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CAMOS 200

CABLE MONITORING OPTICAL SOLUTION FOR HV CABLE MANAGEMENT

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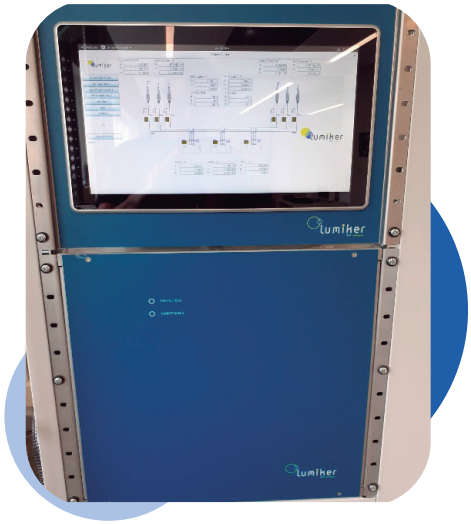


CAMOS is a novel monitoring system for HV Power Cables, based on current measurement in each Cable Sheath and its corresponding Phase. Passive optical sensors (OCT´s) and analog multiplexers are the key elements used, complemented with several processing units that collect, analyze and show the information in real time, providing an embedded alarm system to prevent and detect faults.

CAMOS200 Provides an integral solution for the Efficient Supervision and Maintenance Optimization of HV Power Cables (With the corresponding savings in maintenance costs and the possibility to enlarge asset operating life). Upon its functionalities the following have been developed: Predictive Cable Health Diagnosis, Insulation degradation detection and a novel & accurate Fault Discriminator and Location, based on currents circulating through the cable sheaths.

CAMOS can do a precise discrimination of cable failure on mixed lines (cable + overhead), that allows to coordinate reclosing or blocking actions on the regular line protections on an automatic and real-time basis increasing line utilization.

CAMOS can be used in single or transposed cables of several km of length (up to 20 km without amplifiers, much more with amplifiers).

CAMOS is a very powerful tool that provides users enhanced safety and economic savings, with a continuous supervision of the lines in operation.

MONITORING & DIAGNOSIS

- Capacitive & Ground Circuit Currents in Phase and Angle.
- Cross Current Equilibrium Analysis.
- Harmonics Currents: Wave Quality, Partial Discharges when the Insulation Health is at stake.
- Ground Circuit Surges.
- Currents Synchronization with Main Line Voltage.
- Integration of Bragg Sensors to measure Temperature and displacement.
- Sensors based in Photonics: Optical current transformers (OCT 0A-120kAs) and Local temperature sensors (LTS -25°C-125°C).

PROTECTION & FAULT LOCATION

- Main Line Differential 87L Protection to Discriminate Aerial from Underground Faults.
- Automatic Reclosing for Aerial Faults, and Blocker for Underground Faults.
- Current Oscillography Trigger.
- 3 pre-fault cycles, 22 post-fault cycles, 3 analog voltages, 6 phase currents, sheath currents, and 8 digital inputs to run the fault locator.
- Faulted Phase Identification, major part determination, minor part identification.
- Fault Location with integrated algorithm.

ANALOG COMMUNICATIONS

- Normal G652 Mono-mode fibre.
- One single pair of fibre optic wires can connect up to 9 OCTs.
- Passive Multiplexer that combines individual analogue signals in one.
- CAMOS only uses the C transmission window. It is possible to use other windows for other purposes with the same fibres.

DIGITAL COMMUNICATIONS

- 3 independent Ethernet ports for simultaneous & dedicated network connections with IEEE 1588 support.
- Modem Connection via 4G to send ASCII History of data To cloud.
- IEC 60870-5-104 & DNP3 Plug & Play Connector.

EASY TO ASSEMBLE

- Open and Closed OCTs applicable to Existing (Connected) or new Cables.
- Normal Fibre Fusion or FC/APC Connections.
- Allows Quick and High personnel safety during installation.

MAIN COMPONENTS AND FUNCTIONALITIES

OPTICAL CURRENT TRANSFORMERS

They are passive elements based on the Faraday optical effect. They are compact elements that have an output-input of SM fiber optic, allowing the measurement of current in the three phases individually, and the corresponding sheaths.

Passive Analog multiplexer

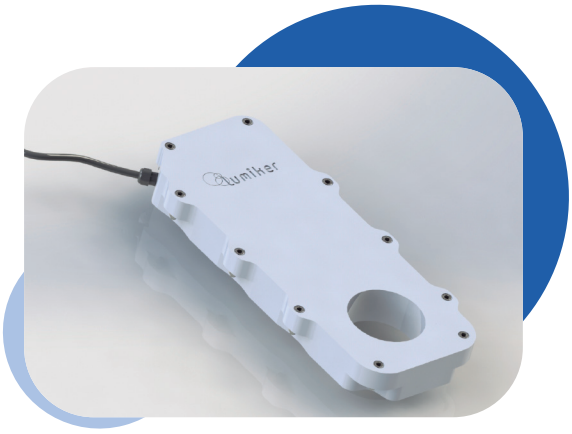
Depending of needs, there are several models: For Power Cable, for Sheaths, screens etc. The Figures show some of the available models that can be installed without need to de-energize the Power Cable, nor to interrupt the Operation of the Asset.

ANALOG MULTIPLEXER

This is a patented and unique device that multiplexes the individual light signals from the OCTs in one single signal, allowing to connect in the same fiber, several optical current transformers. It's a passive element, that does not require any external power source.

OPTICAL CABLE TRANSFORMERS (OCT)

Cable current transformers can read from small Current Ranges 0-10As to short-circuit ranges 500-120ks. Once the light reaches our transformers, they are sensitive to the magnetic field generated by the current in the cable by modifying the polarization of the light that goes back to our interrogator. These transformers are wound in the field according to our easy to install design.



OCT for cable sheath

Seath OCT, HV cable OCT and multiplexer

They use simple single-mode fiber communications. Installation is simple and can be done by any fiber optic communications local contractor.

DATA ACQUISITION AND PROCESSING UNIT

This is the brain system that allows remote acquisition of analog signals, as currents, temperature, amongst other ones. The analog information is converted to a digital one, sampled and later processed and analyzed with different algorithms in two CPUs. See Figure of Data acquisition and process unit.

The components of this unit are as follows:

Optical Interrogator

This is an electronic-optical element that sends synchronized light pulses to the OCT's. By doing this, it collects the synchronized analog data from each OCT.

CPU maintenance

This unit performs a "slow" process from a large volume of current information at the different measured points. This Information is collected from the OCT´s and processed using different algorithms to visualize phase and sheath currents in magnitude and angle, oscillography recording, and different information needed for the remote server.

CPU protection

This unit performs ultra-fast process of information for fault determination and location. The main reason of splitting the process for maintenance and protection, is the big difference in data processing.

While in the maintenance part the data has a large volume of information and low values of analog magnitudes (nominal and sheath leakage currents) the process needs to be more elaborate (rate needed is relative slow: in the order of seconds or minutes). In the case of protection, the volume of data is not so big, but with high magnitudes and needs to be collected and processed in milliseconds time.

Local PC

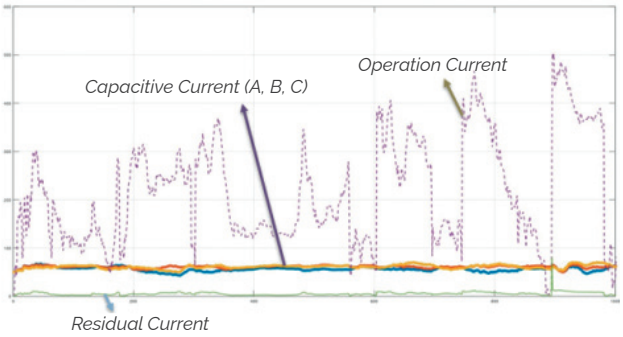
It Collects all values generated by the two CPUs: Maintenance and Protection; generating the different records and information. It also provides the interface for communication with remote devices. In addition, it provides also a SCADA Gateway and a Cloud access with a powerful structure for developing new functionalities. It provides also information local storage, in case of communication loss with the cloud server.

Rf modem (optional)

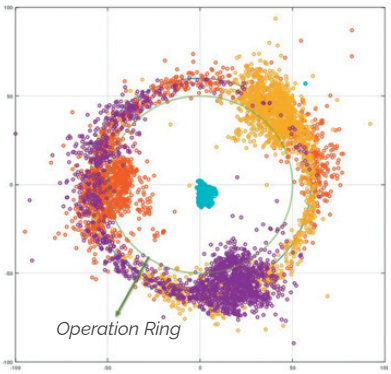
It provides direct connection with remote servers, avoiding the need of using the company's communications systems.

HMI (optional)

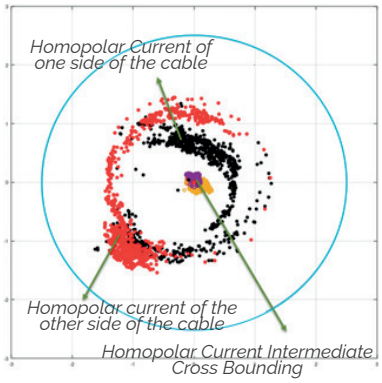
The system has a local interface for data management and local data visualization, as well.



Current measures



Polar indication that cable is normal



Polar indication with cable leakage

DIFFERENTIAL PROTECTION

The operating principle is similar to the other classical line differentials with percentage restrains. The basic equation is as follows:

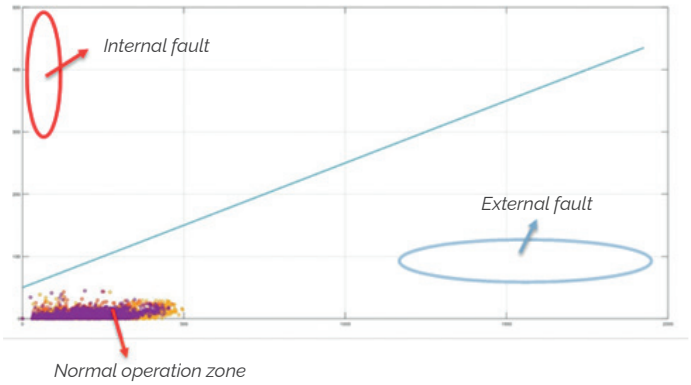
$$I_{op} = I_d - KI_R$$

Where:

I_d = Differential current $I_N + I_{OUT}$

K = Percentage restrain

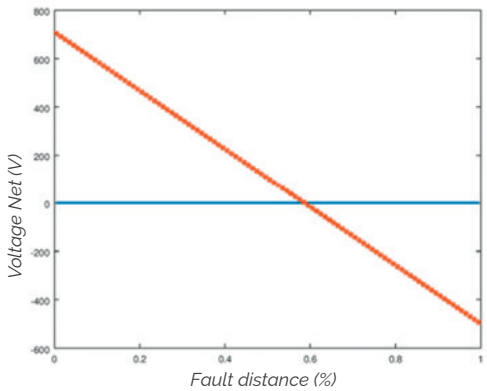
$$I_R = (|I_{IN}| + |I_{OUT}| - |I_{Id}|)/2$$



Operating Characteristic of differential protection

FAULT LOCATION

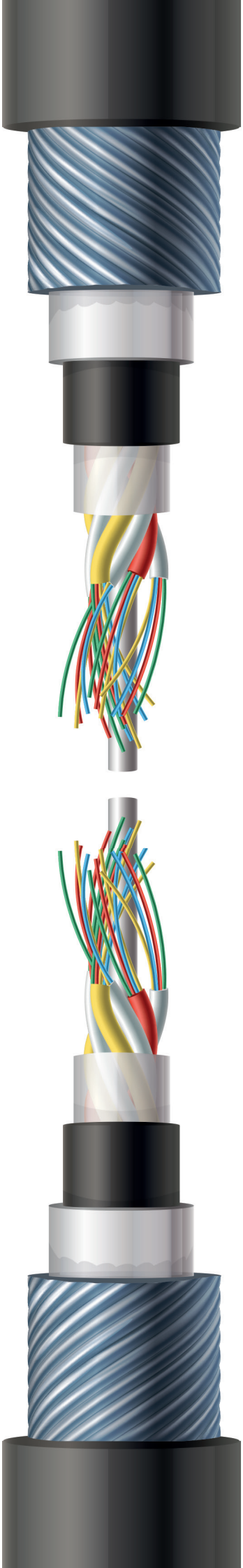
The Fault locator is built on base to the current circulating through the cable sheath. A Detailed explanation can be found in a separate technical document available in our website.



Fault is located where voltage is zero

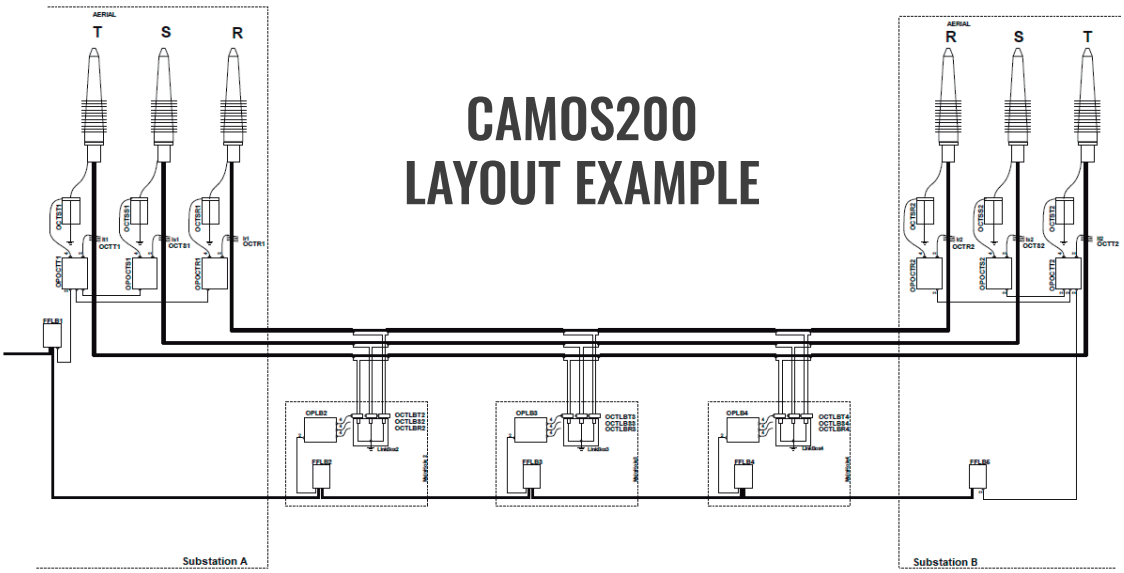
Criteria	ID	Functionalities
Economic efficiency of the system	1	Optimisation of the maintenance strategy and renewal of assets
	2	Modularity in the solution that enables it to be adapted to different types of underground networks, voltages and/or players requirements
	3	Additional harnessing of assets existing in the network maintenance (e.g. optical fibre).
	4	Continous measurement of the losses arising in the cable sheaths.
Security	5	Continous monitoring of underground networks that facilitate the connection with critical assets (both generation and consumption).
	6	Blocking of reclosing in aerial-underground connections if the fault is underground, through fault discrimination
	7	Storage of the information obtained by the sensors in the network manager's own servers
Quality and continuity of supply	8	Specific supervision of critical points in the network (joints, terminations)
	9	Unblocking of reclosing in aerial-underground connections if the fault is aerial, through fault discrimination
	10	Digital communication between teams and interconnection to facilitate certain protections
	11	Continuous supervision of wave quality through the measurements of harmonics
Digitalisation	12	Real time gathering of data on the working condition of underground cables
	13	Direct cloud storage of information relating the upkeep of the facility
	14	Possibility of fully integrating the solution in the SCADA system of the transmission/ distribution company's network
	15	Measurement of electricity aggregates (intensity, voltage) in order to obtain the key parameters for the upkeep of the cable
	16	Continuous measurement of sheath currents
	17	Minimisation of the risk associated with "false positives" as a result of the measurement of a non-electricity aggregate
	18	Sensorisation through passive elements that do not require electrical connection to carry out maintenance
	19	Capacity to integrate sensors for continuous measurement of non-electric parameters (temperature, vibration)
	20	Optimisation of the integration of protection and control elements
	21	Pre-localisation of the fault point
	22	Localisation of the fault point
Environmental, decarbonisation, electrification	23	Minimisation of the possibility of fires associated with live-line work
	24	Minimisation of the contamination associated with trips in conventional vehicles to carry out maintenance tasks
	25	Increase in the reliability of underground networks, which are less affected by extreme weather events
	26	Reduction of dumping of the generation of renewable energy that cannot be managed through the early detection of faults in the underground network

	Criteria	Economic efficiency of the system				Security			Quality and continuity of supply				Digitalisation										Environmental, decarbonisation, electrification			
	Functionalities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Possible solutions	Field tests and trials	■	■						■							■											■
	Traditional prelocalisation methods		■													■						■					
	Traditional localisation method		■													■							■				
	Distributed acoustig sensing	■	■	■		■		■			■		■	■	■			■	■			■	■	■	■	■	■
	CAMOS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■



CAMOS PROCESS UNIT- Technical specifications	
System	
Samples per cycle	288 s/c
Maintenance oscillos	1 cycle, 288s/c, current phases A, B, C per maintenance position + all sheath currents
Protection oscillo	25 cycles (3 prefault), 288s/c, current phases A, B, C per protection position + voltage inputs + all sheath currents
Oscillos trigger	digital inputs (1 for maintenance oscillo trigger and 1 for protection oscillo trigger), communications, scheduled
Oscillos storage capacity	50 GB
Oscillos format	ASCII, COMTRADE
Optical connections	
Number of connections	2/4/6 (according to model)
Maximum link length	10 Km
Fiber Type	G652D, G657.A2
Interrogator unit optical connectors	FC/APC female
Pigtail optical connectors	FC/APC male
SLED: Light emitter	
Center wavelength	1550 nm
ASE* power	40 mW
Optical 3dB bandwidth	33 nm
Laser classification	Class 1
Communications	
Communication port	RS485/Modbus RTU/Phoenix type 3-pole 5.08mm
Service port	RS485/ASCII/Phoenix type 3-pole 5.08 mm
Digital outputs	
Number/Type	8/ no-nc (4 for maintenance CPU and 4 for protection CPU)
Vnom/Current max.	250Vac / 16A Idc, 30A 4s
Operating time/Reset time	<8ms/<6ms
Connector	Phoenix type/5.08 mm
Optoisolated digital inputs	
Number	2 (1 maintenance CPU and 1 protection CPU) Tx board 6 (3 maintenance CPU and 3 protection CPU)
Nominal voltage	120 Vdc
Voltage inputs	
Number	3
Vnom	63Vac ± 20%
Power supply	
Power supply	24 Vdc
Power consumption	<15W
Connector	Phoenix type 3-pole / 5.08 mm
Mechanical data	
Dimensions	1 rack 19"x 6U/10U x 336 mm (height according to model)
Weight	10 Kg
Material	Stainless steel
Immunity tests	Class 4
Environmental conditions	
Storage temperature	-20°C to +70°C
Operating temperature	0°C to +50°C
Humidity (non condensing)	<=95% relative
Approvals	CE, ISO 9001

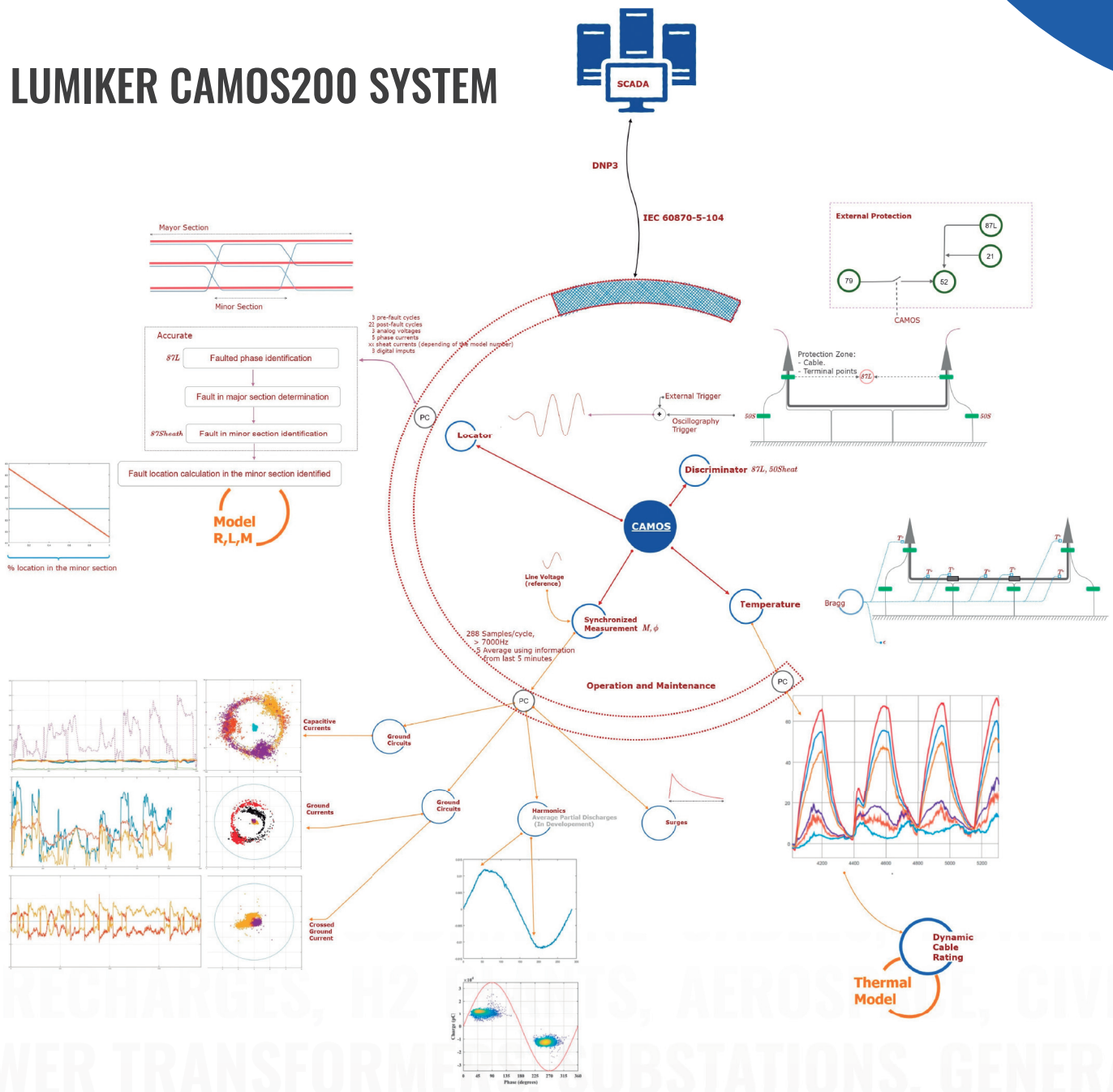
CAMOS200 LAYOUT EXAMPLE



OPTICAL BOX – Technical specifications			
Optical connections	10 m Single Mode fiber for splicing		
Mechanical data	O	I	M
Dimensions			
Weight			
Protection class	IP68	IP66	IPXX
Environmental conditions			
Storage temperature	-40°C to +70°C		
Operating temperature	-20°C to +60°C		
Humidity (non condensing)	95%		

OPTICAL CURRENT TRANSFORMERS – Technical specifications				
Technical data	**OCTCS**	**OCTCC**	**OCTOC**	**OCT1S**
Current measurement				
Current range	1A-400A	100A-60kA (according to model)	100A-60kA (according to model)	1A-400A
Precision	99%			
Optical connections	10 m Single Mode fiber for splicing			
Mechanical data		O	I	M
Protection class		IP68	IP66	IPXX
Environmental conditions				
Storage temperature	-40°C to +70°C			
Operating temperature	-20°C to +60°C			
Humidity	95%			

LUMIKER CAMOS200 SYSTEM



Ordering Notes:

CAMOS can also share the company´s fiber optic system, if required. For details, please contact us.
To view all the options available for CAMOS, please visit Lumiker: http://www.lumiker.com

LUMIKER APLICACIONES TECNOLÓGICAS
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UNDERGROUND/SUBMARINE CABLES, POWER TR
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