Brüel & Kjær Vibro

Encyclopedia

R

Rack

A frame in which a number of electrical or electronic items or modules are mounted and interconnected to operate as an assembly and to perform some specific functions.

Radial

A direction at a machine which is perpendicular to the shaft axis and in the plane of the measurement sensor. In general shaft and casing vibrations are measured in a radial direction.

Radial clearance

Bearing clearance which, due to a different location of the shaft within the bearing shells with two consequential measurements when aligning, can possibly lead to different measured values.

Radial vibration

See Vibration, radial

Radio clock

A radio-controlled quartz clock, which is corrected by signals from time-signal or standard frequency transmitters. In Germany the Federal Physical Technical Institute in Braunschweig is assigned to determine and distribute the legal time information. The definition of the time takes place with the help of highly-stable atomic clocks. The distribution of the official time is made by a time-signal and normal frequency transmitter DCF 77 on long wave $77.5\ kHz$, whose atomic clocks are controlled by the Federal Physical Technical Institution. The long-wave carrier frequency is transmitted within an accuracy of $2x10^{-13}$. The data for second, minute, hour, calendar day, weekday, calendar month and calendar year is transmitted by means of a multiple-coded modulation of the highly-stable sine-wave carrier. Radio clocks are corrected by evaluation

Encyclopedia

R

of the time telegram (usually periodically, e.g. once per 24 h). They consist of the functional modules time-signal receiver with a magnetic-rod antenna, evaluation and control unit, display unit. With the progressing of electronics an ever-closer integration of time-signal receiver and evaluation unit is carried out. Radio clocks can be operated up to distances of more than 1,500 km from the long-wave transmitter DCF 77 in Mainflingen in Frankfurt/Main.

Rahmonic

An individual line in a Cepstrum. A rahmonic in a Cepstrum is a single line which represents a family of harmonics. Its quefrency (the abscissa value with a time dimension in $msecs$) corresponds to the reciprocal frequency spacing of the harmonics in the frequency spectrum.
In certain cases (e.g. with frequency modulation) higher rahmonics can also occur, which do not indicate existent sub-harmonics in the spectrum. In general it is sufficient to consider the fundamental rahmonics which are not quefrency multiples of each other. They contain very significant information about the respective harmonics or sideband families.

Random error

See Error, random

Random time signals; stochastic time signals

Time signals whose course is not predictable, since they derive from a random process that gives out a finite or infinite number of possible signals with predefined probability. Therefore, the statistical properties of stochastic time signals can only be described by means of probability calculations.

Brüel & Kjær Vibro

Encyclopedia

R

RC circuit

An electrical circuit which, as a circuit element, (beside amplifying constructional elements) contains perhaps only resistances (R) and condensers (C). If these circuits are used as filters, then one speaks of RC-filters. Examples are (Fig.1) with the complex transfer function of the RC high-pass

$$\frac{\underline{U_a}}{\underline{U_e}} = \frac{j\omega\tau}{1 + j\omega\tau}$$

and the RC low-pass with the complex transfer function

$$\frac{\underline{U_a}}{\underline{U_e}} = \frac{1}{1 + j\omega\tau}$$

$\tau = RC$. The filters in Fig. 1 and Fig. 2 are four-poles and are thus characterized as such. Two-pole RC-circuits are characterized as RC-two-poles.

RC element

A frequency-dependent four-pole formed from a resistance and capacitance and frequently used in a switching configuration in electronics.

RC elements are used among other things as differentiation circuits or as integrators, for the setting up of filters (high-pass filters, low-pass filter') for the smoothing of parallel alternating currents; as frequency-determining elements in the feedback branch of an oscillator (RC-oscillator, RC-generator); to the coupling, e.g. of amplifier stages (RC-amplifiers).

RC filter

See RC circuit

Brüel & Kjær Vibro

Encyclopedia

R

RC filter, active

A filter with low-, high- and broadband characteristics under application of amplifiers (operational amplifier) and RC networks.
The transfer function of the filter is

$$\frac{\underline{U_a}}{\underline{U_e}} = -\frac{R_N}{R_1}\frac{1}{1 + j\omega C_N R_N}$$

RC generator

See Measurement generator

RC high-pass

See RC circuit

RC low-pass

See RC-circuit

Reactance

Reactance is a circuit element's opposition to an alternating current, caused by the buildup of electric or magnetic fields in the element due to the current. Both fields act to produce counter emf that is proportional to either the rate of change (time derivative), or accumulation (time integral) of the current. In vector analysis, Reactance is the imaginary part of electrical impedance, used to compute amplitude and phase changes of sinusoidal alternating current going through the circuit element. It is denoted by the symbol. The SI unit of reactance is the Ohm.

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Encyclopedia

R

Reactance, capacitive

Capacitive reactance x_C is an electrical resistance inversely proportional to the signal frequency f and the capacitance C.

$$x_C = -\frac{1}{\omega C} = -\frac{1}{2\pi f C}$$

A capacitor consists of two conductors separated by an insulator, also known as a dielectric.

Reactance, inductive

Inductive reactance x_L is an electrical resistance proportional to the signal frequency f and the inductance L.

$$x_L = \omega L = 2\pi f L$$

An inductor consists of a coiled conductor. Faraday's Law of electromagnetic induction gives the back emf (voltage opposing current) due to a rate-of-change of magnetic flux density through a current loop.

Reaction time

In a central processing unit, the time interval between the end of the arrival of a type of problem and the beginning of the processing.

Reaction time to an interrupt signal

The R. is the time interval between the production of an external interrupt signal by the technical process and execution of the first instruction of the associated interruption-answer program in the process computer. This is influenced by the characteristics of the operating system of the computer and by the current load. Deviating from the above definition, in the literature frequently the term "answer period until reaction time" is frequently used.

Brüel & Kjær Vibro

Encyclopedia

R

Reactive current

The component of the current vector, which stands perpendicularly to the direction of the associated vector of voltage:

$$I_b = Isin(\varphi_u - \varphi_i) = Isin(\varphi)$$

Here φ is the phase angle between current and voltage.

Reactive power

The oscillating power in a circuit with reactive elements (capacitance, inductance).

$$P_b = UIsin(\varphi)$$

φ designates the phase difference between current I and voltage U. In the difference between current I and U, and in contrast to it, the active power is converted into another form of energy.

Reactive voltage

The component of the voltage vector which stands perpendicularly to the direction of the associated vector of current:

$$U_b = Usin(\varphi_u - \varphi_i) = Usin(\varphi)$$

Here φ is the phase angle between current and voltage.

Read-only memory

Abbr.: ROM

Brüel & Kjær Vibro

Encyclopedia

R

The user can read the data with a computer from a R., has however no access to the inside of this memory. Once accommodated by the manufacturer on a R. the information can no longer be changed nor deleted. The information remains also after switching the computer off. The general representative of this memory category is the ROM <*read only memory*>, in which the basic operating system, usually also the inserted basic programming language and ever more frequently also *application programs* are contained. ROMs belong also to the category of *non-volatile* memory.

Real current

The projection of the current vector $I^{j\varphi_j}$ onto the direction of the voltage vector $U^{j\varphi_u}$ that belongs to it, i.e. the components of the complex current that is in phase with the voltage:

$$I_w = Icos\left(\varphi_j - \varphi_u\right) = Icos(\varphi)$$

Real-time analyser

The term for a spectrum analyser, which accomplishes the frequency analysis in a real-time operation.

Real-time bandwidth

Frequency range, for which a frequency analysis is possible in a real time operation (real-time processing). The run time for a digital signal analysis is composed of a combination of measurement acquisition time and computing time. During the measurement acquisition time, at the resolution determined by the measurement task, the computing time is a quantity which is dependent upon the hardware of the analyzer.
When the calculation time is shorter than the measurement acquisition time and the calculation is undertaken in parallel with the measurement acquisition, one speaks of real-time operation or real-time processing. The frequency range up to which real-time operation is possible is designated the R. A higher R. requires a higher level of computing power on the part of the analyser. If the analyser does not work in a real time operation, then the measurement acquisition is always terminated before the last computation is completed.

Brüel & Kjær Vibro

Encyclopedia

R

The measurement acquisition is in this case always interrupted up to the conclusion of the computation. Only afterwards can the data be processed. In this non-real time operation, signal information is practically lost.

Real-time frequency

Upper frequency of the frequency range for which frequency analysis is possible in real-time operation.

Real-time processing

A process type using a program for the processing of incoming data which is constantly executable and in such a manner that the processed results are available within a given time interval.

Note 1: The data can, depending upon the application, be obtained after a temporally coincidental distribution or at pre-determined times.

Note 2: The designation "real time processing" is to be avoided, because this term has another meaning in analogue computer technology and simulation techniques.

Real-time processing; Real-time operation

The mode of operation of a computing system, in which programs for the treatment of resulting data are constantly ready for use and in such a manner that the processing results are available within a given time interval. The data can arise, depending upon the application, after a temporally coincidental distribution or at pre-determined points in time. The processing of information (data) at the same speed at which it arises. In contrast to R., during batch processing the information is only collected and processed then in batches. The R. is of special importance for the operation of process computers. Here the electronic processing of the data takes place in the computer with the speed at which the results are required at the output.

Brüel & Kjær Vibro

Encyclopedia

R

Real current

The projection of the voltage vector $U^{j\varphi_j}$ onto the direction of the current vector $I^{j\varphi_u}$ that belongs to it, i.e. the components of the complex current that is in phase with the voltage:

$$U_w = Ucos(\varphi_j - \varphi_u) = Ucos(\varphi)$$

Rear wiring

The totality of the electrical connections at the rear of modules or deployments.
The connection elements are usually provided in wiring frameworks so that the individual connector lugs are located in a given raster perpendicularly on one level. The wiring can be produced with actual wire (or a cable) or as a printed circuit.

Reciprocal transducer

Linear, passive, reversible electromechanical or electroacoustic transducers whose conversion coefficient is equal in both directions.

Record

Data set

Rectangular pulse; square wave pulse

A single-directional impulse, which has a negligibly short rise time and fall-off time and a practically constant instantaneous value regarding its pulse time during this period.

See also rectangular vibration

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Encyclopedia

R

Rectangular vibration; rectangular oscillation

A varying quantity with a rectangular course over time, usually produced by a function generator or an astable trigger circuit. There are applications within all ranges of electronics, in particular in digital techniques.

Rectangular window

The R. is a commonly used window function in digital signal analysis. It represents a special case, because no weighting is applied to the section of the signal which is to be analysed. The result is discontinuities at the edges of the signal if an integer number of periods of the time signal do not exactly fit into the time window.

The most important criteria with the selection of the R. for a practical application are:

- It delivers the best amplitude accuracy (0 % error), but only when an integer number, or multiple, of complete periods of the time signal fit into the frequency range of the selected time window. It is suitable, e.g. for the analysis of transient events which result from shocks or impacts.
- Because no weighting is applied in the measurement, it is especially suitable for the investigation of transient events.
- Discontinuities are created at the edges of the time window with non-periodic signal sections.

The amplitude error in these cases can amount to up to $36\ \%$ ($3.92 \rightarrow$ Decibel [dB]).

Note: With the analysis of periodic vibrations from a machine, the measurement acquisition should always carried out by means of rotor-synchronous signal sampling. This guarantees the periodicity of the signal section acquired and the R. is in this application then ideally suitable.

Rectifier; Rectifier element; Rectifier diode

An electronic constructional element whose resistance value is dependent upon direction. These R. are semiconductor electric rectifiers. Earlier, rectifier tubes were also used.

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Encyclopedia

R

Redundancy

1) The presence of more functionally capable means in a unit than are necessary for the fulfilment of the demanded functions.

Note 1: The number of means without R. which are necessary depends upon the individual case.

Note 2: The conservation of R. requires maintenance, i.e. the monitoring, preservation and, in the case of a failure, the re-establishment of the operational capability of all the means.

2) Information with one determines the content of repetition. R. serves for the reliability and error recognition. If on a transmission path a part of the information is lost, this part can be reconstructed by redundant but correctly transmitted data. During the transmission of data minimum R. is sent with, which permits error recognition and correction.

Reference plane

A plane perpendicular to the shaft axis at which unbalance reference is made.

Reference voltage

A reference quantity in constructional groups in analogue techniques, against which all potentials representing similar quantities are referred. One represents the analogue values then not by the associated potential, but by the relationship between the associated potential and the R. Usually the maximum possible amount of the computing potentials is selected as the R. Thereby the analogue values can be expressed by proper fractions.

Brüel & Kjær Vibro

Encyclopedia

R

Reference voltage source

See Constant voltage source

Regression

Representation of the relationship between a one-dimensional, quantitative, coincidental variable *Y* (regressand, dependent variable) and a one or multi-dimensional coincidental variable $\underline{X}$ (regressor, independent variable) by means of a model $Y = f(\underline{X}) + E$. Thereby $f(\underline{X})$ designates the so-called regression function and E an error quantity.

If $f(\underline{X})$ is a conditional location measure of Y, due to the implementation possibilities of $\underline{X}$ (as a rule, not necessarily, the anticipation value), one speaks of a regression function of type 1. If one sets for a (e.g. linear) function of the components of $\underline{X}$, whose parameters one selects in such a way that they optimally fulfill certain characteristics of a regression function of the 1st kind (e.g. minimum dispersion of the V factors around the regression function), e.g. according to the so-called method of the smallest deviation squared, then one speaks of the 2nd type of regression function.

The subject of a regression analysis is the estimation of the parameters in one of the types according to the given 2^{nd} type of regression function.

Relative bearing clearance

See Bearing clearance, relative

Relative motion

Motion (vibration) referred to a selected mounting plane for the measurement sensor (relative sensor), normally the bearing or bearing block (cover).

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Encyclopedia

R

Relative power level

See Power level, relative

Relative sensitivity (of a transducer)

Relationship of the sensitivity of a transducer under special conditions to a particular reference sensitivity of the same type.

Relative sensor

Sensors which acquire, or measure, the movement of the item under test against an appropriately selected reference system (e.g. bearing or bearing block). This reference system can itself be in motion.

Relative shaft vibrations

See Shaft vibration, relative

Relative shaft vibration measurement

See Shaft vibration, relative

Relative vibration sensor

See Sensor, relative

Brüel & Kjær Vibro

Encyclopedia

R

Relay

A constructional element which through changes in an action quantity makes an opening, closing or switching of electrical circuits and power amplification possible. In the broader sense are included all electronic constructional elements and functional groups used as control switches (e.g. switching transistors and/or light barriers), and in the more narrow sense the contact constructional element with mechanically moving parts.

Reliability

The state of a unit with regard to its aptitude, during or after prescribed periods of time, to fulfil the reliability requirements under prescribed application conditions.

Note 1: Short version of the definition: that part of quality with regard to the behaviour of the unit with respect to defined application conditions during or after prescribed time intervals.

Note 2: Instead of a time interval, for example in hours, a predefined number of operational cycles or similar criterion can be used.

Note 3: In this standard, the concept of reliability, as defined above, is to be understood as comprehensive. By way of contrast, the concept of reliability is defined partly in the sense of “functionality” and partly in the sense of “probability of surviving”; therefore, it is subject to misunderstanding as a translation for “reliability”.

Reliability characteristic

Reliability with defining quality feature.

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Encyclopedia

R

Reliability requirement

Totality of the considered individual requirements for the state of an entity that pertains to the behaviour of the entity during or after prescribed time intervals for prescribed operational conditions and in the considered specification stage of the individual requirements.

Note 1: The reliability requirement is part of the quality requirement (see DIN 55350-12) and runs through several specification stages in the course of reliability planning. In various specification stages, the proportions of the decided and foreseen individual requirements are different.

Note 2: Both the prescribed time periods and the prescribed application conditions are important prerequisites for the planning of reliability requirements but not their components. Details for planning reliability requirements may be found, for example, in DIN ISO 9001, DIN ISO 9004 and in DIN IEC 300.

Remote software

A software program for a PC which when connected to a second PC through a +-modem is able to completely and remotely control the second PC. Everything which can be seen on the remote PC screen can also be seen on the controlling PC screen. Both keyboards are also switched in parallel.

Repair

A measure for re-establishing the desired condition of the technical resources of a system.

These measures consist of:

- Order, order documentation and analysis of the order content
- Planning in the sense of indicating and evaluating alternative solutions under consideration of the operational demands
- Decision for a solution

Brüel & Kjær Vibro

Encyclopedia

R

- Preparation of execution comprising calculation, time-scheduling, coordination, supply of personnel, resources and material, production of work-schedules
- Implementation of advance measures, such as workplace equipment, protection and safety equipment, etc.
- Examination of the preparation and advance measures, including the release for execution
- Execution
- Function-testing and commissioning
- Announcement of readiness
- Evaluation including documentation, cost recording, indicating and if necessary bringing in improvements.

Note: See note under Maintenance.

Repeatability

During alignment, inspection of the correct attachment of the measurement components can be accomplished through repeat measurements. Both measurements should show the same values, otherwise the attachment should be inspected and if necessary, be improved or alternatively, the torsional play and radial play be tested.

Repeatability conditions

Conditions under which individually repeated measured values for the same specific quantity are captured independently from one another in such a way that the systematic deviations for every measurement remain the same.

Repeatability standard deviation

Standard deviation of measured values under repeatability conditions

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Encyclopedia

R

Repeater; Regeneration amplifier; Regenerator

An intermediate amplifier in transmission paths. The R. carries out the functions amplification, restitution, band limitation, and impulse-forming, or at least one of these, for signal regeneration at a signal which is to be transmitted. A R. is introduced e.g. into the transmission path at certain distances to reduce or eliminate distortion, damping and crosstalk and to improve the signal/noise ratio.

Reproducibility

1) The capability of a sensor or measuring instrument to repeatedly reproduce the same value under identical conditions.

2) Also the maximum deviation from the average value of a series of data at different attempts under indentical conditions.

Note: Incorrectly the term "accuracy" is often used in place of R.

Reproducibility conditions, enhanced

Conditions under which a totality of independent measurement results has been gained for the same identical parameter such that by comparing them, systematic deviations in the measurements can be detected.

Reproducibility of standard deviation

The standard deviation of measurement results under enhanced conditions of reproducibility.

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Encyclopedia

R

Reset

A procedure, with which a system is returned to a defined initial state. Frequently "the last action“ while handling digital systems.

Residual unbalance

The unbalance of any kind which remains after balancing has been completed.

Residual unbalance; minimum achievable specific

The minimum value of specific residual unbalance which a balancing machine is able to achieve.

Residual unbalance, permissible

The maximum amount of unbalance in a rigid rotor below which the unbalance condition is regarded as permissible.

Resistance

A physical quantity (resistance) with units of measure called ohms. As a result of resistance, the strength of an electrical current is limited, while passing through a material (resistor, conductor, special case: superconductor). Resistance depends on the properties of the material and its geometric configuration.

Resistance thermometer

A thermometer for which the temperature dependence of an electrical resistance is utilised for the determination of temperature. The resistance thermometer consists of a measurement resistance that is

Brüel & Kjær Vibro

Encyclopedia

R

located in a measuring unit - if appropriate, a protective tube - and the electrical measurement apparatus that determines the resistance - in the simplest case, a cross-spool instrument.

Resolution

- A measure for the number of the pixels, which are available on a screen (e.g. 640x480 of pixels). The greater the number of pixels, so much the better (generally) are the displays on the screen.

- Digital frequency analysis: Distance between the frequency lines Δf.This is dependent upon the sampling frequency f_s and the number of sampled values N, i.e. on the signal acquisition time T:

$$\frac{\Delta f_s}{N} = \frac{1}{T}$$

- Measuring instruments: An indication for the quantitative collection of the characteristics of a measuring instrument for clearly differentiating between closely adjacent measured values.

Resonance

- Feature of a system in forced oscillation where every change – even in the case of a small change – of the excitation frequency causes a reduction of the response of the system.

- The condition where an excitation frequency corresponds with a natural frequency of a system; recognized by a substantial amplitude increase with simultaneous phase shift. With mechanical systems one speaks of mechanical resonance.

By resonance one understands the strong sympathetic vibrations of systems with weakly-damped natural oscillations, if they are periodically excited by relatively weak external forces with a frequency (resonant frequency) which is the same as, or similar to, a natural frequency of the system. The system which is able to

Brüel & Kjær Vibro

Encyclopedia

R

oscillate is called a resonator. In the case of resonance the forced oscillation has a phase shift of 90°C in relation to the exciting oscillation. In the case of extremely small damping it can result in a resonance disaster (destruction of the system which is able to oscillate).

Resonance balance speed

Rate of revolution(s) or range of revolution rate(s) corresponding to the natural frequencies of the rotor-bearing system. If a rotor passes through this/these region(s) during starting and stopping, the rotational ($1n$) vibration amplitude will show a peak and a change in phase angle.

Resonance condition

Difference between excitation frequency and resonance frequency.

Note: With machines one of the most important excitation frequencies is the rotating frequency itself. For quiet running at the service speed, the distance between the highest service speed and the nearest resonant frequency is of prime importance.

Resonance frequency

Frequency at which resonance occurs.

See also Vibration sensor, resonance frequency

Resonance, mechanical

See Resonance

Brüel & Kjær Vibro

Encyclopedia

R

Resonance tuning

See Tuning

Resonant circuit

Oscillation circuit, the connection together of a condenser and a coil in series or parallel, which can excite electrical vibrations. The condenser is charged with a voltage. This voltage is discharged over the coil in which due to the current flow a backlash potential is produced and this again charges the condenser, and in such a way the current continuously swings back and forth. If no new energy is supplied, the vibrations decay rapidly (damped oscillation). R. are used to filter out a certain frequency from various other frequencies and to create certain frequencies.

Response characteristics (of a measurement instrument)

Relationship between the values of the input and the corresponding values of the output of a measurement device under circumstances that exclude the retroactive effect of the measurement device.

Response threshold; **Response value**

The smallest change in the value of an input variable, which leads to a recognizable change in the value of the output variable of a measuring instrument (and/or electronic system).

Response time

With a transfer element, switchgear or a measuring instrument the time interval between the beginning of the effect of an input signal and the beginning of the reaction of the output signal. With time- and time-delay relays as well as with delay lines the R. is purposely used [26].

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Encyclopedia

R

Restart

Reversion to the running condition of a program after an interruption, e.g. by a power failure.

Resultant unbalance force

See Unbalance force, resultant

Resultant unbalance moment

See Unbalance moment, resultant

Resulting unbalance force

The resulting unbalance force of the system from the centrifugal forces of all mass elements of the rotor. It is always related to the shaft axis and is equal to the centrifugal force resulting from the static unbalance.

Resulting unbalance moment

The resulting unbalance moment of the system of centrifugal forces of all mass elements of the rotor about any point on the shaft axis. The size and angular position of the resulting unbalance moment is generally dependent on the position of the reference point.

The resulting unbalance moment is independent of the position of the reference point if the resulting unbalance force is zero.

Brüel & Kjær Vibro

Encyclopedia

R

Reversal error

Hysteresis effect in a measurement device. The reversibility error is the difference in the displays that one gets if the brand of measurement device slowly accommodates the display of smaller initial values of the measured variable one time and larger initial values the next time. The causes of the reversibility error include friction, backlash, elastic aftereffect and hysteresis.

Reversible transducer

Transducers that can turn an electrical signal into an acoustic or mechanical one and vice versa.

Rigid-rotor mode, critical speed

The rotational speed of a rotor, at which a maximum movement of the journals occurs and this movement is substantially larger than the deflection of the rotor.

Rise coefficient; Growth coefficient

With an exponentially growing quantity of an operand, that factor which describes an increase in the amplitude A.

$$A(t) = A_0^{\sigma t}$$

The converse is the decay coefficient (decay time).

RMS

Abbr. for **R**oot **M**ean **S**quare

Brüel & Kjær Vibro

Encyclopedia

R

See RMS averaging; RMS value

RMS averaging

A method of averaging an alternating quantity, e.g. a vibration signal.

See also Averaging of spectra, quadratic

RMS value

The quadratic average value (effective value) of an alternating quantity.

RMS value; Interval RMS value

The RMS value $x_{eff,T}$ of a vibration variable $x(t)$ for the time interval $0 \leq t \leq T$ is defined as the *quadratic average value.*

$$x_{eff,T} = \sqrt{\frac{1}{T}\int_0^T x^2(t)dt}$$

Here: t = time-variable; T = time-interval or averaging time.

With periodic vibrations $x(t)$ the averaging time is equal to the period duration or an integer multiple of it. In the case of non-periodic vibrations the period T is to be agreed and given. In this case it is better to use the expression $x_{eq,T}$. This expression can be understood as the RMS of a constant, or a remaining alike periodic signal, which regarding the time interval T is equivalent to the transferring energy of the original signal $x(t)$.

For a clear distinction of the sliding RMS value, $x_{eff,T}$; $x_{eq,T}$ is also called the Interval RMS value.

Brüel & Kjær Vibro

Encyclopedia

R

RMS value, maximum

The maximum R. of a vibration variable is the maximum value of the sliding RMS within an observation time interval T:

$$x_{\tau max} = max\{x_\tau(t)\}\ f\ddot{u}r\ 0 \leq t \leq T$$

Note: Here the description “Maximum value of the time-evaluated vibration variable” is also used.

RMS value, sliding

The sliding R. of a vibration variable $x(t)$ is defined as

$$x_\tau = \sqrt{\frac{1}{\tau}\int_0^t x^2(\xi) * e^{\frac{t-\xi}{\tau}} d\xi}$$

Here t = observation time; ξ = time-variable, τ = time-constant.

The knowledge of the time constant τ belongs to the indication of sliding R. as momentary samples or as maximum values.

Note 1: Other sliding time window functions (e.g. rectangle) are more difficult to realize, without offering recognizable advantages.

Note 2: The sliding R. of the vibration variable x (t) is also called the time-evaluated vibration variable.

Rolling element

Cylindrical, spherical or drum-shaped parts of a rolling bearing used to transmit a rotating load.

Brüel & Kjær Vibro

Encyclopedia

R

Rolling-element (roller) bearing condition characteristic quantity

BEARCON process

Rolling-element bearing damage frequencies

See rolling-element bearing frequencies

Rolling-element (roller) bearing damage frequencies

Rolling element frequencies

Rolling element bearings; roller bearings; ball bearings

A bearing with rolling elements for transferring loads and reducing friction.

Rotor

The rotating part of electrical machines, turbines, planetary rotation engines, rotating compressors, centrifugal pumps, amongst others; in turbo-machines often called impellers.

Rotor, asymmetric

A rotor which has two different principal moments of inertia (e.g. elliptical cross-section) and/or its bearing support system exhibits different characteristics in the horizontal and vertical direction. A typical example of a R. is the two-pole generator rotor of a turbo set.

Brüel & Kjær Vibro

Encyclopedia

R

Rotor, flexible

A rotor which does not meet the definition of “rigid rotor”.

Rotor, inboard

A rotor with two bearings journals whose centre of gravity lies between the two bearing journals.

Rotor, outboard

A rotor with two bearing journals whose centre if gravity lies outside bearing journals.

Rotor, perfectly balanced

An ideal rotor which has no unbalance.

Rotor, quasi-rigid

A flexible rotor which can be balanced below a rotational speed at which a substantial deflection arises.

Rotor, rigid

A rotor is considered rigid if the unbalance can be corrected in two balancing planes (selected at will) and if its residual unbalance, at any rotational speed up to the maximum service speed, after this correction does not substantially exceed the unbalance tolerance (in relation to the rotational axis). This presupposes that the rotor runs under dynamic conditions which approximate the final bearing support system.

Brüel & Kjær Vibro

Encyclopedia

R

Rotor, symmetric (isotropic)

A rotor which has the same characteristics (rotor and support rigidity, damping and moment of inertia) in all radial directions perpendicular to the shaft longitudinal axis. All introductory forces in a symmetrical (isotropic) R. can be expressed as a function of the radial and tangential displacement velocity and acceleration. A circular cross-section and uniform rigidity of the supports in vertical and horizontal direction are characteristics.

Rotor-synchronous sampling

See Sampling, rotor-synchronous

Rotor-synchronous angle reference system

See Angle reference system, rotor-synchronous

RS 232-C

An RS 232-C is the definition of an asymmetric, serial, bi-directional, asynchronously-operating interface. This corresponds to the V.24N.28 interface and operates with voltage levels between $+3V$ and $+15V$ for control signals and $-3V$ and $-15V$ for data. It operates earth-symmetrically with return cables that are grounded one side <single ended> which means susceptibility to interference (galvanic separation does not work). The cable length with this interface is limited to approx. $30\ m$.

RS-232-C interface; V.24 interface

Abbreviation: RS-232-C interface between data terminal equipment and data communications equipment for serial binary data communication. RS-232-C is an EIA-Standard <**E**lectronic **I**ndustries **A**ssociation **S**tandard> in the USA. The standard corresponds to the CCITT recommendation V.24, and beyond that

Brüel & Kjær Vibro

Encyclopedia

R

contains regulations of the electrical and mechanical interface characteristics as well as standard interfaces for selected system configurations and recommendations, and explains references and the definition of some data communication terms.

RS 422A

An RS 422A interface is a symmetric serial, bi-directional, synchronously operating interface which permits a cable length up to $1200\ m$. This corresponds to the V.11 interface and operates with voltage differences and is therefore extremely rugged against electro-magnetic disturbance (galvanic separation works). Transmission speeds up to $10\ Mbit/s$ are possible.

RS 485

The RS 485 interface is a bus-capable serial, bi-directional, asynchronously-operating interface which permits cable lengths up to $1200\ m$. This operates like the RS 422A interface with voltage differences and is strongly resistant to electro-magnetic disturbance. In addition, in contrast to the RS 422A interface, it is bus-capable. Up to 32 users can be connected to a bus segment.

RTS/CTS

Abbr. for <**r**equest **t**o send/**c**lear **t**o **s**end>

A description for control cables in modems: With hardware handshake the computers and the attached modem inform each other over the control lines RTS and CTS whether the modem and the computer are ready to take up further data to the buffer. This communication is important, if the data transmission rate between the computer and its modem is higher than between the two modems, since otherwise buffer over-runs and data losses can occur.

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Runout

Process-determined measuring error with the non-contacting measurement of shaft vibrations, e.g. according to the eddy-current measurement principle.
A distinction is made between:

- Mechanical R.
  Mechanically conditioned measuring error in the vibration signal: This develops, if a change of gap is measured which is not due to a displacement of the shaft, nor produced by a dynamic movement. Out of roundness of the shaft, scratches, cracks, rust or other electrically conductive deposits, flattened areas on the shaft surface and engraving marks are causes of such measuring errors.

- Electrical R.
  Electrically conditioned measuring errors in the oscillation signal can develop, if the electrical resistance, conductivity, or permeability of the object is uneven, or if local (point-formation) magnetic fields on the surface are present. The output signal is overlaid on an error signal which is constant compared to the rotating speed. With the production of the rotors a procedure is recommended which avoids such measuring errors.

Runout compensation

During the non-contacting measurement of shaft vibrations the actual vibration signal is overlaid by a so-called runout signal that falsifies the measurement. With the R. an electronic correction of the sensor signal takes place around the runout signal (runout), acquired at a low number of revolutions per minute (RDV operation).

Runout error

See Coupling error

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Runout, electrical

See Runout

Runout, mechanical

See Runout

Run-to-failure

With this “method”, the machine continues to operate until one day it breaks down. Such an approach is possible only in the case of such machines with which a sudden and unexpected loss does not result in consequential damage and which can be quickly replaced at any time without any problems.

Operating until breakdown is actually a very widespread and popular method of operation. All household devices, vacuum cleaners, electrical coffee machines, washing machines, dryers, etc. are operated according to this method. They are quickly replaceable in case of a breakdown.

In the industrial world the difficulties resulting from an unexpected breakdown are more severe. In the first place a replacement machine is as a rule not always available from stock, or “off the shelf”, and secondly one can almost always count on direct consequential damage as a result of the breakdown.