



COSI

Compact Sensor Intelligence: Digital Instrument Transformer Solutions for Smart Grids

GE is ahead of the competition thanks to its innovative, patented optical instrument transformer technology. It enables full IEC 61850 implementation and sets the benchmark in transmission network architectures for today's and tomorrow's electricity networks and Smart Grids.

Our technology is based on the effects of light influenced by current (Faraday effect) to measure current. GE's technology is suitable for use in AC or DC transmission systems. The transformer can also be used in high-current DC applications, such as large scale aluminum electrolysis companies.

COSI-CT can be applied in HVAC systems with a rated voltage of up to 1200 kV or HVDC systems with a rated voltage of up to 800 kV. The equipment takes precise measurements within a range between 1 A and 4800 A. The protective current is up to 216 kA (peak value) and the bandwidth is DC 20 kHz.

A Wealth of Benefits

Wide Dynamic Range

1 A to 4800 A. One current transformer can cover a wide dynamic range via the same output. The protective current is up to 216 kA (peak value). The bandwidth is DC to 20 kHz.

Smart Grid Ready

COSI products deliver direct digital output according to IEC 61850-9.2 or 1 A for metering applications.

Standard Optical Fiber

All signals are transmitted through a standard fibre optic cable (same cable as used in Telecoms). By using a globally-available fibre optic cable to connect all electronic equipment, we offer our customers substantial savings on global maintenance.

Lightweight

Typically, an optical sensor represents only 10% of the weight of an oil-filled transformer. As transportation costs and ease of installation depend on the weight and volume, the benefits are immediately apparent. There is no need for special transportation to protect the equipment against vibrations. Moreover, the support structure also depends on weight and dimensions, so global installation costs are also reduced.

Comprehensive Range for AC or DC applications

- COSI-CT Optical current transformer (AC or DC)
- COSI-MU Merging unit
- COSI-CM Combined metering unit
- COSI-CT F3 Flexible optical current transformer

COSI-CT Accreditations

- New York ISO,
- California ISO,
- Lapem Mexico,
- Measurement Canada
- Gost in Russia

Installation Flexibility

Bus mounting is possible, as well as horizontal mounting or assembly directly on the circuit breakers.

All these configurations are possible with digital instrument transformers, but not with oil-filled equipment. The total substation footprint can be reduced by as much as 15 to 25%.



Increased Safety for People, Substation Equipment and the Environment

The COSI range is explosion proof. No oil and no SF₆ mean no environmental costs on end-of-life disposal and no leakage problems. Moreover, horizontal transport and (long-term) storage is possible without risk and there are no ferro-resonance or dangerous open secondary concerns.

Near-zero Maintenance

Time is money and the optical sensors dramatically reduce the number of outages for maintenance. No oil sampling or DGA are needed. Optical sensors offer remote monitoring for preventive maintenance without tripping.

A seismic Solution

Digital instrument transformers offer retrofitting flexibility regardless of seismic withstand. Also, they are constructed with a composite line post insulator for maximum seismic endurance.

Secondary Circuit Saving and “Forgiving Secondaries”

In oil-filled and SF₆ technology, a magnetic current transformer requires two (or more) wires for each core. Losses in the secondary loop can either dramatically increase the core sizes or require greater wire selections. The wide dynamic range of sensors and the Ethernet connection limits the number of “secondaries” and makes most of the secondary wiring obsolete.

In oil-filled current transformers, eventual modifications are either very costly or impossible. Moreover, it is often impossible to add more secondaries or modify key characteristics once the production of a CT is in progress. With digital current transformers, additional secondaries or last-minutes changes in specifications can be handled by the electronics; the turns ratio is user-selectable on site.



Flexibility and Inventory Reductions

Ratio can be modified any time (via computer connection). This results in very short delivery times (from stock). Moreover, the CT ratio can be adapted according to CT location and there is a significant reduction in customer stocks as there are no specific CT needs for each ratio.

Software Evolution

It is possible to update or enhance software throughout the life of the equipment.

Interchangeability

In the case of an (exceptional) failure in the electronics, all that is needed is a very simple box change. No recalibration is required.

Our technology, expertise and experience are our best assets. GE's current transformer COSI-CT is a high-end solution developed by former NxtPhase (now part of Grid Solutions), the USA's recognised pioneer in optical current transformers.

Our optical products are installed around the world in more than 300 substations in 19 countries.

In March 2010, to meet the specific requirements of the Chinese Smart Grid, COSI-CT underwent a dynamic simulation test on a 500 kV transformer substation protection relay in the China Electric Power Research Institute (CEPRI). This is an example of how GE is using COSI-CT to support the development of Smart Grids, since today's power grids need to deliver more energy with greater flexibility and in a more complex environment – using the same infrastructure.

COSI

Compact Sensor Intelligence: Digital Instrument Transformer Solutions for Smart Grids

COSI-CT



Optical Current Transformer

Smart Solutions for Smart Grid

Our comprehensive COSI range (Compact Sensor Intelligence) includes innovative digital instrument transformers for AC and DC applications.

The COSI-CT optical current sensor brings a new level of accuracy to sensing over the range between 1 Arms and 63 kArms.

Key Benefits

- Reduced size and weight are attractive benefits compared to conventional oil-filled equipment, allowing placement in compact substations or in retrofit applications where space may be limited.
- Lightweight dry-type insulator and window head design allow pedestal mounting or suspension from a rigid bus.
- Broad dynamic range making this CT particularly suited for both high-precision metering and protection applications at the same time.
- Accurate measurement of DC and AC to the 100th harmonic and the measurement of phase angle is a must for new Smart Grid applications.



Performance Features

- Accuracy exceeds ANSI/IEEE Class 0.15S/IEC Class 0.2S for metering and IEC Class 5P/IEEE 10% for protection
- Wide dynamic range
- Bandwidth from DC to 100th harmonic
- No magnetic core saturation
- Excellent phase accuracy
- Digital Interface and analog output

Intrinsically Safe, Environmentally Friendly

- No oil, gas or SF₆
- No hazardous open secondaries
- No violent failure

Smart Solutions for Smart Grid

Basic Faraday Effect

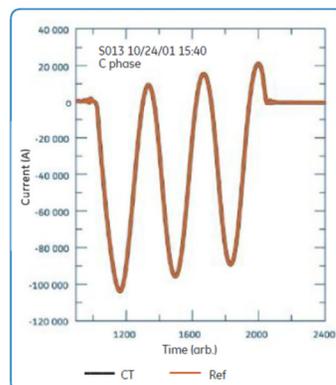
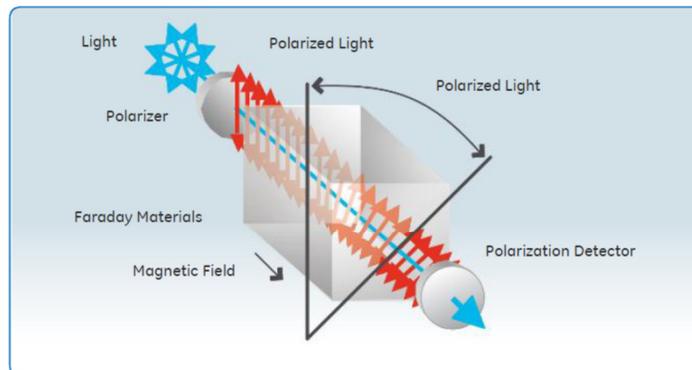
In Faraday Effect current sensors; the current flowing through a conductor induces a magnetic field that affects the propagation of light traveling through an optical fiber encircling the conductor.

A linear state of polarization rotates in the presence of a magnetic field because the field produces a circular birefringence in the glass. Birefringence refers to an optical material with two indices of refraction.

Metering & Protection Accuracy

The COSI-CT design permits measurements to be made with the highest possible accuracy and stability. To address stringent revenue metering applications, its performance exceeds IEC Class 0.02S and IEEE Class 0.3 accuracy (optional 0.15%) with a dynamic range that extends from 1 A to 4800 A.

The COSI-CT has ultra-accurate and stable phase measurement, which is critical for intertie metering. For protection applications, the COSI-CT exceeds IEC Class 5P accuracy ratings and IEEE 10% accuracy ratings.



Fast Fault Response

- Extreme fast and accurate response
- COSI-CT actually measures the dynamic current
- No distortion due to core saturation, no need for TPY - TPZ specs, yet no danger for secondary equipment.



Wide Dynamic Range

Accuracy specification is maintained over a broad dynamic range - from 0.2% to 150% of rated current (extended metering range sensor) and up to 171 kA (protection range sensor). Broad dynamic range allows elimination of separate high and low range CT's.

Wide Bandwidth

Accurate waveform reproduction up to 6 kHz allows full power quality analysis of harmonics and transients with no sensor-imposed limitations.

Choice of Connection Options

New window head design allows a variety of connection options including standard NEMA pads, up to 300 mm rigid bus, or flexible cable pass thru, allowing optimal selection for ease of installation and reliability.



Seismic Stable Dry Type Insulator

Field-proven lightweight composite insulator reduces transportation costs, substation support structure requirements, and installation equipment demands. The lightweight design also allows location in seismically active areas.



Green Design

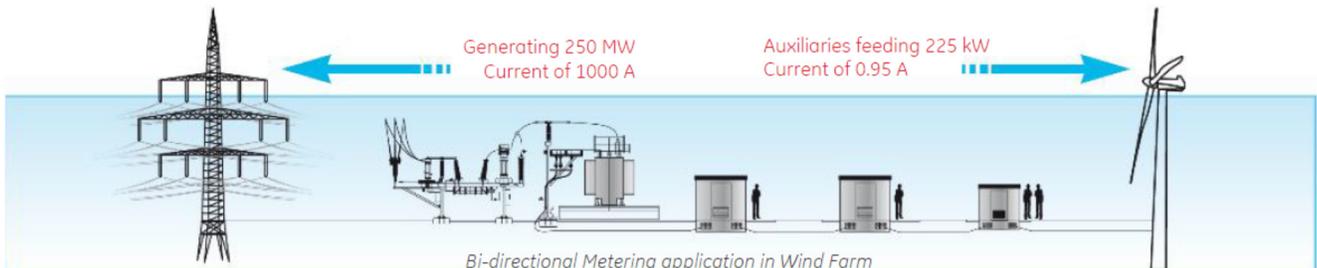
The COSI-CT insulator contains no oil, SF₆ or other gas. There is no internal mechanism for violent failure to endanger personnel or adjacent equipment. There are no environmental concerns or gas to recycle. With an optical design there are also no open secondary concerns.

Low Maintenance

The COSI-CT has no active components at line potential, eliminating the need for costly outages to maintain the electronics. Since there is no insulating oil or paper there are no complex maintenance procedures. The polymeric insulating column employs silicone rubber sheds that do not require live line washing.

Smart Grid Ready with Digital Interface

The standard digital interface will ensure smooth integration of COSI-CT into digital substation applications the accurate measurement of harmonics and phase angle is a must for new Smart Grid applications.



Specifications

Column mechanical & electrical ratings

CT Type		72.5	123	145	245	362	420	550	800
Maximum system Voltage (Um)	kV	72.5	121	145	245	362	420	550	800
Impulse test voltage (BIL)	kV	350	550	650	1050	1300	1550	1880	2100
Minimum creepage distance	in	57	115	115	193	285	562	562	562
	mm	1400	2900	2900	4900	7240	14280	14280	14280
Height	in	54.7	54.7	77.9	107.4	127.1	204.7	204.7	204.7
	mm	1389	1389	1979	2729	3229	5199	5199	5199
Weight	lbs	75	88	88	111	124	177	177	177
	kg	34	40	40	50	56	80	80	80
Static withstand	lbs	675	675	675	900	900	Suspension application only		
	N	3000	3000	3000	4000	4000	Suspension application only		

Ratings and dimensions for IEC pollution Class 2. Other ratings are available.

Environmental

Operating temperature range	- 40° C to 55° C (- 40° F to 131° F) Outdoor Service Conditions
Opto-electronic module	- 5° C to 40° C (23° F to 104° F) Indoor Service Conditions
Seismic capability	0.5 g

Mechanical

Standard pollution withstand	IEC Level II, other ratings available
Insulation	Solid composite insulator
Electronics dimensions	19" x 18" x 8.75" (482 mm x 457 mm x 222 mm) (includes high energy metering interface)

Electronics

Packaged in 2 modules:	Low energy analog interfaces ¹	4 Vrms metering 200 mVrms protection
 Sensor electronics	Dynamic range	< 0.2% error at rated current for 4V output, < 0.5% error at rated current for 200 mV output < 2% error at 108 kApeak (using protection sensor)
	Bandwidth	0.5 Hz to 6 kHz DC available
	High energy analog interfaces ¹	1 Arms [2 ohm burden] or 5 Arms [B0.1 (2.5 VA) burden] nominal at power 0.9 for metering
 Current amplifier	Dynamic range	< 0.2% error from 1 A to 4000 A (using extended metering range sensor)
	Bandwidth	10 Hz to 6 kHz for 1 A metering output
	Input power requirements	70 Vdc to 150 Vdc Typical power 60 W
	Electronic turns ratio	User selectable
	Alarms contacts	Data invalid / Maintenance required

Electrical Performance

Type I ³ :	Metering accuracy	IEC Class 0.2S, IEEE Class 0.3, 0.15S
	Protection accuracy	IEC Class 5P, IEEE 10%
Type II ³ :	Extended range std metering accuracy	0.2% (0.2% to 150% of rated current) ²
Type III ³ :	Extended range high metering accuracy	0.15% (0.2% to 150% of rated current) ²
	Continuous Current	4800 A Max (4800 A, RF = 1; or 3000 A, RF = 1.33; or 2500 RF = 1.5)
	Rated Current	User specified for up to 4000 A
	Short-time Thermal Current	63 kArms for 1 s

1 Scales linearly with primary voltage and current. / 2 Accuracy window moves with selected ratio. / 3 Other ratings available, consult Grid Solutions.



COSI-CT

Optical Current Transformer



High voltage bushing





COSI-CT F3

Flexible Optical Current Transformer

GE comprehensive COSI range (Compact Optical Sensor Intelligence) includes innovative digital instrument transformers for AC and DC applications. The COSI-CT F3 optical current sensors are the most flexible, portable optical current transformer sensors available and the easiest to install.

Enjoy Flexibility

Three product types are available, Type A, Type B, and Closed Loop, each optimized for different applications and specifications. Each F3 has a wrap-around sensing head around high-voltage bushings, generator buses, and other conductors in ways not possible with conventional Current Transformers.

The sensing loop is an all-dielectric cable, which connects to the standard GE electronics, giving the user the same high performance capability and output options as the high-voltage optical CT. It is an ideal solution for installations in difficult spaces, on a temporary or permanent basis.

Type A F3 Current Transformer

The type A F3 CT is a fiber optic current sensor consisting of an electronics module, a fiberglass sensor box, and a flexible PVC conduit wrap-around sensing cable. The sensing fiber resides in the PVC conduit, which attaches directly to the sensor box.

Standard telecommunications optical fiber cabling and wire cabling connect the electronics module to the sensor box. Because the sensor box has a wire connection to the electronics, it should not be installed in a high-voltage environment.

However, it may be installed in a low-voltage environment, allowing the sensing cable to be wrapped around a high-voltage bushing.



Increased Safety

- Enhances operational safety by eliminating the risk of inadvertently open-circuiting an energized CT
- Improved measurement performances
- Combined to GE's MiCOM P645 relay, it provides nuclear power plants with an Open Phase Detection System

Enhanced Flexibility

- 3 models available to suit different applications and specifications
- Portable version for temporary and maintenance needs
- Flexible Form Factor
- Single phase, three phase, and six phase system configurations available

Ease-of-Use

- Ideal for installations in difficult spaces
- Easy installation and configuration
- On-site calibration tool
- Worldwide standard for interconnection



DC valve hall wall bushing



Portable substation



Undersea cable metering & protection

The type A F3 CT has metering grade accuracy to 0.15%, and it can measure both AC and DC currents with this accuracy from 1 A to 160 kA, depending on the number of sensing cable wraps used to measure the current.

The cable length between the electronics module and the sensor box can be up to one kilometer. The sensing cable has a standard length of 20 m, but other lengths may be specified at the time of order.

The output of the type A F3 CT can be an analog voltage (11.3 V full scale), a current (1 A or 5 A formats), or digital (IEC 61850).

Applications

Applications include:

- GIS metering and protection
- wrap-around bushing for metering or protection,
- DC valve hall measurements for metering and protection
- very large aperture applications.

Type B F3 Current Transformer

The type B F3 CT is a fiber optic current sensor consisting of an electronics module, a fiberglass sensor box, and a flexible PVC conduit wrap-around sensing cable.

The sensing fiber resides in the PVC conduit, which attaches directly to the sensor box.

In the type B sensor, no wire connection is required at the sensor box, allowing it to be installed in a high-voltage environment.

The type B F3 CT is a protection grade sensor with accuracy to 1%. It measures AC currents over a bandwidth of 10 Hz to 3 kHz and can cover a range from 1 A to 160 kA, depending on the number of sensing cable wraps used to measure the current.

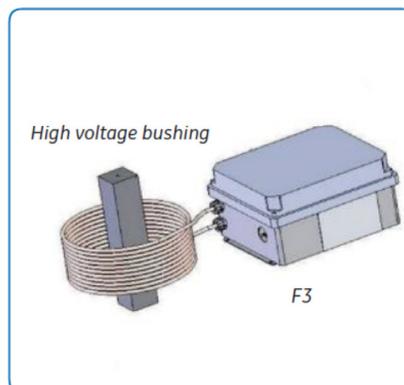
The cable length between the electronics module and the sensor box can be up to 10 km. The sensing cable has a standard length of 20 m, but other lengths may be specified at the time of order. The output of the type B F3 CT can be an analog voltage (11.3 V full scale), a current (1 A or 5 A formats), or digital (IEC61850).

Applications

Applications include:

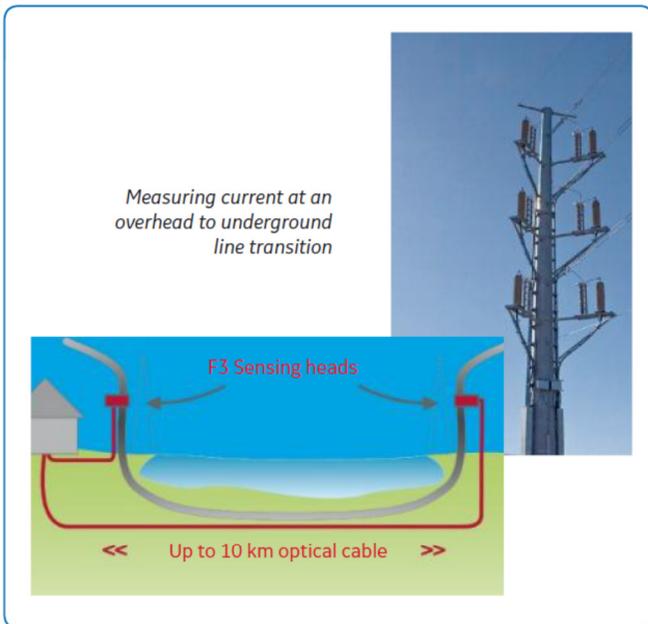
- GIS protection
- wrap-around bushing for protection
- temporary field service measurements
- underground cable monitoring.

Flexible Form Factor



The underground cable monitoring application uses sensors at both ends of the underground line to measure the differential current. When the underground cable is in good condition, there is little to no difference between the two measured currents. But, when the cable between the two sensors has faulted, there is a substantial differential current.

Because the type B F3 CT sensor box can be placed up to 10 km away from its associated electronics, this line differential current protection scheme can be implemented at remote sites where there is no substation or power available (such as an overhead to underground line transition).



Underground Power Line Protection

Closed Loop F3 CT

The Closed Loop F3 CT is a fiber optic current sensor consisting of an electronics module, a fiberglass sensor box, and a flexible PVC conduit wrap-around sensing cable.

The sensing fiber resides in the PVC conduit which attaches directly to the sensor box. Standard telecommunications optical fiber cabling and wire cabling connect the electronics module to the sensor box. Because the sensor box has a wire connection to the electronics, the sensor box should not be installed in a high-voltage environment. However, it may be installed in a low-voltage environment allowing the sensing cable to be wrapped around a high-voltage bushing.



0.1% class Closed Loop F3 metering CT for DC valve hall

The Closed Loop F3 CT uses a current feedback to null the impact of the sensed current on the sensing cable. As a result, the Closed Loop F3 CT achieves accuracies better than 0.1%. Both AC and DC currents are measured from 1 A up to > 500 kA. Because of the need to close the loop with current, the distance between the electronics module and the sensor box is limited to 100 m. The sensing cable has a standard length of 20 m, but other lengths may be specified at the time of order. The output of the Closed Loop F3 CT can be an analog voltage (11.3 V full scale), a 1 A current, or digital (IEC 61850).

Applications

Applications include:

- high accuracy metering
- field calibration
- ultra-high current sensing
- For industrial processing applications above 25 kA, including aluminum smelting, the Closed Loop F3 is sold through our OEM partner, Dynamp LLC.



Dynamp 225 kA 0.1% class DC CT for aluminum smelting

Current Transformers Specifications

- Single phase, three phase, and six phase system configurations available
- Sensor enclosure; fiberglass box;
 - Type A and Type B:
 - Dimensions: 14 x 12 x 5.74 inches
 - Weight: 20 lbs
 - IP66
 - Closed Loop F3:
 - Dimensions: 16 x 14 x 5.74 inches
 - Weight: 45 lbs
 - IP66
- 20-meter length wrap-around sensing fiber standard, other lengths available on request
- Programmable output scaling
- Output format options:
 - Analog voltage (IEC 60044-8 200 mV and 4 V formats), current (1 A or 5 A metering format), digital (IEC 61850)

F3-CT	Type A	Type B	Closed Loop
Class .1			X
Class .15s	X		X
Class .2s	X		X
Class .3	X		X
Class 1		X	
Class 5		X	
AC	X (up to 20 kHz)	X (10 Hz to 3 kHz)	X (up to 20 kHz)
DC	X		X
AC/DC	X		X
Sensor box HV isolated		X	
Max distance between electronics and sensor	1 km	10 km (no repeater)	100 m
Fiber cable required	X	X	X
Copper cables required	X		X

Applications	Type A	Type B	Closed Loop
Bushing	X	X	X
Currents > 160 kA			X
GIS	X	X	
Calibration			X
Field service	X	X	X
Metering	X		X
Protection	X	X	X
Cable monitoring	X	X	

Rated Current Range vs. Number of Fiber Wraps

# of fiber wraps	Minimum rated current*	Maximum rated current*
1	2000 A	80
2	1000 A	40
5	400 A	16
10	200 A	8
20	100 A	4

*F3 maintains accuracy class from 1% to 200% of rated current



COSI-CT F3

Flexible Optical Current Transformer



COSI-CM

Combined Metering Unit Up to 800 kV

COSI-CM combines a conventional CCVT and an Optical Current Transformer.

COSI-CM offers all the advantages of a combined unit as well as all the performances of the standalone units. The solution is used in HV and UHV to provide analog or digital outputs.

The COSI Optical Current Sensor brings a new level of accuracy to sensing over the range between 1 A rms and 63 kA rms.

A lightweight dry type insulator and window head design allow mounting of the Optical CT and CVT on a single pedestal saving valuable yard space. The reduced size and weight are attractive benefits over conventional combined units, allowing placement in compact substations or in retrofit applications where space may be limited.

Its broad dynamic range makes this CT particularly suited for independent merchant plants where extreme accuracy at both full power output and station service draw is demanded.

COSI-CT Metering and Protection Accuracy

Metering performances exceeds accuracy class IEC 0.2S and IEEE 0.15S with a dynamic range that extends from 1 A to 4000 A.

Protection performances exceeds IEC Class 5P accuracy ratings and IEEE 10% accuracy ratings.



COSI-CM

= 1 optical CT + CVT on the same pedestal

- The advantages of combined units
- The advantages of separate CT and VT

Key Benefits

- Improved measurement performance
- Compact design
- Substation footprint savings
- Refurbishing works
- Near zero maintenance
- Reliability, availability, safety
- Long life



CAPTION_Black_Inspira_italic_8pts_(Optional)

Optical Current Transformer Design

Wide Dynamic Range

The accuracy specification is maintained over a broad dynamic range - from 0.2 % to 150 % of rated current and up to 171 kA peak protection range.

High Bandwidth

The accurate waveform reproduction up to 6 kHz allows full power quality analysis of harmonics and transients with no sensor imposed limitations.

Dry Type Insulator

The field-proven lightweight composite insulator reduces substation support structure requirements.

Intrinsically Safe, Environmentally Friendly Design

The CT insulator contains no oil, SF₆ or other gas. There is no mechanism for violent failure to endanger personnel or adjacent equipment. With an optical design there are also no open secondary concerns.

Low Maintenance

The COSI-CT has no active components at line potential, eliminating the needs for costly outages to maintain the electronics.

Since there is no insulating oil or paper, there are no complex maintenance procedures.

The polymeric insulating column employs silicone rubber sheds that do not require live line washing.



Capacitor Voltage Transformer Design

Single post design

Uses a single post to take up less space in the substation design that requires meter quality CVT.

CVT Accuracy Classes

Accuracy classes available are 0.2 %, 0.5 %, 1 %.
Nominal voltage classes 69 kV to 765 kV for every application.

CVT High Reliability

The major insulation of the CVT, the capacitor stack, comprises homogeneously assembled capacitor elements, making it extremely surge resistant.

CVT Less Weight, Easier to Ship

CCVTs weigh less than the comparable voltage class VTs and can be shipped with the individual sealed capacitor units disassembled from the base assembly to facilitate shipping and handling. This also means lower freight and material handling cost for the customer.



COSI-CM 345 kV

Insulation Integrity

Over time the CVT is assured by a metallic diaphragm assembly which hermetically seals the oil from the atmosphere.

CVT Insulators

Can be provided with porcelain or polymer insulators.



Rated Power Output

Operating temperatures	
* Outdoor service	-40 to 60 C°
* Indoor service	-5 to 40 C°
Continuous Current	4000 A max
Rated Current	User selectable up to 4000 A
Short-time Thermal current	63 kA rms for 1 sec or 50 kA rms for 3 sec
Short-time Dynamic current	200 kA peak

* Extended temperature ranges also available

VT Specifications for COSI-CM (CVT/COSI-CT)

Accuracy	Classes 0.2, 0.3
Insulator type	Porcelain or composite

COSI-CT specifications

Bandwidth *	10 Hz to 6 kHz
Metering interface	1 A (RF=2) 5 A (RF=1.5) IEC 61850
Protection interface	200 mV (IEC 60044-8) IEC 61850
Accuracy **	Classes 0.1, 0.15, 0.2, 0.3
Insulation type	Solid composite insulator
Weight	<200 lbs for all voltage classes

* Extended bandwidths from DC to 10 kHz available

** Extended range available on all accuracy classes

Technical Data Needed to Quote COSI-CM

COSI-CM quantity: _____

Rated voltage level: _____ kV

Rated primary currents: _____ A

Short circuit current: _____ kA _____ s

Rated frequency:	60 Hz	<input type="checkbox"/>	50 Hz	<input type="checkbox"/>		
CT accuracy - metering:	IEEE 0.3	<input type="checkbox"/>	IEEE 0.15	<input type="checkbox"/>	IEEE 0.15 S	<input type="checkbox"/>
	IEC 0.5	<input type="checkbox"/>	IEC 0.2	<input type="checkbox"/>	IEC 0.2 S	<input type="checkbox"/>
Rated output - metering:	1 A	<input type="checkbox"/>	5 A	<input type="checkbox"/>	IEC 61850-9-2LE	<input type="checkbox"/>
CT accuracy - protection:	IEEE10%	<input type="checkbox"/>	IEC 5P10	<input type="checkbox"/>	IEC5 P20	<input type="checkbox"/>
	IEC 5P30	<input type="checkbox"/>				
	with optical CT*					
Rated output - protection:	200 mV rms	<input type="checkbox"/>	IEC 61850-9-2LE	<input type="checkbox"/>		
VT accuracy:	0.2 %	<input type="checkbox"/>	0.5 %	<input type="checkbox"/>	1 %	<input type="checkbox"/>
Rated output - VT:	100 V/√3	<input type="checkbox"/>	110V/√3	<input type="checkbox"/>	115V/√3	<input type="checkbox"/>
	120 V/√3	<input type="checkbox"/>	200V/√3	<input type="checkbox"/>	230V/√3	<input type="checkbox"/>

* air gap cores is not a relevant issue since they have no cores

COSI-CM

Combined Metering Unit
Up to 800 kV

Open Phase Detection System

COSI Digital Instrument Transformers with P40 Agile Protection

Optical | Precise | Dependable: Open Phase Detection for the most critical standby power supplies

OPD monitors the availability and health of standby power supplies. Due to the criticality of the circuits supplied, nuclear plant operators are assured that the standby supply will be available to serve the demand should switchover occur.

GE's Open Phase Detection (OPD) system is a fully integrated solution to a problem that has vexed the nuclear power industry: how to best provide open-circuit protection for off-site auxiliary power transformers serving nuclear generating stations. GE's OPD schemes are capable of detecting such scenarios and isolating the power transformers when required, in both unloaded and loaded conditions.

The problem solved is to detect the loss of a single phase in the supply path to power transformers caused by incorrect switching operations or an unintentionally open or grounded conductor. This requires that the scheme is sensitive enough to measure the transformer magnetizing current on two phases, and its absence on a third phase.

The extremely low current levels to be measured mean that conventional current transformers would not be sensitive enough. GE's COSI-CT digital instrument transformers prove to be perfect for the task, using optical measurement technology to directly measure the magnetizing current. The measurements are published via Ethernet using IEC 61850-9-2LE, with MiCOM Agile P645 process bus relays providing the protection.

Overview

While numerous approaches have been tried by others, only GE's OPD system offers this unique combination of attributes:

Safety

GE's OPD system eliminates the need for conventional current transformers (CT). While analog CTs have been an industry workhorse for years, their usage comes with a significant risk: an improperly isolated CT circuit that's opened can result in physical harm to equipment and personnel. When open-circuited, a CT can develop high voltage that results in arcing, associated heat, and burning. By employing an optical sensor instead of a traditional CT, GE's OPD system enhances operational safety by eliminating the risk of inadvertently open-circuiting an energized CT.



Key Benefits

- Safety – no wired cross-site CT circuits
- Optical technology sensitive to measure magnetizing current as low as 10 mA primary
- Slip-over optical CT for easy retrofitting of an existing installation
- Fully standards-compliant IEC 61850 solution, nothing is proprietary
- Secondary engineering in minimum panel footprint



Reliability

GE's OPD system is dependable. It can be counted on to successfully operate when it should operate.

The system has been battle-tested both in the lab and where it counts, in the field.

Security

GE's OPD system design is guided by the philosophy that avoiding false operation is just as critical as flawless performance during legitimate open-circuit conditions. GE's solution only initiates equipment isolation when necessary to remove an open-phase fault, not for faults outside the zone of coverage. Line faults, inrush currents, and high load transfer conditions will not initiate operation.

Selectivity

GE's OPD system offers reliable and secure system operation because, uniquely, it integrates inputs like circuit breaker status, over/under current, neutral current, negative sequence current, and single pole logic with independent phase settings. Processing such inputs helps to overcome the challenges associated with the significant variance of current magnitudes in a properly functioning power transformer. These can range from tens of milliamps in each phase (and unequal because of the core geometry) when a power transformer is energized but unloaded, to thousands of amps when the transformer is fully loaded. Another design element is "time discrimination" - the coordination between the OPD system and the neighboring line, transformer, voltage, and/or motor relays.

Convenience

GE's OPD system incorporates two independent OPD functions inside a single housing. This ensures that OPD is provided (1) for an unloaded transformer, and (2) for a loaded transformer.

Additionally, the digital nature of the system eases testing and maintenance. No test switches are required to prevent disconnection of wires during testing, as all equipment requiring isolation is connected through a fiber network.

To ease diagnostic work, safe, digital, test signals can be injected into the process bus.

Cost-effectiveness

GE's OPD system is a fully-digital solution, meaning that minimum equipment and circuitry is required for each installation. Ease of application, installation, testing and maintenance contribute further to savings. Finally, GE's OPD systems are configurable to each unique application. The days of one-size-fits-all, off-the-shelf solutions are gone, along with their costs and risks.



P645 process-bus protection relay in half-rack 8 inch case

Open Phase Detection System



XMU800

Merging Unit for Low Power Instrument Transformers

In the digital chain for current and voltage measurement, the XMU800 merges digital data to make them IEC 61850 compliant. It interfaces with multiple digital primary converters installed on the primary equipment.

Smart and Powerful Device

When signals coming from LPIT primary sensors are digitised via the PC12 primary digital converter, the data is sent to the XMU800. Several PC12 can send their data to one merging unit.

The XMU800 merges all signals and synchronises them using 1 PPS (Pulse Per Second) input or the PTP IEEE 1588 protocol. Then, the data is packed into one or several IEC 61850-9-2 frames and sent to protection relays, data loggers, smart terminals, etc. The device has a powerful FPGA core (Field-Programmable Gate Array), creating a real time matrix for inter-connections between HV sensors and secondary Intelligent Electronic Devices (IEDs).

Compliant with GIS Architectures

The XMU800 design is compact, with all the communication ports at the back of the box. It fits in a 19-inch wide bay. The large number of I/O ports allows the XMU800 to fulfill most GIS substation architectures (single busbar, double busbars, one-and-a-half circuit breaker) thanks to the 13 Ethernet ports.

Highly Communicative Device

Thanks to its powerful core, the device is able to communicate via IEC 61850-9-2 (& 9-2 LE) and IEC 61869-9 ready, sending sample values (SV) to a 9-2 network simultaneously over several ports.

Key Benefits

- High-performance and rugged design
- Self-monitored and easy to set up via webserver
- Many input/output ports provide compatibility with most known GIS layouts
- Remote supervision of primary sensors and converters



User-friendly Interface

A webserver is integrated into the device and allows users, depending on access rights, to check the status of the unit, change certain parameters and display measured values on a webpage. This can be done via any computer equipped with a standard internet browser.

Available ports:

- 1 PPS input (a PPS output is also available for daisy chaining for IEEE 1588 synchronisation)
- Ethernet input ports
- Power supply and alarm contact
- HMI Ethernet connection
- Optional ports on request (e.g. 600044-8)



XMU800 rear view

Technical Characteristics

Rated Supply Voltage

Option 1: 100 to 350 Vdc
+ 100 to 240 Vac
Option 2: 20 to 72 Vdc
Power cons. max. 18 W @ 25°C

Ambient Temperature

-40°C up to 70°C

Protection Index

IP20, as per IEC standard

Case Material

Anodised aluminium (EMC)

EMC immunity Standards

IEC 61000-4-2,4,5,8,16 Level 4
IEC 61000-4-3,6,17 Level 3

Emissions Standard

EN55022 Class A

Communication Standards

IEC 61869 -1, -6, -7, -8, -9



Ratings

Unit Type		XMU800
Ethernet ports:		
- Input (PC12)	Qty	6
- Output (61850-9-2 type)	Qty	7: 4LC, 3RJ45
- HMI/8.1 connections	Qty	1 front (HMI) + 1 rear (8.1 compliant)
PPS synchro. ports	Qty	1 In + 1 Out
Optional ports (Compliant 44-8)	Qty	8 (4 In + 4 Out)
Auxiliary contacts	Type	Alarm NO & NC
MTBF (acc. To MIL-HDBK-217F)	Hours	340 000
Dimensions (mm):		
- Height:	mm	90
- Width:	mm	480
- Depth:	mm	240 / 340 with optical fibre

Important note:

This product may not be sold on its own. It must always be integrated in a global Low Power Instrument Transformers (LPIT) solution.

XMU800

Merging Unit for Low Power Instrument Transformers