OPTICAL
CURRENT
TRANSFORMER

arteche

Moving together

DIGITAL MEASUREMENT FOR DIGITAL SUBSTATIONS

New Intelligent Electronic Devices (IED) for protection, control and metering applications in primary substations can receive and process voltage and current measurements as digital values.

This change disrupts the traditional substation engineering where lots of low voltage cables had to be installed between each IED and the instrument transformers. IEC 61850-9-2 process bus and IEC 61869-9 allow the operation of different IEDs with the Sampled Values provided by digital Instrument Transformers regardless of the manufacturer or the underlying voltage and current measurement technology.

At the same time, the evolution of technology allows new approaches to voltage and current measurement in HV grids. These non-conventional instrument transformers can offer some interesting features compared to conventional instrument transformers in terms of linearity, accuracy range, insulation etc.

Optical current transformer

OPTICAL CURRENT TRANSFORMER

The optical current transformer is a highly accurate optical current transformer for high voltage systems, based on a fully passive optical transducer. The optical current transformer provides a digital measurement solution for metering and protection applications in the next generation of high voltage digital substations.

The operation of the optical sensor is based on the Faraday Effect. The polarization state of a linearly polarized optical signal is rotated as it travels through a magnetic field. For an optical signal which travels along a closed path, the angle of rotation is proportional to the current enclosed by the path.

The rotation of the polarization state of the light is measured interferometrically as the phase difference between circularly polarized optical signals which travel in opposite directions around a coil of fiber that encloses the primary.

ARTECHE optical current transformer uses the most advanced fiber sensing technology based on a patented technique that allows the construction of passive, interferometric transducers with Class 0.2 accuracy over an unlimited dynamic range.

The transformer is composed of these elements:

› ECO, consisting of:
  | Sensor head.
  | Post type polymer insulator with solid and dry insulation with an embedded fiber optic for sensor head connection.

› SDO MU Merging Unit.

_ PASSIVE

_ MODULAR

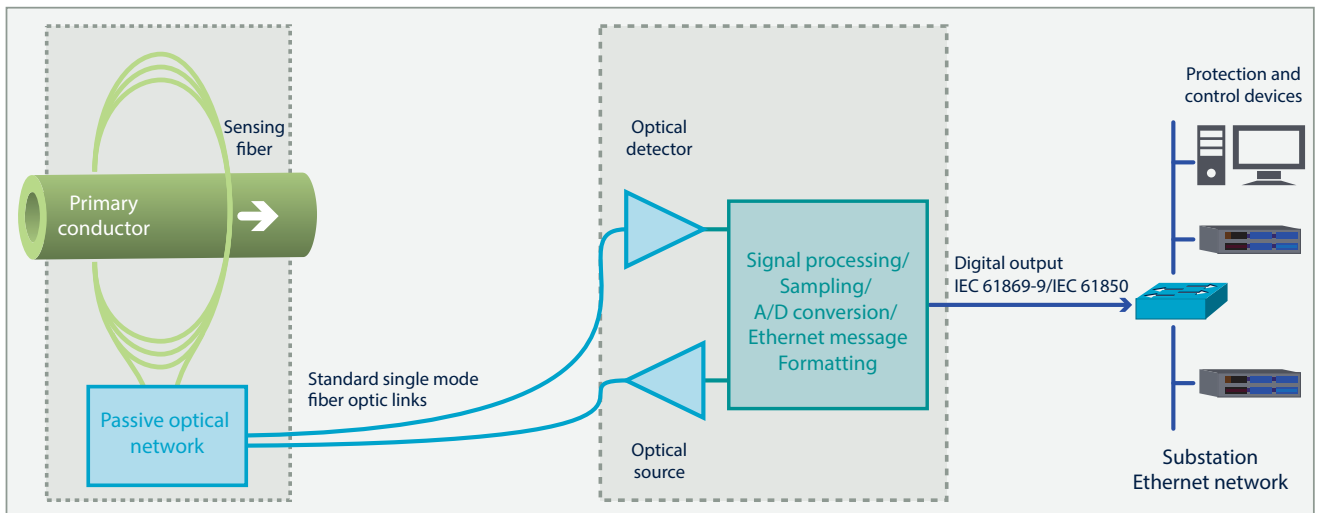_ ACCURACY OVER AN UNLIMITED DYNAMIC RANGE

Sensor Head

Measures AC or DC current with an optical transducer.

SDO MU. Merging Unit

Provides Sampled Values, fully digital measurement output for metering and protection applications as defined in IEC 61850-9-2 LE and IEC 61869-9 standards.

> Simplified block diagram of optical current transformer.

APPLICATIONS

Optical current transformer is ideally suited for digital measurement for metering & protection based on the IEC 61850 process bus protocol and IEC 61869.
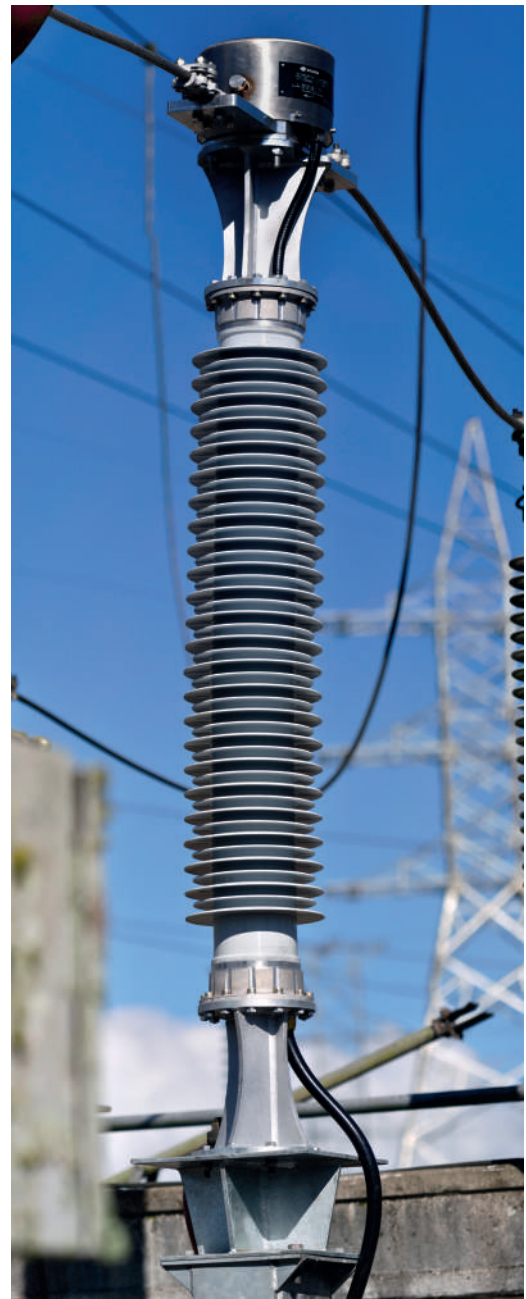
SYSTEM ARCHITECTURE

The sensor head is connected to the primary conductor in the switchyard. Typically it will be mounted on an insulator column. However, other options are possible, for example by using suspension type HV links or by integrating the sensor into other apparatus such as circuit breakers or disconnecting switches.
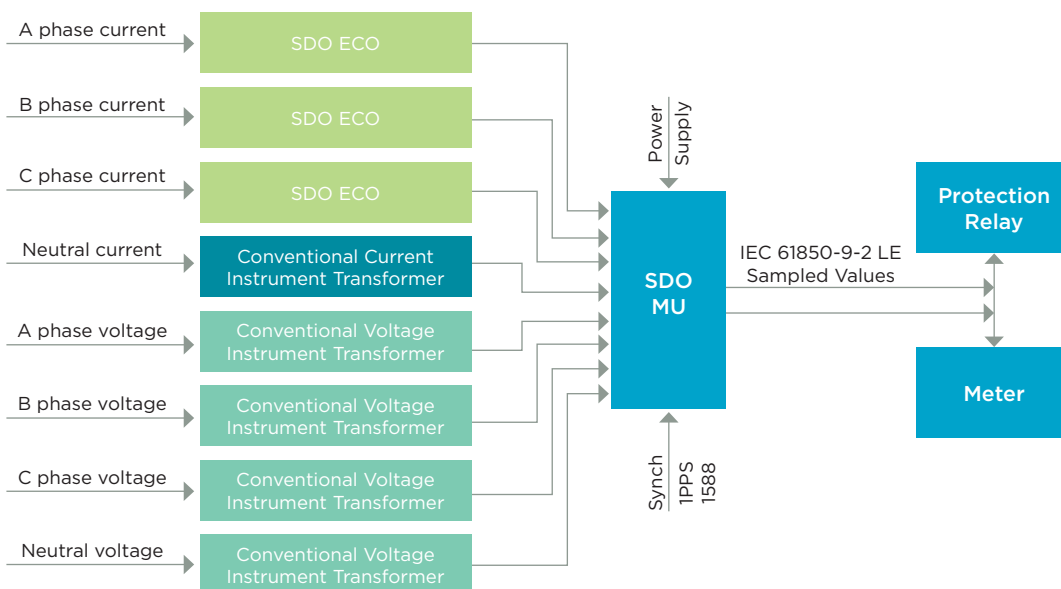
The SDO MU is an integral part of the optical current transformer. It sends and receives the optical signal to and from the sensor controlling up to three current sensors. In addition to that, it can interface with conventional CT's and VTs.

The SDO MU performs all the necessary signal processing and analog to digital conversion. It samples the measured values according to frequencies specified by IEC 61850-9-2LE and IEC 61869-9.

Then it synchronizes and merges the current and voltage channels before encoding the output signal to the digital format of Sampled Values (SV) and streams it via two redundant Ethernet ports to the Process Bus network.

› SDO ECO with sensor head and insulator.

A phase current	SDO ECO
B phase current	SDO ECO
C phase current	SDO ECO
Neutral current	Conventional Current Instrument Transformer
A phase voltage	Conventional Voltage Instrument Transformer
B phase voltage	Conventional Voltage Instrument Transformer
C phase voltage	Conventional Voltage Instrument Transformer
Neutral voltage	Conventional Voltage Instrument Transformer

Power Supply

SDO MU

IEC 61850-9-2 LE Sampled Values

Protection Relay

Meter

Synch 1PPS 1588

› Interfaces of SDO MU merging unit.

COMPONENT DESCRIPTION

ECO

| SENSOR HEAD

› Fully passive current transducer based on optical fiber. No power supply required in the switchyard.
› Full galvanic insulation.
› No risk of open secondaries.
› Maintenance free.
› Reduced dimensions for an optimized substation footprint and easy retrofit integration.
› Class 0.2 accuracy as per IEC 61869-2 and full linearity over an unlimited dynamic range.
› Single transducer for both metering and protection applications.
› The current transducer is independent from the voltage level.
› It can be designed for DC measurement.
› Redundancy (optional):
  • Redundant measurement with a single sensing coil.
  • 2 sensing coils in one sensor head.

| INSULATOR

› Dry solid insulation. No oil or SF$_6$. Without risk of leakage or violent failure.
› Standard voltage levels: 145 kV, 245 kV, 300 kV, 420 kV and 550 kV. Additional voltage levels available on request.

SDO MU MERGING UNIT

› 19" 3U Rack mounted signal processing IED installed in the protection and control panel.
› Input interface:
  • 3x Sensors.
  • 4x Conventional VT.
  • 4x Conventional CT.
› Time Synchronization: 1PPS / IEEE 1588 (PTP).
› Digital output via dual Ethernet port. Compliant with IEC 61850-9-2LE and IEC 61869-9.
› Seamless fail over network redundancy:
  • High-availability Seamless Redundancy (HSR).
  • Parallel Redundancy Protocol (PRP).

_ SAFE
_ ENVIRONMENTALLY FRIENDLY
_ LOW MAINTENANCE
_ PTP (IEEE 1588)
_ HSR & PRP

SDO MU MERGING UNIT: FRONT AND REAR VIEW

1. 4x20 Alphanumeric display.
2. 8 Indicating LEDs.
3. Ethernet Configuration port.
4. Rating plate.
5. Optical Channel.
6. Voltage Inputs.
7. Current Inputs.
8. 1PPS synchronism input.
9. 61850 communication ports.
10. Digital Outputs.
11. Power supply.
12. Grounding Screw
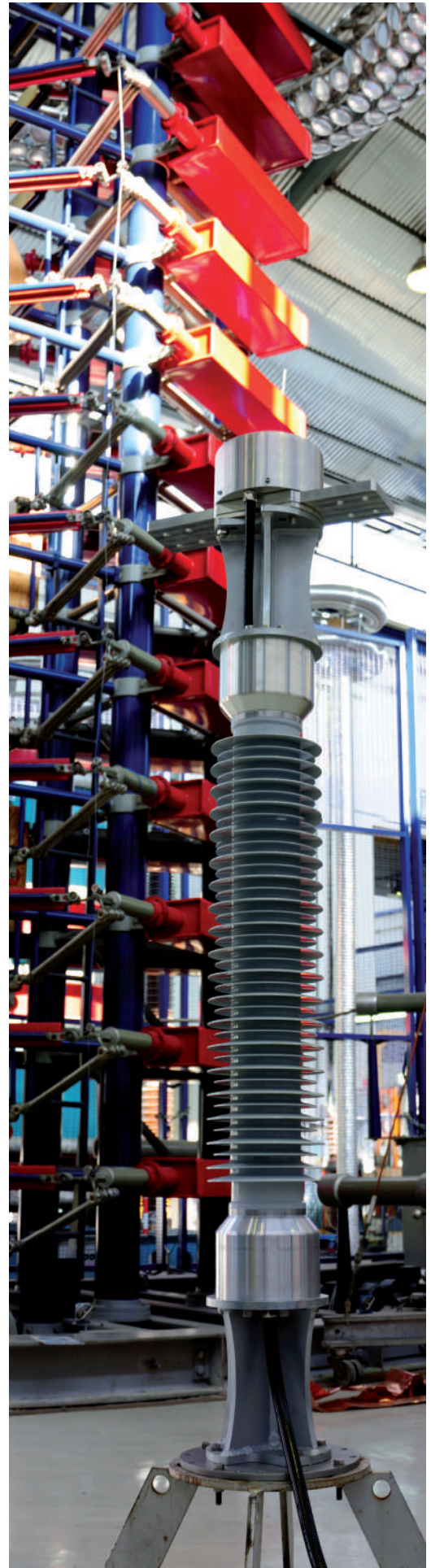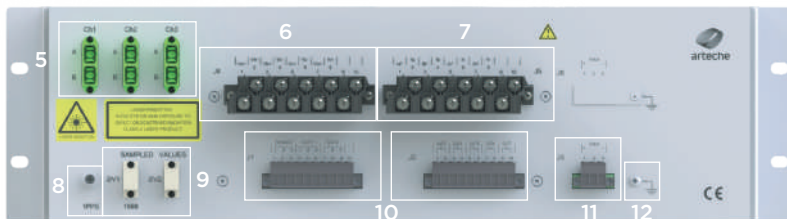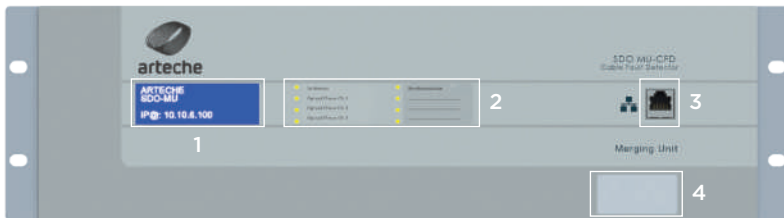
> Routine tested in ARTECHE's laboratory.

Optical current transformer

TECHNICAL SPECIFICATIONS

SENSOR HEAD	
Nominal current	User specified for up to 4800 Arms
Rated short-time thermal and dynamic current	80 kA 1s, 200 kA
Rated continuous thermal current	Up to 4800 Arms
Accuracy	0.2 s / P20
Bandwidth	1.5 kHz at 80 samples/cycle 6 kHz at 256 samples/cycle
Weight	15 kg
IP protection	IP66
Primary terminal	Aluminum
Temperature	-40°C to +55°C
Humidity	100% Storage 90% Operating
Vibration	1G
Fiber type for connection with the SDO MU merging unit	Standard duplex single mode

INSULATOR (CUSTOMER SPECIFIED)						
Maximum system voltage (Um)	kV ms	145	245	300	420	550
Rated power-frequency withstand voltage	kV rms	275	460	460	630	680
Rated lightning impulse withstand voltage	kV peak	650	1,050	1,050	1,425	1,550
Rated switching impulse withstand voltage	kV peak			850	1,050	1,175
Minimum creepage distances 31 mm/kV	mm	4,495	7,595	9,300	13,020	17,050
Minimum flashover distance	mm	1,200	2,200	2,320	3,250	3,800
Static withstand loads FR	N	3,000	4,000	4,000	5,000	5,000
MML	N	3,000	4,000	4,000	5,000	5,000
SML min	N	5,000	6,250	10,000	12,500	12,500

SDO MU MERGING UNIT

MECHANICAL

Dimensions	482x324x123 mm • 19" 3U Rack	
Weight	5.5 Kg	

POWER SUPPLY

Voltage Range	110-220 Vdc	48 - 125 Vdc
Frequency	50/60 Hz	
Power Consumption	25 W	

ENVIRONMENTAL

Operating temperature	-5°C to +45°C
Storage temperature	-40°C to +85°C
Humidity	90% Without Condensation
Maximum height	2,000 m
Vibration	0.5 G

OPTICAL INTERFACE

Number of channels	Up to 3 Duplex SC/APC
Wavelength	1,550 nm, 1,300 nm
Power Output	< 10dBm
Type of fiber	SM G.652.D

ANALOG INPUTS

Current	4 x 1A / 5A
Voltage	4 x 100/$\sqrt{3}$ - 110 V

RELAY CONTACT OUTPUTS (Configurable by the user)

Description	Service 1 NC/NO Service
	Outputs 1 and 2 NC/NO
	Outputs 3 to 7 NO

SAMPLED VALUES

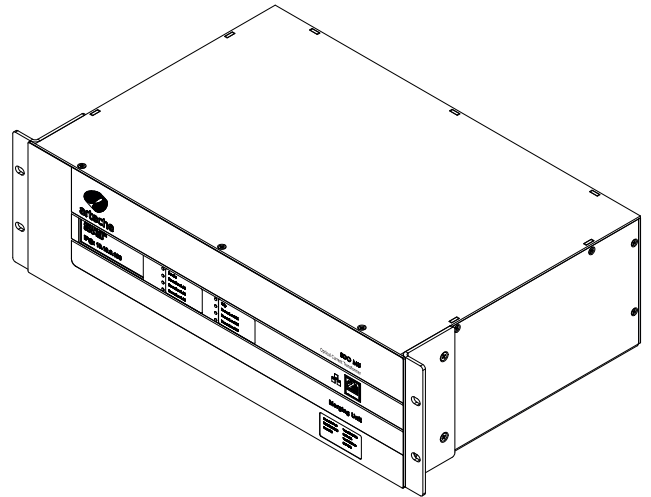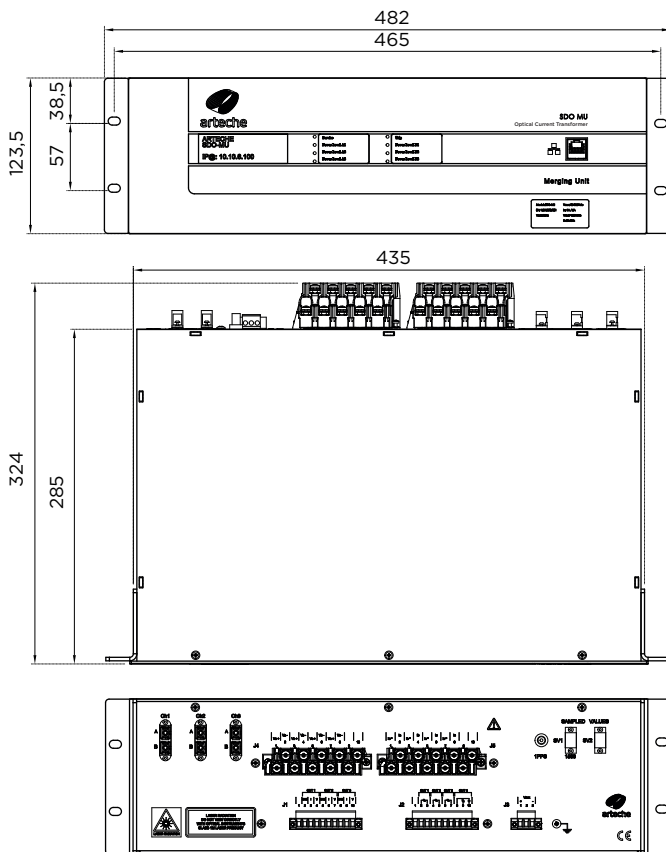|	
Number of ports	2
Physical interface	2 x 100 Base FX Ethernet
Type of connector	LC type Optical MM
Protocol	IEC 61850-9-2 LE IEC 61869-9
Grids	F4000S1I4U4, F4800S1I4U4, F4800S2I4U4, F12800S8I4U4, F15360S8I4U4, F14400S6I4U4

SYNCHRONIZATION

1 PPS	Optical MM ST
PTP	IEC 61588:2009 profile IEC PAS 61850-9-3:2016 IEEE C37.238:2017

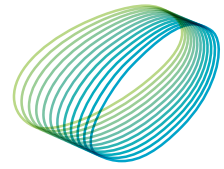## USER-MACHINE INTERFACE

Display	4x20 Alphanumerical
LEDs	8 x User Configurable: status & alarms
Configuration port	Front 10/100 Base TX
Software configuration	Web Browser

DRAWING DIMENSIONS

> SDO Merging Unit.