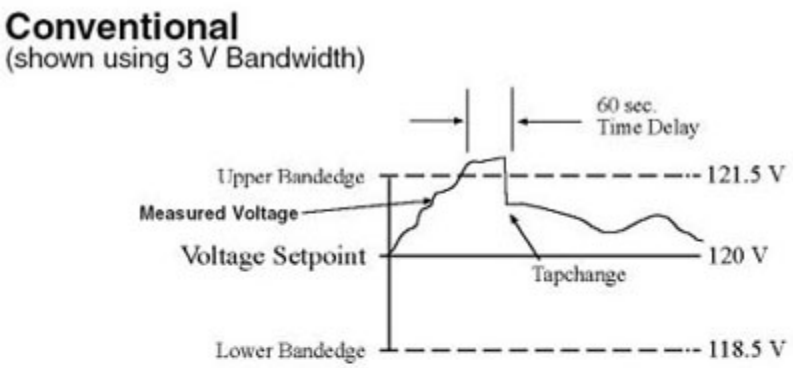
Beckwith Electric's "Autodaptive®" Volt/VAr Management System utilizes the coordinated operation of independent, adaptive, distributed, intelligent devices on the distribution system. This system consists of autodaptive pole-top capacitor bank controls (ACC's), autodaptive tapchanger controls (ATC's), and autodaptive regulator controls (ARC's). The system uses voltage regulation quality factor (VRQF), defined as the rms deviation of the voltage from a reference voltage as recursively averaged over a moving six hours, as a control target and a proposed standard method of stating the quality of voltage regulation.

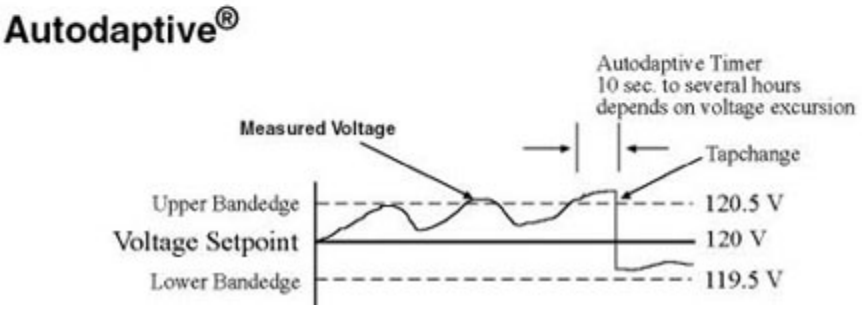
There are two features that are being proposed for the future. The first feature will be transformer load management which provides an input to the ATC for transformer oil temperature. The control will have the ability to reduce the bus voltage to reduce peak loads if the internal transformer temperatures approach damaging levels. The second feature will be control of substation capacitor banks.

System Components

M-2501A Autodaptive Capacitor Control (ACC)

The ACC's on any distribution circuit work together, without communications, using very precise measurement of the fundamental component of voltage and comparison to previous voltage profiles, to help regulate the voltage furnished to customers along the line. By compensating for VArs required in the vicinity of each capacitor bank, the power factor along the distribution feeder remains near unity.





Controller data includes a history of the last 16 switch operations, the resulting voltages and the time of switching as well as a 24-hour voltage profile and VRQF.

Much of the LTC transformer or regulator output voltage variation is reduced by downstream ACC operations. The necessary tap changer operations per week are greatly reduced from those necessary with conventional controls.

The operation of the ACC, when used on distribution feeders, is based on the measured voltage at the bank location as well as the history of voltage and switch operations. The autodaptive algorithms use three adaptations to determine the controls operation:

- a voltage reference based on the long-term (approximately 7 day) average voltage. This voltage level may also be preset.
- a bandwidth based on the average voltage change with capacitor bank operation,
- an adaptive timer adjusted to maintain the average daily count of operations at one or two operations per day *on a long-term basis*.

M-2667 Autodaptive Tapchanger LTC Control (ATC) and M-2670 Series of Autodaptive Regulator Controls (ARC)

The system location and programming of the ATC allow it to monitor the distribution system VAr requirements and calculate internal transformer VAr requirements. This allows the control to target unity power factor at the primary side of the transformer. The ATC precisely measures the fundamental component of distribution substation output voltage and uses this in comparison to previous measurements to determine how to influence the ACC's switching patterns to modify VAr flow.

Both the ATC and ARC use measured transformer or regulator VAr flow to temporarily adjust the voltage bandcenter to influence the ACC's to more rapidly add or remove capacitor banks on the feeders. The ATC and ARC operations are based on the Voltage Regulation Quality Factor (VRQF). The ATC has a voltage level setting, a bandwidth (one or two volts) as determined by the intertap voltage of the transformer and a VRQF setting. The resulting band edges are where adaptive non-linear integrating timers begin their operation. The Control Comparison figure illustrates the increased sensitivity of the Autodaptive controls versus conventional controls.

Kinetrics - Dynamic Feeder Rating System

Dynamic feeder rating (DFR) systems are an important alternative to analytical methods for determining real-time conductor operating temperatures and corresponding real-time cable ratings. DFR can be used to enhance the current-carrying capacity of power cables and eliminate the risk of overheating. They allow utilization of cable systems to their maximum capabilities and are particularly useful when a deferment of capital programs is desirable

Kinectrics' Dynamic Feeder Rating (DFR) system is configured to link several remote terminal units (RTU) positioned at strategic locations along the cable route to a main computing unit (CPU), that is generally installed at a substation. The system is designed for both new and retrofit cable installations.

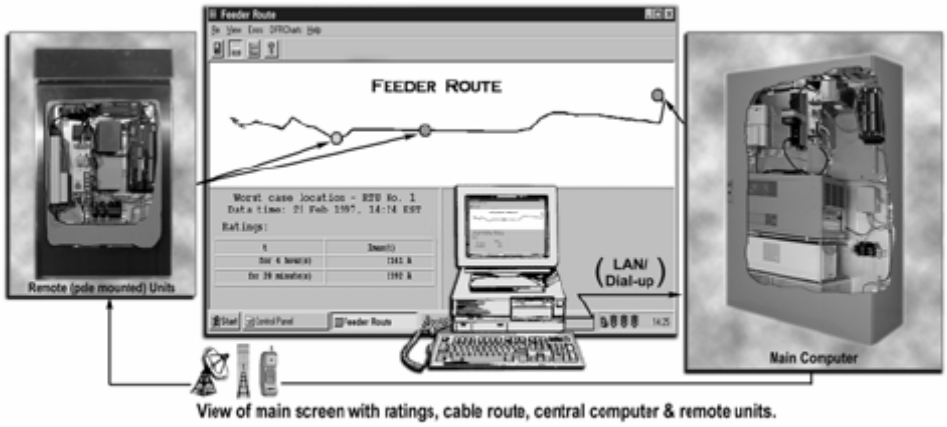


Figure 1. Kinectrics' Dynamic Feeder Rating System

The key performance characteristics of the RTUs provide reliable acquisition and storage of cable and ambient temperatures and load current data. These data items are transferred at regular intervals to the CPU under typical field conditions, including transient potential rises. Cable and soil temperature data can be acquired by a distributed fiber optic measurement system capable of collecting temperature information along the entire cable route.

The DFR software program calculates cable conductor temperature, and steady state and emergency ratings in real-time. The user specifies the relevant maximum operating temperatures and the duration of the emergency. The software computes the maximum current that the cable can carry for the specified conditions.

Calculation of the steady-state rating can be performed in two modes. In one case, standard Neher/McGrath or IEC 287 calculations are performed with the user-specified load-loss factor. In the second case, the program evaluates recorded load variations over a 24-hour period and assumes the same variations during the following period. Duration of this period is such that the steady-state conditions are achieved.

Time-dependent ratings are based on the method described in the IEC Standards 853-1 and 2. Similarly, as in the steady-state case, two modes of load representation can be considered during the emergency period: (1) a step function can be applied, or (2) the load curve from the last 24 hours can be scaled.

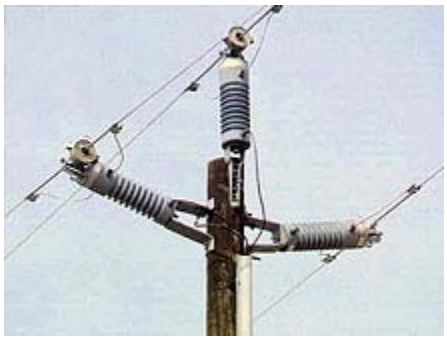
During the steady state and time-dependent calculations, the thermal and electrical parameters of the model are continuously adjusted so that the computed and measured cable surface temperatures match.

Exacter Inc Outage Avoidance System

An EXACTER unit is mounted inside a utility vehicle (or other vehicle), and as the vehicle moves about its normal routes, the unit surveys the area for sources of distribution line emissions using advanced sensor arrays. Collected feeder information is transmitted to a Knowledge Database (Web Information Portal) where it is analyzed for known failure-prediction signatures for power lines, transformers, regulators, insulators, cutouts, lightning arrestors, and other line components. EXACTER assesses the intensity of each failure signature and assigns it a Maintenance Merit™ (severity number). GPS mapped equipment locations and processed information is returned for preventive maintenance scheduling.

Lindsey

CURRENT AND VOLTAGE SENSORS



Overhead Current and Voltage Monitoring Insulators (CVMI)

Lindsey Manufacturing Co. has created a complete line of accurate, cost effective, **overhead** and **underground** Current and Voltage Sensors. These Lindsey Current and Voltage Sensors can easily be retrofitted to existing equipment or built into new equipment.

Overhead Current and Voltage Monitoring Insulators (CVMI)

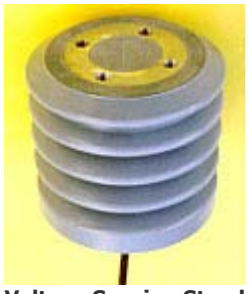
Lindsey Current and Voltage Monitoring Insulators (**CVMI**) are approved for distribution systems operating at **15, 25, 35 and 46kV**, and each meet the BIL test requirements for its insulator class. Different styles of **CVMI**'s have been developed for a variety of applications

Clamp Top CVMI for replacing any horizontal or vertical line post insulator

Bus Bar style CVMIs are equipped with standard 2 or 4 hole NEMA pads

Substation/Switchgear style CVMIs are used where a conductor can be threaded through and clamped to the stainless steel tube

Multicore Sensor eliminates the need to cut the conductor or make a jumper through a tube



Voltage Sensing Standoff Insulators are interchangeable with porcelain standoffs with a 3 in. bolt circle

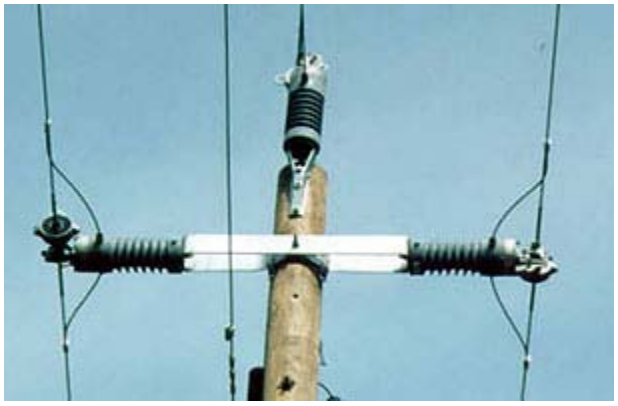
Standard Voltage Monitoring Insulator (SVMI) for recloser applications Requiring voltage sensing on both sides of a recloser

Mesure seven power parameters, set alarms and detect fault direction

Accuracy ±5%

Typical Applications of Lindsey CVMIs & SVMIs

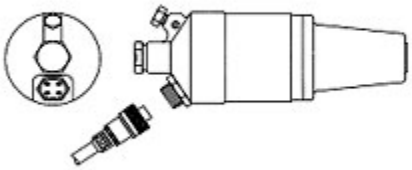
Lindsey Standard Voltage Monitoring Insulators (**SVMI**) are used on a team of three reclosers to determine llocation of a fault and automatically reconfigure the feeder.



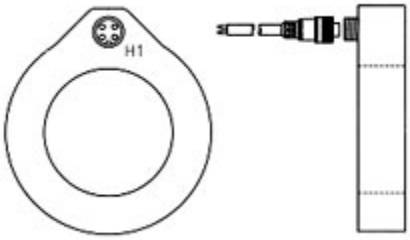
Clamp Top **CVMI**s for monitoring feeders with 1% current and voltage accuracy

Underground Elbow Sense Current & Voltage Monitors

Lindsey ElbowSense Current and Voltage Monitors use proven CT and voltage sensor technology from the original Lindsey **CVMI** and fit standard 600 amp T-body 15, 25 and 35kV connectors. They are easily retrofitted to existing padmount or submersible equipment. These sensors may also be used with outdoor, overhead mounted equipment that use standard elbows.



The ElbowSense voltage monitoring plug replaces the standard plug insert furnished with all 15 to 34.5kV, 600 Amp T-Body elbow assemblies. Instead of relying on an inaccurate capacitive test point, the encapsulated, precision, resistive voltage divider provides a 1% accurate AC signal proportional to phase-to-ground voltage.



The ElbowSense Current Monitoring Ring is a special purpose window type current transformer sized to fit over 600 amp or 200 amp elbow connectors. These ElbowSense Current Monitoring Rings are sealed and encapsulated in a durable, waterproof housing and fitted with a watertight connector.

Typical Applications of Lindsey Elbow Sense Current & Voltage Monitors

ElbowSense voltage monitoring plug installed in a 35kV pad-mounted switch enclosure

ElbowSense Current Monitoring Ring used in a Two Way Submersible switch.

SmartPin & ElbowCap Technology

The SmartPin current and voltage sensing system is a low cost solution for monitoring overhead distribution lines. The system consists of three sensor pins capable of supporting standard pin insulators (vertical orientation) and a control box for calibration and display of readings. Each sensor pin contains a hall effect current sensor and a capacitive voltage divider.

Features:

1. Monitors Real Time Current, Voltage and Phase Angle.

2. Calculates:
   - Current (A,B,C phases & Neutral)
   - kVAr (A,B,C Total)
   - Power Factor (A,B,C 3 ph Composite)
   - Phase Angle (A,B,C 3 ph Composite)
   - kW (Total)
   - kVA (3 ph Composite)
   - Phase Rotation (ABC/CBA)

3. Fault Indication:
   - Phase (s),Direction and Loss of Voltage

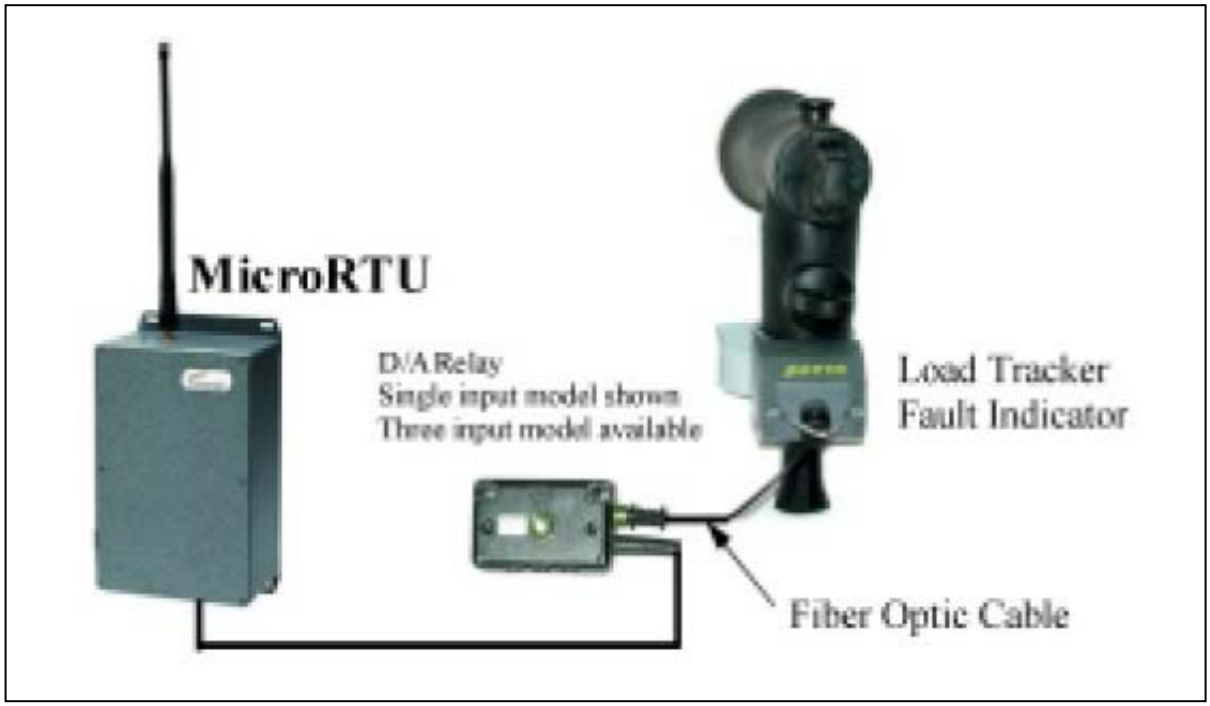
4. DNP 3.0 Protocol through RS232 Serial Port.

The SmartPin control box displays a current measurement from each phase, calculates and displays neutral current, displays fault alarms and loss of voltage alarms. Power for the unit can be 120/220 VAC 50/60 Hz, or 12 VDC.

The ElbowCap current and voltage sensing system is a low cost solution for monitoring underground distribution feeders. The system consists of three sensors that snap onto the capacitive test point of standard 200A and 600A elbows with a control box for calibration and display of readings. Each sensor contains a hall effect current sensor and a capacitive voltage divider (with the same features as the SmartPin).

Telemetrics/Horstmann Faulted Circuit Indicator

Faulted circuit indicator (FCI) is equipped with a micro-RTU and communication facility so that operations personnel can be notified by email, pager, text messaging or voice with the time and location of the fault. FCI alarms can also be sent to a SCADA system. The MicroRTU communicates using the cellular data network. Airtime and data access fees begin at $6 per month.



GridSense Line Tracker

LineTracker Lt30 and LT30 Plus, Pole Mounted Fault Loggers

The LT30 and LT30 Plus are mounted about 2 metres below single circuit, 3 phase, 3 wire (not suitable for 4 wire, i.e. 3 phases and neutral), HV overhead lines and log all relevant data concerning any fault or switching of the line, date and time stamped. They also log self clearing faults, i.e. sudden surges in current, insufficient to trip the

protection, but indicative of a tree brushing a line, cracked insulator, etc, which allow maintenance crews to eliminate the problem before real faults occur.

As the LT30 and LT30 Plus are non contact sensors and monitor the combined magnetic and electric fields of the circuit, they are not suitable for multi circuit poles or where there are other HV circuits nearby. In these instances, the LT40 or LT50 conductor mounted units should be installed. However the LT30 and LT30 Plus are particularly suitable for detecting and indicating low earth (ground) leakage faults, protected by Sensitive Earth Leakage (SEL) relays. Both store data for local downloading and visual (flashing LED amber red or green) indication or remote reporting at a control room or direct to trouble men, etc.

The LT30 stores up to 15 time stamped events and the data may be downloaded locally using an infrared receiver, whereas the LT30 Plus stores up to 100 plus events and may be locally downloaded using an RF (Radio Frequency) receiver, identical to those used for the LT40, LT50 conductor mounted LineTrackers.

For further details, refer to the specifications, download a brochure or request a quotation

Specifications - LT30 Pole Mounted Fault Logger

Overhead System	3 phase, 3 wire, single earth / 1 phase, 2 wire / SWER
Visibility	Xenon tube >200m in daylight, LED 20m
Line Voltage	5kV to 66kV
Reset of Xenon Flash	Voltage returns or time, fully configurable
Load Current Detection	5 - 1000A
Trigger Principle	100% increase over prior load history, fault type determined by voltage status during & after fault. Fault / inrush discrimination at switch on
Reset of LED Indicator	Voltage return (permanent faults only) or time, fully configurable
No. of Events Recorded	15, 10 Permanent or Transient, 5 recloses & self clearing
Details Stored Per Event	Type, Time Stamp, pre/during/post fault field values, duration of fault current & trip time in cycles, time of voltage restoration, recloser events, load history
Communication	LTC30 Infrared hand held controller for interrogation, data download, configuration and reset
Operating Temp Range	Ambient: -40?C to +50?
Power Source	Solar array of mono crystalline cells
Energy Storage	1 x 2v 8Ah rechargeable sealed lead acid battery
Indication Light Source	Single xenon flash. 2x2 high intensity LEDs
Flash Rates	Xenon: 1 flash every 4 sec in sunshine, 8 sec at night. LED: 2 or 6 multiple flash bursts
Dimensions	280mm (l), 200mm (w), 240mm, (h) or 11" x 8" x 9"
Housing	Foamed Luran S, IP rated
Weight	3kg or 7lb, shipped

Ametek

LL-230A Specifications

Conductor Size: 0.2 to 1.093 inches diameter (Max. 795 MCM). A rubber adapter is used for bare or insulated conductor diameter 0.2 to 0.4 inches.
Maximum Conductor Voltage: 69 kV

Current Range: 0-1000 amps
Battery Life:
Lithium batteries: 1 year minimum
Can be supplemented by a standard 9 V alkaline battery.
Memory:
Recording memory is user selectable to stop when full or continuously record on a first-in, first-out basis.
Data storage capacity is determined by averaging interval selected.

Averaging Interval	**Maximum Storage**
15 min.	66 days
5 min.	22 days
1 min.	4.5 days

Resolution: 1 Amp
Accuracy: <5% of reading
Internal Clock Accuracy: One minute per 2 weeks over specified temperature range.
Operating Temperature Range:
-40°C to +55°C
Weight: 5.0 lbs. (2.3 kg) nominal
Environment:
Lifetime warranty for water-resistance

Joslyn

Faulted Circuit Indicators

Overhead Fault Indicators

- Series 1548 Fault Indicators adaptive/fixed trip, battery powered (up to 69kV)
- Series 1547 Fault Indicators adaptive/fixed trip, line powered (up to 35kV)
- Series 1514 Fault Indicators fixed trip, line powered (up to 35kV)

Underground Fault Indicators: Single/Three Phase Applications (up to 35kV)

- Series 1547 Fault Indicators adaptive/fixed trip, line powered flag indicating, LED/SCADA options)
- Series 1514 Fault Indicators standard (line powered Flag indicating, LED/SCADA options)
- Series 1541/42/43 Fault Indicators fixed trip (battery powered) LED indicating
- Series 1515 Fault Indicators fixed trip (line powered Flag indicating, LED/SCADA options) 3 phase applications
- Series 1516 Fault Indicators Standard (line powered Flag indicating, SCADA options) 3 phase applications

Overhead/Underground Fault Indicators Radio Options

- Radio Faulted Circuit Indicator Systems
- 1560 Series Radio Receiver (Handheld or RTU/SCADA)
- 1570 Series Radio Receiver (Control/Transmitter)
- 1548 Series Overhead Radio Fault Indicating (up to 69kV)
- Smartlink Series 5000 Cellular RTU for Faulted Circuit Indicators provides 2-way communications for automated fault reporting
- 2700 Series SmartLink Two-Way Cellular Radio DA System