

# DP Sensors

# SUMMARY

- Techimp approach to PDA
- Sensors:
  - Capacitive couplers
  - High Frequency Current Transformers
  - TEV sensor
  - TEM antenna
  - HORN antenna
  - UHF antennas
  - Tap adapters

# TECHIMP APPROACH TO PDA

Techimp PD instruments are characterized by:

- Ultra Wide Band (UWB) frequency bandwidth. The range 15 kHz ÷ 30MHz is aimed at:
  - maximizing the frequency content of the detected signals;
  - having a better wave shape characterization;
  - having a thorough evaluation of the detected signals;
  - complying with IEC 60270 (when required);
- Waveforms digital sampling. The onboard high speed A/D is aimed at:
  - acquiring the full signals (no peak detection);
  - performing elaboration on complete signals;
  - exploiting a huge amount of information for a better evaluation;
- On-board elaboration of the waveforms. The high speed hardware elaboration of the detected signals allows:
  - processing a large amount of data;
  - reducing the transmitted and stored data;
  - having no losses of important information along the process.

# TECHIMP APPROACH TO PDA

- Time-Frequency mapping. It allows:
  - describing the wave shape of signals through two numbers (Equivalent Timelength and Equivalent Frequency) only;
  - having similar signals (i.e. coming from the same or similar sources) characterized by similar T-F map location (clusterization);
  - processing directly on the fly the information through hardware;
- Noise rejection. The on-line T-F map approach allows:
  - characterizing the noise sources in terms of Equivalent Timelength and Equivalent Frequency;
  - discarding the noise signals on the fly (VS gating);
  - smart filtering (no additional hardware required);
- Separation of different phenomena. It allows:
  - tracking of each single phenomenon (monitoring);
  - analyzing the time behavior of each phenomenon separately;
  - identifying each of them univocally.

# TECHIMP APPROACH TO PDA

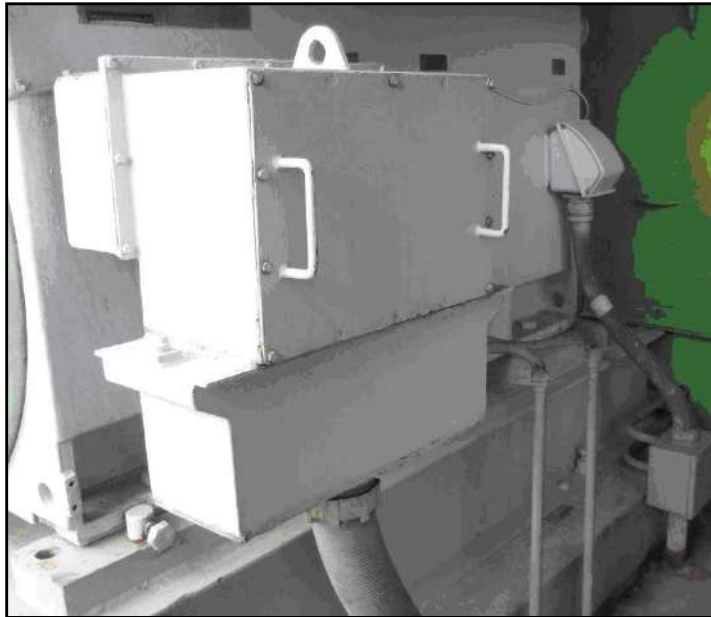
- Wide range synchronization channels. The wide frequency bandwidth of the synchronization channels (0.1 Hz ÷ few kHz) allows:
  - having a wide range of PD applications, from VLF to repetitive impulse testing with the same hardware;
  - having a deeper analysis on the stress voltage.
- Standard TCP/IP communication protocol. The standard proprietary protocol allows:
  - connecting the device to a standard Intranet/Ethernet network;
  - connecting to the device remotely from anywhere;
- Investigation in the UHF range. The unique technology by Techimp allows:
  - using UHF sensors when required (GIS, VSD);
  - shifting down the UHF bandwidth of the sensors to meet the PD device bandwidth;
  - avoiding losing information about the wave shapes (and thus still exploiting the T-F map approach).

# CAPACITIVE COUPLERS



# CAPACITIVE COUPLERS

## 7.2 kV couplers (MOTORS)



### TCL7.2 SPECIFICATIONS

Capacitance	940pF $\pm$ 10%
Capacitor type	Ceramic
Body material	Epoxy resin
Coating varnish	Epoxy resin
High voltage frequency range	50 ÷ 60 Hz
Rated Voltage (phase-to-phase)	7.2kV <sub>rms</sub>
AC voltage withstand	28kV <sub>rms</sub> (equivalent to class 12kV)
DC voltage withstand	75kV <sub>peak</sub> (equivalent to class 12kV)
Lightning pulse withstand	75kV <sub>peak</sub>
Creepage distance (IEC60815)	140mm (medium level pollution)
Tan $\delta$	<0.3%
PD level @ 7.6kV / 50Hz	<2pC
Operative temperature range	-20 ÷ +90°C
Vibration withstand	5G or 6mm <sub>pp</sub> (whatever is greater) from 5Hz to 500Hz
High voltage connection	M4 female thread
Overall Dimensions	Height 95mm; Diameter 80mm (without base)
Weight	1.0kg (without base)
Connector	BNC





# CAPACITIVE COUPLERS

## 12 kV couplers (SMALL GENERATORS & MOTORS)



### TCL12 SPECIFICATIONS

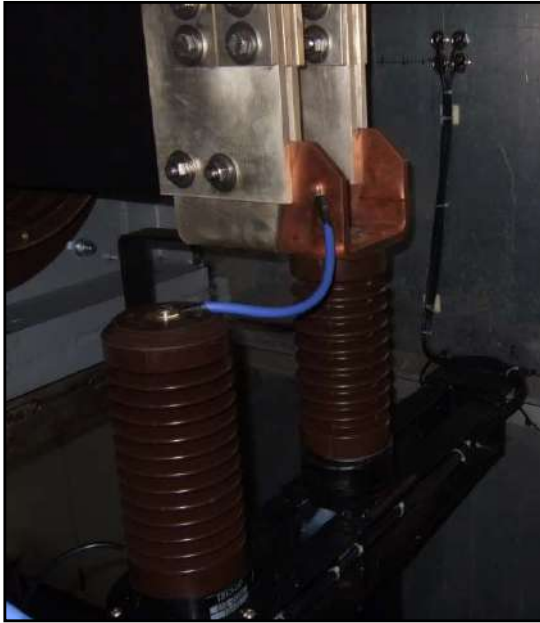
Capacitance	940pF ±10%
Capacitor type	Ceramic
Body material	Epoxy resin
Coating varnish	Epoxy resin
High voltage frequency range	50 ÷ 60 Hz
Rated Voltage (phase-to-phase)	12kV <sub>rms</sub>
AC voltage withstand	28kV <sub>rms</sub>
DC voltage withstand	75kV <sub>peak</sub>
Lightning pulse withstand	75kV <sub>peak</sub>
Creepage distance (IEC60815)	280mm (medium level pollution)
Tan δ	<0.3%
PD level @7.6kV / 50Hz	<2pC
Operative temperature range	-20 ÷ +90°C
Vibration withstand	5G or 6mm <sub>pp</sub> (whatever is greater) from 5Hz to 500Hz
Moisture resistance	MIL-STD-202G / Method 106G
Salt atmosphere resistance	MIL-STD-202G / Method 101E
High voltage connection	M8 female thread
Overall Dimensions	Height 160mm; Diameter 146mm
Weight	2.0kg
Connector	BNC





# CAPACITIVE COUPLERS

## 24 kV couplers (MID&LARGE GENERATORS)



### TCL24 SPECIFICATIONS

Capacitance	470pF ±10%
Capacitor type	Ceramic
Body material	Epoxy resin
Coating varnish	Epoxy resin
High voltage frequency range	50 ÷ 60 Hz
Rated Voltage (phase-to-phase)	24kVrms
AC voltage withstand	50kVrms
DC voltage withstand	125kVpeak
Lightning pulse withstand	125kVpeak
Creepage distance (IEC60815)	520mm (medium level pollution)
Tan δ	<0.3%
PD level @15.2kV / 50Hz	<2pC
Operative temperature range	-20 ÷ +90°C
Vibration withstand	5G or 6mm <sub>pp</sub> (whatever is greater) from 5Hz to 500Hz
Moisture resistance	MIL-STD-202G / Method 106G
Salt atmosphere resistance	MIL-STD-202G / Method 101E
High voltage connection	M8 female thread
Overall Dimensions	Height 255mm; Diameter 145mm
Weight	3.2kg
Connector	BNC



# CAPACITIVE COUPLERS

## 36 kV couplers (LARGE GENERATORS)



### TCL36 SPECIFICATIONS

Capacitance	310pF ±10%
Capacitor type	Ceramic
Body material	Epoxy resin
Coating varnish	Epoxy resin
High voltage frequency range	50 ÷ 60 Hz
Rated Voltage (phase-to-phase)	36kVrms
AC voltage withstand	70kVrms
DC voltage withstand	170kVpeak
Lightning pulse withstand	170kVpeak
Creepage distance (IEC60815)	740mm (medium level pollution)
Tan δ	<0.3%
PD level @22.9kV / 50Hz	<2pC
Operative temperature range	-20 ÷ +90°C
Moisture resistance	MIL-STD-202G / Method 106G
Salt atmosphere resistance	MIL-STD-202G / Method 101E
High voltage connection	M8 female thread
Overall Dimensions	Height 340mm; Diameter 145mm
Weight	4.0kg
Connector	BNC



# CAPACITIVE COUPLERS

Data at a glance

Total numbers of couplers installed:	~1000
Total numbers of defective products returned:	0
Total working hours:	~20 million hours
Expected operating life:	in excess of 1 million hours
Routine tested in accordance with:	
	IEC 60358
	IEC 60270
	IEC 60694

Type tested and validated for the following performances:

- Endurance
- Temperature
- Vibration

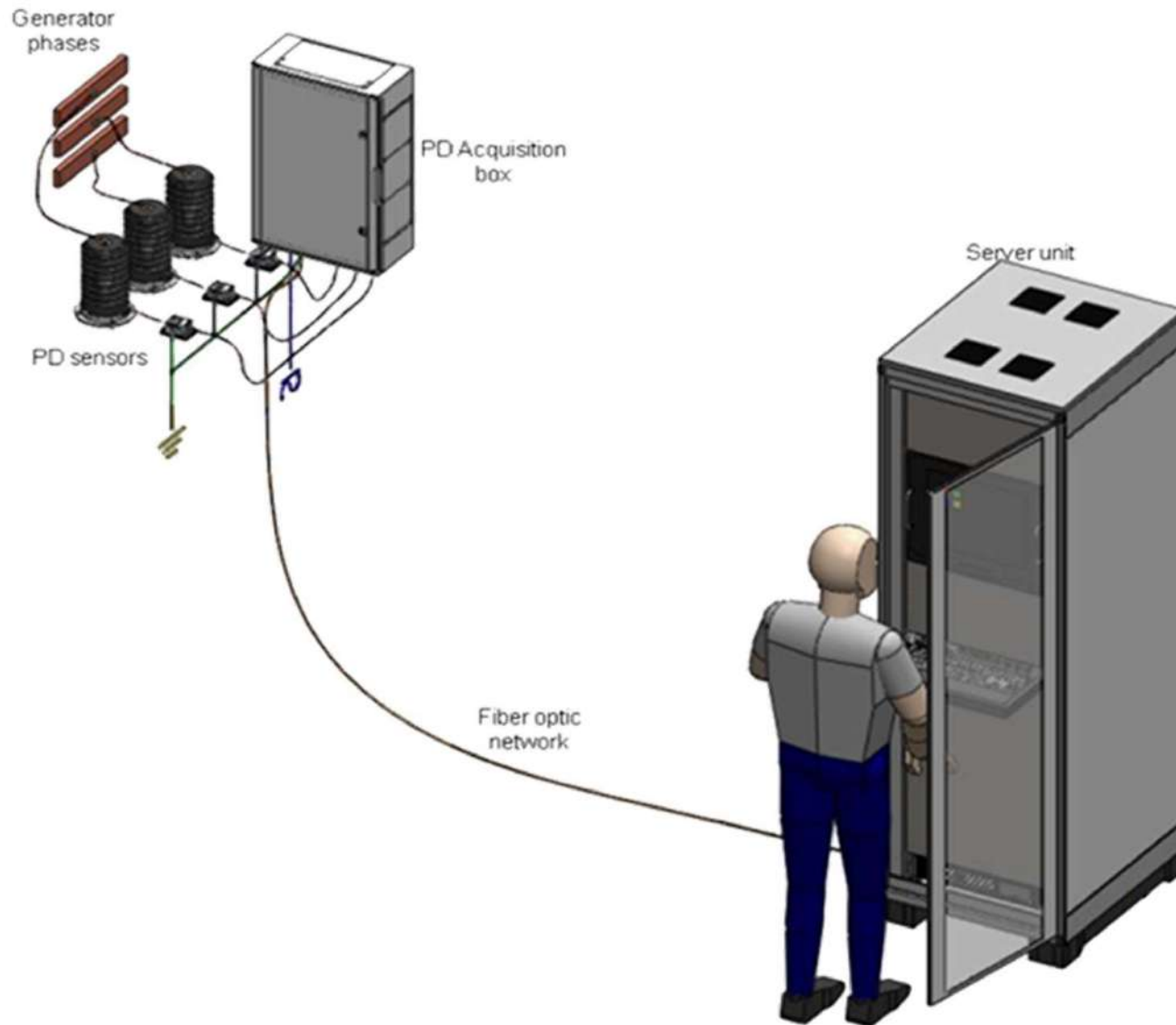
# CAPACITIVE COUPLERS

## Mica VS ceramic

- Mica capacitor is an assembly of several elementary capacitors (> 20 units) with high costs and a manufacturing process causing defects (e.g.: internal voids).
- Low tangent delta high voltage ceramic capacitors, are suitable for high-volume production processes.
- The design has overcome shock and severe long term vibration and extreme temperature test, in order to guarantee full performance over the whole life expectancy.
- TECHIMP has developed an epoxy resin die casting molding process along with mechanical and surface epoxy painting finishing. The result is a high level body and surface characteristics HV PD Coupler.
- The design has also overcome to salt atmosphere test (MIL-STD-202G) and moisture resistance test (MIL-STD-202G).

# CAPACITIVE COUPLERS

## Connection scheme





# CAPACITIVE COUPLERS

Example: Cruise ships

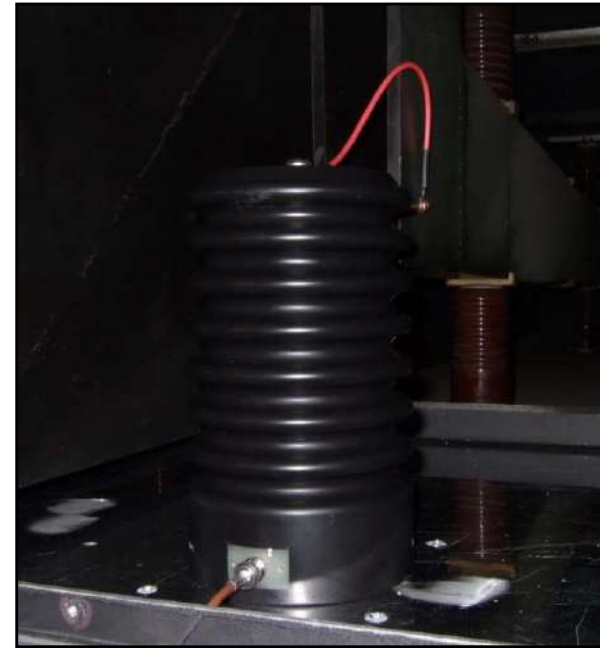
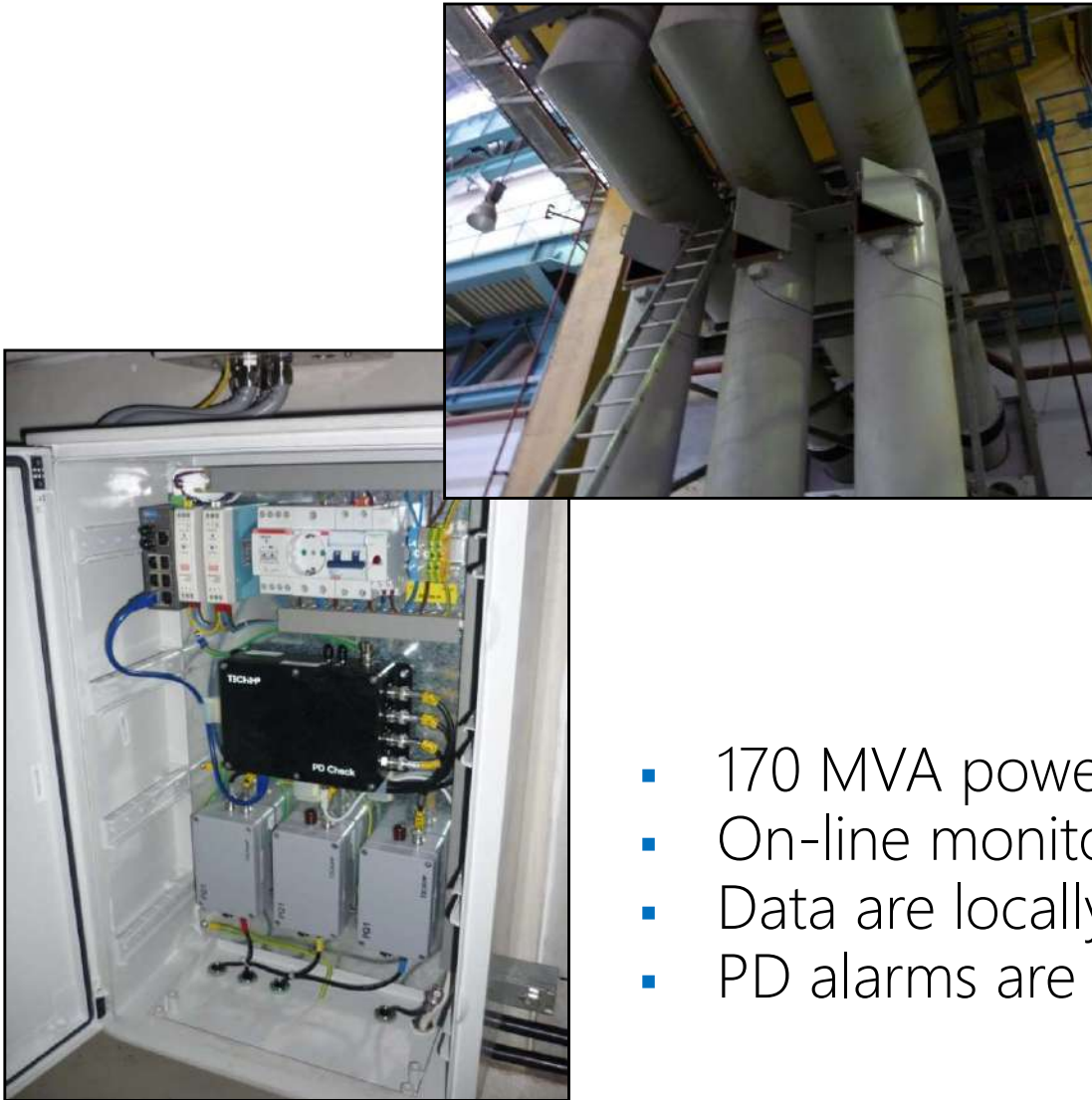


- propulsion motors on cruise ships
- Every ship has two 6 phase motors
- Central unit collects data from Acquisition box
- Data are organized in a database



# CAPACITIVE COUPLERS

Example: Power generator



- 170 MVA power generator
- On-line monitoring through Acquisition Unit
- Data are locally stored in the PDCHECK memory
- PD alarms are shown locally

# CAPACITIVE COUPLERS

Example: Hydro generator



- Hydroelectric power plant
- PD alarms
- Acquisition Unit are fed to client server through Ethernet



# HFCTS

## High Frequency Current Transformers

HFCTS have the following characteristics:

- High level of galvanic insulation from the high voltage;
- High sensitivity;
- easiness of use;
- lower cost;
- no access to high voltage required;
- passive inductive sensors for PDs;
- installed around the ground connection of the accessories;
- on/off line tests and permanent monitoring;
- terminations and sectionalized joints;
- in case of straight joints, HFCT can be applied around the ground connection outside of the link box

Various typologies of HFCTS to meet different requirements:

- HFCT 30mm
- HFCT 50mm
- HFCT clamp 39mm
- HFCT clamp 140mm

# HFCTs

High Frequency Current Transformers

HFCT 30mm



HFCT 50mm





# HFCTS

High Frequency Current Transformers

HFCT clamp 39mm



HFCT clamp 140mm



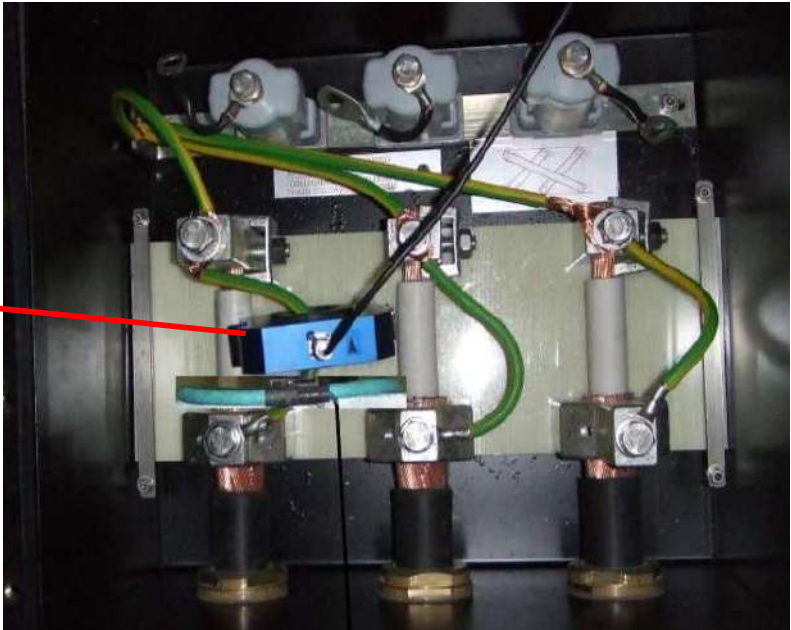
# HFCTS

HFCT installation

Termination



Joint - Link box



HFCT



# TEV

## Transient Earth Voltage

The working principle is direct Capacitive coupling with a Switchgears earthed metal case.

The two ends of TEV sensor can be coupled magnetically to virtually any opening on a metal surface.

The sensor picks up the electric signal of PD activity onto the two metallic surfaces.

Thanks to its special design it offers higher sensitivity than other single ended TEV sensors.

TEV is the optimal sensor for direct installation on medium voltage Switchgears.

Optionally amplifiers and signal conditioning devices are available by Techimp to further improve sensitivity.

# TEV

## Transient Earth Voltage

Property	Value
Bandwidth:	0.1 MHz- 300 MHz, stand alone sensor Techimp Frequency Shifter recommended (with PDCheck)
Working principle:	Capacitive coupling
Overall Dimensions:	130 x 70 x 25 mm
Weight (without the RF cable):	80 g
Connector:	BNC
Power Supply:	Only for optional devices (frequency shifter)
Installation:	Coupled to the earthed metallic case of Switchgears
Operational limits:	Env. Temp: 0-65°C; Env. RH: 0-100%



# TEM

## Transverse Electro Magnetic

TEM antenna is a partial discharge sensor designed to receive electromagnetic (EM) emissions from PD.

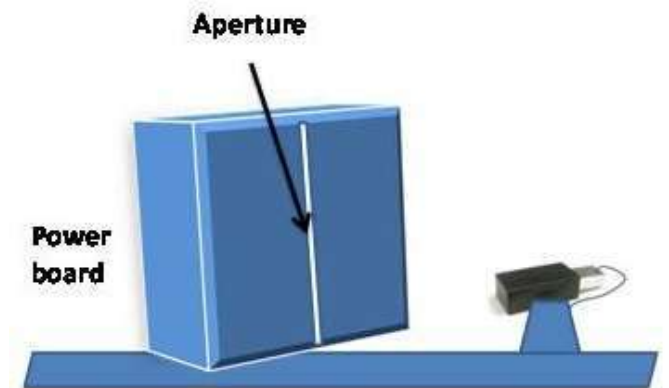
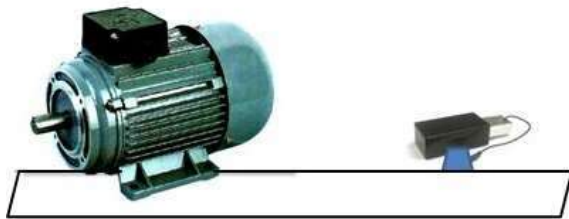
TEM is a broadband antenna suitable in a number of different applications, optimized to operate in a frequency range typical for PD activity with maximum sensitivity and gain.

TEM is the optimal sensor for direct installation on medium voltage Switchgears and motors, but it can be virtually applied in any electrical equipment provided that it has apertures or EM transparent surfaces.

# TEV

## Transient Earth Voltage

Property	Value
Bandwidth:	100MHz – 3GHz, stand alone sensor Techimp Frequency Shifter recommended (with PDCheck)
Gain:	1.8-4.25 dBi
Typical VSWR:	5:1
3dB Beam width:	100° - 210°
Polarization:	Linear
Impedance:	50 Ohm
Overall Dimensions:	80 x 150 x 50 mm
Weight (without the RF cable):	250 g
Connector:	Type N
Power Supply:	Only for optional devices (frequency shifter)
Installation:	In proximity of EUT apertures
Operational limits:	Env. Temp: -20-65°C; Env. RH: 0-100%



# HORN ANTENNA

## UHF antenna

Horn antenna is a partial discharge sensor designed to receive electromagnetic (EM) emissions from GIS/GIL, or MV/HV power transformers.

Horn antenna is a broadband antenna with a flat response suitable in a number of different applications, optimized to operate in a frequency range suitable for PD activity monitoring and it was designed to provide maximum sensitivity and high gain.

Horn is the optimal sensor for direct installation on high and medium voltage GIS/GIL and Transformers. It can be however virtually applied in any electrical equipment provided that it has apertures or EM transparent surfaces.

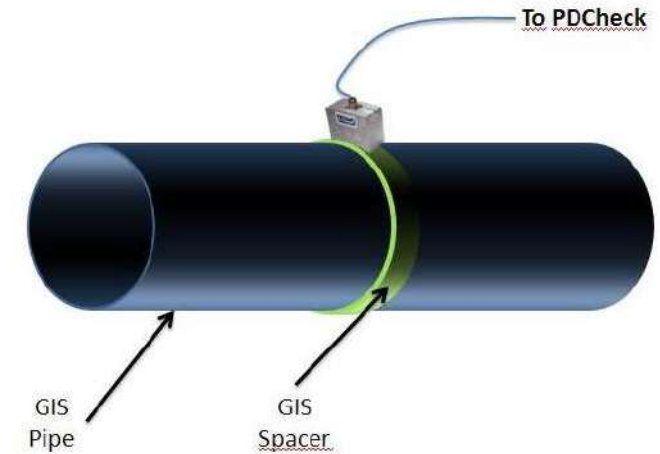
Horn antenna can be used in conjunction with Techimp Frequency Shifters product range, specifically designed and optimized to get the best performance with Techimp PD devices.

# HORN ANTENNA

## UHF antenna

### SPECIFICATIONS

Bandwidth	500MHz – 3GHz
AF (Antenna Factor)	50 – 30 dB/m
Typical VSWR	5:1
3dB Beam width	60° - 140°
Polarization	Linear
Impedance	50 Ohm
Overall Dimensions	70mm x 100mm x 50mm
Weight	260 g
Connector	Type N
Installation	In proximity of NON-SHIELDING apertures
Operational limits	Temp: -20-65°C; rh: 0-100%



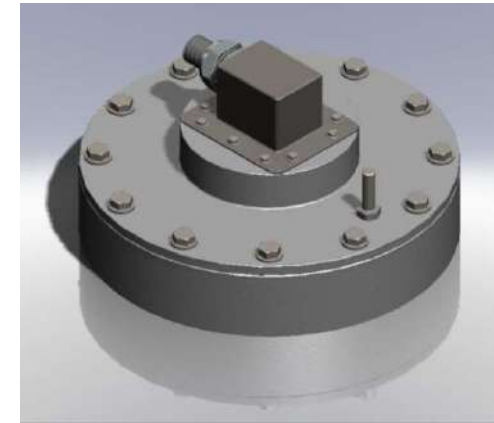


# UHF ANTENNAS

## FMC coupler



## Spiral antenna



# TAP ADAPTERS

Techimp Tap Adapter allows to detect PDs from the test tap of the transformer bushings. A synchronization signal can be derived as well.

It is suitable for both single shot as well as continuous PD monitoring.

Several thousands of hours of operation are a guarantee of reliability and accurate design.

BNC termination is available to connect the Voltage Tap to the coaxial cable. The cable ends into the Derivation Box which usually lays at ground level.

The measurement impedance and an overvoltage protection are integrated into the Tap Adapter. Values of the above electrical components are chosen on the basis of the bushing capacitance (commonly referred as  $C_1$ , to be provided by the Customer).

In case of long term overvoltage the units has a fail safe protection which shunts the measurement impedance to ground, thus preventing the bushing from overvoltage and spark over on the test tap. It has a fully sealed body suitable for reliable outdoor installation.

# TAP ADAPTERS



## BUSHING MODELS CURRENTLY EQUIPPED

ABB	GOB
ABB <i>formerly HSP</i>	EKTG
ABB <i>formerly ASEA</i>	GOA
PASSONI & VILLA	PNO
PASSONI & VILLA	POBO
PASSONI & VILLA	PCTO
TRENCH	ETG
TRENCH	COT

## SPECIFICATIONS

Voltage output @ 50Hz or 60Hz	1 ÷ 10Vrms
Max output transient voltage	90V <sub>peak</sub>
V <sub>out</sub> vs V <sub>in</sub> phase shift	90°
Operating temperature	-25°C ÷ +65°C
Output connector	BNC
Protection degree	IP66
Current to ground @ 50Hz or 60Hz	Below 10mA