A Practical Guide for understanding

Turbine Supervisory Instrumentation

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TURBINE SUPERVISORY INSTRUMENTATION

A Primer

A shift from steam to gas

At one time, a majority of the world's electrical power generation came from steam turbines coupled to generators. Whether the steam was produced by burning either conventional fossil fuels such as coal, gas, or oil, or by the heat from nuclear fission in a reactor, the process was essentially the same: heat the water to steam, expand it through a turbine coupled to a generator, and recycle the depleted steam/water to heat it again through the boiler or reactor.

Today, generation methods to meet the global power demand have largely shifted to gas turbines instead of steam turbines, augmented by a much higher percentage of renewable sources (wind, solar, geothermal).

This shift has occurred for two reasons: gas turbines are more efficient than steam turbines in extracting energy from a given amount of fuel, and gas turbines create fewer pollutants (emissions per MW of generation).

The world's most efficient gas turbines, for example, can today realize efficiencies approaching 45%. In comparison, plants composed solely of steam turbines rarely exceed 35% efficiency.

The persistence of steam turbines

Regardless, a sizable installed base of steam turbines still exists around the world and will remain for the foreseeable future. Also, installation of new steam turbines will continue as the waste heat from a gas turbine's exhaust can be used to boil water and create steam for a steam turbine. Such plants are known as "combined cycle" facilities because they combine the thermodynamic cycles of both gas and steam turbines in the generation of electricity. As a result, they are more efficient than so-called "simple cycle" plants – whether composed solely of gas turbines (typical efficiency of 35-40%) or solely of steam turbines (typical efficiency of 30-35%).

In contrast, a typical combined cycle plant boasts an efficiency of 50-60%. This added efficiency occurs because heat from the gas turbine that formerly went up the exhaust stack is instead routed through a HRSG (Heat Recovery Steam Generator).

The resulting steam is expanded through a turbine that drives another electrical generator, producing more power without the need for any incremental fuel. Identical fuel content in a combined cycle plant thus produces more MW of electricity than in a similarly sized simple cycle gas turbine plant.

Size matters

One of the ways that steam turbine efficiency is optimized is through size. One large steam turbine is more efficient than multiple small steam turbines operating in parallel to produce an equivalent output. In a fossil-fueled power plant, a typical steam turbine will range in size from 50MW to as much as 1200MW (Figure 1.1). In a nuclear power plant, a typical steam turbine will range in size from 800MW to as much as 1770MW. The massive size of these machines means that rotors are often very long. Also, because the casing of a steam turbine is designed as a pressure vessel, it is typically very thick (300 mm or more)

and expands/contracts more slowly than the rotor. These and other factors combine to result in a suite of measurements that are unique to large steam turbine generators and supplement the conventional radial vibration, phase reference, bearing temperature, and thrust position measurements typical of all rotating machines with fluid-film bearings.

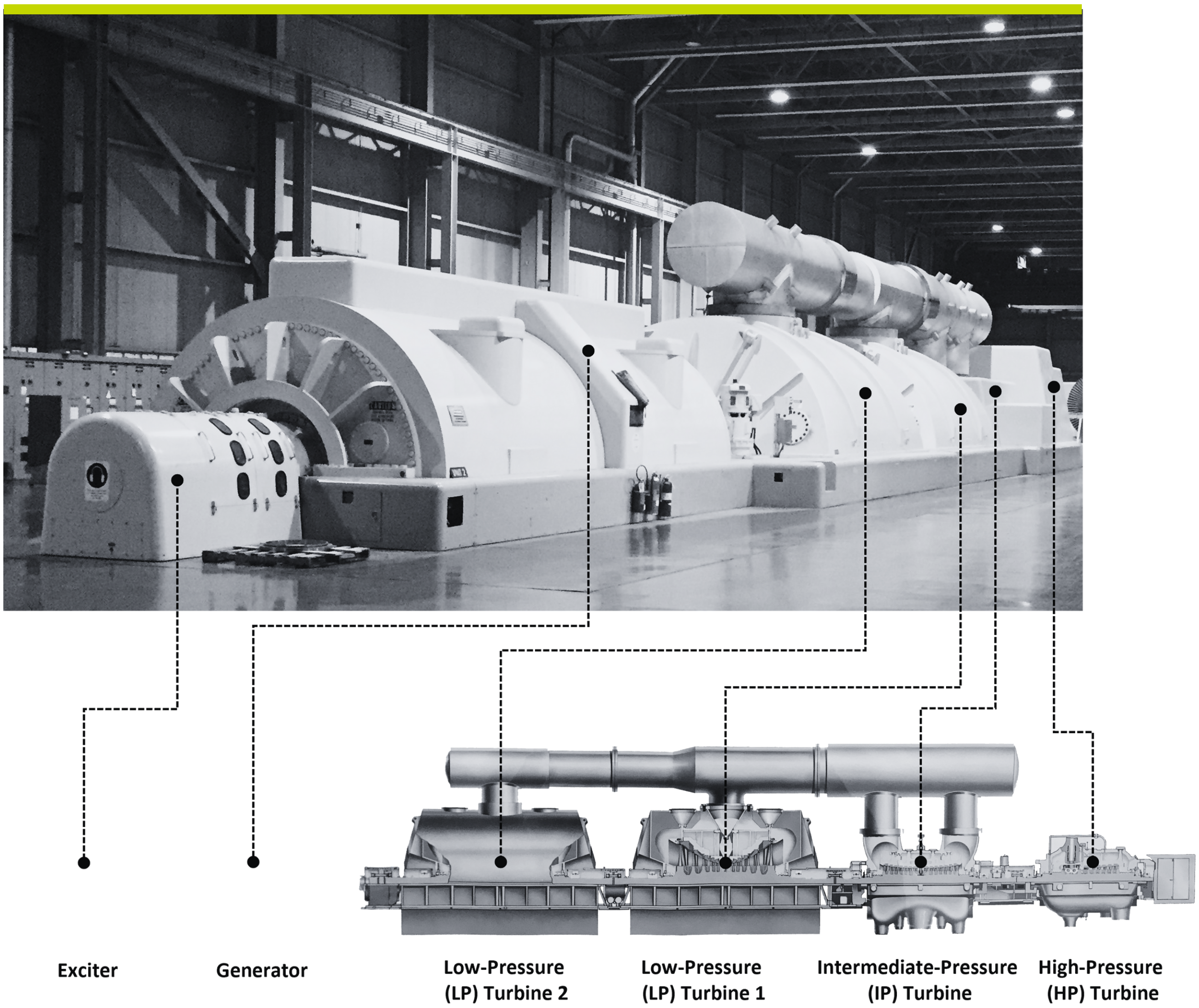

Figure 1.1

A 525MW steam turbine generator consisting of HP, IP, and dual LP cases along with generator and exciter. The steam enters the IP turbine case from the bottom and exits on the top where it flows to both LP turbines in parallel. Note that the generator and exciter are shown in the photo, but not in the corresponding illustration. Images courtesy of Ontario Power Generation.

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TURBINE SUPERVISORY INSTRUMENTATION

Specialized measurements

The specialized measurements unique to steam turbine generators are made with so-called Turbine Supervisory Instrumentation (TSI) and are described below. These measurements, along with conventional vibration, position, temperature, and phase reference measurements, are shown in Figure 2.

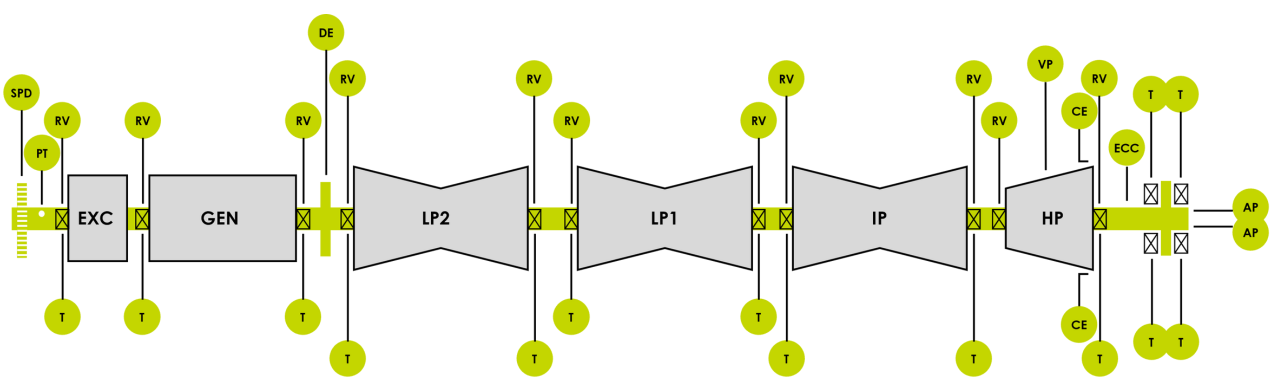


Figure 1.2

A diagram of the steam turbine generator train of Figure 1.1 showing the locations of its TSI measurements.

AP	Axial (Thrust) Position
CE	Case Expansion
DE	Diferential Expansion
ECC	Eccentricity
PT	Phase Trigger
SPD	Speed/Zero Speed
T	Temperature (bearing)
VP	Valve Position

Differential Expansion (DE)

As noted previously, large steam turbines have massive cases relative to their rotor, resulting in different rates of thermal expansion. This is due in part to the differences in metallurgy and corresponding thermal coefficients of expansion, but also due to the extreme differences in mass and thermal inertia between the (relatively) light rotor and its much heavier casing.

As super-heated steam is introduced to a turbine, its casings and rotors will expand at different rates. If the expansion of these parts relative to one another is not closely measured and controlled, the rotating parts (e.g., turbine blades) may come into contact with the non-rotating parts (turbine diaphragms) and substantial damage may occur.

To maximize the efficiency of steam turbines, the clearances between blades and diaphragms are – by design – quite tight and only a small amount of differential movement can be tolerated.

Differential expansion measurements are often made near the low-pressure casing because the shaft is axially constrained at its thrust bearing location (near the high-pressure turbine) and then grows (expands) outward from that point down the length of the machine through the IP and LP casings.

However, the location can vary depending on which turbine casing is being measured for differential expansion. For example, the machine of Figure 1.1 has the differential expansion measurement on the outboard side of the HP turbine as shown in Figure 1.2. Regardless of where the DE measurement location is found, the principle is the same: ascertaining the relative thermal growth between the turbine casing and the rotor.

Because the amount of thermal expansion can be substantial, and beyond the linear range of most conventional proximity probes, it is often the case that a special arrangement of two probes must be used to encompass the full range of differential expansion.

However, in a few cases, only a single transducer can address the required range – particularly when so-called "extended range" sensors are used. Each type of differential expansion measurement is described next.

Single-Channel Differential Expansion (Collar) SCDEC

This measurement is made utilizing a single proximity probe, attached to the machine casing, vand observing a special collar specifically intended for the DE measurement (Figure 2). The gap between the probe tip and the observed perpendicular collar surface represents the relative movement between casing and rotor.

NOTE

When the probe is rigidly affixed to the machine foundation, rather than the machine housing, the contribution due to expansion of the housing is removed from the measurement. This is known as rotor expansion since it indicates the amount of absolute growth/shrinkage of only the rotor rather than its relation to the housing which can also grow/shrink.

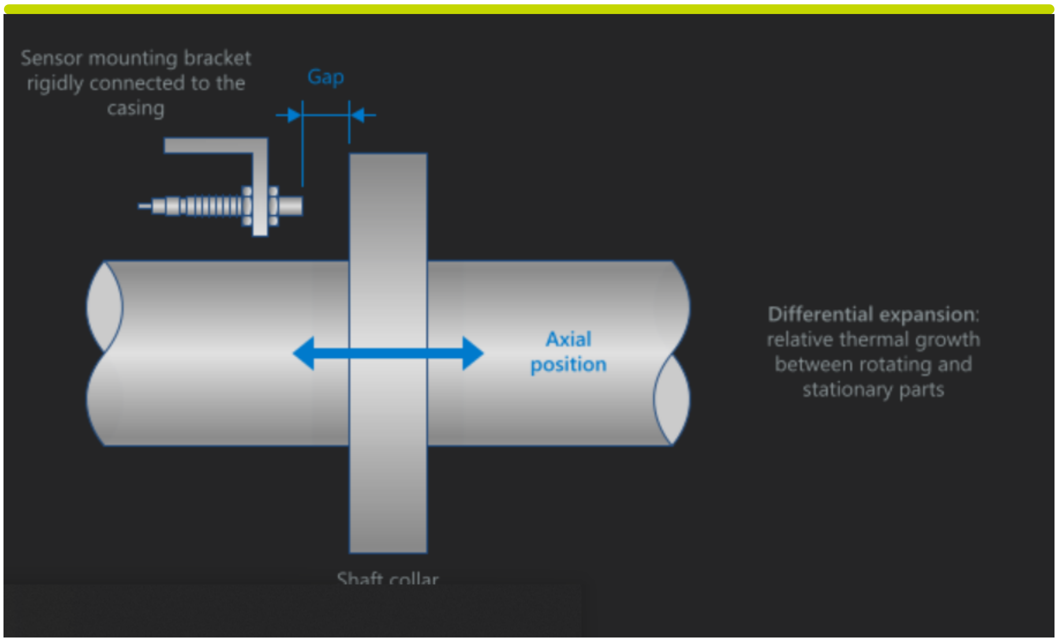


Figure 2

Screen capture from VM600MK2 configuration software (VibroSight PROTECT) depicting a Single-Channel Differential Expansion (Collar) measurement.

Single-Channel Differential Expansion (Pendulum) SCDEP

This measurement is made via a special pendulum that changes the angle of the probe target as the shaft expands or contracts relative to the machine casing.

The angle changes by means of a magnet on the shaft collar that pulls the pendulum in either direction as the shaft grows or shrinks. Using the trigonometric relationships among the various geometries of the probe/target arrangement, changes in probe gap are converted to the actual differential expansion. In this way, a much greater range of expansion can be observed than if the probe was simply observing a perpendicular collar. See Figure 3.

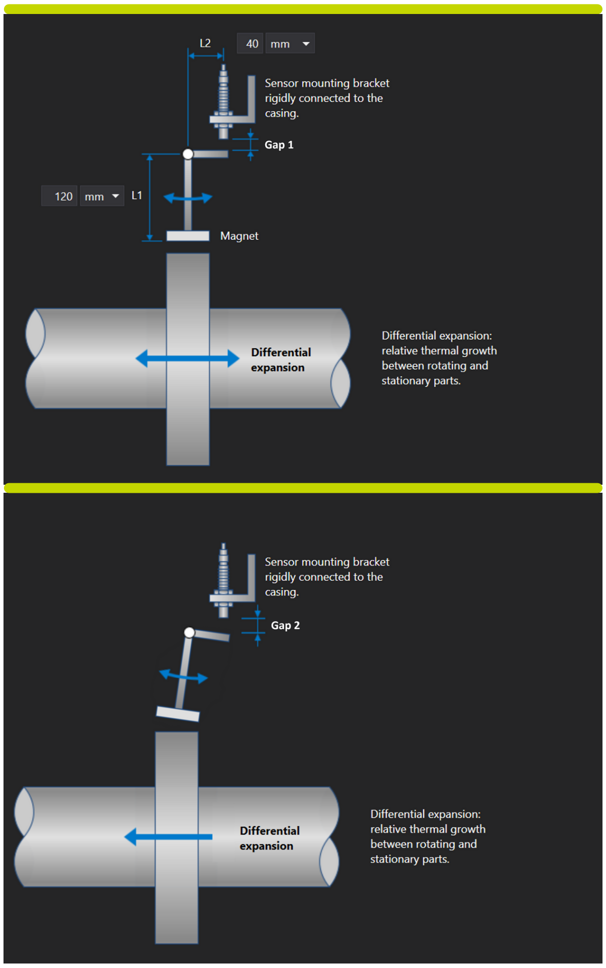


Figure 3

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a SCDEP measurement. In the bottom image, the shaft has expanded to the left, rotating the pendulum clockwise and increasing the probe gap (Gap 2 > Gap 1).

Dual-Channel Differential Expansion (Collar) DCDEC

This measurement uses two probes: each facing the other and observing opposite sides of the DE collar.

As the movement goes beyond the linear range of one probe, it enters the linear range of another one. In this manner, the total range becomes twice the range of a single probe and the probes thus "complement" each other's range. For this reason, it is sometimes referred to as "complementary input differential expansion." See Figure 4.

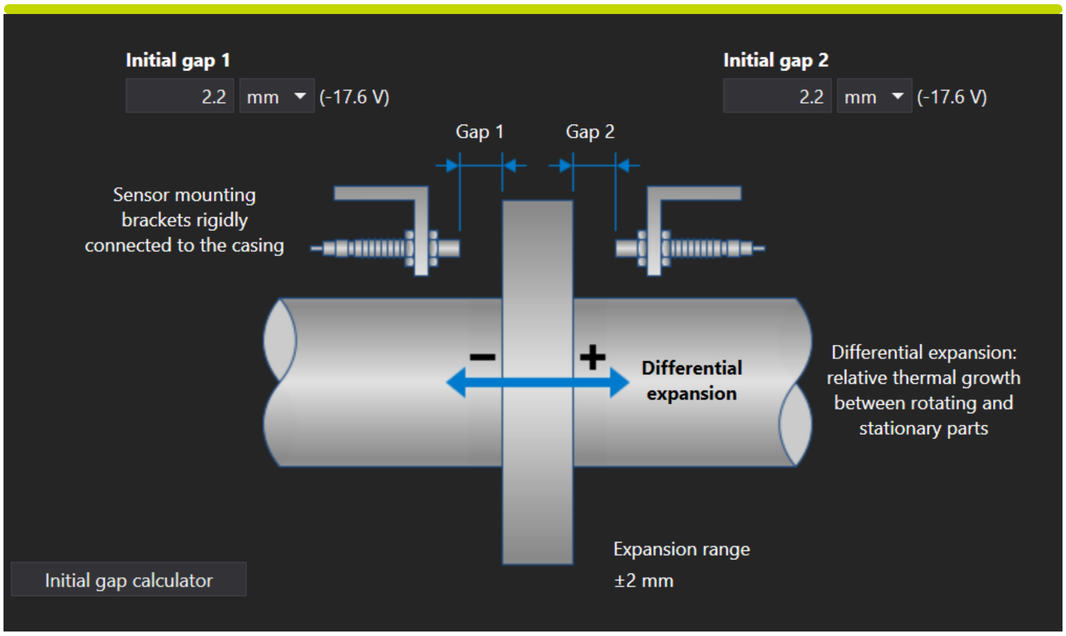


Figure 4

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a DCDEC measurement.

Dual-Channel Differential Expansion (Dual Taper) DCDEDT

By using a tapered (ramped) surface on the shaft, a radial probe can observe changes in gap as the shaft grows or shrinks. Unlike a conventional radial vibration measurement where the probe's gap does not change as the shaft grows or shrinks axially, the tapered surface will change the probe's gap due while axial movement occurs. Because the change in probe's gap is related to the sine of the taper's angle, a given probe's range can cover a considerably larger magnitude of differential expansion.

For example, if the taper's angle is 12°, the probe's range can encompass approximately five times more differential expansion than if it were merely observing a perpendicular DE collar.

However, because the probe's gap is a composite of the shaft's radial position in the bearing's clearance and the axial position of the taper, the signal from a single probe reflects both contributions. To isolate only the effects of the taper's axial position, and not the shaft's radial position, a second probe is used, allowing the effects of the shaft's radial position to be subtracted from the composite contributions of both axial and radial changes. The second probe can be used to observe either a second taper or a conventional non-tapered part of the shaft.

The DCDEDT measurement is depicted in Figure 5. The tapered surfaces can be either of a convex design as shown, or of a concave (so-called "butterfly") design as depicted in the inset.

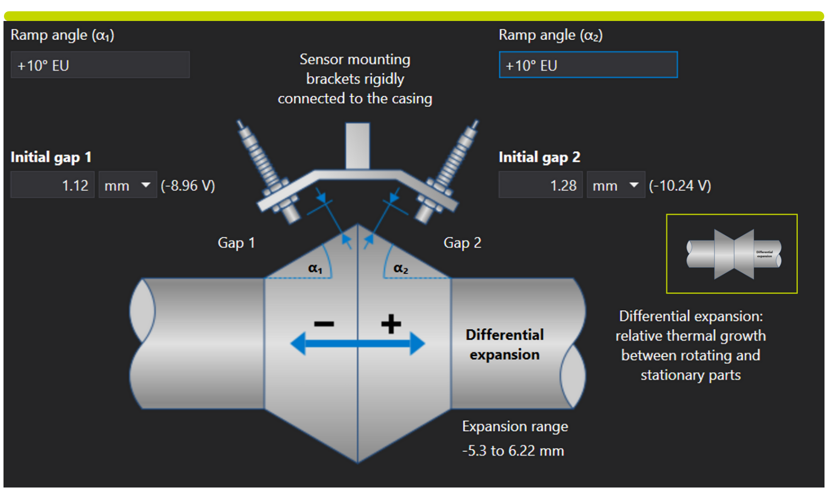


Figure 5

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a DCDEDT measurement. In this instance, the tapers are back-to-back, forming a convex shape. A so-called "butterfly" taper arrangement is shown in the green inset and is used by some turbine manufacturers instead of the convex arrangement, but the probe configuration considerations are essentially identical.

Dual-Channel Differential Expansion (Single Taper) DCDEST

This measurement is similar to the DCDEDT measurement but uses a conventional radial surface for one probe and a tapered surface for the other.

The two probes serve the same purpose as with a dual taper, but the probe observing the non-tapered surface contains only the radial position information while the probe observing the taper contains both the differential expansion and radial position information. Referring to Figure 6, by subtracting the signal of Probe 2 from the signal of Probe 1, and via trigonometry for the tapered surface, the differential expansion can be ascertained.

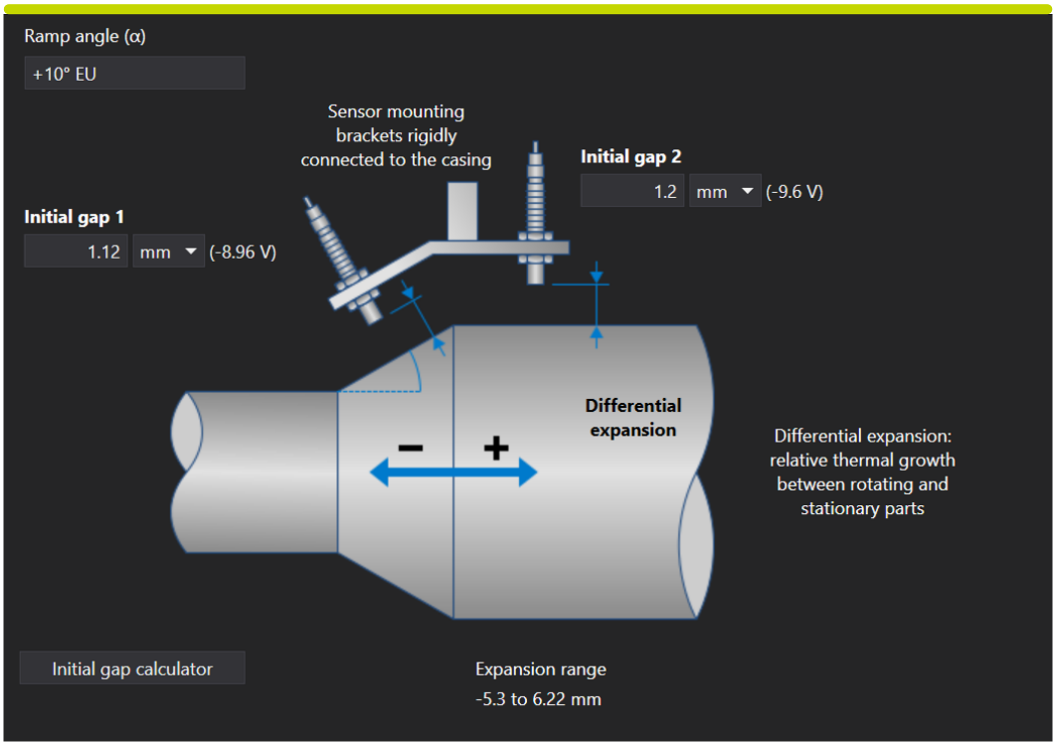


Figure 6

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a DCDEST measurement. In this instance, the ramp is on the left.

A NOTE ON EXTENDED-RANGE PROBES

One of the reasons that dual-channel DE arrangements are used is because smaller probe diameters (with correspondingly smaller linear ranges) can be used. In some cases, however, DE probes with more than the conventional 2mm or 4mm linear ranges are encountered or required. This is often the case with turbines where a simple perpendicular collar is used instead of a tapered surface. For these applications, so-called "extended-range" probes with diameters of up to 50mm and corresponding linear ranges of up to 28mm will often be used. These probes can be treated by the VM600Mk2 configuration software (VibroSight PROTECT) as "custom" transducer types and are thus fully compatible with the VM600Mk2 platform

Housing Expansion (HE)

Steam turbine rotors are generally fixed at a thrust bearing on the inboard side of the HP turbine and allowed to expand from there along the length of the turbine generator train. Because the high-pressure turbine has the hottest steam, it undergoes the most expansion and may be designed to be fixed at one end of the housing while allowing the other end to expand on the turbine's sliding feet. If one or more feet become stuck, problems can ensue such as a crooked (cocked) housing or a stuck housing with the result of a housing-to-rotor rub and/or a permanently warped housing.

Housing expansion on large turbines can be well above 25-50mm and is most often measured by way of an LVDT (Figure 7) to monitor that the turbine housing is properly sliding (expanding or contracting) on its feet.

The measurements can be brought into the VM600Mk2 as either a native LVDT voltage signal or as a quasi-static process variable signal from LVDTs with a 4-20mA output.

Although a single LVDT can be used and measurements made on only one housing foot, it is more common to equip both sides with LVDTs, allowing not only the individual movements to be measured, but also the differential between the two sides. Refer to Figure 8.

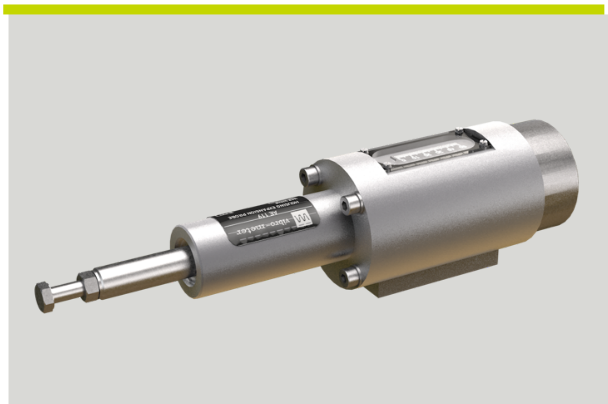


Figure 7

The vibro-meter AE119 is typical of LVDTs used for housing expansion measurements.

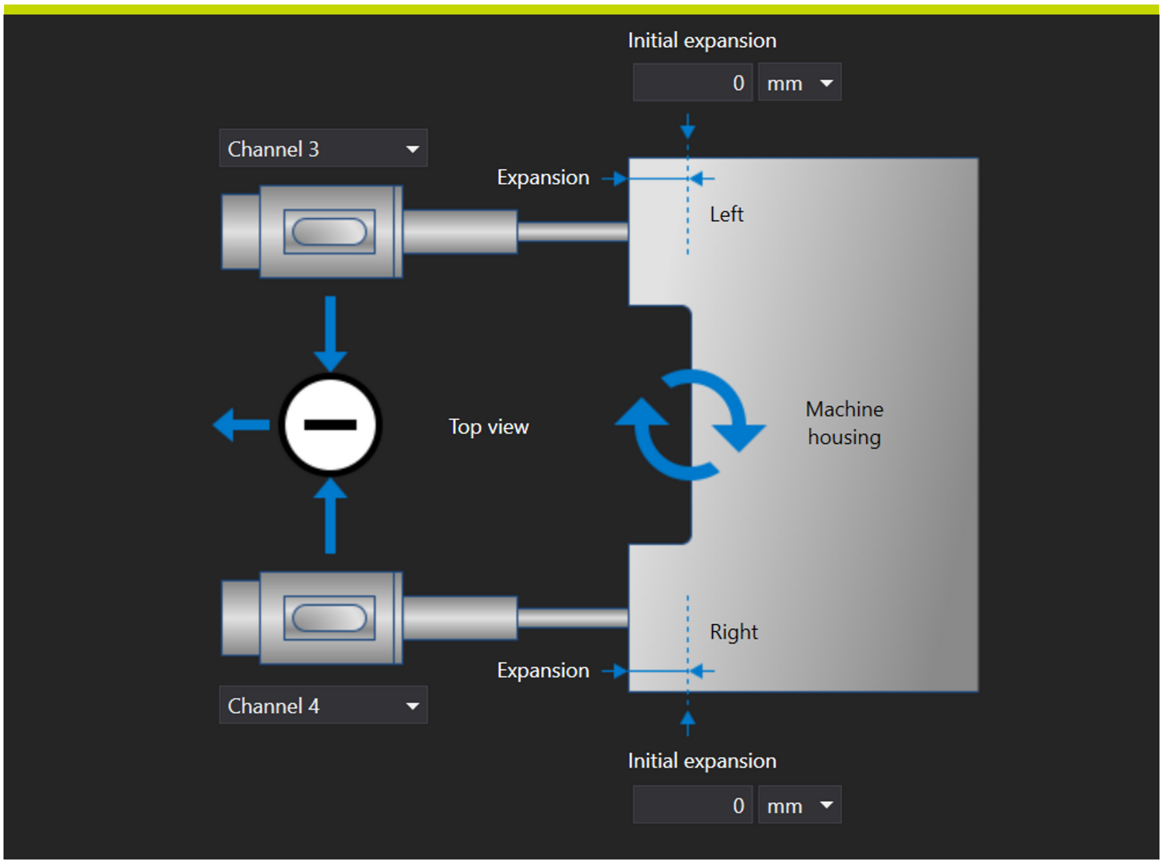


Figure 8

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a dual-channel housing expansion (differential) measurement. The expansion of each side of the casing is measured and the monitor can display both these absolute values as well as the differential between the two – useful for determining when a single foot is stuck and ensuing so-called "cocked housing" conditions.

Valve Position VP

Large valves are used to admit steam to the HP turbine. Multiple valves are often arranged into a so-called "valve rack" where cams drive lever/plunger arrangements that open and close the valves due to their substantial size. This is depicted in Figure 9.

One method to measure the valve position is by means of a rotary potentiometer that detects the rotary position of the cam. These are rarely encountered any longer and are primarily of historical interest. More commonly, LVDTs are used to measure the valve's plunger position (stroke).

The valve position measurement is thus similar to the casing expansion measurement in which LVDTs are used to measure linear movement. However, the environmental conditions at the valve rack are usually more aggressive in both temperature and humidity due to the hot steam passing through the valves.

For this reason, for valve position measurements AC LVDTs are usually used instead of the DC LVDTs with their lower temperature ratings sufficient for casing expansion measurements.

In the past, valve position measurements were usually incorporated in the TSI system. Today, however, this is becoming less common and the measurements are usually brought directly into the turbine control system instead.

Valve position in the TSI system is thus most often encountered in upgrade situations where an older TSI rack (such as the vibro-meter MMS system) is being replaced with an identical suite of measurements in a newer hardware platform such as the VM600Mk2. The measurement is treated as a quasi-static channel type in the MPC4Mk2 module and can be made in any of its 6 available channels. However, because valve position does not require dynamic signal processing, it is often allocated to either auxiliary channels 1 or 2.

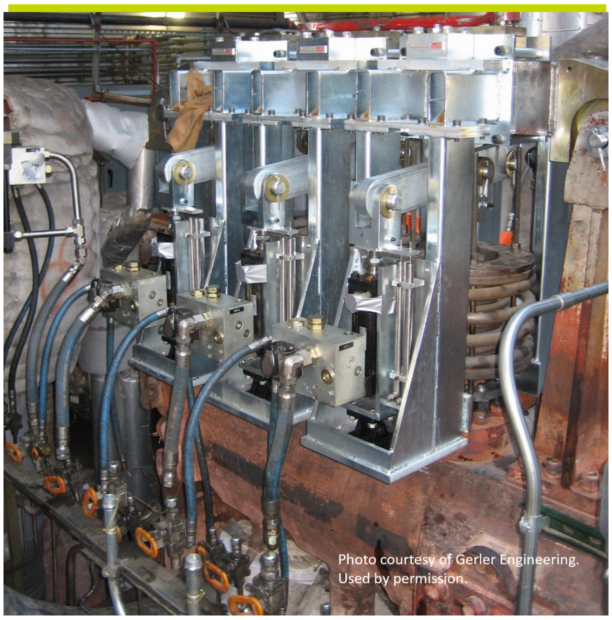


Figure 9

A typical steam turbine valve rack (top) and animation showing operation (bottom).

Eccentricity ECC

Because steam turbine rotors are quite long, they will sag due to gravity if allowed to remain at rest for too long. Rather than allowing the turbine train to stop rotating altogether when the steam turbine is not in operation, it is usually placed on a turning gear (sometimes called a jacking gear or barring gear) that slowly rotates the train at speeds as low as 2-3 rpm, thus preventing a flexible bow from developing.

Regardless, a certain magnitude of bow will be present in the rotors, and during startup the extent of this bow must be carefully monitored and controlled. This measurement is known as rotor eccentricity – or simply eccentricity – and it is depicted in Figure 10.

Eccentricity measurements are made to ensure that the amount of bow is not excessive, allowing a safe startup within acceptable vibration limits. In severe cases of bow when the machine was not stopped due to excessive eccentricity, operators have been known to flex a rotor beyond its elastic limits, resulting in a permanently bent shaft rather than a temporary bow.

The eccentricity measurement is usually made near the high-pressure turbine casing, well removed axially from a bearing or nodal point and thus where the eccentricity will be more pronounced and easily observed (usually on the HP turbine's stub extension in the front standard). The machine of Figure 1.1 is thus typical as the eccentricity measurement is made at the extreme outboard end of the HP casing as shown in Figure 1.2.

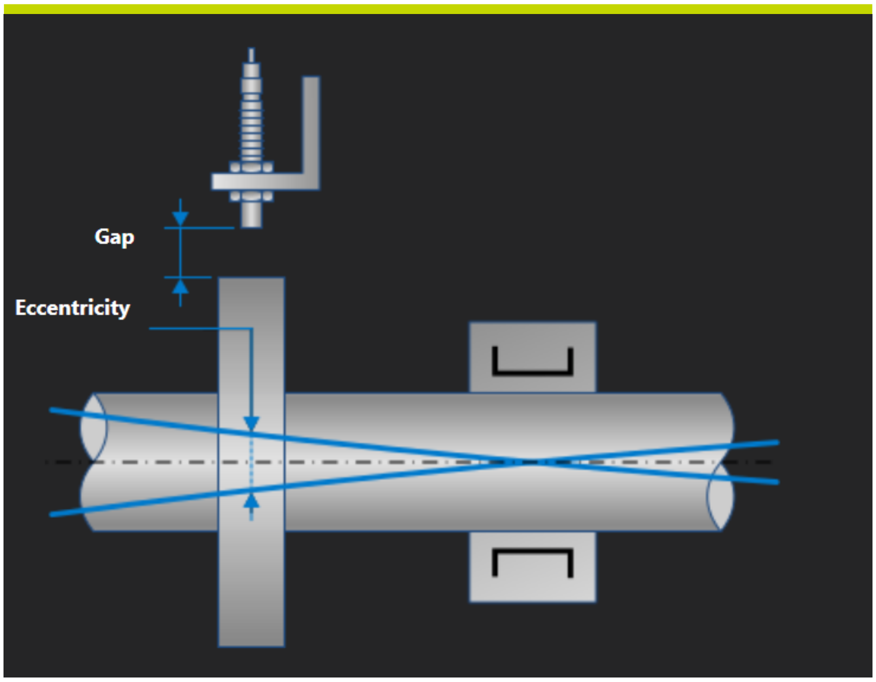


Figure 10

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting an eccentricity measurement. Unlike radial vibration, which is measured very near to a bearing location, eccentricity is measured at a location where any residual shaft bow will be quite pronounced.

Zero Speed ZS

As mentioned in the section on eccentricity, shaft bow is a concern with large steam turbines and thus a turning gear is used rather than allowing the rotor to come to a complete standstill when the turbine is not operating.

Turning gears are typically engaged when the rotor has slowed to an acceptable speed – usually less than 100 rpm on some turbines and for others much slower and in the range of only 2-3 rpm. At these speeds, if a conventional once-per-turn phase reference signal is used to indicate speed, it could take as much as 30 seconds between pulses measured by the speed indicating probe.

For this reason, a toothed wheel or gear is typically used, allowing the speed to be updated more frequently and speed to be measured more accurately (a full revolution of the shaft is not required to detect change). See Figure 11.

The zero-speed measurement is simply an underspeed alarm that detects when the rotational speed has dropped below an acceptable threshold and the turning gear can thus be safely engaged. Because the measurement is so critical, and the implications of engaging a turning gear before the rotor has sufficiently decelerated are so substantial, it is customary to use redundant probes and compare the rpm measurement from each to ensure they agree within a configurable percentage.

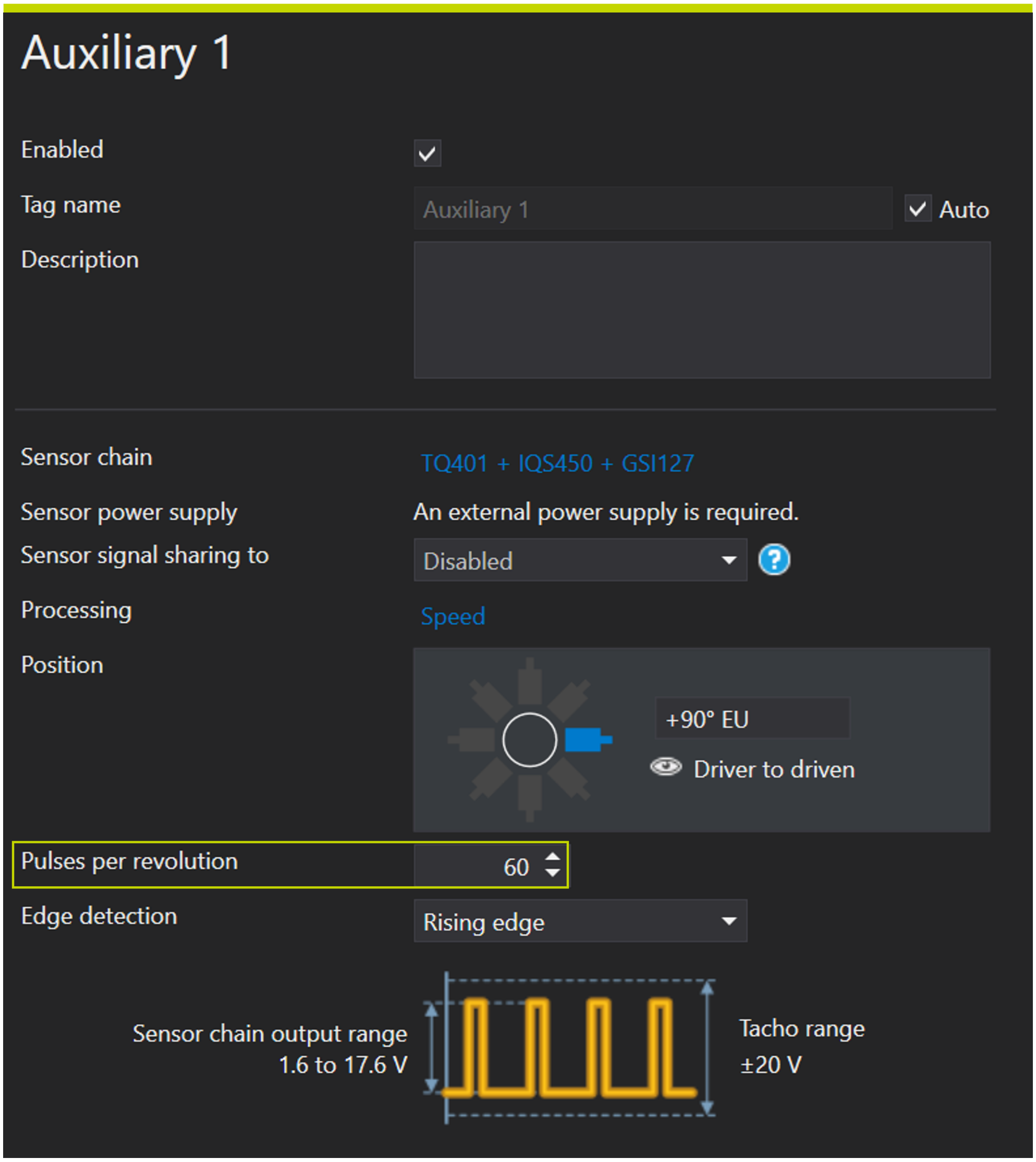


Figure 11

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a tachometer measurement from a 60-tooth gear. Such a configuration is typical of zero-speed measurements where adequately fast updates must be available – beyond what is available from a once-per-revolution phase marker when a machine is turning at very low rpms.

TURBINE SUPERVISORY INSTRUMENTATION

3 Conventional measurements

All machines with fluid-film radial and axial (thrust) bearings are best monitored by a suite of measurements that are not unique to large steam turbine generators.

As such, they cannot correctly be called “TSI” measurements, but they do form part of the total complement of measurements for these machines. These are discussed next.

X-Y Shaft-Relative Vibration XYSRV

These measurements (Figure 12) are made with a pair of orthogonal proximity probes mounted near each radial bearing.

The orthogonal probe arrangement allows measurement in each plane of vibration.

Because the probe mounting directions are rarely true horizontal and true vertical, they are generally
referred to as X and Y rather than horizontal and vertical. Not only can the vibration in each direction be measured, but a composite measurement showing the shaft orbit can also be obtained.

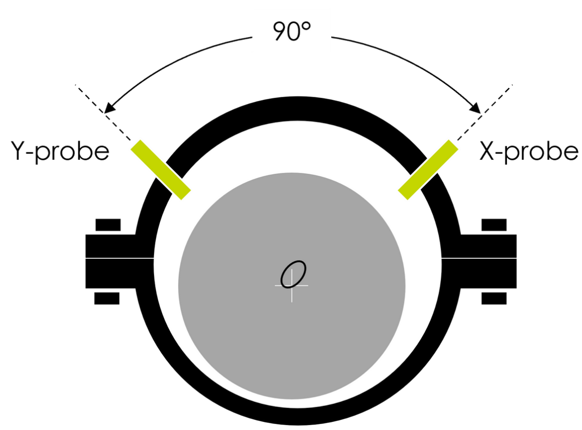


Figure 12

X-Y shaft-relative vibration measurements are made by means of two orthogonal proximity probes. They observe the instantaneous shaft position within the bearing clearance, relative to the probe mounting location (usually the bearing housing).

The largest axis of the orbit is known as Smax and is a common parameter computed by the monitoring system for assessing vibration severity – particularly in European countries. See also Figure 13.1 and 13.2.

When only a single probe is used, the measurement is referred to as simply shaft relative vibration (the X-Y is omitted). This is generally discouraged because it is only able to observe vibration in a single direction and is thus "blind" to vibration in the orthogonal axis – no matter how severe it might be.

A single probe also constrains diagnostic capabilities because an orbit can no longer be generated along with the highly useful information it contains.

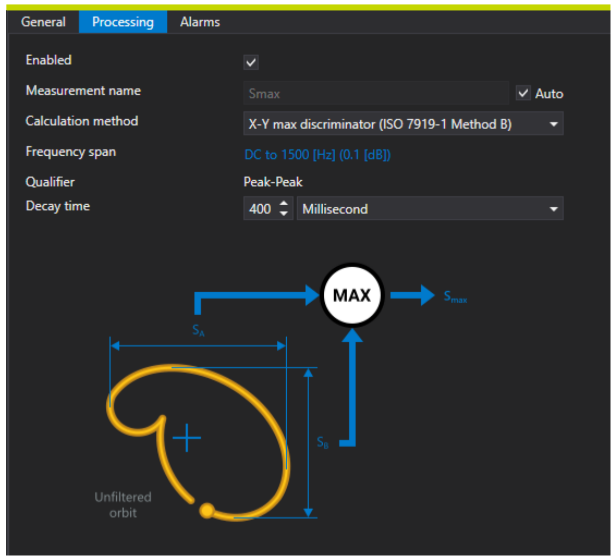


Figure 13.1

Figure 13.2

Screen captures from VM600Mk2 configuration software (VibroSight PROTECT) depicting an X-Y shaft-relative vibration measurement. Such a configuration creates a channel pair capable of returning not only individual amplitudes, but also composite measurements such as Smax. In this example, the X probe is on channel 1 and the Y probe is on channel 2. The bottom-most screen capture shows the composite signal from the two proves resulting in a shaft orbit. The major axis of the shaft orbit is known as Smax and is frequently used as a protective parameter.

Bearing Absolute Vibration / Shaft Absolute Vibration BAV/SAV

Thermal power plants usually employ multi-story buildings with the turbines on the top-most floor, allowing piping and associated steam admission to come from under the turbines. Such designs often result in compliant support structures where substantial seismic (bearing housing) vibration can occur.

While this is not limited to large steam turbine generators, it is quite typical of them. For such machines, it is advisable to measure both X-Y shaft relative vibration, as noted in the previous bullet, and also bearing housing vibration.

Although bearing housing vibration measurements are frequently made at “top dead center” on the bearing cap, and thus in the pure vertical axis (Figure 14), it is also possible to mount seismic (i.e., velocity or acceleration) sensors orthogonally in the same axis as the shaft relative proximity probe(s) on the same bearing. In this arrangement, so called “shaft absolute” measurements can be made which represent the subtraction of the cap seismic movement from the shaft relative movement.

Because the proximity probes measure the combined relative motion between the bearing housing and the shaft, by subtracting the bearing housing motion, it is possible to isolate the shaft motion relative to free space instead of relative to the bearing housing. For this reason, it is thus described as a shaft absolute measurement. See Figure 15.

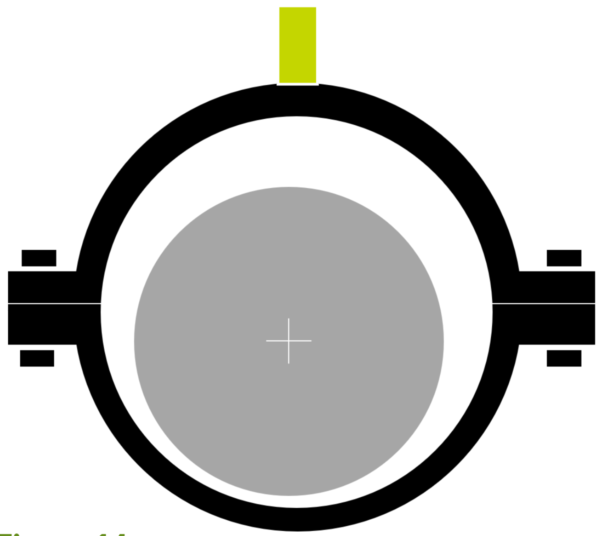


Figure 14

Bearing absolute vibration measurement involves use of a seismic sensor (velocity or acceleration) to measure the vibration of the bearing housing (or “cap”) relative to free space; it measures only housing motion – not shaft motion.

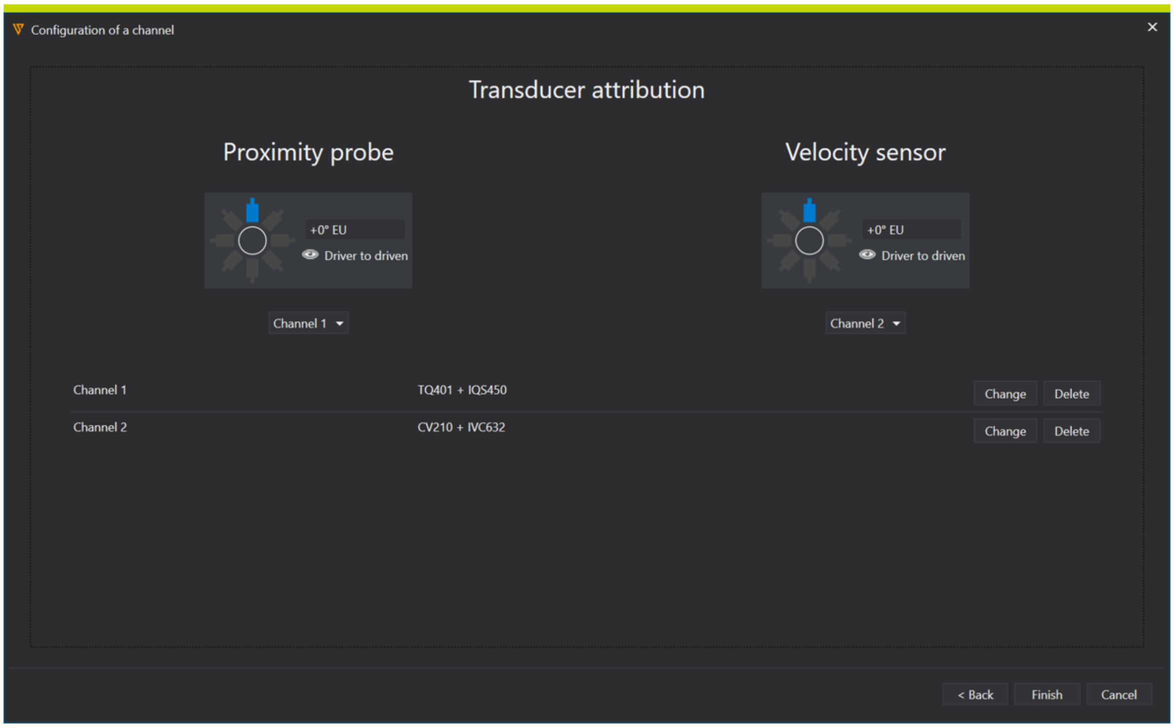


Figure 15

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) showing a channel pair used to make a shaft absolute measurement. It consists of a proximity probe on channel 1 and a velocity sensor on channel 2.

Axial (Thrust) Position AP

Axial position measurements (see Figure 16) are used to determine whether thrust forces are occurring in the expected direction (i.e., normal) or abnormal direction (i.e., counter) and if the bearing is properly constraining the shaft's axial movement.

Thrust bearing failures can be especially catastrophic because they allow rotating and stationary parts to come into contact along the entire length of the shaft, thus potentially damaging the entire rotor and every machine case.

Because this measurement is so vitally important as part of the machinery protection strategy, it customarily incorporates two probes in a dual-voting (2-out-of-2) arrangement where both probes must detect excessive movement before alarming. This voting is required under API standard 670 for machinery protection systems and it is a recommended best practice for all machinery. A configuration option also exists for 1-out-of-2 voting.

NOTE

When axial probes are rigidly affixed to the machine's casing, rather than the thrust bearing structure, the affect due to movement of the bearing structure is removed from the measurement. This is known as rotor position since it indicates the amount of movement relative to the machine casing rather than relative to the bearing to which it is attached (and which can also move). Unlike rotor measurements on casings that undergo significant thermal expansion, the rotor position measurement is assumed to be on casings that exhibit negligible thermal expansion. When the casing itself can undergo thermal expansion/contraction, the probe should be affixed to the machine's foundation rather than its case. See also the note on rotor expansion on page 4.

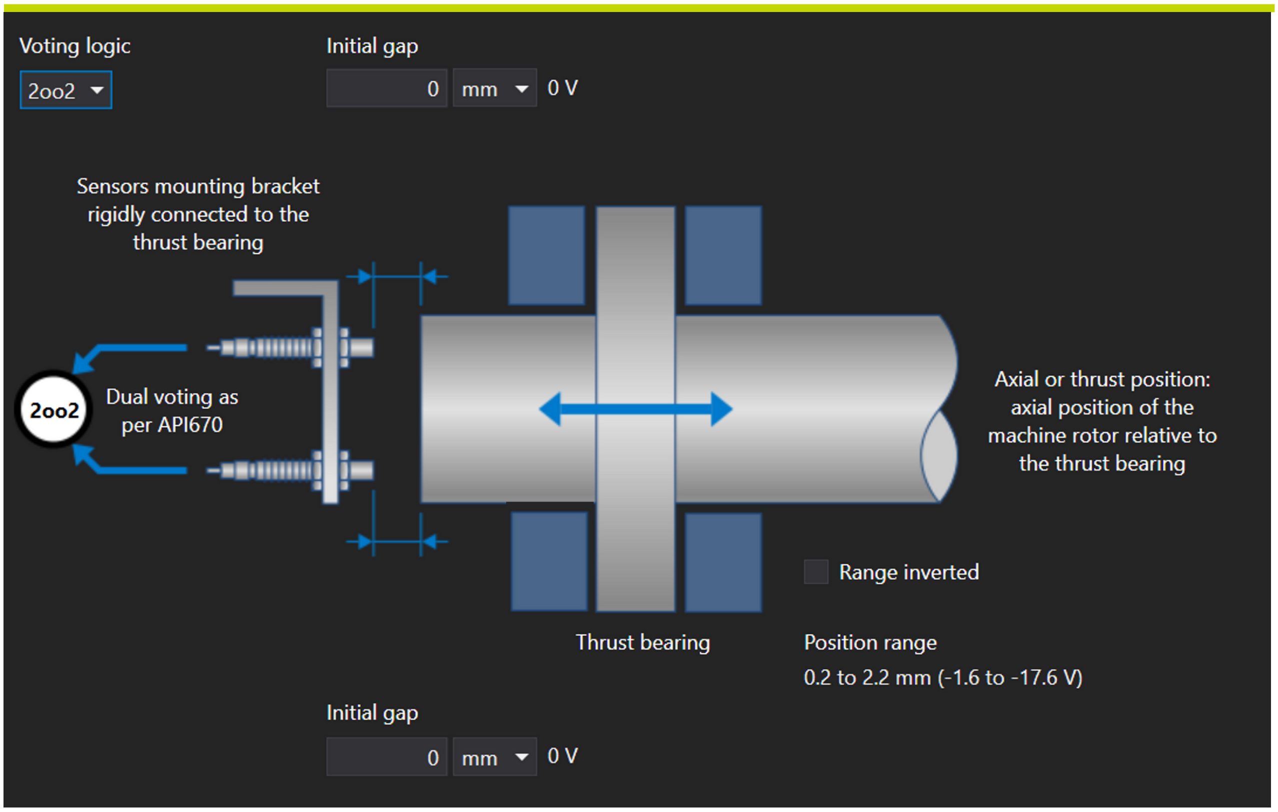


Figure 16

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a dual-voting (2oo2) axial position measurement. 1oo2 voting is also a configurable option using the appropriate drop-down voting logic selection in the upper-left corner of the screen.

Phase Trigger PT

Similar to a timing mark on an automotive engine's crankshaft, a phase trigger sensor provides a reference pulse such that the rotative position (degrees of rotation) of the shaft at a precise instant in time can be determined.

This measurement allows vibration phase to be computed for all radial vibration probes and bearing cap sensors as well as measurements filtered to multiples of machine running speed such as 1X, 2X, ½X, etc.

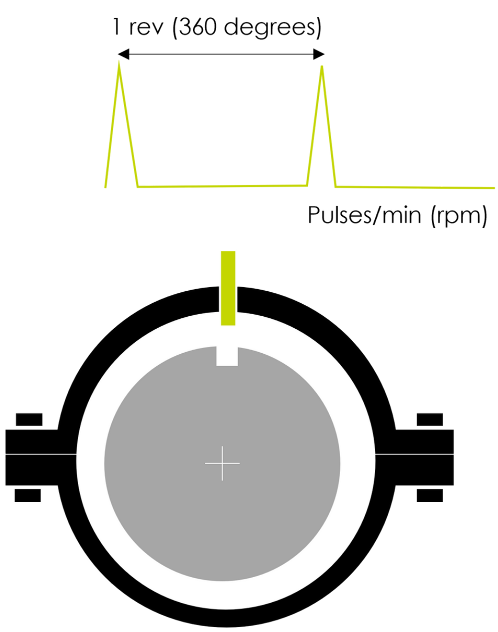


Figure 17

A phase trigger (or phase reference) sensor provides a once-per-turn signal used for phase measurements.

Phase is highly useful for vibration diagnostics and is in fact so useful, that diagnostics are greatly hampered if this phase reference information is lost. For this reason, many customers prefer to install redundant phase trigger probes so that in the event the primary probe fails, the secondary one is available.

Unlike many other measurements, such as a failed radial vibration sensor, a failed phase trigger
sensor affects almost every other sensor in terms of available machinery diagnostic capabilities. The shaft surface discontinuity for a phase trigger is often a key (projection) or keyway (notch) but sometimes consists of a groove made specifically for this purpose.

On large steam turbine generators, care should be taken to place the mark at a location where thermal growth of the rotor will not cause the discontinuity to move outside the observable probe field as can happen when the measurement occurs at the extreme end of the shaft near the generator or exciter.

If no other suitable location is available, the discontinuity should be sufficiently long so that any expansion or contraction does not allow the discontinuity to leave the probe's observable field.

A phase trigger sensor can also be used for speed measurements, but the update rate and accuracy will not be as good as is achievable from a multi-tooth wheel, such as that used for the zero-speed measurement. However, this is normally not a concern for machines turning at medium speeds such as a 3000 rpm or 3600 rpm steam turbine driving a generator.

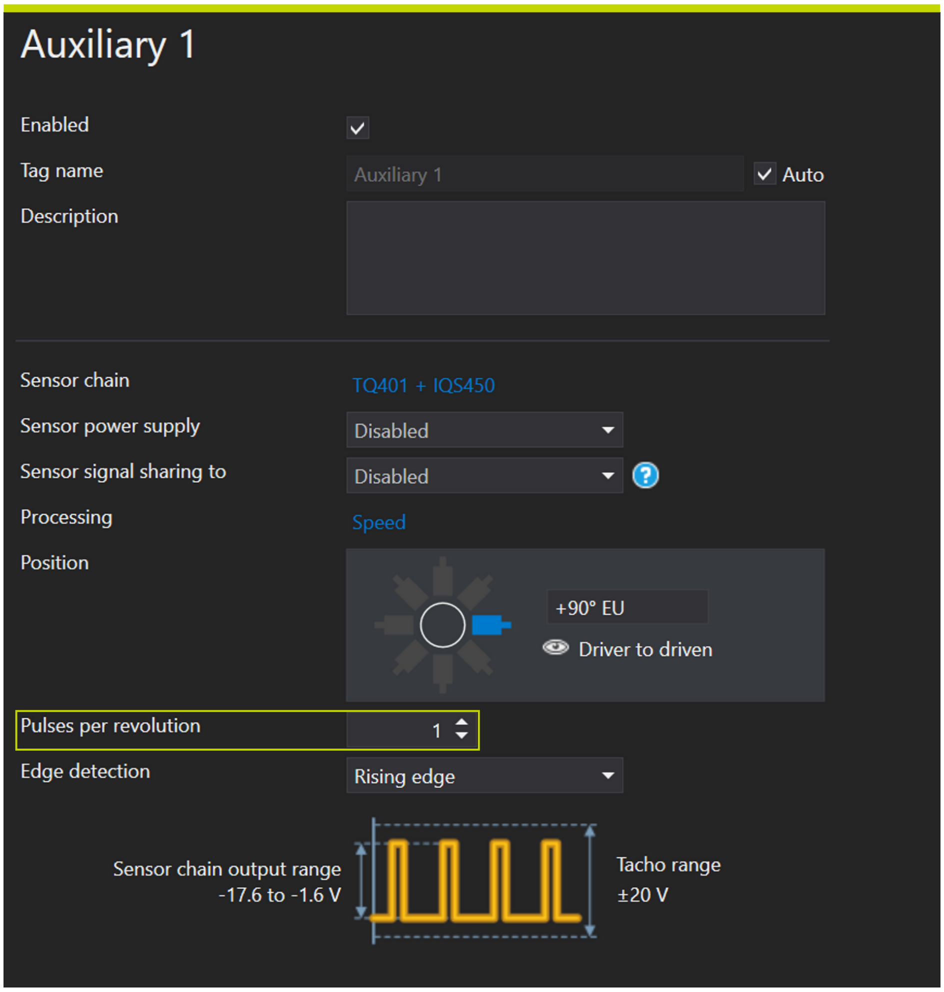


Figure 18

Screen capture from VM600Mk2 configuration software (VibroSight PROTECT) depicting a phase reference measurement. Unlike the configuration of Figure 11 (60 pulses per revolution), a true phase trigger must have only a single pulse per revolution.

Bearing Temperature T

Excessive loading on fluid-film bearings – whether radial or thrust – can melt the babbitt material and cause major issues beyond just the bearing if not detected.

It is customary to embed temperature sensors – whether RTDs or thermocouples – into the bearing to measure pad temperatures and ensure they remain within acceptable limits, well below the babbitt melting point.

Today, temperature measurements are frequently brought directly in the turbine control system where other protective parameters may also reside.

However, many customers still prefer to place these measurements in the vibration monitoring system. For such customers, the VM600Mk2 can directly accept both thermocouples and RTDs by means of special 8-channel monitoring modules.

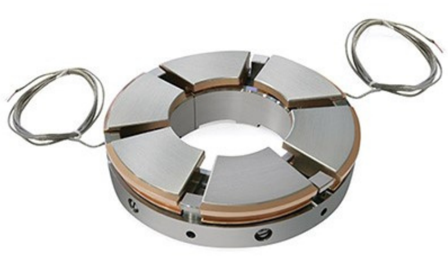


Figure 19

A typical tilting-pad thrust bearing with two embedded temperature sensors. Photo courtesy of bearingsplus.com.

Overspeed

Turbine overspeed is one of the most potentially catastrophic scenarios that a machine can sustain. Because the centripetal forces acting on rotating parts such as turbine blades and couplings are related to the square of the rotative speed, a turbine is designed to incur only small excursions (20-30%) beyond its rated speed – whether designed for the 50Hz (3000 rpm) or 60 Hz (3600 rpm) market.

When excessive centripetal forces occur, blades may liberate from the rotor, becoming projectiles and potentially puncturing the casing. In addition, rotors can bend, couplings can fly loose, and the machine can literally “come apart” (Figure 21).

For a steam turbine, this can be especially consequential because the hot, high-pressure steam is no longer constrained within the pressure vessel (machine case) and can inflict tremendous damage to people and property when it escapes.

For all of these reasons, overspeed measurements are very specialized, involving multiple layers of redundant tachometers and sensors, often in a 2-out-of-3 arrangement to achieve SIL 3.

The tachometer channels in our VM600Mk2 platform are thus not intended for overspeed measurements. Instead, we provide the SpeedSys300 platform (Figure 20), specifically designed to address turbine overspeed applications.

Industry best practice is to separate the overspeed system from the turbine control system as well as from the machinery vibration system; the SpeedSys300 is thus designed as a stand-alone platform for overspeed protection.

Figure 20

Vibro-meter's SpeedSys 300 is a SIL 3-rated overspeed detection system.

Figure 21

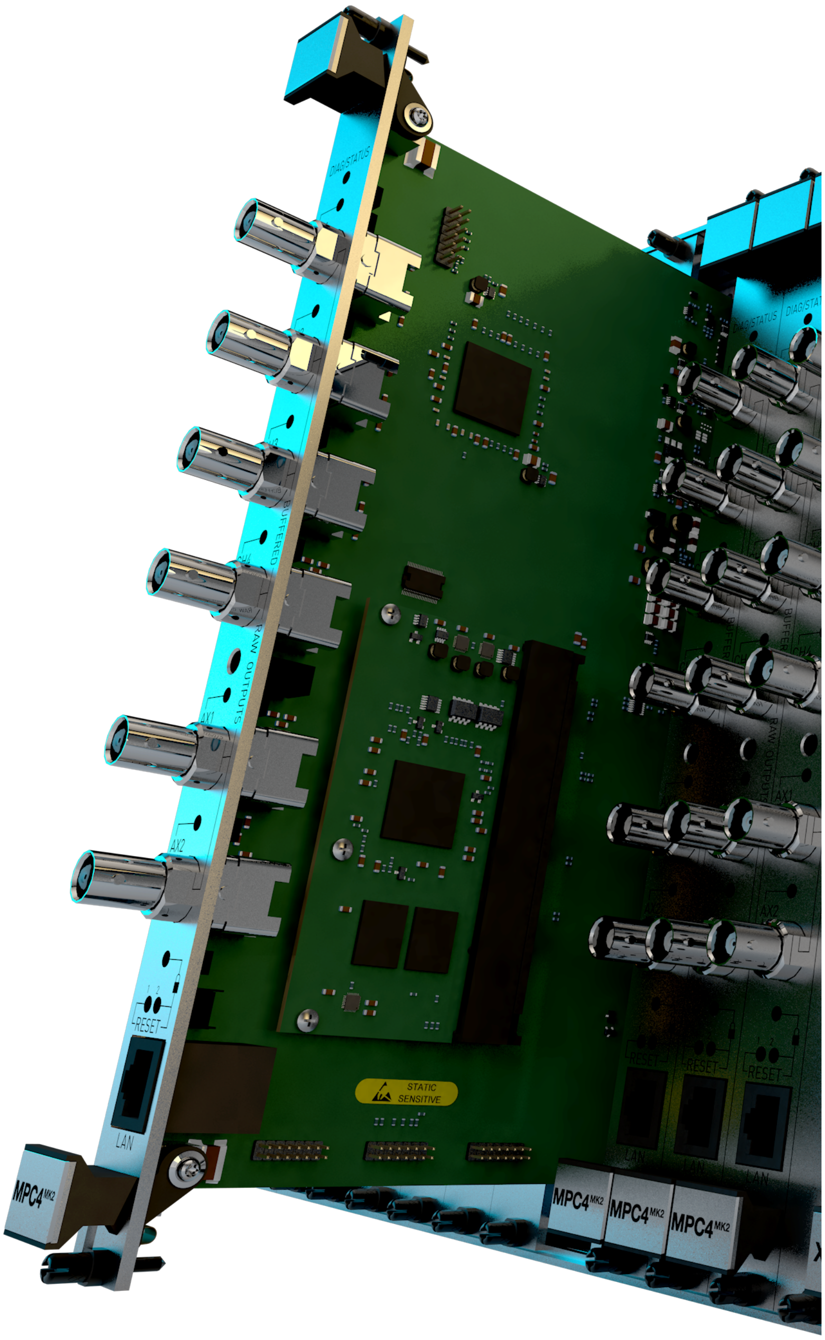
Aftermath of catastrophic overspeed of a 64MW steam turbine generator. A massive portion of a shaft spool piece (inset) punctured a wall many meters away during the event, coming to rest in the men's locker room.

4 TURBINE SUPERVISORY INSTRUMENTATION
Summary

The VM600Mk2 has been specially designed to address the measurement needs of most industrial machine types, including gas and steam turbines. For steam turbines in power generation service, specialized TSI measurements are required and the VM600Mk2 has channel types to address each of these. Because the VM600Mk2 uses an innovative “single module” design to provide all channel types in a single module (MPC4Mk2), spare parts are dramatically reduced.

In addition to machinery protective functions, the new MPC4Mk2 incorporates integrated condition monitoring capabilities, providing all necessary machinery measurement functionality in a compact, 6-channel design that occupies only a single slot in the VM600 chassis.

Customers can thus rely on vibro-meter to fully address the needs of these important machines with a second-generation platform that will provide reliable protection and condition monitoring well into the next two decades.



MEGGITT

About us

Meggitt pioneered high performance sensing and condition monitoring solutions for extreme environments. After working with the world's turbine manufacturers for more than 60 years, Meggitt through vibro-meter portfolio remains master of all aspects of the condition monitoring and machinery protection disciplines—how from high performance sensing, data acquisition and management to the high speed digital networking and the signal processing algorithms that can deliver diagnostics for prescriptive maintenance solutions.

Meggitt PLC

Headquartered in the United Kingdom, Meggitt PLC is an international group operating in North and South America, Europe and Asia. Known for its specialised extreme environment engineering, Meggitt is a world leader in aerospace, energy and defence markets. An 11,000-strong workforce serves customers from around 40 manufacturing facilities and regional offices worldwide.

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