SENTRAN

Glossary

Innovative Measurement Solutions

GLOSSARY OF TERMS FOR TRANSDUCERS, LOAD CELLS AND WEIGH MODULES

This purpose of this document is to provide a comprehensive, alphabetical list of terms and definitions commonly employed in the terminology and performance parameters relative to specifications for strain gauge based transducers and related devices. The definitions herein are compatible with common understanding in the industrial community.

ACCURACY
Stated as a limit tolerance that defines the average deviation between Actual Output and Theoretical Output. In practical transducer applications, the potential errors of nonlinearity, hysteresis, nonrepeatability and temperature effects do not normally occur simultaneously, nor are they necessarily additive. Therefore, accuracy is calculated based upon the RMS value of potential errors, assuming a defined temperature range, full rated load applied, and proper set up and calibration. Potential errors in other components of the measuring system, e.g. readout devices, structures, terminal connections, mechanical interfaces, and the like are not included.

AMBIENT CONDITIONS
The conditions (humidity, pressure, temperature, etc.) of the environment surrounding the transducer.

AMBIENT TEMPERATURE
The temperature of the environment surrounding the transducer.

ANGULAR LOAD, CONCENTRIC
A load applied concentric with the Primary Axis at the point of application, and at some angle with respect to the Primary Axis.

ANGULAR LOAD, ECCENTRIC
A load applied eccentric with the Primary Axis at the point of application, and at some angle with respect to the Primary Axis..

APPLIED LOAD
A mechanical force introduced to a transducer for purposes of producing a measurable electrical value.

AXIAL LOAD
A load applied along a line concentric with the Primary Axis.

BRIDGE RESISTANCE (WHEATSTONE)
The bridge input resistance is measured across the excitation terminal points in strain gauge-based transducers. The bridge output resistance is measured across the signal terminal points in strain gauge based transducers.

CALIBRATION
The comparison of a transducer output signal against a known standard.

CALIBRATION CURVE
A comparison of the transducer output to a known standard when the output is measured between the terminal points of zero (no-load) and rated capacity.

CAPACITY
See Rated Capacity

SENTRAN, LLC 4355 LOWELL STREET, ONTARIO, CA 91761, U.S.A.
888-545-8988 T: 909-605-1544 FAX: 909-605-6305 **www.sentranllc.com**

COMBINED ERROR (Nonlinearity and Hysteresis)
The maximum deviation from the straight line drawn between the terminal points of zero (no-load) and rated capacity, usually expressed as a percentage of the rated output and measured on both increasing and decreasing loads.

COMPENSATION
The utilization of supplementary devices, materials, or processes to minimize known sources of error.

CREEP
The change in transducer (load cell) output occurring with time, while under load, and with all environmental conditions and other variables remaining constant. Note: While this effect is present to some degree when load is placed on the load cell, it is usually measured with the rated load applied, and expressed as a percent of rated output over a specific period of time.

CREEP RECOVERY
The change in the transducer (load cell) output signal occurring with time immediately after removal of a load which had been applied for a specified time interval, environmental conditions and other variables remaining constant during the loaded and unloaded intervals. Normally expressed in units of % of applied load over a specified time interval. Normally the applied interval and the recovery interval are equal. It is common for characterization to be measured with a constant load at or near capacity.

CREEP RETURN
The difference between the transducer (load cell) output signal prior to application of a load for a specified time interval (usually minutes) and the output signal following removal of the load for the same period as it was applied. Expressed in units of % of applied load over a specified time interval, it is common for characterization to be measured with a constant load at or near the transducers rated capacity.

CROSSTALK
With one transducer component loaded to capacity, and the other unloaded, the output of the unloaded component should not exceed a specified tolerance, usually expressed as a percentage of rated output.

CYCLIC LOADING
Cyclic loads on a structure can lead to fatigue damage, cumulative damage, or failure. These loads can be repeated loadings on a structure or can be due to vibration.

DEAD LOAD
Dead loads are also known as permanent or static loads. These are loads that are static over time, such as a frame, structure or other immovable object.

DEFLECTION
The change in position of the transducer along the primary axis, with all other mechanical influences remaining constant, between no-load and rated load conditions, usually expressed in inches (mm).

DRIFT
A random change in output under constant conditions.

DYNAMIC LOAD
A dynamic load is non-static loading. It may involve considerations such as impact, momentum, vibration, slosh dynamics of fluids and similar phenomenon.

ECCENTRIC LOAD
Any load applied parallel to, but not concentric with, the primary axis.

ERROR
The algebraic difference between the indicated value and true value being measured.

EXCITATION
The voltage or current applied to the input (excitation) terminals of the transducer bridge.

FATIGUE CAPACITY
Capacity as a percentage of the nominal load limit capacity, and based on 1 x 106 cycles (minimum) from zero to full fatigue capacity and 5 x 106 (minimum) from full fatigue capacity tension to full fatigue capacity compression load.

FULL SCALE OUTPUT (FSO)
The output corresponding to the signal generated by a transducer when loaded to its rated capacity. Also referred to as rated output.

HYSTERESIS
The algebraic difference between 1) the output at a given descending load point from the maximum rated load, and; 2) the output at the identical load point ascending from minimum load. It is typical for the measurement load point to be at 40-60%FS, and expressed in units of %FS. Measurements should be taken as rapidly as possible to minimize the potential effect of creep.

IMPACT LOAD
An impact load is one whose time of application on a material is less than one-third of the natural period of vibration of that material.

INPUT RESISTANCE
The resistance of the transducer bridge circuit measured at the “+” and “-” excitation terminals with no load applied and with the output terminals open-circuited.

INSULATION (LEAKAGE) RESISTANCE
The DC resistance measured between three points: the transducers bridge circuit and the transducer element; the transducer bridge circuit and the cable shield; the transducer element and the cable shield. Note: Normally insulation resistance is measured with a minimum of fifty volts DC potential applied and under standard test conditions.

LIVE LOAD
An imposed load borne or sustained as a quantity for measurement of weight, force, torque or pressure.

LOAD
A weight, force, torque or pressure properly applied to the transducer.

LOAD CELL
A precision, electromechanical spring element commonly constructed of alloy tool steel, stainless steel or an aluminum alloy that produces a low level voltage output signal proportional to an applied load, weight or force.

LOAD MODE
A method of application of a load. Load can be defined as compression (pushing), tension (pulling), torsional (twisting), universal (pushing or pulling) or multi-axis (involving torsional and axial loading in combination).

MAXIMUM LOAD
The highest load identified for a specific test or application, which may be any load up to and including the rated capacity of the device.

MAXIMUM LOAD, SAFE
The maximum axial load which can be applied safely as determined by the manufacturer, without producing a permanent shift in performance characteristics beyond those specified. Normally expressed in units of %RC (Rated Capacity).

MAXIMUM LOAD, ULTIMATE
The maximum load which can be applied as determined by the manufacturer, without potentially producing a structural failure. Normally expressed in units of %RC (Rated Capacity)

MAXIMUM LOAD MOMENT, SAFE
The maximum moment which can be applied safely as determined by the manufacturer, without producing a permanent shift in performance characteristics beyond those specified. Normally expressed in units of %RC (Rated Capacity).

MAXIMUM MOUNTING TORQUE, SAFE
The maximum torque which can be applied safely as determined by the manufacturer, without producing a permanent shift in performance characteristics beyond those specified. Normally expressed in units of %RC (Rated Capacity).

MAXIMUM SIDE LOAD, SAFE
The maximum side load, or force, which can be applied safely as determined by the manufacturer, without producing a permanent shift in performance characteristics beyond those specified. Normally expressed in units of %RC (Rated Capacity).

MEASURING RANGE
A selected range of active measurement between minimum capacity and maximum capacity of a transducer or of a transducer system for a given application.

MODE
The direction of the applied load which is commonly referred to in terms such as compression, tension, universal (compression and tension), torsional, absolute, relative, differential, bi-axial, or multi-modal.

NATURAL FREQUENCY
The frequency of free oscillations under conditions of no load.

NO LOAD
The condition of the transducer when in its normal physical orientation there is no load of any kind applied.

NOMINAL LOAD LIMIT CAPACITY
The designed normal operating maximum capacity of a transducer. Output sensitivity of a transducer is based on this capacity unless otherwise specified.

NONLINEARITY
The algebraic difference between 1) the output at a given load point ascending from zero, and; 2) the theoretical straight line between zero load and rated capacity. For specification purposes, it is common for the measurement load point to be at 50%FS as this is typically the point of maximum nonlinearity. Nonlinearity is expressed in units of %FS. Measurements should be taken as rapidly as possible to minimize the potential effect of creep.

NONREPEATABILITY
The maximum difference between output readings for identically repeated loads under identical loading and environmental conditions. Normally expressed in units of %RO.

OUTPUT
The electronic signal (voltage, current, etc.) produced by the transducer and measured as the algebraic difference between the signal at applied load and the signal at minimum load. Note: When the signal is directly proportional to the excitation, the output must be expressed in terms of volts per volt, volts per ampere, etc. of excitation.

OVERLOAD RATING, SAFE
The maximum load in percent of rated capacity, which can be applied to the transducer without producing a permanent shift in performance characteristics beyond those specified.

OVERLOAD RATING, ULTIMATE
The maximum load in percent of rated capacity, which can be applied without risk of structural failure of the load-bearing element.

OUTPUT RESISTANCE
The resistance of the transducer bridge circuit measured at the “+” and “-” signal terminals with no load applied and with the input terminals open-circuited.

PRESSURE TRANSDUCER
A precision, electromechanical assembly commonly constructed of alloy tool steel, stainless steel or analuminum alloy incorporating a spring element and bridge circuitry that when excited by a voltage produces a low level voltage output signal proportional to an applied pressure.

PRIMARY AXIS
The axis along which the transducer is designed to be loaded for measurement purposes.

PSI (psi)
The abbreviation for pounds per square inch.

PSIA (psia)
The abbreviation for pounds per square inch absolute.

RATED CAPACITY (RC)
The Maximum axial load that a transducer is designed to measure within its specifications.

RATED OUTPUT (RO)
The algebraic difference of the transducer output at no-load compared to its output with the rated load applied.

REFERENCE STANDARD
A force-measuring device whose characteristics are precisely known relative to a primary standard.

RESISTANCE, ELECTRICAL
A measure of the degree to which an object opposes the passage of an electric current. The standard primary unit of electrical resistance is the Ohm.

RESOLUTION
The smallest change in mechanical input that produces a measurable change in the output signal.

SENSITIVITY
The ratio of the measurable change in the output signal to the change in the mechanical input (load).

SHUNT CALIBRATION
The electrical simulation of a transducer output signal accomplished by connecting a resistance at appropriate points in the circuitry of a value known to produce a specific output value.

SIDE LOAD
Any load applied to the transducer which is perpendicular relative to the primary load axis. For example, an applied load acting at 90° relative to the primary axis is considered a “pure” side load.

SIDE LOAD REJECTION
The mechanical and/or electrical ability of a transducer to ignore the effects of an applied side load with or without a load being simultaneous applied in the primary measurement axis. Side load rejection is typically expressed as a ratio of applied axial load to maximum recognition of an applied side load, e.g. a side load rejection ratio of 500:1.

SIGNAL
The output (voltage, current, etc.) produced by the transducer and measured as the algebraic difference between the signal at applied load and the signal at minimum load. Note: When the signal is directly proportional to the excitation, the output must be expressed in terms of volts per volt, volts per ampere, etc. of excitation.

SPAN
The numerical value of the variation between the output at no load and the output at rated load.

SPECIFICATION
The error limits within which a device should function for a given technical parameter; An explicit set of requirements to be satisfied by a material, a design, and/or a product.

STABILIZATION PERIOD
The time required to assure that any further change in a measured parameter is accepted as stable.

STANDARD TEST CONDITIONS

A set of standard environmental conditions under which measurements are made for purposes of achieving measurement reciprocity. Non-standard measurement conditions can result in significant measurement differences.
Standard test conditions are as follows:

- Temperature: 72°F (23°C)
- Relative Humidity: 90% or less
- Barometric Pressure: 28 to 32 inches Hg
- Gravity: The uncertainty in force is dependent upon the uncertainties in the measured values of the mass, gravitational acceleration, and the ratio of the air and weight densities present at the test location. These site values are generally measured and certified by a meteorological authority and the value of these effects then become a part of the measurement correction algorithm for the site.

STATIC ERROR BAND

An error band depicting maximum deviations for ascending and descending calibration points from a best fit line through zero output. This band takes into account the effects of nonlinearity, hysteresis, and zero return, being expressed in units of %FS.

STRAIN GAUGE

A strain gauge is a device used to measure strain on an object. The most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive, such as cyanoacrylate. As the object is deformed, the foil is deformed, causing its electrical resistance to change. This resistance change, usually measured using a Wheatstone bridge, is related to the strain by the quantity known as the gauge factor.

SYMMETRY ERROR

The algebraic difference between the rated output in tension and the average of the absolute values of rated output in tension and rated output in compression. Normally expressed in units of % of Rated Output (RO).

TEMPERATURE EFFECT ON OUTPUT

The change in output due to a change in ambient temperature. Normally expressed as the slope of a chord spanning the compensated temperature range and in units of %/°F or %/100°F.

TEMPERATURE EFFECT ON ZERO BALANCE

The change in zero balance due to a change in ambient temperature. Normally expressed as the slope of a chord spanning the compensated temperature range and in units of %/°F or %/100°F.

TEMPERATURE RANGE, COMPENSATED

The range of temperature over which the transducer is compensated to maintain rated output and zero balance within specified limits.

TEMPERATURE RANGE, SAFE (OPERATING)

The extremes of temperature within which the transducer will operate without permanent adverse change to any of its performance characteristics.

TERMINAL RESISTANCE

The resistance of the transducer circuit measured at specific adjacent bridge terminals, at standard temperature, with no-load applied, and with the excitation and output terminals open-circuited.

TERMINAL RESISTANCE, EXCITATION (INPUT)
The resistance of the transducer circuit measured at the excitation terminals, at standard temperature, with no-load applied, and with the output terminals open-circuited.

TERMINAL RESISTANCE, SIGNAL (OUTPUT)
The resistance of the transducer circuit measured at the output terminals, at standard temperature, with no-load applied, and with the excitation terminals open-circuited.

TOGGLE EFFECT
The shift in zero balance resulting from a complete cycle of equal tension and compression loads. Normally expressed in units of %FS.

TORQUE TRANSDUCER
A precision, electromechanical assembly commonly constructed of alloy tool steel, stainless steel or an aluminum alloy incorporating a spring element and bridge circuitry that when excited by a voltage produces a low level voltage output signal proportional to an applied torque.

TRACEABILITY
The step-by-step transfer process by which the transducer calibration can be related to primary measurement standards.

ULTIMATE OVERLOAD
The point at which the structural element of the transducer is susceptible to critical damage, including ultimate failure (material breakdown). This specification is commonly established at reasonably conservative levels, as the liability associated with an ultimate failure can be very significant in terms of human safety and material risk.

WHEATSTONE BRIDGE
A measuring instrument invented by Samuel Hunter Christie in 1833 and improved and popularized by Sir Charles Wheatstone in 1843. It is used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. The Wheatstone Bridge can be used to measure very low values of resistances down in the milli-Ohms range.

WHEATSTONE BRIDGE CIRCUIT
An electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. The Wheatstone Bridge circuit is nothing more than two simple series-parallel arrangements of resistances connected between a voltage supply terminal and ground producing zero voltage difference between the two parallel branches when balanced. A Wheatstone bridge circuit has two input terminals and two output terminals consisting of four resistors configured in a diamond-like arrangement.

ZERO BALANCE
The output signal of the transducer with the rated excitation voltage applied and with no load applied. zero balance usually is expressed in percent of rated output (Full Scale Output).

ZERO RETURN

The algebraic difference between the zero balance as measured immediately before applying a load for a specified duration of time, and the zero balance as measured immediately after removing a load for the same duration of time.

ZERO SHIFT, PERMANENT

A permanent change in the no-load output.

ZERO STABILITY

The degree to which the transducer maintains its zero balance value for a specified duration of time, with all environmental conditions and other variables remaining constant, usually expressed in percent of rated output.

SENTRAN, LLC 4355 LOWELL STREET, ONTARIO, CA 91761, U.S.A.
888-545-8988 T: 909-605-1544 FAX: 909-605-6305 **www.sentranllc.com**
T-109.00