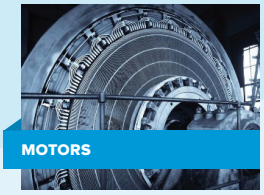
PORTABLE PARTIAL DISCHARGE MONITORING INSTRUMENT

Periodic Online Monitoring of Partial Discharges on motors, generators, switchgear, isolated phase bus and dry type transformers.


MOTORS


TURBO GENERATORS


HYDRO GENERATORS


SWITCHGEAR


ISOLATED PHASE BUS


DRY TYPE TRANSFORMERS

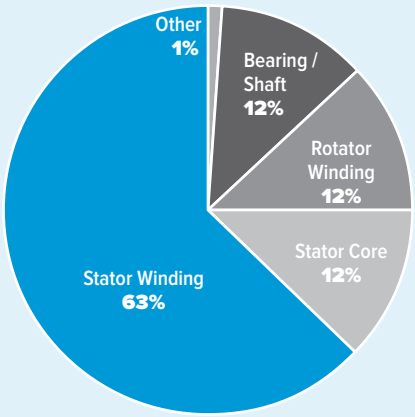
IRIS POWER
A QUALITROL Company

Partial Discharge Is A Leading Symptom Of Failures On Generators, Motors And Switchgear

Insulation problems are one of the principal causes of forced outages for generators, motors switchgear and dry type transformers which result in considerable damage and lost revenues. Periodic online monitoring of partial discharge provides a cost effective and proven technique to minimize the risk of unexpected failures.

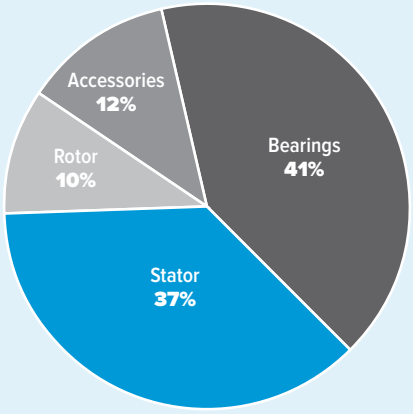
FAILURE MECHANISMS FOR GENERATORS, MOTORS AND SWITCHGEAR

Generator Failures



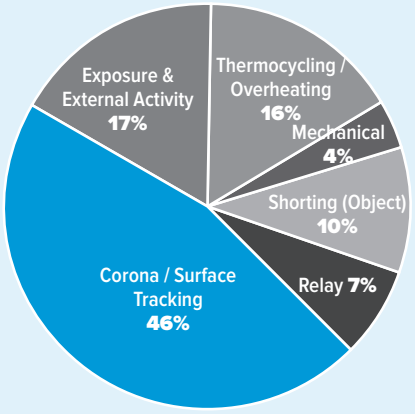
Allianz insurance, Survey 1996-1999
VDE Colloquium, June 28, 2001

Motor Failures



1980's EPRI Study on 7,500 Large Induction Motors

Switchgear / Bus Failures



IEEE Paper, 2002

Avoid In Service Failures With Early Detection Of Failure Mechanisms

Partial Discharge monitoring has become an important tool for condition based maintenance of motors, generators, switchgear and isolated phase bus by identifying risks of failure caused by abrasion of insulation, loose stator winding wedges, thermal degradation of insulation and manufacturing defects.

Iris Power online partial discharge monitoring instruments has accurately identified problems on many hundreds of motors and generators with dozens of published case studies by Iris Power customers that confirmed their Iris Power partial discharge monitoring instrument can help:

- Prioritize assets needing immediate maintenance
- Identify and repair damage at an earlier stage
- Avoid in-service failures
- Reduce outage frequency when results are good
- Obtain information regarding the type and location of maintenance required prior to outages
- Reduce overall cost of maintenance

Industry-Wide Acceptance Of Online Partial Discharge Monitoring

High Frequency Partial Discharge monitoring has won worldwide acceptance across utilities, major industrial companies and manufacturers. Iris Power has provided products for partial discharge monitoring on thousands of over 15,000 assets globally in addition to partial discharge monitoring being recommended in industry standards such as IEEE Standard 1434-2014 and IEC TS 60034-27-2:2012.

> We have not found another test method that produces as much decision support data for generator stator maintenance planning based on actual in-service insulation condition... Analysts were able to recommend the needed corrective maintenance before the maintenance outages began.

Development Of Iris Power Partial Discharge Monitoring

The development of the first Iris Power partial discharge testing system in 1990 was funded by the North American utility industry (CEA and EPRI) to provide generator owners a method of detecting stator insulation problems and obtaining adequate data to make maintenance decisions independent of equipment manufacturers.

The TGA / PDA product line has been designed to monitoring partial discharges under normal electrical, mechanical and thermal environmental operating stresses without interference from external noise such as power system corona, output bus arcing or other common electrical disturbances.

There are over 60,000 Iris Power partial discharge sensors installed across thousands of motors, generators, switchgear and dry type transformers globally. Additionally, Iris power has a unique database of over 550,000 results collected across all makes and sizes that is accessible by Iris Power customers to assist in understanding the relative health of their assets.

Data Collection Method

Data can simply and safely be collected in a non-destructive manner based on sound scientific and empirical principles that are recommended by manufacturers and industry standards such as the IEEE Std. 1434-2014 and IEC60034-27-2: 2012.

The operator connects the Iris Power portable instrument to a coupler termination box and the control computer running the Iris Power software. The test takes about 30 minutes per machine.

Presented Results

The magnitude, phase position, polarity and number of partial discharge pulses detected at each coupler are automatically recorded and can be viewed immediately or stored for subsequent analysis.

THE RESULTS PRESENTED INCLUDE:

- Graphs depicting the nature and severity of partial discharge activity.
- Trend curves highlighting the progression of these mechanisms over time
- Measurements that can be compared with a statistical databases of over 550,000 tests to determine immediately which equipment is at risk of failure.

PRODUCT OVERVIEW

The Iris Power portable partial discharge monitoring instrument provides you with the most reliable and flexible solution on the market.

- Modular product configurations suitable for generators, motors, switchgear, dry type transformers and isolated phase bus
- Advanced noise separation based on pulse shape and time of arrival methods
- Connect with 80 pF Epoxy Mica Capacitors (EMCs), Stator Slot Couplers (SSC™) and 1 - 2 nF capacitive couplers testing a frequency range of 0.1 MHz to 350MHz
- Data acquisition inputs for up to 12 channels
- Capable of offline low frequency testing in a frequency range of 50kHz – 5 MHz
- Operator friendly monitoring and diagnostic software
- Ability to operate instrument from 12V battery pack

Partial Discharge Monitor Configuration Options

The Iris Power TGA™ and PDA™ portable instruments provide you a flexible, reliable and cost effective method of periodically monitoring partial discharges across motors, generators, switchgear and dry type transformers. The TGA and PDA instruments are available in a variety of configurations in order to accommodate partial discharge testing on all types of sensors and assets at your facility. There are four types of sensor technology configurations that the portable instruments are capable of measuring.

EMC Couplers Turbine Generators, Motors, Switchgear & Isolated Phase Bus

The most common method in industry for periodic measurement of online partial discharge in motors, turbine generators, switchgear and dry type transformers is using the Iris Power high frequency 80pF epoxy mica capacitive bus coupler (EMC™).

The TGA-B™, TGA-SB™ and TGA-BP™ portable instruments are equipped to analyze EMCs connected in directional configurations.

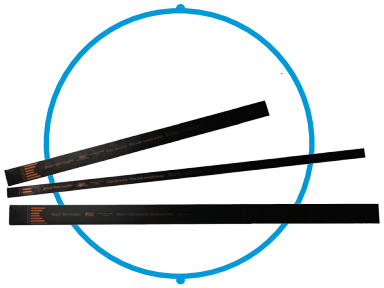
EMC Couplers Hydro-Generators

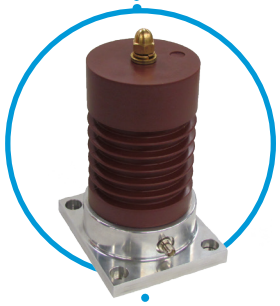
The size of hydro generators allows for the installation of high frequency 80pF epoxy mica capacitive coupler pairs on parallel circuits within each phase to improve the precision of locating and diagnosing stator windings insulation issues.

The PDA-IV™, TGA-SP™ and TGA-BP™ portable instruments are equipped to analyze EMCs connected in differential configurations.

A USER'S PERSPECTIVE:

By combining on-line monitoring and a diminished schedule of off-line testing, the utility has switched from time-based to a condition-based procedure for allocating resources for testing and maintenance..., the maintenance staff can discern more thoroughly the condition of the insulation and what, if any, repairs or changes in operating procedures need to be done to increase the lifespan of the unit.





Stator Slot Couplers Turbine Generators

Iris Power Stator Slot Couplers (SSC) are the most sensitive partial discharge sensors in the world. The broadband antenna sensor is permanently installed under the line end of the stator winding wedges or between the top and bottom bars to accurately classify sources of partial discharges originating within the machine. The stator slot couplers are not connected to the high voltage winding and are not subject to any high electrical stresses. SSCs are recommended for hydrogen cooled turbine generators.

The TGA-S and the TGA-SB portable instruments are equipped to analyze the stator slot coupler configuration.

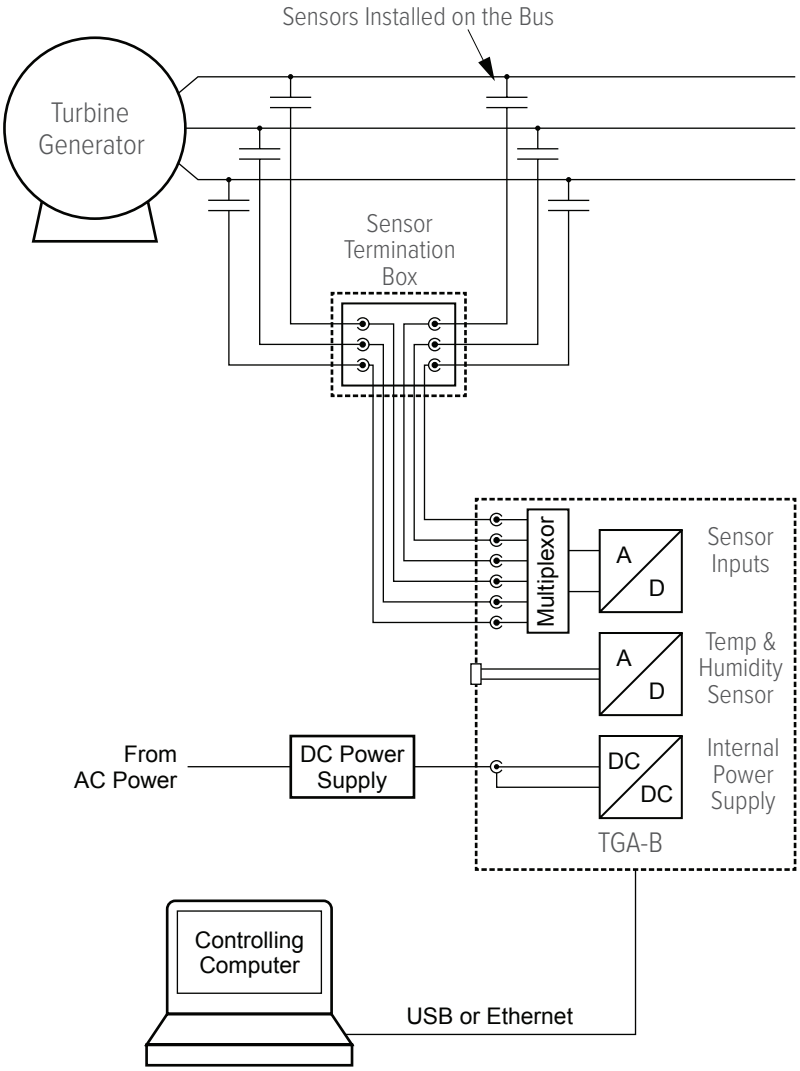
Capacitive Couplers for Low Frequency Testing

The Iris Power TGA portable instruments provide the ability to measure partial discharges on assets with previously installed capacitive couplers (for example 1 nF and 2 nF sensors). Note that Iris Power recommends the use of 80 pF sensors to reduce the risk of false indication and to ensure results can be referenced against the Iris Power Partial Discharge Severity Tables.

The TGA-B, TGA-SB and TGA-BP portable instruments can be used.

Epoxy Mica Capacitive Couplers On Typical Turbine Generator Installations

The directional configuration entails the use two 80pF high voltage epoxy mica capacitive couplers (EMC) per phase with the Iris Power portable partial discharge monitoring instrument. The 80pF capacitive bus couplers block the 50 Hz or 60Hz power frequency voltage allowing high frequency fast rise-time pulses which are caused by partial discharge to pass through. This configuration can also be used for monitoring of the isolated phase bus.



Sensor Installation And Configuration

Two epoxy mica capacitive couplers per phase are typically installed per phase on the machine terminals in a 'Directional' configuration where:

- The 'Machine' couplers are installed as close as possible to the stator winding on each phase.
- The 'System Couplers are installed on the incoming phase bus at a convenient location towards the power system but at least 2 meters or 6 feet from the 'Machine Coupler'.

Noise Separation Methods

The installation configuration with two capacitive couplers allows for the instrument to digitally distinguish between power system noise and winding partial discharges using a time-of-arrival analysis process.

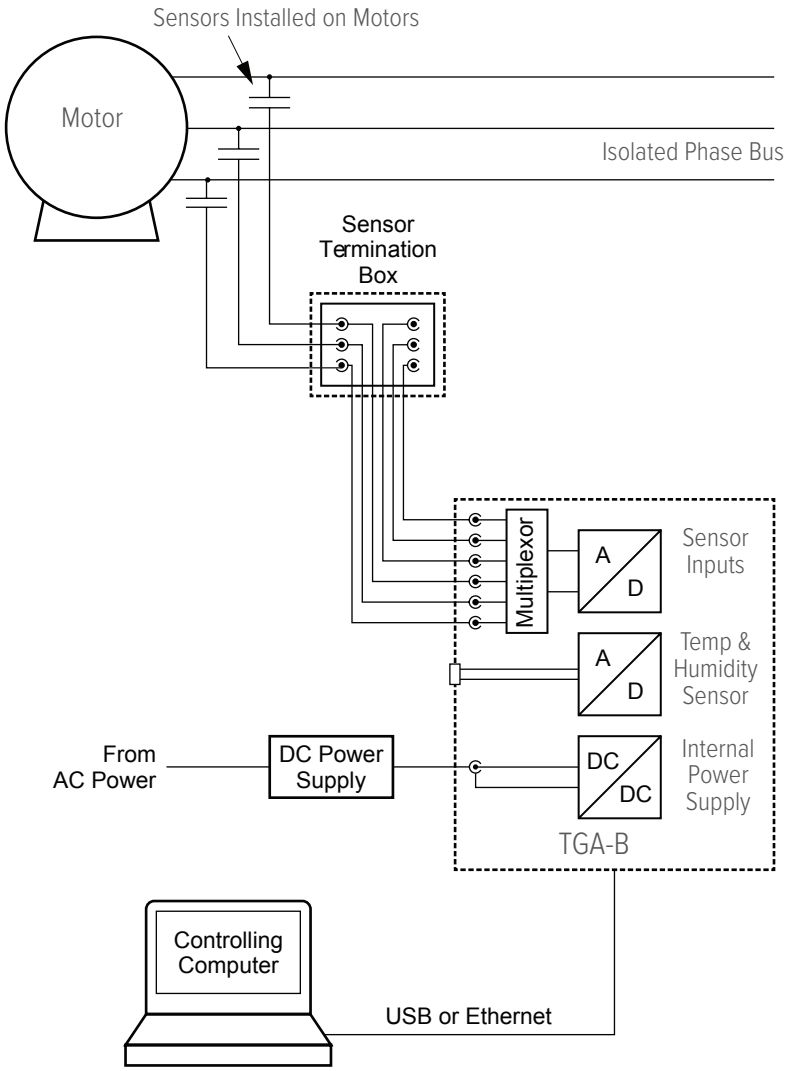
Pulses arriving at the machine sensor first are classified as machine partial discharges while pulses arriving at the system sensor first are classified as system disturbances. Any pulses arriving with pulse characteristics outside those of partial discharges are also separated as system noise.

APPLICABLE PRODUCTS

Iris Power **TGA-B, TGA-SB, TGA-BP**

Epoxy Mica Capacitive Couplers On Motors

The directional configuration entails the use of one 80pF high voltage epoxy mica capacitive coupler (EMC) per phase with the Iris Power portable partial discharge monitoring instrument. The 80pF capacitive bus couplers block the 50 Hz or 60Hz power frequency voltage allowing high frequency fast rise-time pulses which are caused by partial discharge to pass through.



Sensor Installation And Configuration

Partial discharge monitoring on motors typically have a single coupler per phase installed by the unit and is referred to as a 'single ended installation'.

Noise Separation Methods

Motors are typically connected to the power system by long power cables and are separated by more than 30 meters or 100 feet. In this case, high frequency disturbances are attenuated when detected at the instrument. Since the instrument automatically uses pulse shape for separating noise, the attenuated pulses observed that have a rise times longer than typical partial discharges are automatically classified as system disturbances and noise.

Variable Frequency Drives

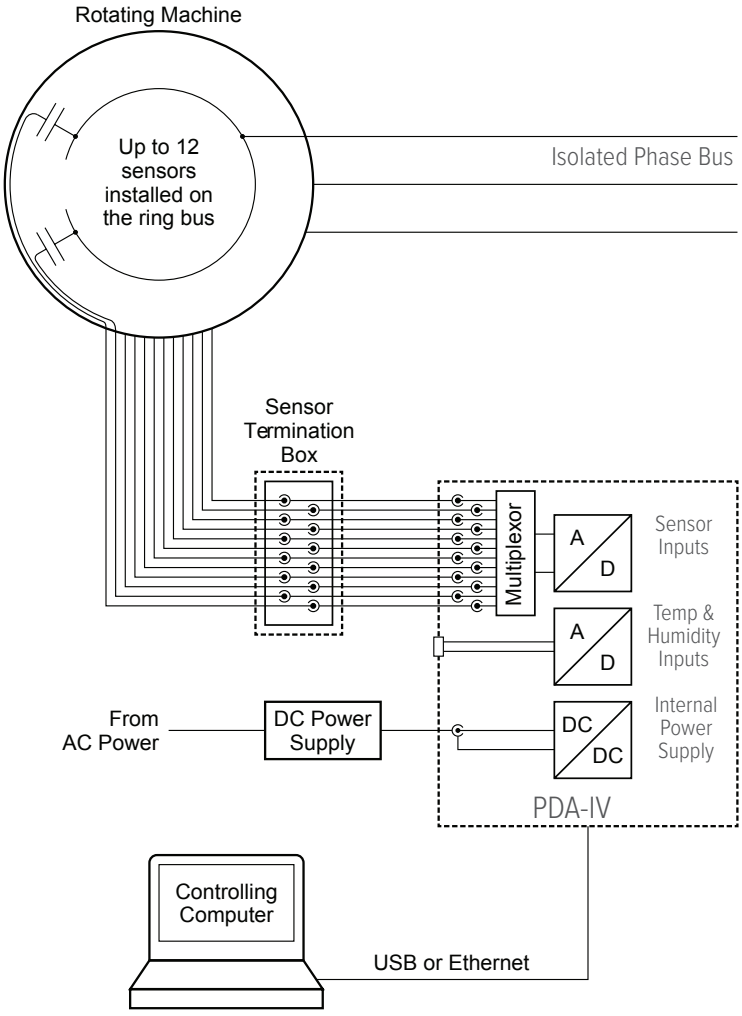
Iris Power offers the industry's most reliable means of monitoring partial discharges on voltage source pulse width modulated inverter fed drives through the use of an external reference circuit with a capacitive divider. The system is able to supress switching transient noise generated by the inverter which typically has pulse magnitudes a 1,000 times larger than the magnitude of stator winding partial discharge.

APPLICABLE PRODUCTS

Iris Power **TGA-B, TGA-SB, TGA-BP**

Epoxy Mica Capacitive Couplers On Typical Hydro Generator Installations

Partial discharge monitoring on hydro generators typically entails the installation of at least two 80pF high voltage epoxy mica capacitors (EMC) per phase. The 80pF capacitive bus couplers block the 50 Hz or 60Hz power frequency voltage allowing high frequency fast rise-time pulses which are caused by partial discharge to pass through.



Sensor Installation And Configuration

For hydro-generators that typically have at least 1 meter or 3 feet of circuit ring bus on each of the parallels to be monitored, couplers are usualy installed within the stator frame using a the 'Differential" configuration on the line end of each stator parallel circuit. For systems with more than two parallels per phase, it is possible to have a coupler on each parallel for extra winding coverage on large hydro generators.

Noise Separation Methods

This installation configuration allows for the instrument to digitally distinguish between power system noise and winding partial discharge using the time of arrival in addition to pulse shape.

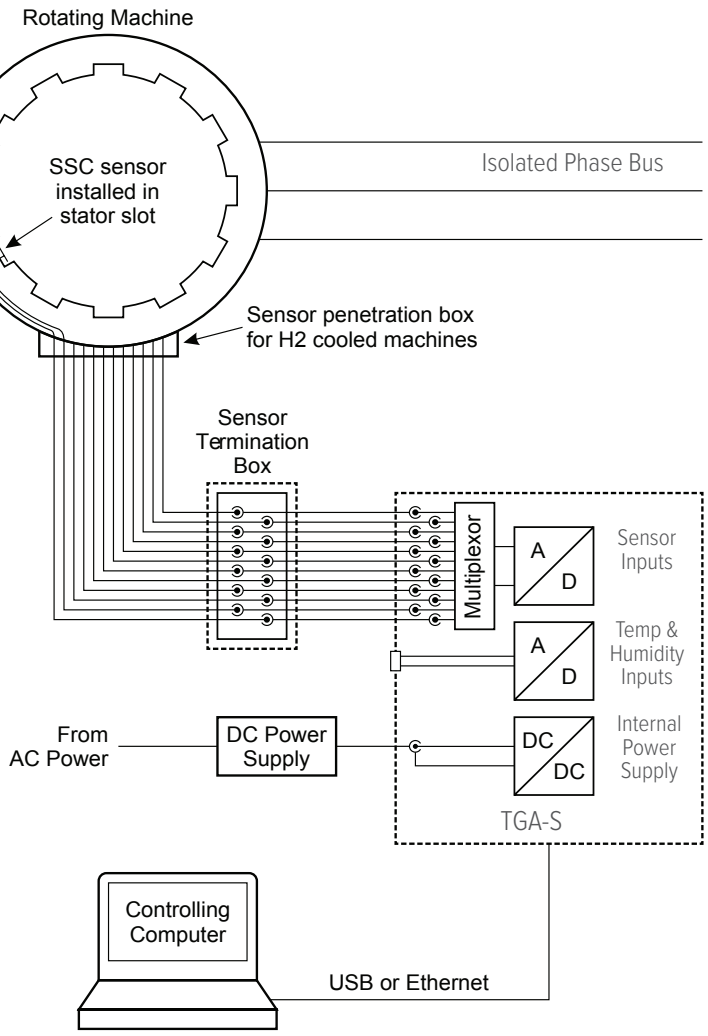
Pulses originating in the power system arrive at the same time to the instrument through the sensors so are automatically classified as system disturbances or noise. Other pulses are classified as machine partial discharges and are assigned to the coupler that detects the pulse first.

APPLICABLE PRODUCTS

Iris Power **PDA-IV, TGA-SP, TGA-BP**

Stator Slot Couplers On Typical Hydrogen Cooled Turbine Generator

The Iris Power portable partial discharge monitoring instrument can be used with the Iris Power Stator Slot Couplers (SSC) sensor which are the most sensitive partial discharge sensors available in the world and the least likely to have false indications. The instrument is able to determine the quantity, magnitude, shape and direction of propagation of partial discharges in the generator. The stator slot couplers are not connected to the high voltage winding and are not subject to any high electrical stresses. Stator Slot Couplers are most frequently used for hydrogen cooled turbine generators.



Sensor Installation And Configuration

The Stator Slot Couplers are installed under the stator wedges or between the top and bottom bars at the line-ends of each stator winding parallel. The Stator Slot Coupler is a broadband antennae which separates partial discharge in the stator slot and partial discharges in the stator endwindings.

Noise Separation Methods

The instrument digitally distinguishes between power system noise and winding partial discharge using pulse shape and polarity. A primary method of classifying disturbances or noise is by the pulse width:

- Partial discharges in the stator slot when detected by stator slot couplers have a pulse width of less than 6ns.
- Disturbances at the generator terminals when detected by stator slot couplers have a pulse width of greater than 8ns.
- External disturbances when detected by stator slot couplers have a pulse width of greater than 20ns.

APPLICABLE PRODUCTS

Iris Power **TGA-S, TGA-SP, TGA-SB**

Your Fleet Of High Voltage Assets Are All Built Differently... So Don't Try To Measure Everything The Same Way.

Iris Power provides flexible configuration options so each of you have the best sensor, noise filtering and diagnostic algorithms for the application regardless if it is for a motor, generator, switchgear or transformer.

CONFIGURATION OPTIONS	PDA-IV	TGA-S	TGA-B	TGA-SB	TGA-SP	TGA-BP
						
Typical Asset Application						
Large Hydro Generator	X				X	X
Turbo Generator		X	X	X	X	X
Motor			X	X		X
Switchgear			X	X		X
Dry Type Transformer			X	X		X
Isolated Phase BUs			X	X		X
Sensor Compatability						
80 pF EMC - 6.9 kV to 35 kV	X		X	X	X	X
Stator Slot Coupler (SSC)		X		X	X	
1000pF Capacitive Coupler	X		X	X	X	X
Sensor Channel Inputs						
80 pF Epoxy Mica Capacitor	12		6	6	12	12
Stator Slot Coupler (2 per sensor)		12		12	12	
Noise Separation Techniques						
Pulse Shape Analysis	X	X	X	X	X	X
Time of Arrival –Directional			X	X		X
Time of Arrival –Differential	X				X	X
Time of Arrival – Single Ended			X	X	X	X
Stator Slot		X		X	X	

Common Product Specifications

High Frequency	
Frequency Bandwidth	0.1 MHz - 350 MHz
Phase Windows	100 phase windows per cycle
Pulse Amplitude Range	10 PulseAmplitude sensitivity ranges: 2 mV-34 mV 5 mV-85 mV 10 mV-170 mV 20 mV-340 mV 50 mV-850 mV 100 mV-1700 mV 200 mV-3400 mV 500 mV-8500 mV 1000 mV-17000 mV 2000 mV-34000 mV
Data Acquisition Time	1s or 5s per magnitude window
Resolution	1ns with stator slot couplers 6ns with 80 pF EMC Couplers
Ambient Temperature Sensor	✓
Ambient Humidity Sensor	✓

Operating Conditions	
Operating Temperature	-15°C to 45°C (5°F to 113°F)
Relative Humidity	95% non-condensing

Accessories Included	
Power Supply Cord	1.8m (6 ft)
Power Supply Adapter	Input: 100-240 VAC, 1.5A, 50-60Hz Output: 12 VDC, 5A
Ethernet Cable	3m (10ft) CAT-5
AC Reference Cable	1.8m (6ft) Shrouded Plug
USB Cable	1.5m (5ft)
Impact Resistant Case	41 cm x 31 cm x 21 cm (WxDxH) 10 kg (22 lbs)
PowerCable Storage Bag	✓

Software & Manual	
PDLITEPRO	✓
PDVIEW STANDARD EDITION	✓
PDVIEW ADVANCED EDITION	Optional
USER MANUAL	✓

Options	
Variable frequency Drive **Motor Reference Frequency** **Filter**	20 Hz - 100 Hz Reference Circuit Capacitive Divider
Low Frequency Testing	Offline Testing 80pF EMC 25kV or 28 kV 50 kHz- 5 MHz
Shipping Case	✓
Controlling computer	DetailsAvailable On Request

Testing And Certification	
Environmental Vibration Test	IEC 60068-26
Shock Test	IEC 60068-2-27
Transit Vibration	MIL-STD 810G, Method 514
Electrical	CE, UL

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