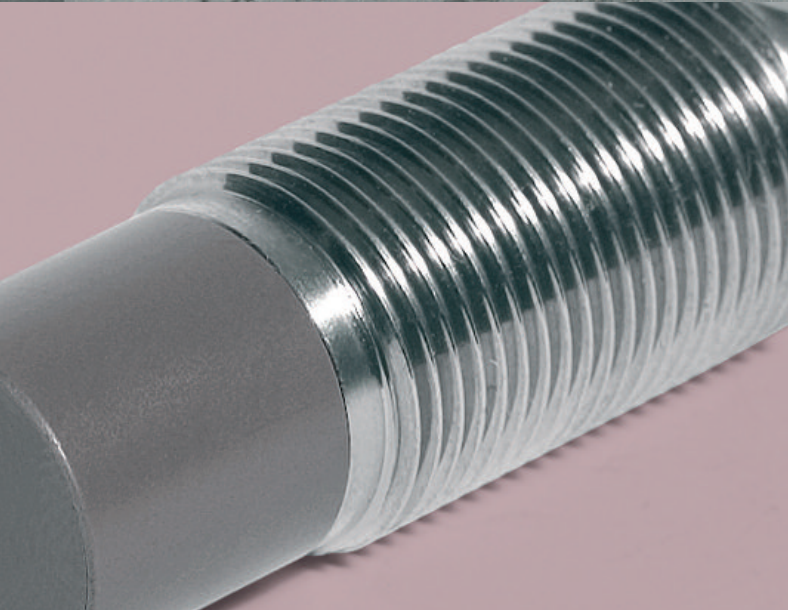
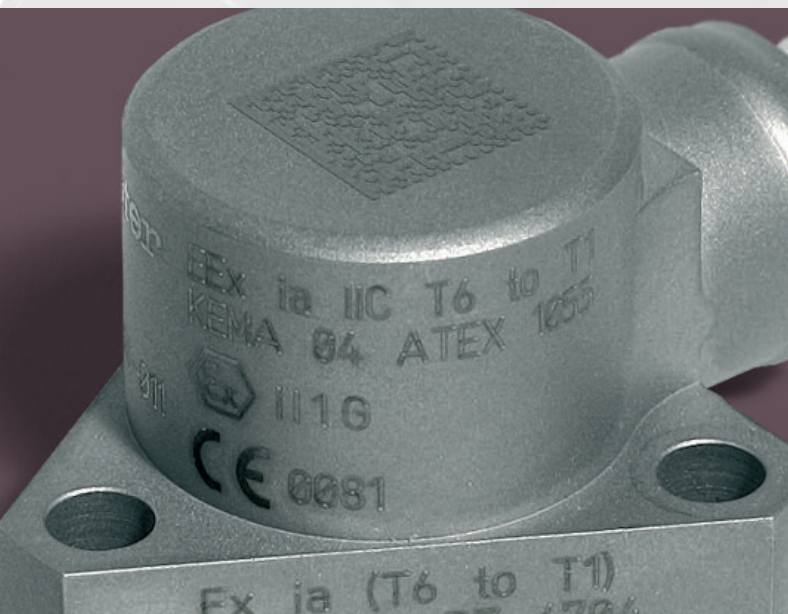


Sensor systems for turbomachinery



Sensor systems applications

For over 60 years, Meggitt has provided superior quality vibration sensing systems to monitor critical plants and equipment.

Today, our Vibro-Meter® sensor systems are successfully used in numerous industries where high capital rotating machinery represents a major asset. They protect and monitor thousands of machines worldwide.

- » Heavy duty gas turbines
- » Industrial and aero-derivative gas turbines
- » Steam turbines (nuclear and conventional)
- » Hydro turbines
- » Large generators
- » Large pumps, compressors and fans
- » Large electric motors and propellers

Whether your business is power generation, oil and gas production, petrochemical or marine, understanding the condition of your machinery and its mechanical behaviour is necessary to prevent failure and achieve optimum efficiency.

We make it our business to provide the best solutions for your measurement and monitoring requirements to protect your investment. This helps you reach higher levels of reliability, machine availability and output.

Today, our highly reliable sensor systems for harsh environments are adopted by most major OEMs.



Sensor systems overview

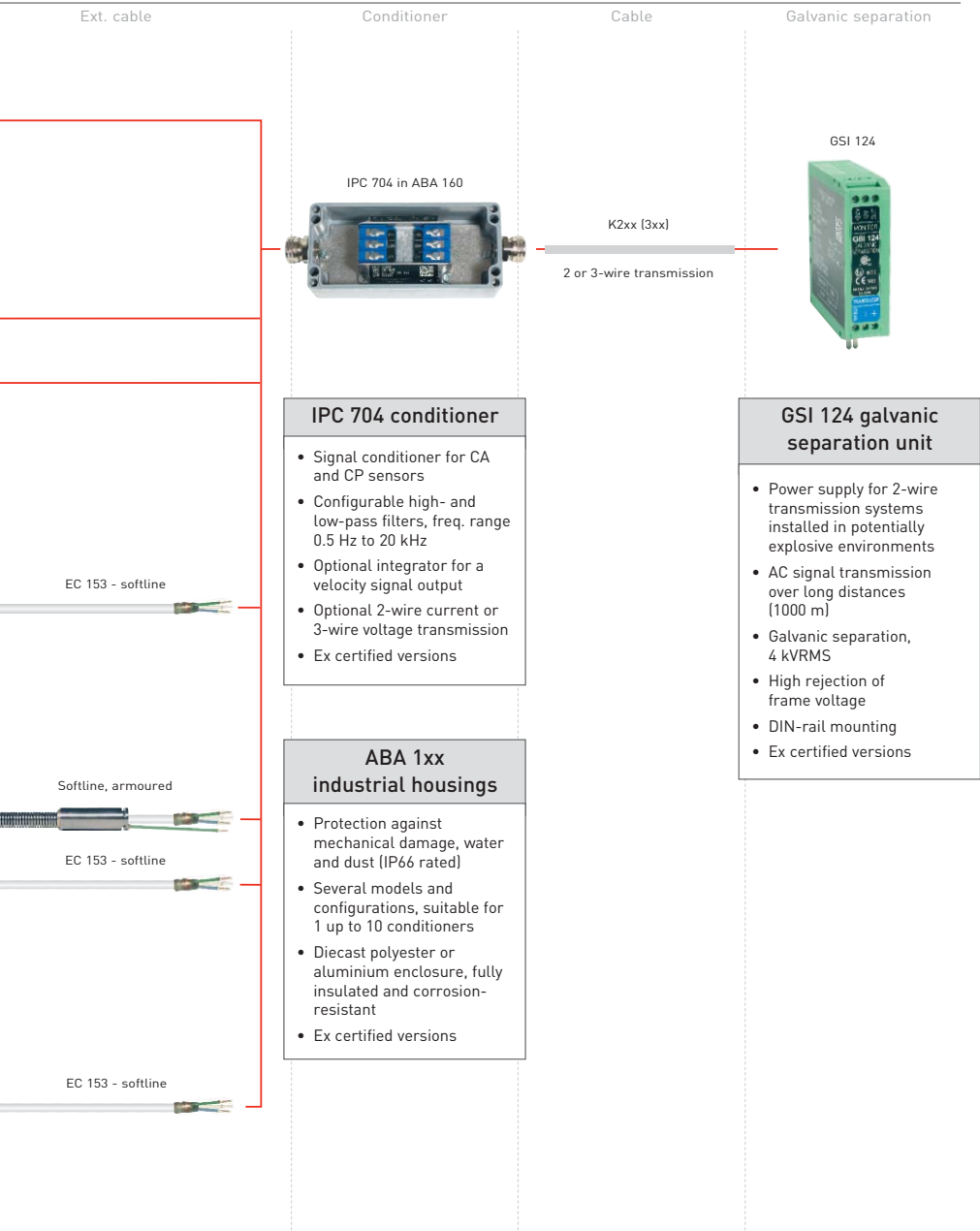
Whether measuring dynamic pressure, acceleration or displacement, Meggitt's Vibro-Meter sensors are the most accurate, reliable and cost-effective solutions available. We have a comprehensive range of sensor systems, which are standard solutions with numerous OEMs.

CA and CE accelerometers.....	2 - 5
	provide vibration measurements in harsh industrial conditions. We have a wide range of sensors, with sensitivities from 10 to 100pC/g, over a broad range of temperatures, from standard (120°C) up to extreme (700°C). The CA series works in the most severe environments, whilst the CE series includes conditioners and is hence more economical and simpler to integrate.
CP dynamic pressure sensors.....	6 - 7
	are qualified by major OEMs for gas turbine combustor pulsation monitoring. The CP series uses Meggitt's acceleration compensation patented technology and reaches the highest sensitivity in the industry (over 750pC/bar). Meggitt's CP sensors have an extreme temperature capability (up to 777°C) and a very high frequency response range (up to 15 kHz). Meggitt's CP sensors are key to optimising low NO _x emissions.
TQ proximity probes.....	8 - 9
	are eddy current transducers for contactless measurements of relative vibration or axial displacement in turbines, alternators, turbo-compressors and centrifugal pumps. Our wide series of probes is API 670 compliant and available for high-pressure and watertight applications, with measuring ranges up to 12 mm.
CV velocity sensors.....	10 - 11
	are widely installed on all types of low speed turbomachinery, especially hydro turbine-generator sets. The CV series measures absolute vibration down to very low frequencies thanks to the conditioner's low frequency linearisation function.
EW ice detection system.....	10 - 11
	detects initiation of ice on gas turbine inlets. The EW system discriminates between ice and water and optimises the use of bleed air in gas turbine de-icing systems.
LS air gap monitoring system.....	10 - 11
	measures the air gap between rotor and stator using a capacitive technology. LS systems are an important indicator of machine condition in hydroelectric generators.
Complete monitoring solutions.....	12
Case studies.....	13
Our expertise.....	15

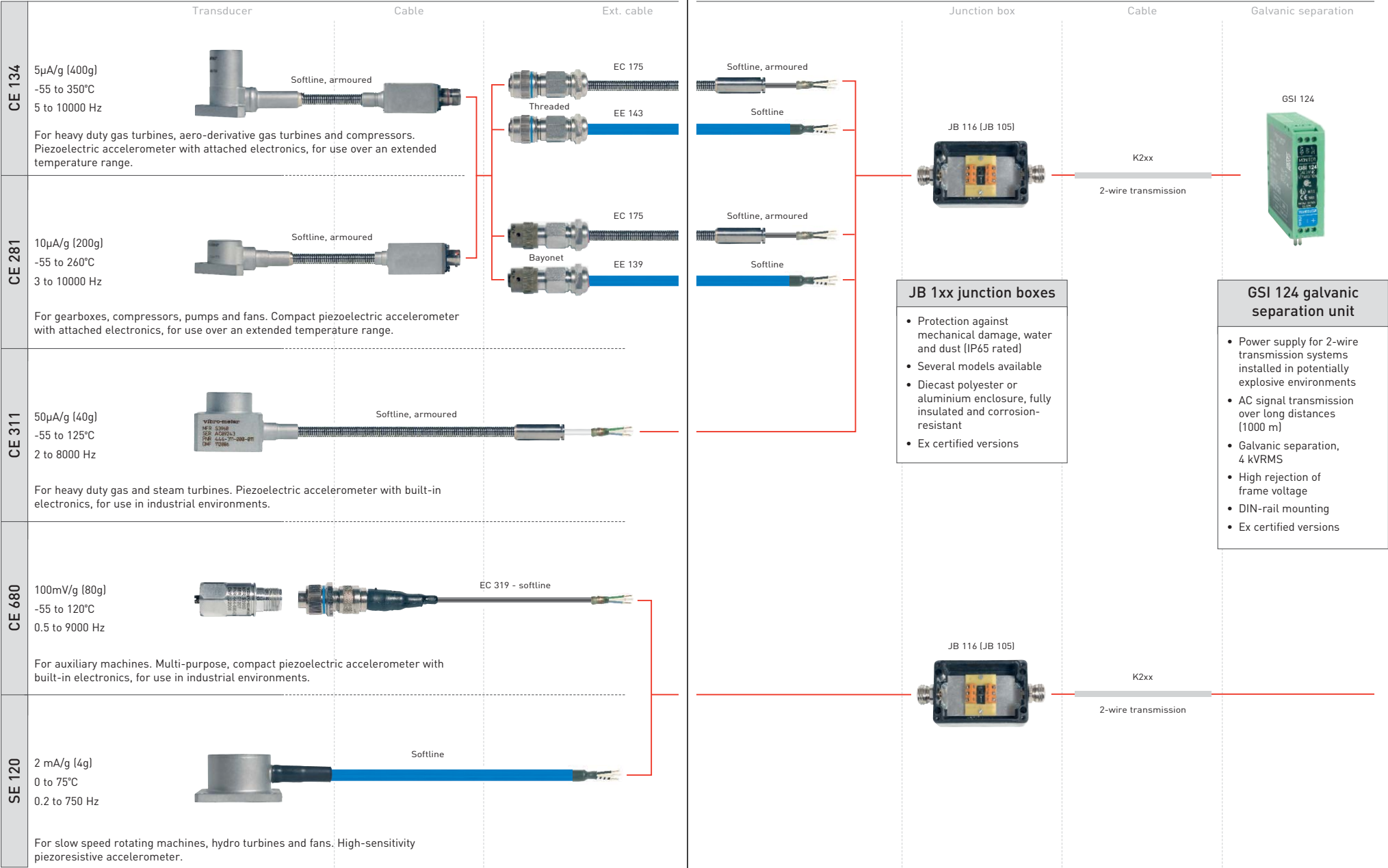
Accelerometers with external charge amplifiers

	Transducer	Cable
CA 202	100pC/g (400g) -55 to 260°C 0.5 to 8000 Hz For heavy duty gas and steam turbines. Piezoelectric accelerometer for use over an extended temperature range.	Softline, armoured
CA 280	100pC/g (500g) -55 to 260°C 0.5 to 10000 Hz For heavy duty and aero-derivative gas turbines, gearboxes, compressors and marine applications. Multi-purpose, compact piezoelectric accelerometer for use over an extended temperature range.	EC 222 - softline EC 119 (390) - softline, armoured
CA 306	50pC/g (100g) -55 to 500°C 5 to 3000 Hz For aero-derivative and industrial gas turbines. Piezoelectric accelerometer for use at high temperatures. Similar parts are standard with numerous OEMs.	MI, overbraided
CA 134	10pC/g (500g) -196 to 500°C 0.5 to 6000 Hz For cryogenic applications and gas turbines. Piezoelectric accelerometer for use over a very wide temperature range.	EC 069 - MI EC 112 - MI EC 119 (390)
CA 901	10pC/g (500g) -196 to 700°C 3 to 3700 Hz For heavy duty gas turbines. Piezoelectric accelerometer for use at extreme temperatures. Similar parts are standard with numerous OEMs.	MI

MI = Mineral integral
Certified versions for use in potentially explosive atmospheres are available.

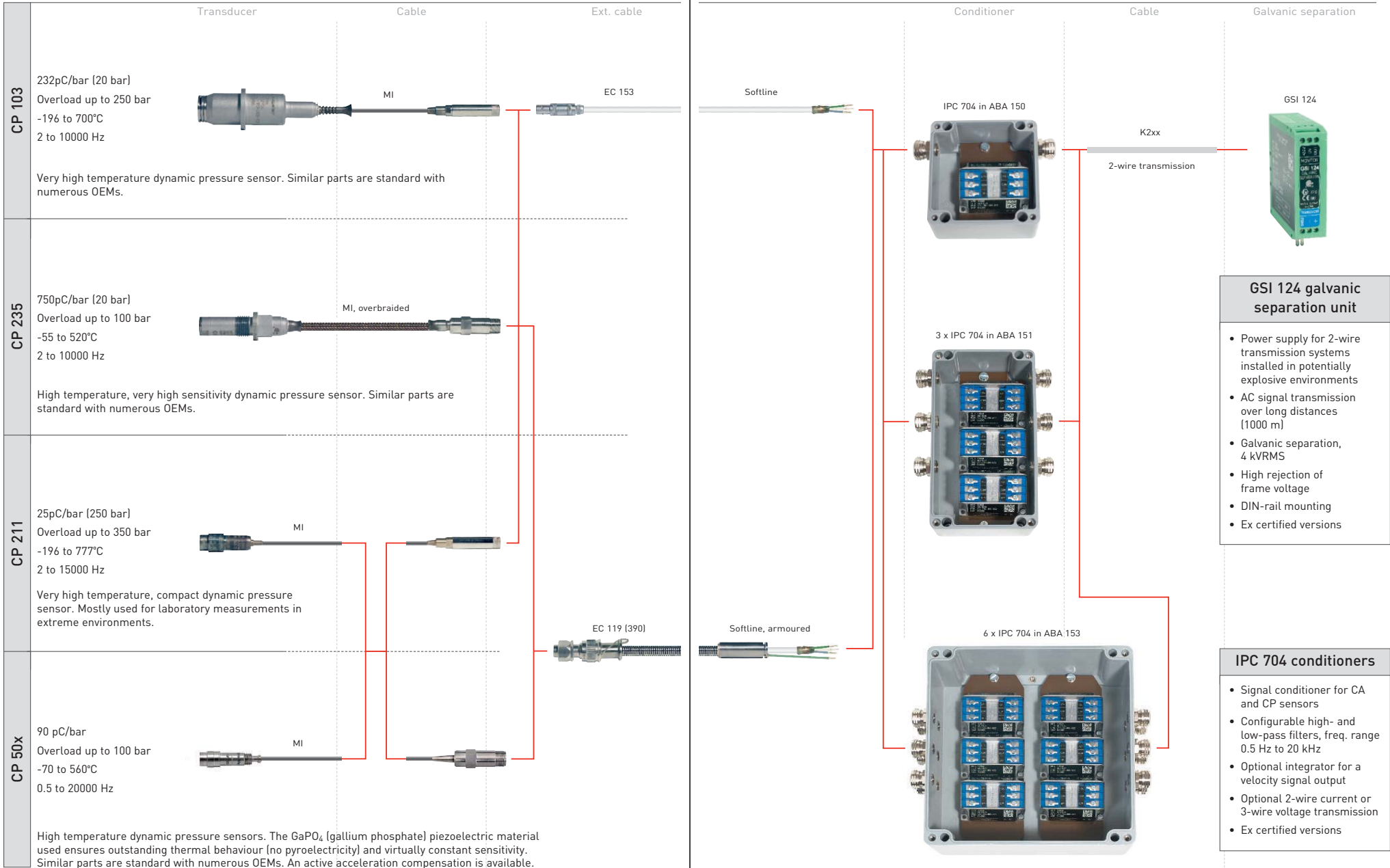


Accelerometers with built-in or attached electronics



MI = Mineral integral
Certified versions for use in potentially explosive atmospheres are available.

Dynamic pressure sensors for combustion monitoring

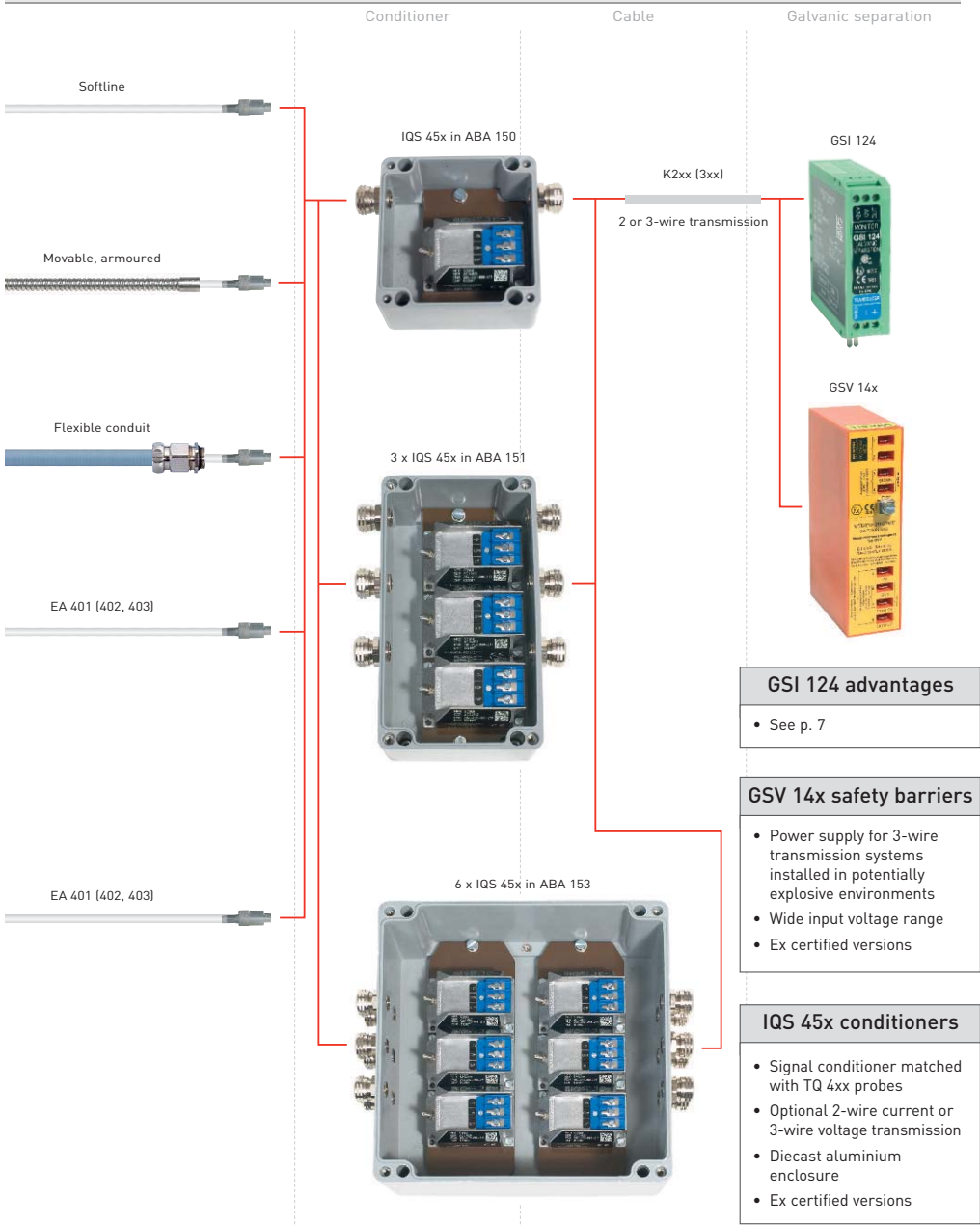


Proximity probes for all displacement measurements

	Transducer	Cable	Junction box / protection
TQ 401	8 mV/μm or 2.5 μA/μm (2 mm range) -40 to 180°C 5mm Ø tip	Softline	
TQ 402	8 mV/μm or 2.5 μA/μm (2 mm range) 4 mV/μm or 1.25 μA/μm (4 mm range) -40 to 180°C 8.2mm Ø tip	Softline	SG 101 (102)
TQ 422	4 mV/μm or 1.25 μA/μm (4 mm range) -25 to 140°C 12.7mm Ø tip Pressure proof, 100 bar (tip)	Softline	KS 107
TQ 432	4 mV/μm or 1.25 μA/μm (4 mm range) -25 to 140°C 12.7mm Ø tip Pressure proof, 100 bar (tip) Reverse mount	Softline	JB 118
TQ 412	8 mV/μm or 2.5 μA/μm (2 mm range) 4 mV/μm or 1.25 μA/μm (4 mm range) -40 to 180°C 8.2mm Ø tip Reverse mount	Probe adaptor	PA 151
TQ 403	1.33 mV/μm or 0.417 μA/μm (12 mm range) -40 to 180°C 18mm Ø tip	Softline	
TQ 423	1.33 mV/μm or 0.417 μA/μm (12 mm range) -25 to 140°C 25 mm Ø tip Pressure proof, 100 bar (tip)	Softline	

All "softline" cables can be delivered in armoured version.

Displacement range from 0.2 to 12 mm. For measuring relative vibration, axial thrust, differential expansion and phase reference on turbomachinery. Transmission distances over 1000 m. Various body lengths and tip diameters are standard. High pressure versions, reversible mounting, armoured cable protection and probe adapters are available. These products are compliant with API 670 standards.



Velocity sensors

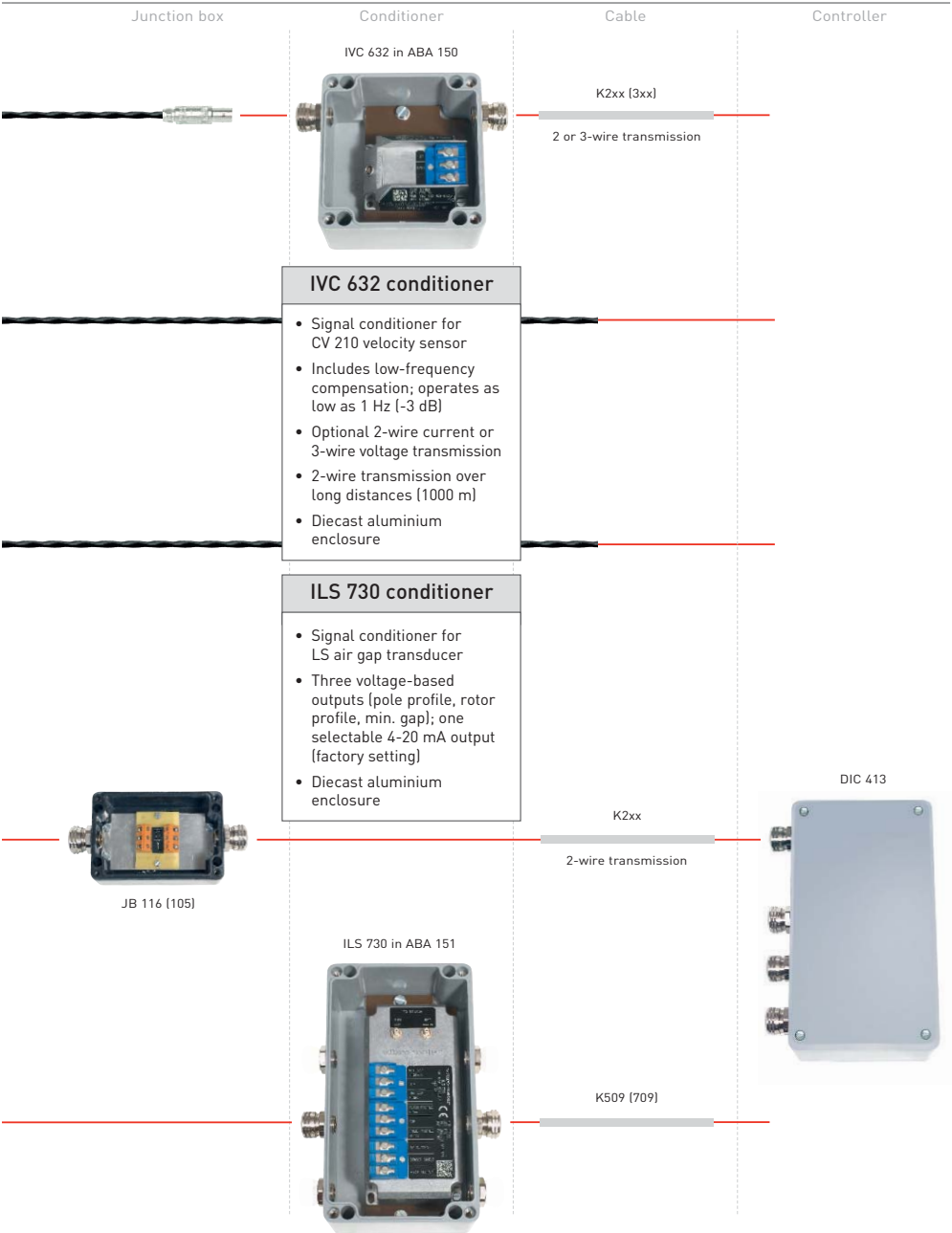
	Transducer	Ext. cable
CV 210	<div>50 mV / mm/s</div> <div>50 µA / mm/s</div> <div>(50 mm/s)</div> <div>-40 to 100°C</div> <div>1 to 400 Hz</div> <div>For hydroelectric generators. Low-speed velocity transducer with stainless steel body, ideal for moist or corrosive environments.</div>	<div>ED 109 - softline (112 - armoured)</div>
CV 213	<div>20 mV / mm/s</div> <div>(1000 mm/s)</div> <div>-29 to 204°C</div> <div>10 to 1000 Hz</div>	<div>ED 120 - softline</div>
CV 214	<div>20 mV / mm/s</div> <div>(1000 mm/s)</div> <div>-29 to 121°C</div> <div>10 to 1000 Hz</div> <div>For hydro and steam turbines. Low-speed velocity transducers, resistant to dust and moisture (IP64 rated).</div>	<div>ED 121 - softline</div>

Ice detection system

EW 140	<div>0.2 to 2 mm ice</div> <div>-55 to 120°C</div> <div>For all gas turbines. Detects initiation of ice on gas turbine inlets. Used by turbine de-icing systems to optimise the use of bleed air.</div>	<div>EC 119 - softline, armoured</div>
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Air gap monitoring system

LS 120	<div>2 to 33 mm</div> <div>-15 to 125°C</div> <div>For large hydroelectric generators. Monitors the air gap between the rotor and stator.</div> <div>Certified versions for use in potentially explosive atmospheres are available.</div>	
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Complete monitoring solutions

One source

Request a complete solution from Meggitt. In our facility in Switzerland more than 600 employees combine their expertise and commitment to design and build all parts of our system: sensors for harsh environments (measuring vibration, dynamic pressure, displacement, blade tip clearance, etc), high performance monitoring systems and software. Our sales and support network delivers outstanding service worldwide.

Plant asset management

Reduces the risk of failures and downtime, enables maintenance planning, increases global plant effectiveness

Plant asset management system



Turbine health management

Safety, return on assets and environmental impact

VM600

Protection, condition and performance monitoring



Turbine health management system



Blade tip clearance
Efficiency optimisation



Microwave sensors

Structural damages
Combustion humming, outer segments

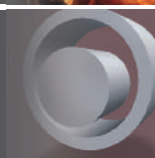


Dynamic pressure sensors

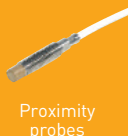


Piezoelectric accelerometers

Bearing
Defect detection



Piezoelectric accelerometers



Proximity probes

Up to 900°C

Very high

Up to 700°C

High

Up to 260°C / 180°C

Standard

Turbomachinery operation

Safety, maintenance optimisation, lower spare parts inventory, improved efficiency, reduced emissions



Case studies

Heavy duty gas turbine: Siemens SGT5-4000F

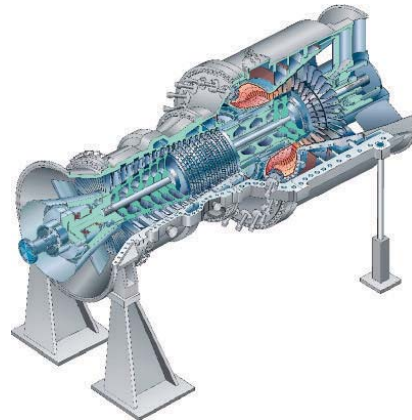
Combustion and vibration monitoring (VM600 with CP and CA sensors)

The SGT5-4000F (V94.3A) dry low-NO_x gas turbine (GT) is one of the most powerful in operation, designed for large-scale applications with more than 280 MW ISO output. Meggitt is the exclusive supplier of protection and monitoring equipment for this GT, Siemens' proven workhorse, with more than three hundred units in operation worldwide.

One of the major industrial challenges with heavy-duty GTs is to combine the highest possible efficiency with extremely low NO_x emissions and low combustion temperatures. Measuring the dynamic pressure at different locations in the combustor is a proven way to control combustion. Thus, pulsation monitoring systems are essential during both tuning and operation.

The sensors and monitoring equipment provided by Meggitt allow Siemens to control combustion parameters such as fuel injection, which leads to extremely low emissions, reduced fuel consumption and long intervals between major inspections. Our sensing and monitoring systems on the SGT5-4000F include extreme temperature dynamic pressure sensors (CP 216), high sensitivity piezoelectric accelerometers (CA 201 and CA 901) and protection and monitoring systems (VM600).

Meggitt is proud to have contributed to making the SGT5-4000F one of the most efficient GTs available for power generation applications.



SGT5-4000F
(© Siemens AG)

Hydro turbine-generator: Cahora Bassa Hydro Power Plant (Mozambique)

Air gap and vibration monitoring (VM600 with CE, LS, SE and TQ sensors)

The Cahora Bassa dam on the Zambezi river was completed in 1975 and renovated in 2003; its plant comprises 5 Francis turbines with a total power of 2.1 GW. Within the renovation project, Alstom selected Meggitt to provide machinery vibration and generator air gap sensors with a networked protection and condition monitoring system.

Condition monitoring of hydroelectric generators is critically important, especially monitoring the distance between the rotor poles and the stator walls, called air gap. To increase efficiency in generators, the air gap is reduced to a minimum. However, both the stator and the rotor on large hydroelectric machines can be quite flexible and their shape and location are affected in operation by

centrifugal, thermal and magnetic forces. This means that the air gap can only be effectively measured while the generator is in service. In the absence of effective monitoring, efficiency would decrease and potential machine damage could occur.

In Cahora Bassa, each generator is equipped with a capacitive air gap measurement system (4x LS 120 sensors with ILS 730 conditioners). This on-line system is used when the machine is rotating and withstands the extremely high magnetic fields in the air gap. Furthermore, each turbo generator has piezoresistive, low-noise, low-frequency SE 120 accelerometers to measure the bearings' absolute vibrations. On rotating parts, the relative shaft

Balance-of-plant: Yonghung Thermal Power Plant (South Korea)

Proximity, displacement and vibration monitoring (VM600 with TQ and CE sensors)

Yonghung is the largest coal fired power plant in South Korea. Each 870 MW supercritical unit is designed for variable pressure operation at 3600 RPM and 560°C. Yonghung is designed with the philosophy of preserving the environment using two stage combustion with low-NO_x burners followed by selective catalytic reduction.

To ensure efficient plant operation and to achieve their environmental objectives, Yonghung TPP has 22 VM600 racks that provide over 800 dynamic measurement points on units 3 and 4. These Meggitt systems secure and monitor a variety of machines for the steam turbine and the balance-of-plant in Yonghung, such as BFP (boiler feed pump) turbines, BFP motors, forced draft fans, primary air fans, condensate pumps (booster and water), blowers and air compressors.

At Yonghung TPP, Meggitt's highly reliable sensors for harsh environments measure a range of vibration and displacement characteristics. Proximity probes (TQ 402) and piezoelectric accelerometers (CE 680) measure shaft position, relative shaft vibration (x-y),

rotational speed of shaft and bearing broadband absolute vibration. Furthermore, Vibro-Meter sensors on the primary air fan enable the pre-heater system to use hot air to remove moisture from coal before the combustion process, which reduces NO_x emissions. The machinery protection functions and the condition monitoring functions of the VM600 system then process the signals and provide a complete data overview. This is necessary to maintain an efficient plant operation through diagnostics and plant health management.



Yonghung TPP (courtesy of Vibro Korea)

vibration is performed by the eddy current TQ 402 proximity probes. The stator's structural vibrations are monitored with compact piezoelectric accelerometers (CE 680). Coupled with our sensors, the VM600 protection and condition monitoring system ensures the highest safety level during operation.

Early detection of air gap anomalies using the equipment supplied by Meggitt enables condition monitoring of Cahora Bassa hydroelectric generators. As a result, plant efficiency is optimised, generator damage can be avoided and operators can more efficiently predict and plan maintenance outages.



Cahora Bassa HPP
(courtesy of Hidroelectrica de Cahora Bassa)

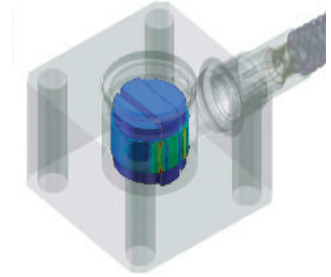
Our expertise

Engineering

Thanks to our experienced engineers and experts, Meggitt's R&D department provides our customers with the latest technology in sensing systems for turbomachinery, often used in harsh environments.

Meggitt has ongoing collaborations with several renowned universities and institutes of technology. As a result of our continuous innovative effort, we own a range of patents, guaranteeing the uniqueness of our technology and know-how.

We maintain our cutting edge by using modern tools, in-house developed software and state-of-the-art simulation and design software such as Matlab®, Simulink®, Cadence®, Allegro® and Solidworks® amongst others.



Manufacturing

Meggitt's large and modern manufacturing facility in Switzerland is designed to ensure the highest quality standards and organised to efficiently produce large scale orders, as well as small batches. In the 1980s we introduced our first production planning system to reach high quality and productivity objectives.

Sensors are manufactured from a large number of miniature, precisely-machined parts. Our experts use CNC-based equipment for precision machining, vacuum annealing, vacuum welding, argon arc welding and electron beam welding, amongst other techniques. To produce our electronic sub-assemblies, we invested in fully-programmable SMD assembly lines and automatic visual inspection equipment.



As a 21st century high-tech international organisation, we are concentrating on strategic manufacturing processes with the aim of increasing added value from the point of view of the customer.

Quality management

The quality and reliability of Meggitt's products have been widely recognised by customers for many years. Following our entry into the aviation sector in the 1970s, a quality system was put in place so that we could be certified by the associated customers and certifying bodies. First certified to ISO9000 in 1995, we have been recertified regularly since. Our latest BS EN ISO 9001:2008 certification was awarded in April 2013.

Today, we have a very large team of experts working for quality assurance, ensuring the quality of engineering and software, the standardisation, the calibration of equipment, qualification tests and certification.

Our quality policy applies to everything we undertake. All employees strive to consistently develop, maintain and improve our quality management system at every opportunity. External and internal customers are the focus of everything we do.



Headquartered in the UK, Meggitt PLC is a global engineering group specialising in extreme environment components and smart sub-systems for aerospace, defence and energy markets.

Some 10,000 people are employed across manufacturing facilities in Asia, Europe and North America and regional bases in India and the Middle East.

Meggitt's civil aerospace presence covers large commercial transports, regional aircraft, business jets, helicopters and general aviation.

Its defence markets cover all military aircraft types, land systems, naval platforms and aerial, land-based and marine threat simulation training and weapons systems development. The firearms element of this capability extends into law enforcement and security organisations.

The group's growing presence in energy is driven by our core fluid controls, heat management and sensing and monitoring capabilities, many of which are deployed to help reduce the maintenance costs, fuel consumption and carbon emissions of industrial gas and steam turbines.

www.meggitt.com

Meggitt Sensing Systems is the world's leading provider of high performance sensing and condition monitoring solutions for extreme environments

Meggitt Sensing Systems, a Meggitt group division, has operated through its antecedents since 1927 under the names of ECET, Endevco, Ferroperm Piezoceramics, Lodge Ignitions, Sensorex, Vibro-Meter and Wilcoxon Research.

Today their operations are integrated under one strategic business unit called Meggitt Sensing Systems to provide complete systems with these renowned product brands from a single supply base.

www.meggittsensingsystems.com

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MEGGITT
smart engineering for
extreme environments