

TECHNICAL DATASHEET

36-0790-04

TOTUS G9

TOTAL TRANSFORMER MONITORING



SINGLE ASSET PRODUCTS		MULTIPLE ASSETS PRODUCTS	
T1G9	T3SPG9	T2G9	T3MAG9
T1G9INT3	T3SPG9INT3	T2G9INT3	T3MAG9INT9
T1G9INT6	T3SPG9INT6	T2G9INT6	
T1G9INT9	T3SPG9INT9		

Rev:
August 2019

TECHNICAL SPECIFICATION

PRODUCT STANDARDS

BS EN 61326:2013	Electrical equipment for measurement, control and laboratory use. EMC requirements.
IEC 61000-6-2:2005	Electromagnetic compatibility (EMC). Immunity for industrial environments
IEC 61000-6-5:2015	Immunity for equipment used in power station and substation environment
BS EN 61010:2010	Safety requirements for electrical equipment for measurement, control, laboratory use. General requirements

DISSOLVED GAS ANALYSIS SYSTEM SPECIFICATION

Methodology	Photo Acoustic Spectroscopy (PAS)
Extraction Method	Head space
Oil Circulation	Anti-cavitation's pumps
Air bubble elimination	Intelligent bubbletrap
Key fault gasses monitored	Totally 7: Hydrogen (H ₂) ¹ Methane (CH ₄) Ethane (C ₂ H ₆) Ethylene (C ₂ H ₄) Acetylene (C ₂ H ₂) Carbon Monoxide (CO) Carbon Dioxide (CO ₂)
Additional gases	Oxygen (O ₂) ² Nitrogen (N ₂) ³
TDCG Monitored	Yes ³
Moisture in oil (H₂O RS)	Yes ¹
Transformer Oil Temperature	-40°C to +120°C
Transformer Oil Pressure	Up to 3 bar (43PSI)
Consumables Required	No
Calibration Required	No
Carrier Gasses Required	No
Manual Oil Sample	Available from the unit without any operations on tubing, connections and valves
Multiple Tank Capability	Yes
Measurement Frequency	1h, 2h, 4h, 8h, 12h, 1d
Accelerated Measurement	Yes, based on system alarms
Gas level indication	Absolute ppm concentration & Rate of Change
Gas trend representation	1d, 1w, 1m, 3m, 1y, All
Standard Tubing	Flexible

¹ Dedicated & Separate Sensor² Oil immersed sensor³ Calculated

DISSOLVED GAS ANALYSIS DETECTION RANGES

Hydrogen (H₂)	5 – 5000 ppm
Methane (CH₄)	1 – 50000 ppm
Ethane (C₂H₆)	1 – 50000 ppm
Ethylene (C₂H₄)	1 – 50000 ppm
Acetylene (C₂H₂)	0.1 – 50000 ppm
Carbon Monoxide (CO)	1 – 50000 ppm
Carbon Dioxide (CO₂)	3 – 50000 ppm
Moisture in oil (H₂O RS)	0 – 100% RS
Oxygen (O₂)	100 – 50000 ppm
Nitrogen (N₂)	10000 – 150000 ppm

DISSOLVED GAS ANALYSIS ACCURACY

Hydrogen (H₂)	± 5% or ± LDL
Methane (CH₄)	± 5% or ± LDL
Ethane (C₂H₆)	± 5% or ± LDL
Ethylene (C₂H₄)	± 5% or ± LDL
Acetylene (C₂H₂)	± 5% or ± LDL
Carbon Monoxide (CO)	± 5% or ± LDL
Carbon Dioxide (CO₂)	± 5% or ± LDL
Moisture in oil (H₂O RS)	± 5% or ± LDL
Oxygen (O₂)	± 10%
Nitrogen (N₂)	± 15%

DISSOLVED GAS ANALYSIS REPEATABILITY

Hydrogen (H₂)	< 1% over 10 measurement*
Methane (CH₄)	< 1% over 10 measurement*
Ethane (C₂H₆)	< 1% over 10 measurement*
Ethylene (C₂H₄)	< 1% over 10 measurement*
Acetylene (C₂H₂)	< 1% over 10 measurement*
Carbon Monoxide (CO)	< 1% over 10 measurement*
Carbon Dioxide (CO₂)	< 1% over 10 measurement*
Oxygen (O₂)	< 1% over 10 measurement*

*at initial calibration

BUSHING MONITORING

Leakage current Range	0 – 200 mA
Sensors	Bushing Tap Adaptors
N. of Input channels	Up to 9
Input signal measuring range	0 – 1 V
Input signal frequency	50 – 60 Hz, ± 0.01 Hz
Sampling rate	18 kS/s
Resolution	14 bit
Magnitude accuracy	0.1%
Phase Angle Accuracy	0.05°
Acquisition mode	Simultaneous on all channels. Continuous 24/7
Averaging capability	Hourly, Daily, Weekly, Monthly
Standard Signal Cable	Armored Twin-Axial

BUSHING ADAPTORS

Type of impedance	Resistive
Overvoltage protections	Yes, Inside Bushing adaptor
Overcurrent protections	Yes, Inside Bushing adaptor
IP Rating	IP67
Material	Aluminum Alloy 6082-T6
Dimensions (H x W x D)*	51 x 75 (max) x 93 mm 2 x 3 (max) x 3.7 inches
Weight*	310 g
Max Operating Temp.:	+80°C
	*Bushing adaptor body only.

DATA STORAGE & MANAGEMENT

Data storage	32GB SSD memory, >10 years
Trending capability	1d, 1w, 1m, 1y, All
Memory saving approach	Progressive compression, No data erase.

ALARMS AND I/O

High Visibility LED	Green, Amber, Red
Analog Inputs	4 x PT100 probes, 3 x 4 -20 mA input, 1 x AC input
Digital Inputs	5 x 24V isolated
Digital Outputs	4 x NO or NC

ENVIRONMENTAL & MECHANICAL CHARACTERISTICS

Operating Temp. Range	-45°C to +55°C
Cold Start temperature	-45°C
Operating Humidity Range	0 – 100% RH
Storage Temp. Range	-50°C to +85°C
Elevation range	Up to 3500 m
Enclosure IP Rating	IP56
Enclosure Material	Powder Coated SS
Color	RAL 7035
Enclosure Dim. (H x W x D)	762 x 1053 x 310 mm 30 x 41.5 x 12.2 inches
Enclosure Weight	< 90 kg < 198 lbs

PARTIAL DISCHARGE & HIGH ENERGY EVENTS

Measuring Principle	Electrical
Sensors	Bushing Tap Adaptors
N. of Input channels	Up to 9 & 1 gating
Input signal measuring range	From -10V to +10V
Bandwidth	Ultra-wide (Up to 50MHz) & Wide (IEC60270)
Sampling rate	100 MS/s
Resolution	12 bit
Accuracy	Amplitude: <5%
Time resolution	10ns
Acquisition mode	Simultaneous on all channels Continuous 24/7
Standard Signal Cable	Armored Twin-Axial

THROUGH FAULT CURRENT (OPTIONAL)

Measuring Principle	Electrical
Sensors	Split core Current Probe
N. of Input channels	Up to 9 (3 sets of 3)
Input signal measuring range	From -14V to +14V
Sampling rate	18 kS/s
Bandwidth	Up to 500 Hz
Resolution	14 bit
Accuracy	Amplitude: <5%
Acquisition mode	Simultaneous on all channels upon a trigger event

SOFTWARE CHARACTERISTICS & FEATURES

Platform	Linux based
Visualization & Configuration	Web Based
Transformer Condition	Yes, based on IEEE std and GIGRE.
Advanced Analytics	Yes

COMMUNICATIONS

Available Protocols	HTTP, HTTPS, Modbus, DNP3*, IEC61850*, MQTT*
Available Carriers	Ethernet (RJ45), 3G, USB, RS232*, RS485*, Fiber Optic*, PSTN Modem*, Power Line Carrier*

*Provided as options upon request

POWER SUPPLY

AC Power Supply	90 – 250 Vac, 47 – 63 Hz
DC Power Supply	110 – 220 Vdc
Power consumption	500 W maximum

ADD-ON & OPTIONAL

The following option are available:

SENSORS: Upgrade Kits for additional Bushings (max 9 in total);
Additional Temperature Probes (i.e. Bottom Oil, LTC compartment);
Through Fault Current Monitoring (TFC);

MOUNTING Stand Mount;
Wall Mount;
Transformer Mount;

TUBING Rigid tubing

GENERAL AC/DC power Supply switchbox;
Sunshade;
Heat Traces

SIGNAL CABLE Non-Armoured;

Product has been type Tested as detailed in Table 1:

EMC IMMUNITY	IEC 61000-4-2	ESD	8kV air, 6kV contact
	IEC 61000-4-3	Radiated RF Immunity	10V/m
	IEC 61000-4-4	EFT	4kV
	IEC 61000-4-5	Surge	2kV L-L, 4kV L-E
	IEC 61000-4-6	Conducted RF immunity	10Vrms
	IEC 61000-4-8	Power Frequency Magnetic Field	30A 1min, 300A, 3s
	IEC 61000-4-10	Damped Oscillatory Magnetic Field	100 kHz and 1 MHz, 100 A/m
	IEC 61000-4-11	Voltage dips	
	IEC 61000-4-12	Ring Wave	1kV L-L, 2kV L-E
	IEC 61000-4-16	Conducted Common Mode Immunity	30 V for 1 Minute, 300 V for 1 Seconds
EMC EMISSION	IEC 61000-4-18	Damped Oscillatory Wave	0.5kV L-L, 1kV L-E
	CISPR11	RF emissions	Not applicable
ENVIRONM. TESTS	IEC 61000-6-4	RF emissions	Not applicable
	BS EN 60068-2-6:2008	Vibration – Sine Wave	10-150 Hz, 1g, 10-150Hz, 0.5g
	BS EN 60068-2-1:2007	Cold start	-40°C
	BS EN 60068-2-1:2007	Cold	-40°C, 16hrs
	BS EN 60068-2-2:2007	Dry heat	+55°C, 16hrs
	BS EN 60068-2-30:2005	Damp heat cyclic	+25°C ... +40°C, 80 – 100% RH, 2 x 24hrs
	BS EN 60259:1992 +A2:2013	Ingress protection	IP56
	BS EN60721-3-4 (4M4)	Vibration tests	2 – 200Hz, 1g or 3mm

Table 1: International standard compliance summary

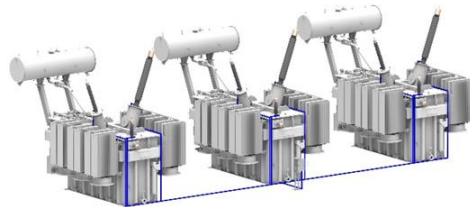
PRODUCT CONFIGURATIONS

TOTUS G9 can be provided in different configurations to cover several possible layouts of Transformer installations. Here in the following the complete list of the G9 gas analyzer variants together with legend and simplified layout.

PRODUCT CODE	PRODUCT DESCRIPTION
T1-G9	1 Transformer, DGA only
T1-G9INT3	1 Transformer, DGA & 3 bushings
T1-G9INT6	1 Transformer, DGA & 6 bushings
T1-G9INT9	1 Transformer, DGA & 9 bushings
T2-G9	2 Transformers, DGA only
T2-G9INT3	2 Transformers, DGA & 3 bushings on 1 transformer
T2-G9INT6	2 Transformers, DGA & 3 bushings each transformer
T3SP-G9	3 single-phase tanks transformer, DGA only
T3SP-G9INT3	3 single-phase tanks transformer, DGA & 1 bushing each tank
T3SP-G9INT6	3 single-phase tanks transformer, DGA & 2 bushings each tank
T3SP-G9INT9	3 single-phase tanks transformer, DGA & 3 bushings each tank
T3MA-G9	3 Transformers, DGA only
T3MA-G9INT9	3 Transformers, DGA & 3 bushings each transformer

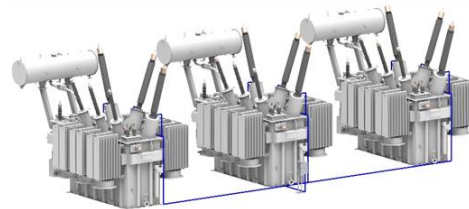


T1-G9INT3
T1-G9INT6
T1-G9INT9



T2-G9INT6

T3SP-G9INT3
T3SP-G9INT6
T3SP-G9INT9



T3MA-G9INT9

Fig. 1: Product Configurations – Installation examples

Proper choice of the product configuration is a fundamental prerequisite for the technical application onsite. Based on the Product code desired, the enclosure will be provided with all the required internal components.

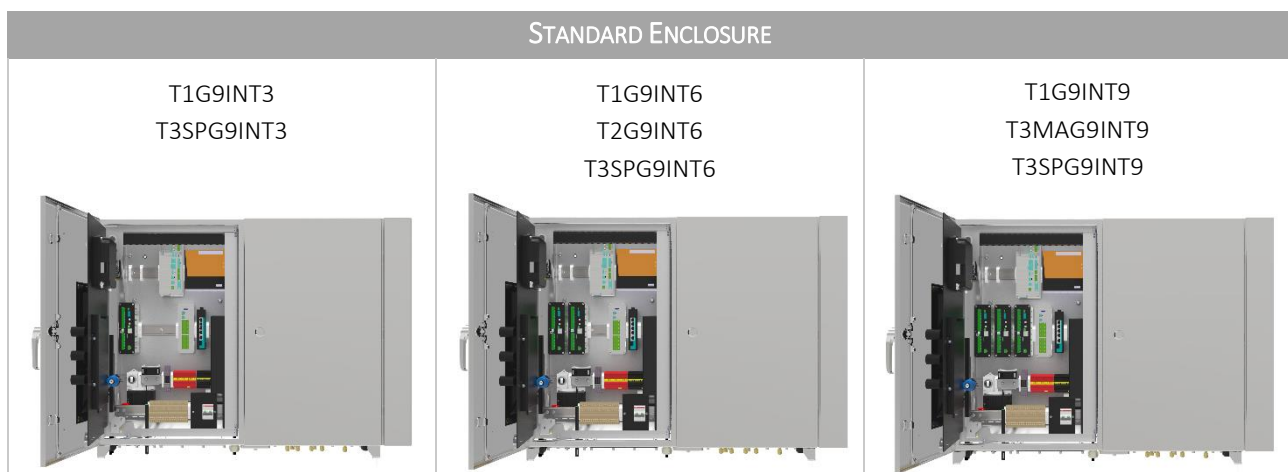
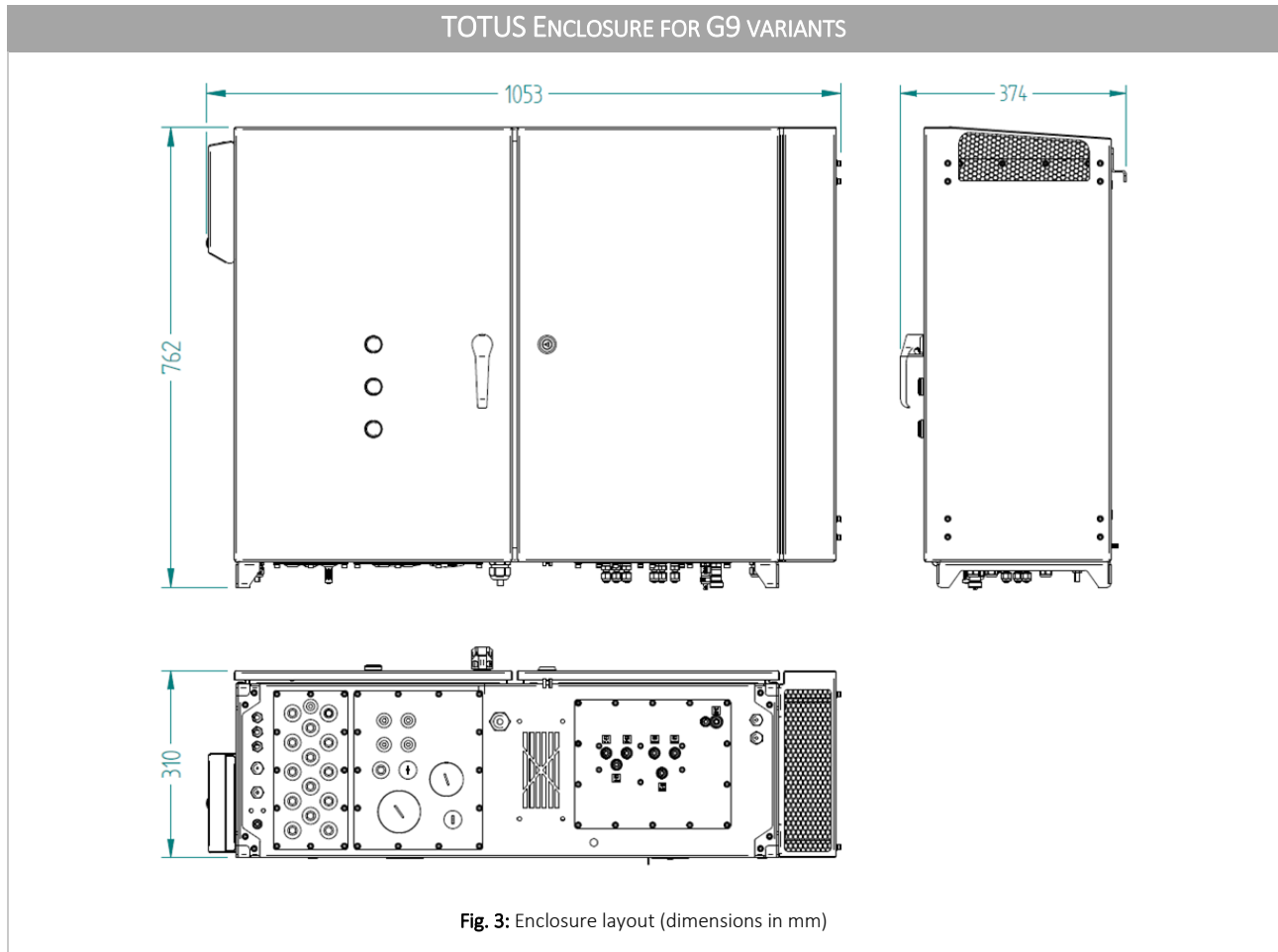


Fig. 2: Example of product configurations - enclosure internal arrangement

MECHANICAL DETAILS

TOTUS G9 is provided by default with an enclosure and a dedicated mounting frame in order to enable for a flexible and quick installation minimizing the time required to install and facilitating the fixing operations.



TOTUS G9 has been designed to avoid introduction of any gas bubble into the oil that is returned to the Transformer after the DGA measurement has been performed. An additional security is provided by the intelligent Bubble Trap which capture any bubbles before the oil returns to the Transformer.

NOTE: for **TOTUS G9** analyzer, the bubble trap is installed within the cabinet when provided for a three-phase transformer monitoring. Only in case of multi-tank option (single-phase transformers or multiple assets), the intelligent bubble trap is provided as an external component as reported in Fig. 4.

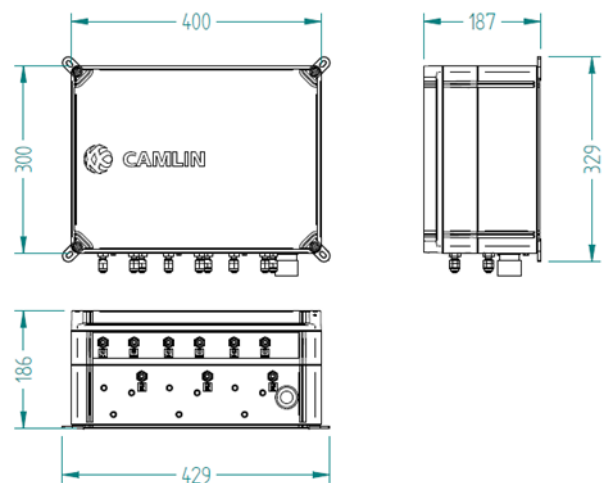


Fig. 4: External Bubble trap layout (dimensions in mm)

A dedicated mounting frame is provided by default on any **TOTUS G9** in order to facilitate the installation procedure.

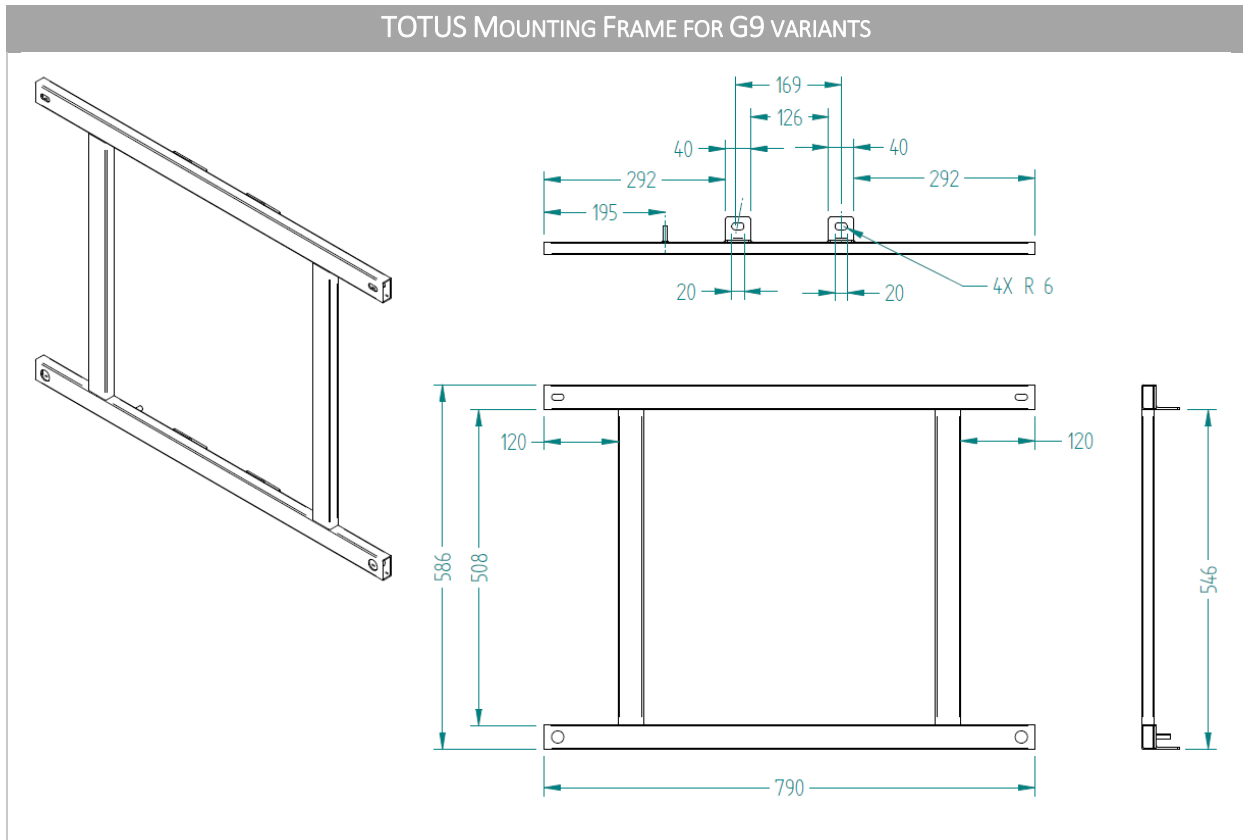


Fig. 5: TOTUS mounting frame layout for G9 analyzer (dimensions in mm)

During the installation stage the mounting frame helps lift and temporarily position the enclosure which minimizes the time, material and personnel required onsite.

For further details please refer to the installation manual.

The standardization of the fixing points with all CAMLIN transformer monitoring systems enables for any system to be installed using the same mechanical specifications. This helps both the OEM and Utilities during the preparation and installation requirements of their projects.

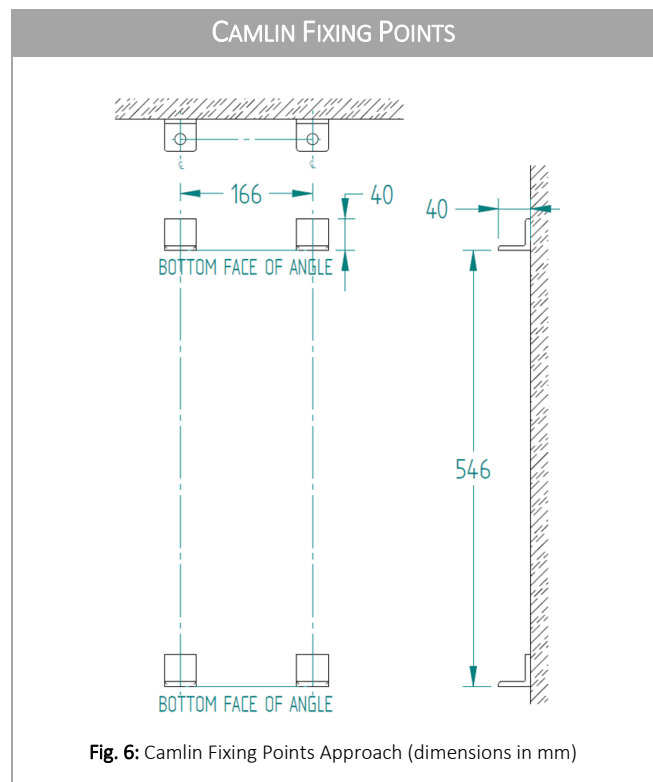


Fig. 6: Camlin Fixing Points Approach (dimensions in mm)

MOUNTING OPTIONS

TOTUS G9 is suitable for 3 different mounting methods:

- 1) Stand Mounted
- 2) Wall Mounted
- 3) Transformer Mounted

Detail "a" on the mounting stand is used to enable the external bubble trap assembly in case multiple tanks must be monitored.

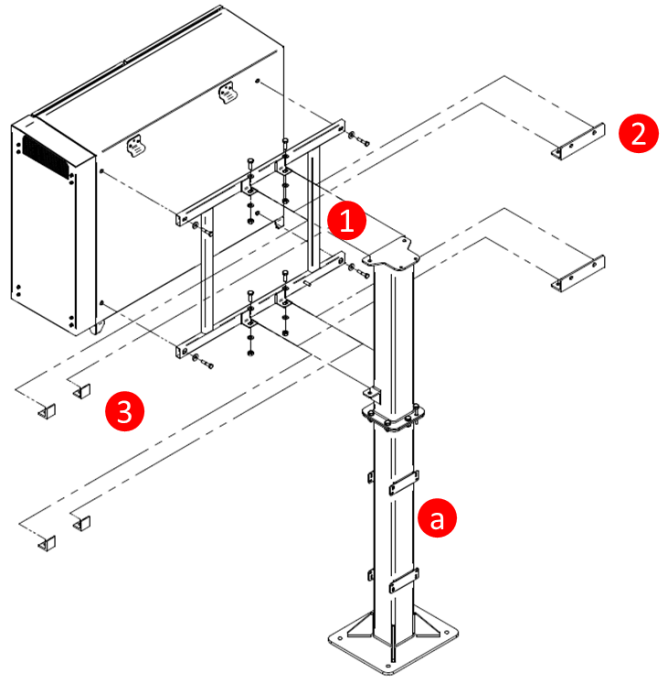


Fig. 7: Mounting Options overview

STAND MOUNTED

TOTUS G9 mounting stand is purchased separately. The stand is provided fully equipped with all necessary items required for installation.

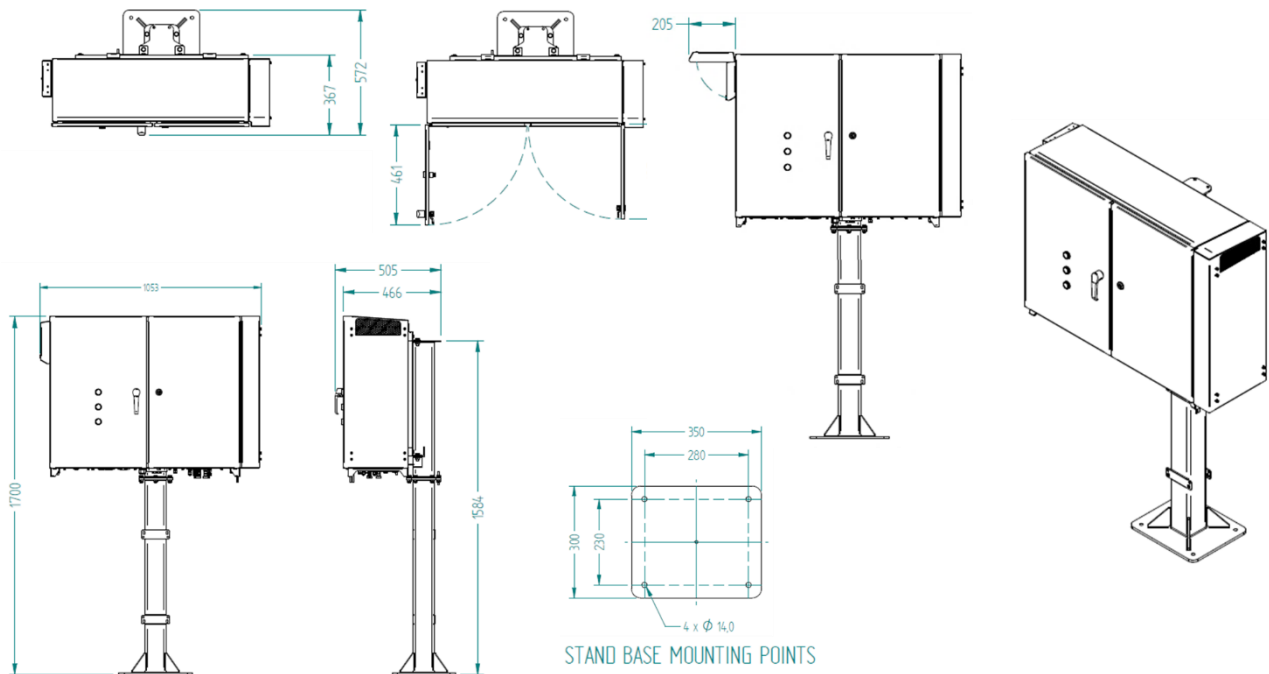


Fig. 8: Stand Mounted layout (dimensions in mm)

In case of multiple oil lines, the intelligent bubble trap will be mounted as an external component, on the mounting stand, in correspondence of its specific supports beneath the unit enclosure.

WALL MOUNTED

TOTUS G9 wall mount is purchased separately. The wall mounted dimensions and layout are shown in Fig. 9 and it comes equipped with all necessary items to be properly installed.

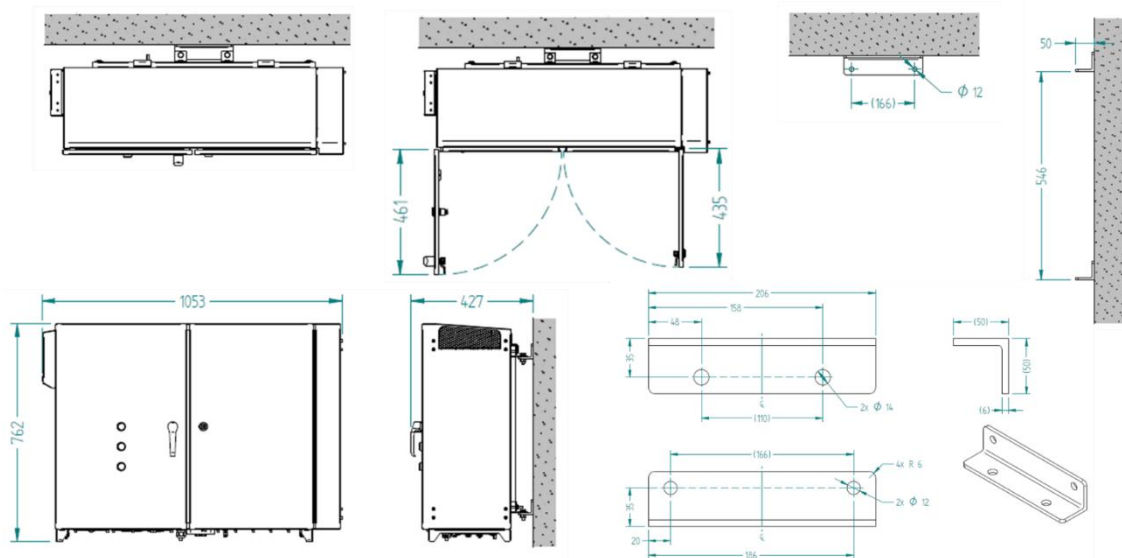


Fig. 9: Wall mounted layout (dimensions in mm)

In case of multiple oil lines, the intelligent bubble trap will be mounted as an external component. In order to arrange for a proper bubble trap positioning, Fig. 10 report three suggested options with relevant distances from the Camlin fixing points.

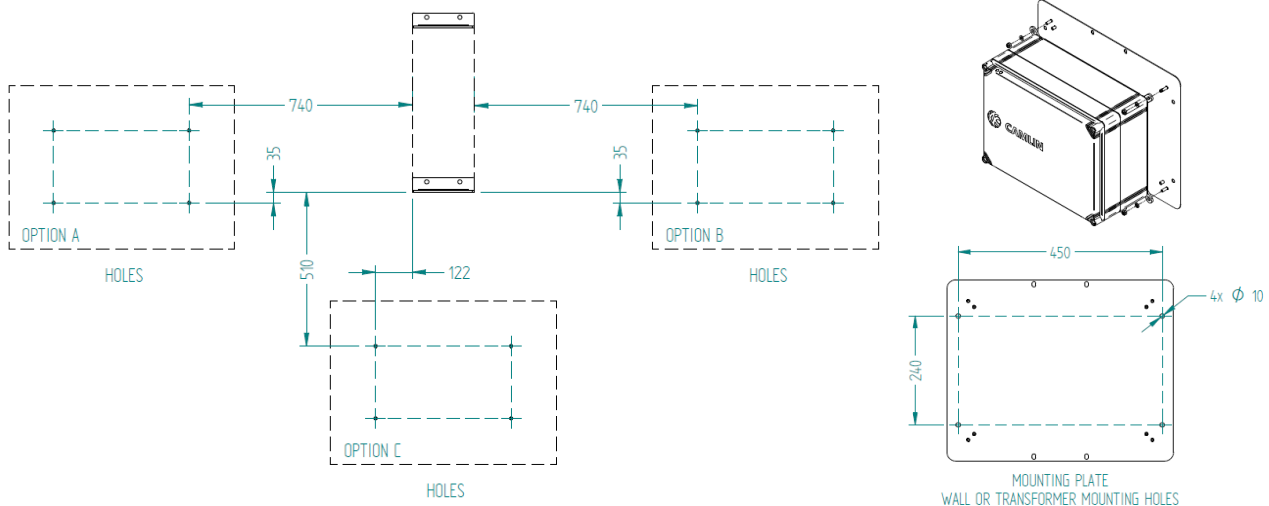


Fig. 10: External bubble trap fixing points, recommended positions and quotes (in mm)

TRANSFORMER MOUNTED

In order to arrange for Transformer mounted approach, Main unit enclosure fixing points must be arranged as per Fig. 6 specification. Angled supports can be used as shown in Fig. 11.

It is recommended to consult Camlin Power's Technical Support Team to verify the transformer mount arrangement in order to ensure a smooth and successful installation.

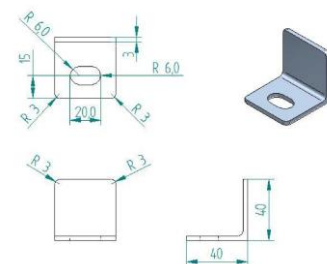


Fig. 11: Angled support/fixing points (in mm)

STANDARD SYSTEM COMPONENTS OVERVIEW

TOTUS G9 system is composed of 9 key elements when fully equipped:

- Oil System
- Bushing Adaptor
- Offline Tool
- Twin-axial Signal Cable
- Load Current Sensor
- Ambient T. & H. sensors
- Oil Temp. sensor
- GSM & GP antenna
- Customer Terminal Block

Each component will be described in the below paragraphs.

OIL SYSTEM

TOTUS G9 will take a fresh sample of oil from the Transformer during each measurement cycle by first circulating the oil for ~10 minutes and then extracting a representative main tank oil sample. The key gases are then extracted from the oil sample and measured. Once the gas measurement is performed, the oil sample is returned back to the Transformer tank. The main components of the oil system are:

- Oil supply valve
- Manual oil sample port
- Oil return valve
- Tubing/Pipes
- In-Line Oil Filters
- Oil Fittings and connections

To gain the most representative DGA results it is important the oil supply valve on the Transformer is located at a point in the tank with good internal oil circulation: a valve on a cooling radiator that is not active will supply 'stagnant' oil that is not representative of the conditions inside the Transformer main tank.

During the measurement process, TOTUS G9 will de-gas the oil sample before returning it to the Transformer Tank through the intelligent bubble trap. In order to maintain a high quality of the measurement it is important to ensure a separation of at least 25cm (10") between the supply and the return valves.

Some older Transformers may have only 2 drain valves on the tank. For this reason, the TOTUS G9 is provided with a **manual oil sample** port so that an oil sample may still be drawn using a glass syringe for laboratory analysis.

TOTUS G9 is supplied with an installation hardware kit that contains all the necessary 1/4" fittings to assemble and install a bleed port at the **oil return valve** on the transformer tank.

During the project installation planning, the materials used for the oil system and tubing needs to be selected considering the following aspects:

- **Rigid tubing** normally costs less than braided hoses but requires significantly more labor during the installation process to bend and fit the piping in place. Overall cost is higher than using SS Braided hoses.
- **SS braided hoses** whilst more expensive than rigid tubing requires significantly less labor and is safer to work with in a high voltage environment. Overall cost is lower than using Rigid tubing.



Fig. 12: Oil line installation kit

NOTE: If TOTUS G9 is going to be installed in an area that is prone to seismic activity, then braided hoses is highly recommended as it provides flexibility and movement.

BUBBLE TRAP

The Bubble Trap module is embedded within **TOTUS G9** on the oil return line to the Transformer. During the commissioning process, all air is removed from the Bubble Trap by bleeding the oil loop under vacuum.

In the unlikely event bubbles may appear within the Oil loop, they will accumulate at the top of the reservoir within the bubble trap and force the oil level downwards. The system continuously checks the oil level within the Bubble Trap. If the level reaches a predetermined level the unit will shut off the DGA sampling function to prevent air from entering the transformer and will trigger an alarm through the Web User Interface.

In case of multiple oil lines, the intelligent bubble trap is mounted as an external component.

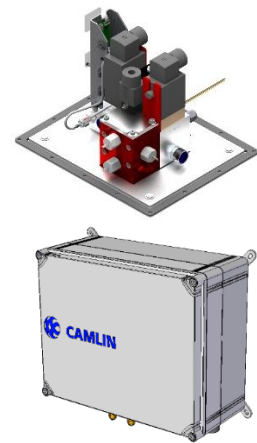


Fig. 13: Bubble trap layout; internal (top), external (bottom)

2/2 OIL VALVE



Fig. 14: 2/2 Oil valve

2/2 oil valve reference number from Burkert.com 134244 or contact Camlin requesting part VAL00024 which will come supplied with the connecting cable and fitting as a replacement.

- Direct-acting and compact valve up to diameter of DN6.0
- Vibration-proof, bolted coil system
- Increased leak-tightness with welded plunger
- Guiding tube
- Energy-saving

TUBING / PIPES

Tubing / Pipes for the **TOTUS G9** system can be found in 2 possible variances:

- HHT Flexible Braided Hose
- Rigid Stainless-Steel Hose

The HHT Flexible Braided Hose is the ideal solution for oil piping connections. It makes mounting and installation of oil lines easier, more economical and safer. It also facilitates more efficient connecting, disconnecting and cleaning as needed of the oil tubing.



Fig. 15: HHT Flexible Braided Hose.

Variable length, high flexibility, high pressure and broad chemical compatibility makes this hose suitable for any application. The reference number from Ham-let.com is THT-04-TS1/4-TS1/4-6M.

The Rigid Stainless Steel ¼" 0.035" wall thickness, seamless tube, is used where flexible hose is not permitted. Its seamless form and robust nature combined with its reliability make it a commonly requested secondary form for transferring oil between the asset(s) and the **TOTUS G9**.



Fig. 16: Rigid Stainless-steel hose.

3m & 6m lengths are provided and are then cut and shaped on site. High Pressure and chemical compatibility make this tubing a suitable selection for any application. The reference number from Swagelok.com 316L-SS-T4-S-035-20

IN-LINE OIL FILTERS



Fig. 17: In-line Oil Filters

In-line oil filters should be assessed annually. At which point can be replaced or re-installed. This ensures supply of oil to the unit is purged of debris and smooth oil flow is maintained. If a partial or full blockage occurs, it will trigger a low-pressure oil alarm through the Web User Interface.

In-line Oil filters are supplied direct from Camlin – Please quote part number FIL 00005 for replacements. Stainless Steel In-Line Particulate Filter, 1/4 in. Swagelok Tube Fitting, 40 Micron Pore Size

OIL FITTINGS AND CONNECTIONS

Fittings and connections used for the installation of the oil lines for the **TOTUS G9** are listed in the table below. In case a replacement is required, please quote the ICAPS reference number below detailed in the first column.

	ICAPS	DESCRIPTION	SWAGELOK P/N	HAMLET P/N	QTY
	MEC 00147	S/S HEX NIPPLE ¼ MNPT	SS-4-HN	122H-SS-1/4	1
	MEC 00759	S/S MALE ELBOW ¼ MNPT	SS-4-ME	100HM-SS-1/4	1
	MEC 00760	S/S VALVE ¼ FNPT	SS-43GF4	H810M-SS-N-1/4	2
	MEC 00761	S/S MALE CONN. ¼ COMP. X ¼MNPT	SS-400-1-4	768L-SS-1/4X1/4	3
	MEC 00145	S/S BALL VALVE ¼ COMP	SS-4P4T-BK	H800S-SS-L-1/4	1
	MEC 00763	S/S CHECK VALVE ¼ MNPT	SS-4CP2-1/3	H480OP-SS-N-1/4-1/3	1
	MEC 00764	S/S STREET TEE ¼	SS-4-ST	3750H-SS-1/4	1
	MEC 00143	S/S STREET ELBOW ¼	SS-4-SE	116H-SS-1/4	1
	MEC 00765	S/S PLUG ¼	SS-400-P	7121L-SS-1/4	1
	MEC 00140	S/S UNION ¼	SS-400-6	762L-SS-1/4	2
	MEC 01118	S/S P CLIPS	SS-TBP6	BSS100	20
	MEC 00800	S/S Nut	SS-400-NFSET (Comes as Set)	761LSS1/4	2
	MEC00801	S/S Back Ferrule		760LBSS1/4	2
	MEC 00802	S/S Front Ferrule		760LFSS1/4	2

BUSHING ADAPTORS

Bushing Adaptors are composed by 3 elements:

1. Connector;
2. Body;
3. Head.

The Bushing Adaptor, designed for IP67 applications, can be used for both Bushing Monitoring and Partial Discharge detection.

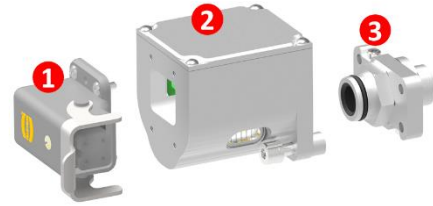


Fig. 18: Bushing Adaptor overview.

It is provided with protection circuitry to ensure the voltage is maintained at a safe level if there is an open circuit condition due to the cable being disconnected. Additional 90V spark gaps (GDT) are included at the output of the coupler to protect against over-voltages.

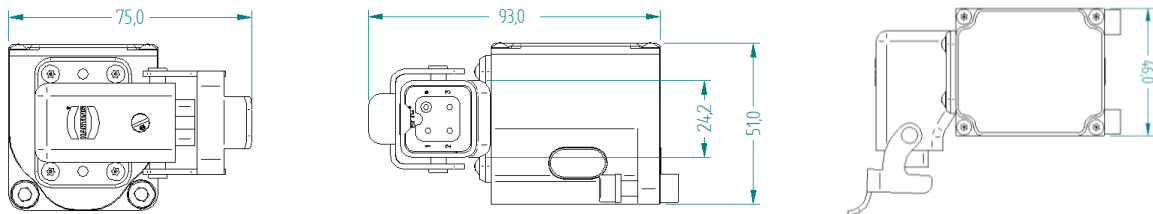


Fig. 19: Bushing Adaptor mechanical details (dimensions in mm)

OFF-LINE TEST TOOL

The purpose of the off-Line Test tool is to allow users to perform conventional Off-Line PF testing with the Camlin Bushing Adaptor head cap.

Thanks to the unique design of Camlin Tap adaptors this purpose can be easily achieved by removing the body only. The head of the Tap adaptor can be left in place protecting the Bushing test tap threads from accidental cross threading damage.

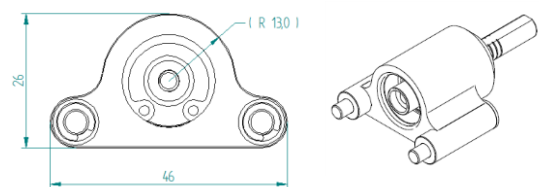


Fig. 20: Offline Test tool mechanical details (dimensions in mm)

“Offline Test Unit” kit is composed of 4 items:

1. Offline Test Tool (preassembled with proper Shaft Extension)
2. In case 6 bushing are being monitored, Offline Test Tool Secondary (preassembled with proper Shaft Extension)
3. Spare o-rings, silicone grease, conductive paste, 4mm ¼” hex bit
4. Torque driver is located on clip inside left hand side door

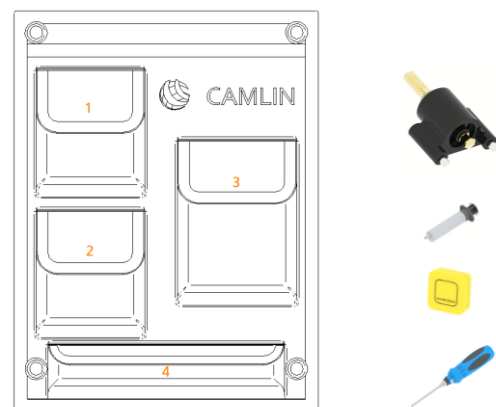


Fig. 21: Offline Test Kit

For further instruction please refer to document: 40-0172-01 within the enclosure door panel.

TWIN AXIAL SIGNAL CABLE

The connection from the Bushing Adaptors to the Acquisition Box is made using armored twin axial signal cables which comply with the “Belden 9463 LS” technical specification.



Fig. 22: Twin axial Cable layout

Typical cable used is Belcom, Data Guard SWA Industrial Twinax Blue 78 Ohm. The technical specifications are:

CONDUCTOR:	AWG20 (7xAWG28) tinned Cu	SHEATH	
INSULATION:		Material:	FRNC
Material:	Polyethylene	Colour:	Blue (like RAL 5012)
Diameter over insulation:	1.96 ± 0.05 mm	Nominal thickness:	0.89 mm
Colour of insulation:	Clear and blue	Nominal diameter:	6.35 mm
FILLER (2x):		ARMORING	
Material Solid:	Polyethylene	Material:	single steel wire 0.90 mm
Diameter:	1.32 mm	Optical coverage:	>95 %
Colour:	Clear Foil (Z-fold®)	SHEATH	
Material:	Aluminum / Polyester	Material:	FRNC (UV stabilized)
Thickness:	9/23 µm	Colour:	Blue (like RAL 5012)
DRAIN WIRE	AWG20 (7xAWG28) tinned Cu	Nominal thickness:	1.30 mm
BRAIDING		Nominal diameter:	10.75 mm
Material:	0.122 mm tinned Cu	FLAME RESISTANCE:	IEC 60332-3C
Coverage:	55%	OIL RESISTANCE:	GOOD (ASTMD471)
Radiation resistance:	IEC544 (CERN)	HALOGEN CONTENT ACCORDING TO IEC754-1:	ZERO

For additional details please refer to the original manufacturer specification: BELDEN, “Technical Data Sheet, 9463LS_v8, 2007-02-12”

Installation Remarks: There is no requirement for additional conduits or pipelines as the cable is already armoured.

LOAD CURRENT SENSOR

Split-core sensors are ideal for installation on existing electrical wiring by clamping around the conductor. The Load Current Sensor has a self-locking mechanism.



Fig. 23: Load CS (1).

Main Characteristics:

- Rated input up to 5A of secondary CT current;
- Output of 0.333V at rated Current;
- Linearity accuracy $\pm 1\%$;
- Accuracy at 10% to 130% of rated current
- 8 ft. twisted-pair lead, 22 AWG
- UL Standard 61010-1, EN 60044-1

Alternatively, a 4-20mA load current sensor can be provided based on the product variant to be supplied.

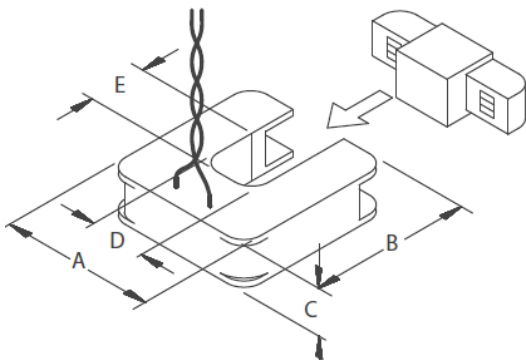
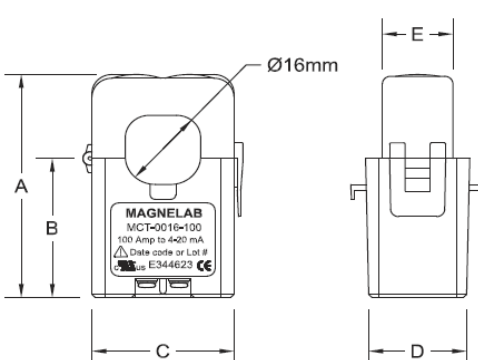


Fig. 24: Load CS (2).

Main Characteristics:

- Rated input up to 5A of secondary CT current;
- Output of 4-20mA DC;
- Accuracy $\pm 2\%$ FS, Ripple within 2% of the output voltage
- 8 ft. twisted-pair lead, 22 AWG
- 24Vdc Loop power 20-30 Vdc (25mA Max)
- UL Recognized 61010-1, CE and RoHS compliant

Mechanical details and dimensions as follow:

LOAD CS MECHANICAL DETAILS					
					
DIMENSION	INCH	MM	DIMENSION	INCH	MM
A	2.000	50.80	A	2.22	56.00
B	2.100	53.34	B	1.44	36.60
C	0.610	15.49	C	1.19	30.00
D	0.750	19.05	D	1.24	31.00
E	0.750	19.05	E	0.76	19.00
Fig. 25: Load CS (1) mechanical details			Fig. 26: Load CS (2) mechanical details		

AMBIENT TEMPERATURE AND HUMIDITY SENSOR

EE061 probes are the ideal solution for cost-effective, highly accurate and reliable measurement of relative humidity and temperature. The analogue humidity output provides a current signal with 4-20mA while a passive temperature output signal is available.



Fig. 27: Ambient T. & RH sensor.

Main Characteristics:

- Housing IP65
- Output: resistive, PR100 4 wire.
- Working Range: 0...100% RH; -40 ...+60 °C
- Analogue output: 0...100% RH 4...20mA (two wire) RL<5000hm;
- Accuracy at 20°C (68°F), 12V DC: ±3% RH (10...90% RH), ±5% RH (<10% RH and >90% RH);

OIL TEMPERATURE SENSOR

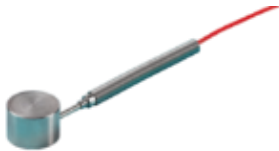


Fig. 28: Pt100, Oil temperature sensor.

Main characteristics:

- Surface Temperature measurement of ferrous materials;
- Pt100 IEC 60751 Class B: 2008;
- Operating range: -10°C to +100°C;
- Magnet strength: 6Kg;
- Magnet Dimensions: 25mm dia. X 13.5mm thick.
- supplied with 20mtrs of PVC insulated leads

GSM ANTENNA



Fig. 29: GSM Antenna

Main characteristics:

- Penta band (Quad band GSM / GPRS and 3G 2100MHz)
- High gain
- Improved signal quality with provided low loss cable
- RoHS compliant
- Camlin Reference Number ANT00022, from siretta.co.uk. OSCAR1A/5M/SMAM/S/S/31

GPS ANTENNA



Fig. 30: GPS antenna

Main characteristics:

- Penta band (Quad band GSM / GPRS and 3G 2100MHz)
- Can be mounted securely inside or outside,
- IP65 rating
- footprint of 46mm diameter, height of 14.5mm
- Camlin Reference Number ANT00030, from siretta.co.uk TANGO20/3M/SMAM/S/S/26

CUSTOMER TERMINAL BLOCK

Customer terminal block represent the interface between Camlin system and customer external connections. A DIN rail terminal block is provided to allow for future Camlin I/O and monitoring features to be added to correlate additional transformer related inputs and values. Customer terminal block is composed of:

- Inputs: designed for reading external signals
- Outputs: designed to send signals to external systems

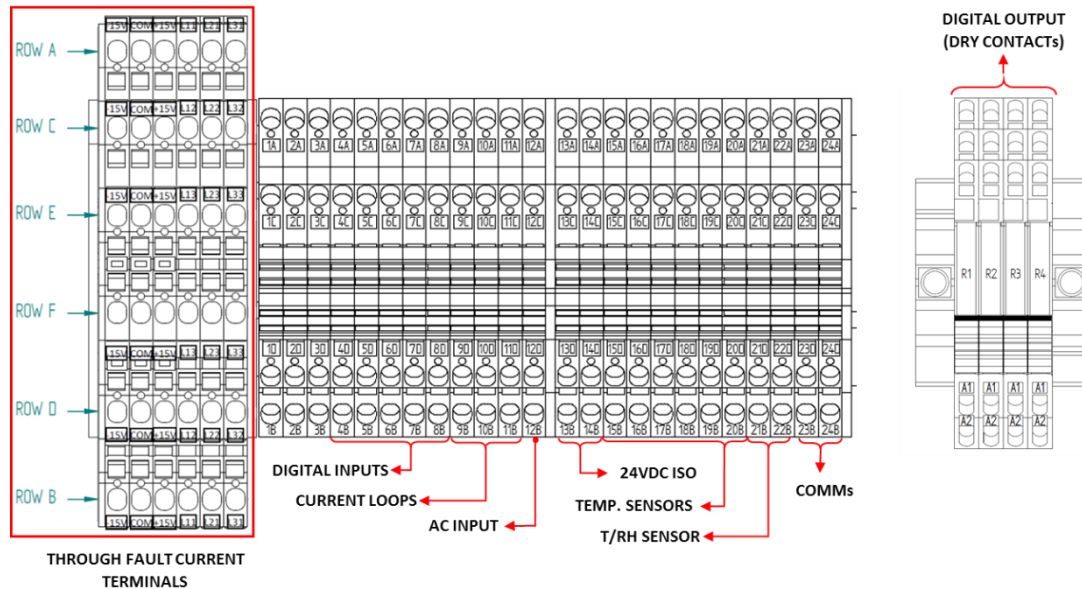


Fig. 31: Customer Terminal Block Layout

1. **Through Fault Current (optional):** Used to plug the TFC signal cable and enable the Through Fault Current Monitoring add-on. It is composed by 4 main functional components (from left to right): DC/DC Converter ± 15 V, Earthing Terminal, Power Terminals, Signal Terminals.
2. **COMMs:** used for RS232 or RS485 signal cable wires to enable the interface between the monitoring system and the customer network. Terminals are normally empty and wired based on the specific comm option selected.
3. **24 V Digital Inputs:** Used to receive signal/warning from customer notification systems. Fully passive and insulated each other.
4. **Current Probe:** Used by the system to collect transformer load data from the Load Current Transformer. Since this is an input, it is not able to generate any current.
5. **Current Loops:** Used to collect current signals from customer data acquisition systems. Typically, 4-20 mA signals. Fully passive inputs insulated each other.
6. **24 Vdc:** Used to provide power supply to probes (if needed). Current loops generally must be fed, and these terminals enable for an easy probe power supply wiring.
7. **Temperature sensors:** Used by the system to collect temperature data from probes. 3 different temperatures can be collected.

Note: In order to cover most of the probes available on the market a 4-wires configuration is provided in the terminal block. In order to ensure safety, temperature terminals can emit maximum 1 mA with maximum 5 VDC.

8. **Digital Output:** Used to provide alarm signals to the customer or substation warning system. Digital outputs are also passive, in fact, each of them is a NO/NC diverter switches controlled by the monitoring unit. Activation of the specific quantity will trigger the commutation of the NO/NC diverter switch. Rating of the NO/NC diverter switch is 6A @ 250V. One of the digital outputs is used for power cut alarm purposes.

OPTIONAL - THROUGH FAULT CURRENT (TFC)

Through fault current monitoring represent a diagnostic add-on for the **TOTUS G9** system. Key system components are represented by:

- Current Probes, 1 per phase
- TFC Signal Cable
- Customer Terminal Block Terminals

Each component will be described in the below paragraphs.

CURRENT PROBE



Fig. 32: TFC-Current Probe.

Split-core sensors are ideal for installation on existing electrical wiring by snapping around the conductor. The Current Probe has a self-locking mechanism.

Main Characteristics:

- Rated input up to 100Amps AC/DC;
- Power Supply ± 15 V (25mA)
- Output of ± 4 V at rated Current;
- Accuracy at 1% at rated current
- Operating temperature -20°C to 75°C
- UL recognized IEC 61010-1, CE, and RoHS Compliant

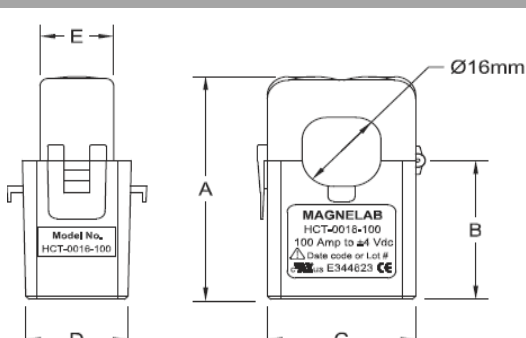
TFC CURRENT PROBE MECHANICAL DETAILS			
	DIMENSIONS	INCH	
		MM	
	A	1.82	46.0
	B	1.03	26.1
	C	1.18	30.0
	D	1.25	31.7
	E	0.76	19.3

Fig. 33: TFC Current Probes Mechanical details

Through Fault Current requires 3 current probes (1 per phase). In case of three phase transformers a single group of current probes will be provided already wired in the same connector. In case of single-phase transformer current probes will be delivered in 3 separated independent sets with 1 probe each.

Final configuration is subjected to the final site arrangement.

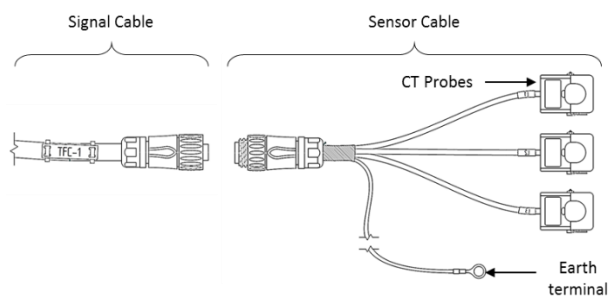


Fig. 34: TFC current probe for Three phase transformers

TFC SIGNAL CABLE

The connection from the current probe to the Acquisition Box is made using an armoured signal cable. The cable is designed to be run by itself without the need for conduit.



Fig. 35: TFC Signal cable

LIICY is a shielded, multiconductor signal and control cable recommended for use Utility substation environments and in European designed computer, data transmission and office equipment, process control and instrumentation, where additional EMI protection is required.

CABLE STRUCTURE:

Core Material:	Copper conductor,
Conductor Size:	0,5mm ²
Insulation	Special PVC compound type T12 to
Material	DIN VDE 0207-363-3 / DIN EN 50363—3
Colour code	Identification adapted to DIN 47100, without colour repetition
Layout	Core stranded in Layers with optimal lay length

SHIELD:

Material	Tinned copper with braid
Coverage	85% approx..

INNER JACKET:

material	Special PVC compound type TM2 to DIN VDE 0207-363-4-1 / DIN EN 50363—4-1
Colour	Grey (RAL7001)
Diameter	6.8 mm approx

ARMOURING:

Material	Steel Wire Armour (SWA)
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OUTER JACKET:

material	PVC
Colour	Black
Diameter	10.6 mm approx

ENVIRONMENTAL CHARACTERISTICS:

Temperature range (static)	-30°C up to +70°C
Temperature range (flexing)	-5°C up to +70°C
Peak operating voltage	Max 500 V
Testing voltage	1200 V

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