PT580-CFG Configuration Software for

PT580 Digital Vibration Switch

User Manual

Installation, Operation, Maintenance

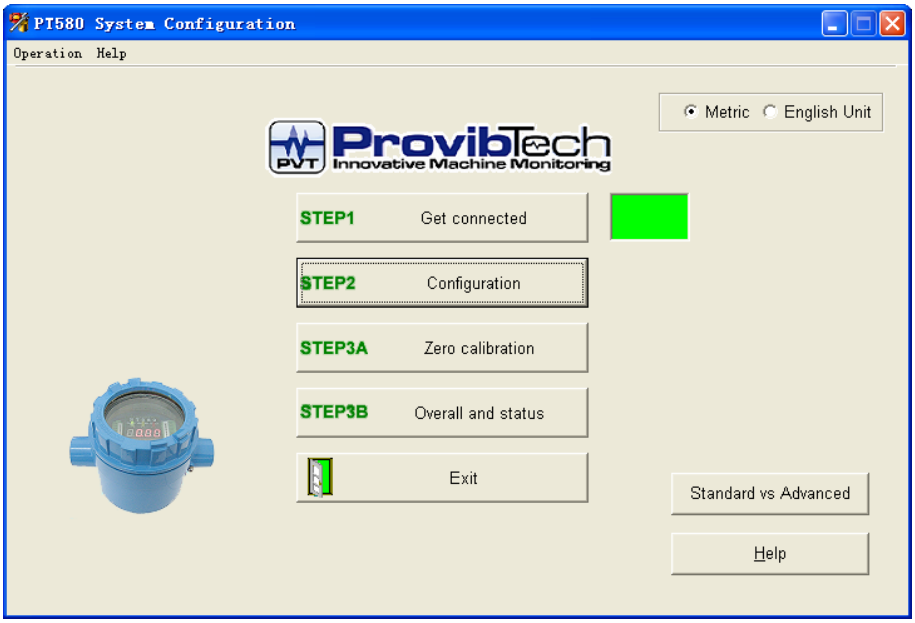

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Table of Content

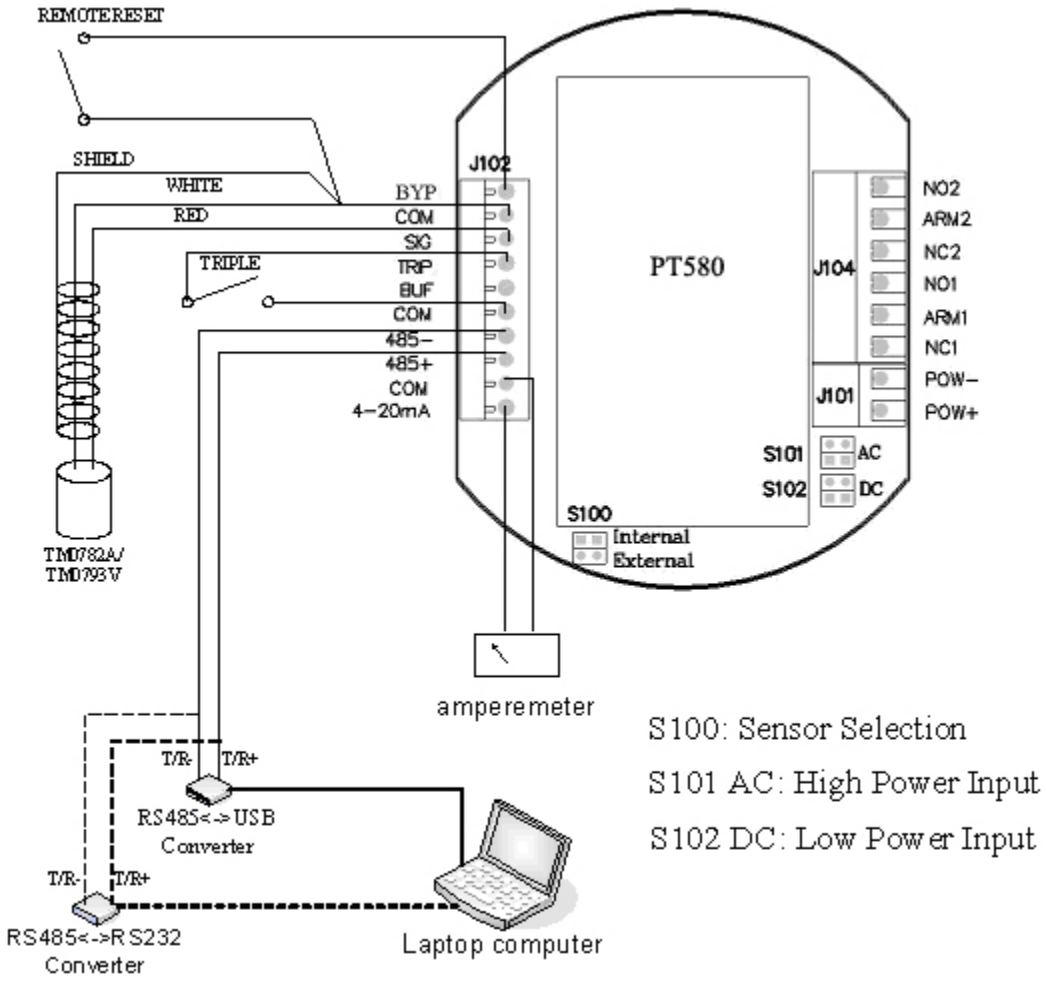
PT580 Introduction

PT580 digital vibration switch is the world's first digital vibration switch that offers to customer much more features comparing to traditional analog vibration switch. PT580 makes the field configuration of the system easier. It also supports Modbus RTU digital communication. PT580 is ready for condition monitoring with no additional hardware required.

- ✓ Field setup for alarm set-point, relay latching, time delay, alarm delay
- ✓ Field calibration of ZERO (4.0mA) and SPAN (20mA)
- ✓ Field configuration for advanced functions, such as trip multiply, internal or external sensors, and power up inhibit
- ✓ Modbus RTU ready
- ✓ Universal power supply
- ✓ Programmable with acceleration or velocity output
- ✓ Programmable with true PK or RMS

PT580-CFG Configuration Software Installation

System Wiring Diagram (configuration)



Either of RS485 to Usb and RS485 to RS232 can be used

S100: Sensor Option: for internal and external sensor.

S101: When the power is 220V or 110V AC, short it.

S102: When the power is 24V DC, short it

J101: Power input.

J102: Reset/Bypass, External sensor input, Triple/multiply, Buf, Modbus, 4-20mA.

J104: Relay output（For Triac option, NO2、ARM2、NO1、ARM1 are used for wiring）.

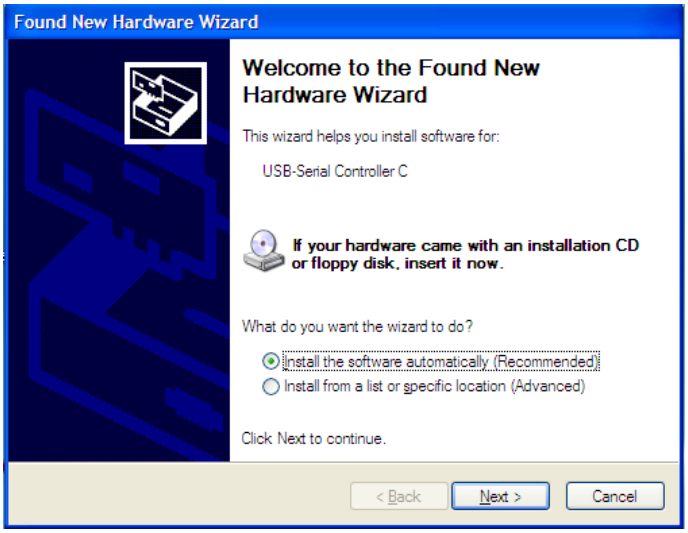
CAUTION:

S101 for high voltage power supply and S102 for low voltage supply. Wrong settings may damage the switch!

Load USB-RS485 Converter driver

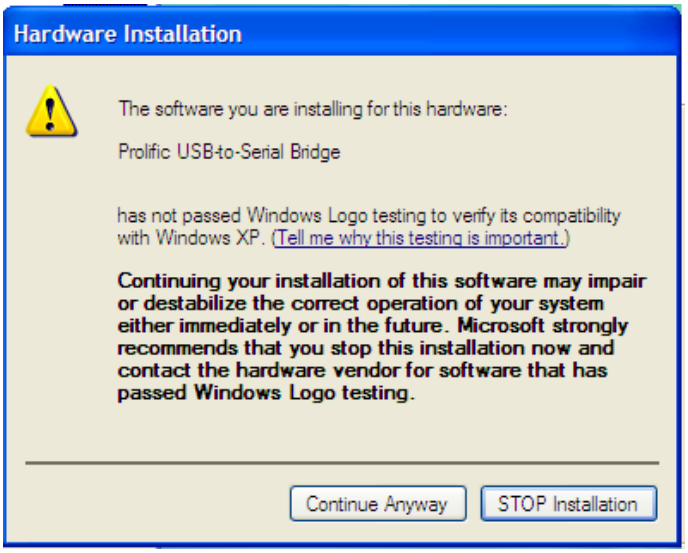
a. Plug USB-RS485 Converter into a USB PORT on your computer;

b. Computer will find a new hardware and pop up following **Found New Hardware Wizard** window;



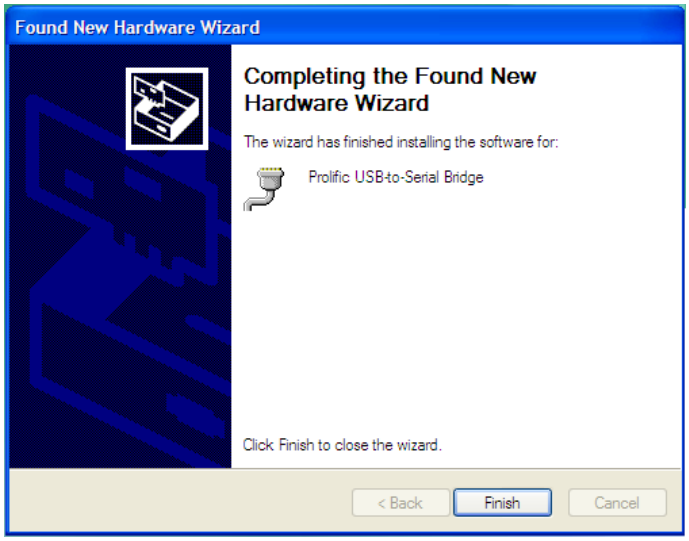
c. Insert USB-RS485 Converter driver CD into your computer CD ROM and click Next;

d. Wait few seconds computer will pop up **Hardware Installation** window;



e. Click Continue Anyway;

f. Click Finish on next **Completing the Found New Wizard** window;



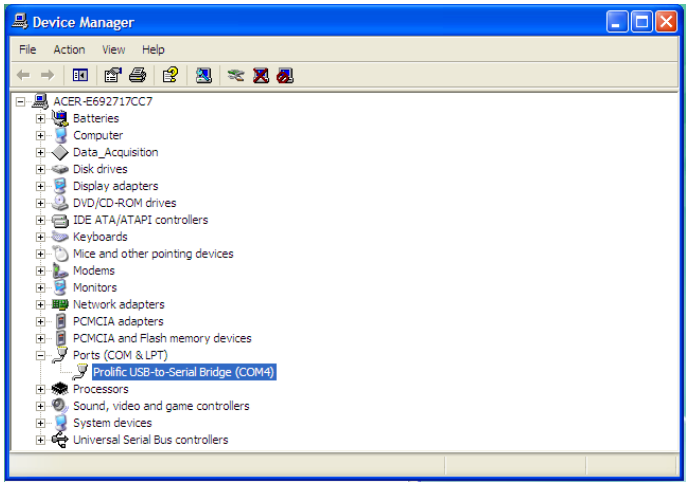
Find the COM Port

a. Click windows **Start**;

b. Right click **My Computer**;

c. Click **Properties**;

d. On **System Properties** window click **Hardware** then click **Device Manager**;



e. On **Device Manager** window click ” +” on Ports , then you will know which COM PORT the USB converter connects to.

NOTE:

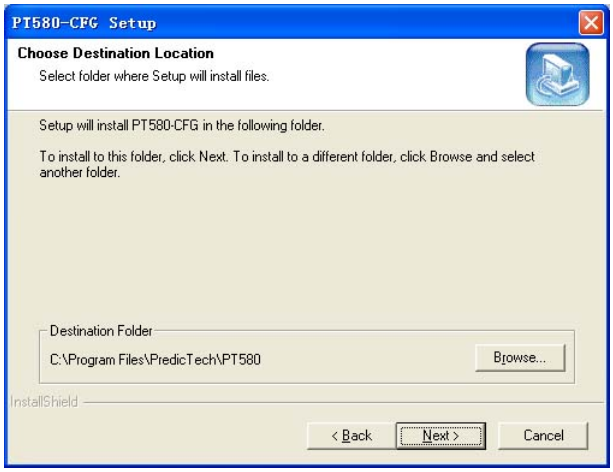
You can also install PT580-CFG software, and use the **Auto-search** feature to find out the COM port and Baud rate. See it in the following section.

PT580-CFG software Installation

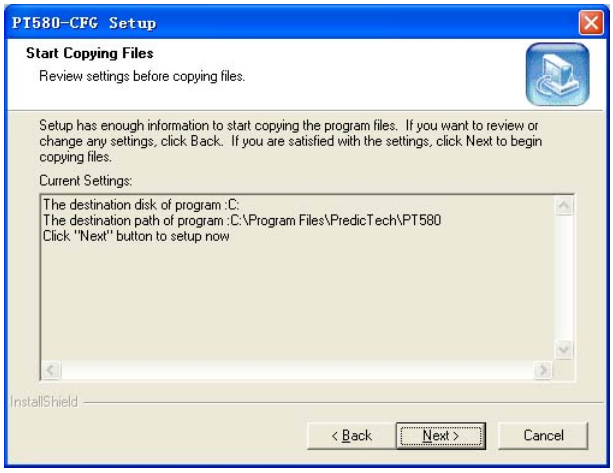
PT580-CFG provides one installation CD for user. Put CD into the CD-ROM and startup the disk. Double click the Setup.exe to startup the installation program.

1. Initialization interface. Click Next to continue.

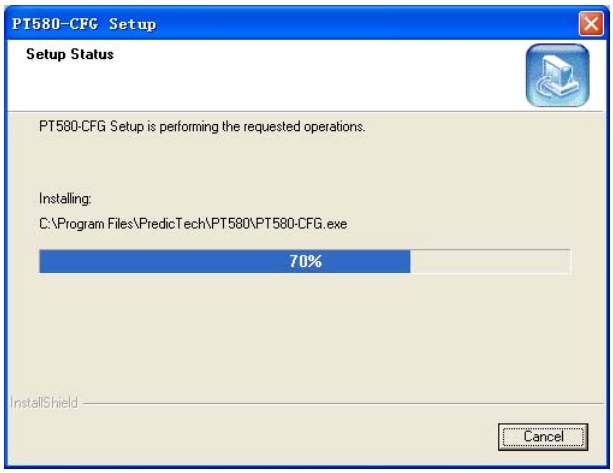
2. Use default files location or select the file location you want, and then click Next to continue.



3. Show destination disk and destination path of the program. Click Next to continue.

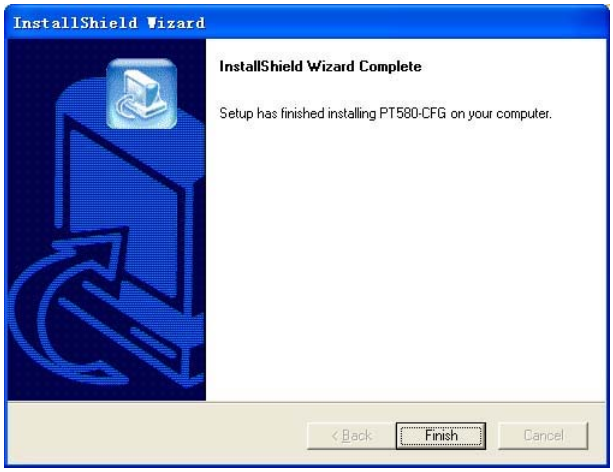


4. Click Next to continue to start copying files.



In the following window, pitch on “Don’t display this message again” and then click Ignore.

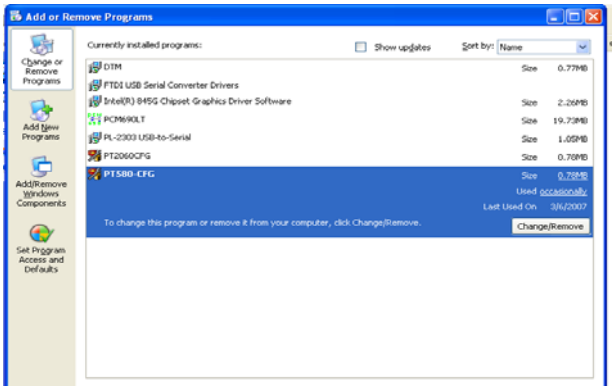
5. Click Finish to complete the installation.



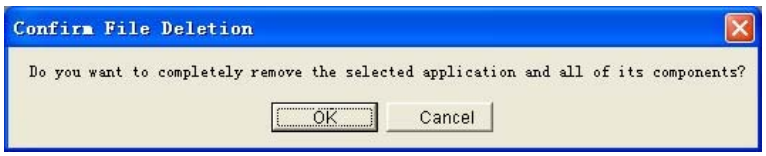
6. Choose whether to restart your computer right now.

PT580-CFG software Uninstall

1. Open control panel; double-click Add or Remove Program Icon. Select PT580-CFG application on Change/Remove program property page, and then click Change/Remove. Now you can remove this application from your computer.



2. Click Start->All Programs->DTM->Uninstall menu and then click OK in **Confirm File Deletion** window.

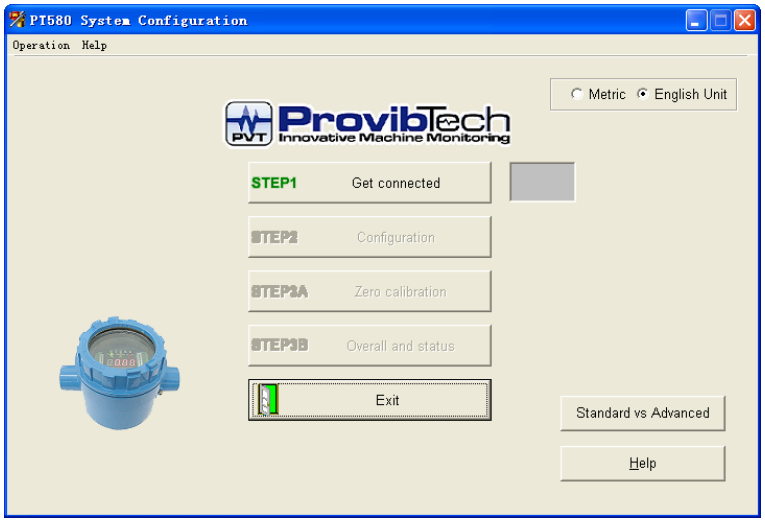


PT580-CFG Standard Edition Operation

Start PT580-CFG Standard

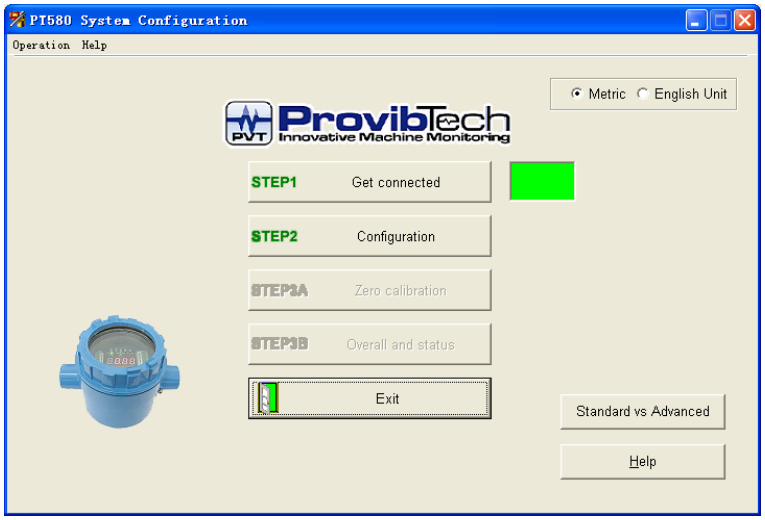
Double-click shortcut of PT580-CFG on the desktop.

Ten seconds later, the main window appears:



After you start PT580-CFG, software will try to connect with PT580 automatically. If PT580-CFG succeeds in connecting with PT580, status of the main window will change. Get connected and Configuration on the main window will be enabled. At the same time, the color of the on-line symbol will turn to green.

Configuration Software



And if PT580 fails to connect with the upper-computer, PT580-CFG will change with Get connected enabled. Color of the online symbol is still gray.

The operation will be divided into four steps:

Step1: Get connected

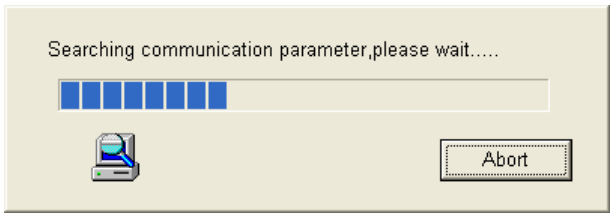
Step2: Configuration

Step3A: Zero calibration

Step3B: Overall and status

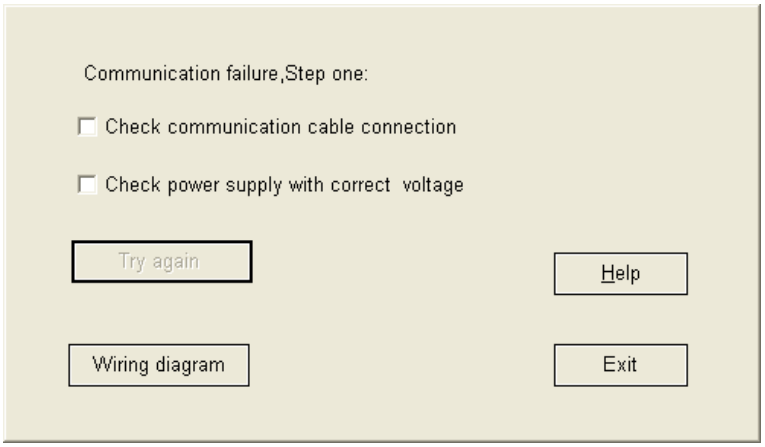
Get connected

Ensure PT580 is well connected. Click Get connected (Operation->Get connected); status window appears:



✓ Status window disappears automatically if the searching operation succeeds:

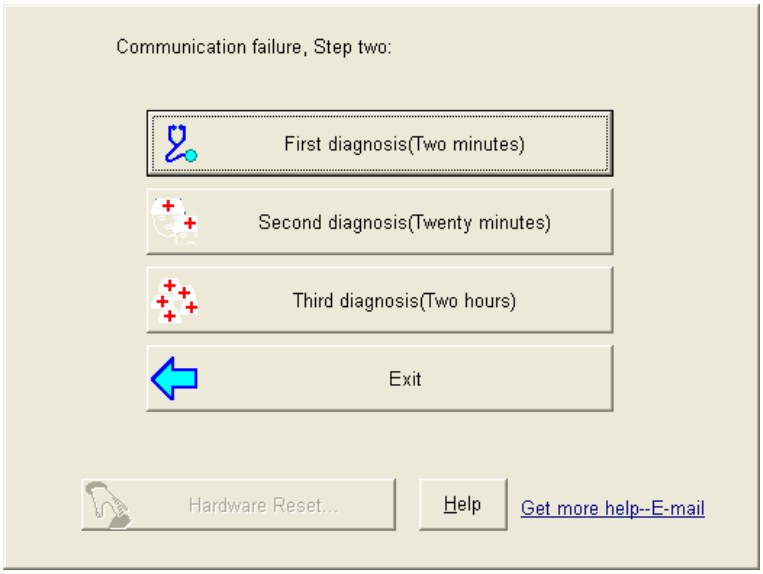
✓ If PT580 fails to communicate with the upper-computer, you will see the following window:



Please mark the check box mentioned in the window. View the Field Wiring Diagram please click Wiring diagram. After confirming the two check boxes, Try again will be enabled again. Please click this button to search again. PT580-CFG will back to the main window if the searching succeeds.

✓ And if the searching was still failure, another window appears:

Configuration Software



The window provides tools for diagnosis of different levels:

1. First diagnosis

In first diagnosis, the searching range is enlarged, such as BaudRate, Port No. etc. You will wait for two minutes. If the communication succeeds, PT580-CFG will back to the main window. And if it fails yet, you can choose the second diagnosis.

2. Second diagnosis

More advanced searching mechanism is provided in the second diagnosis. But the maximum waiting time will be up to twenty minutes. If failed, you can start the third diagnosis.

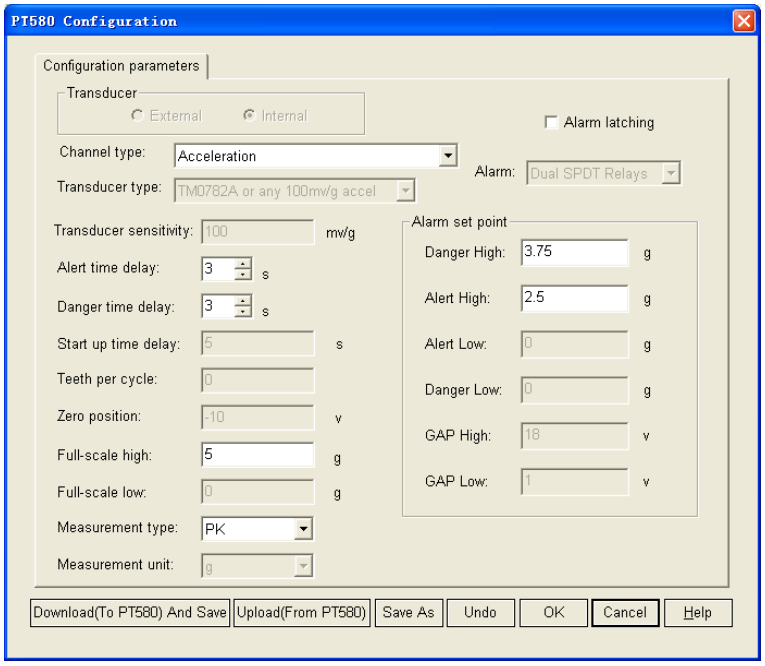
3. Third diagnosis

Third diagnosis is the longest diagnosis PT580-CFG provided. The maximum waiting time will be up to two hours.

Hardware Reset: **Future release.

Configuration

For external sensor, make sure you had chosen proper channel type and transducer type before configuration, or PT580 may not work. When the connection succeeds, Configuration and Operation->Configuration menu enable. Just click it.

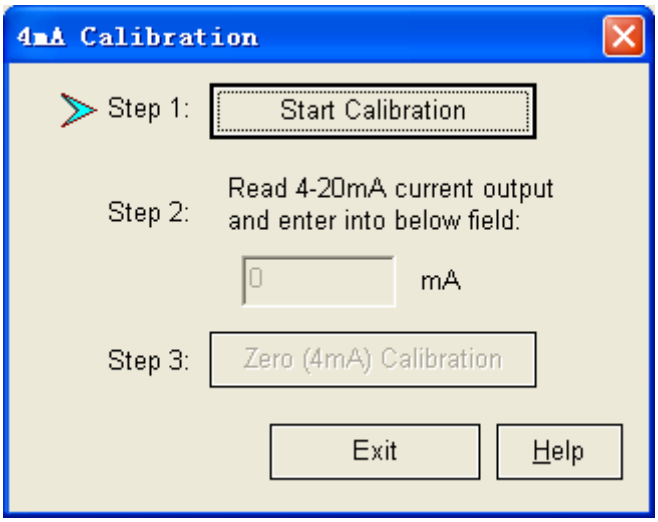


In addition, you can change some common parameters such as Full-scale, Alarm set point, Alert (Danger) time delay, etc. according to the field condition.

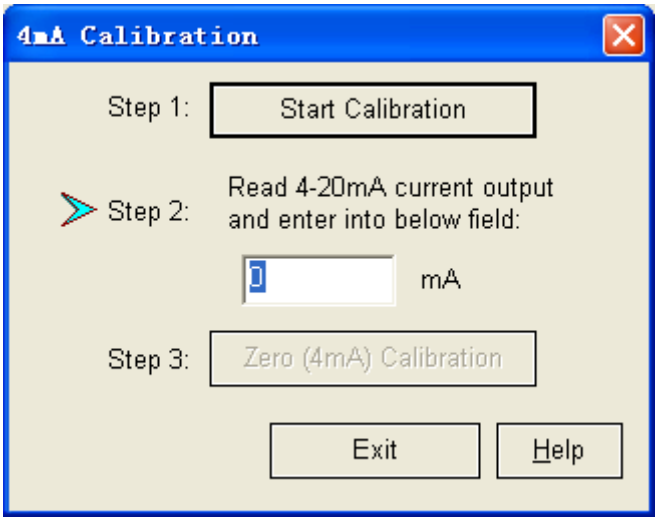
Customers are advised to save parameters as a file for a further reference when they are downloading or uploading the information.

Zero calibration

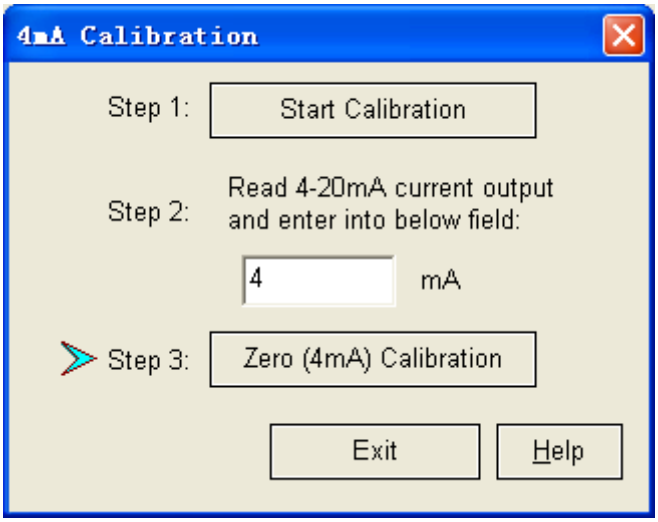
Click Zero calibration or Operation->4mA Calibration menu on the main window. The calibration window of 4mA is below:



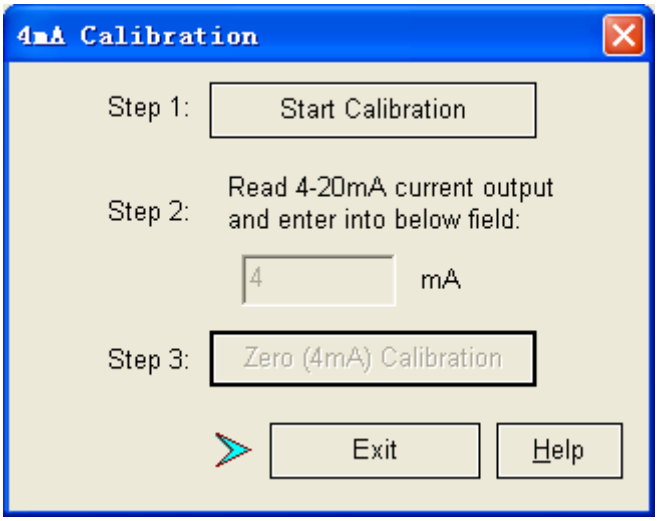
Step1: Click Start Calibration to inform PT580 to start zero calibration.



Step2: Read the current value measured by the amperemeter and enter the number into the box.



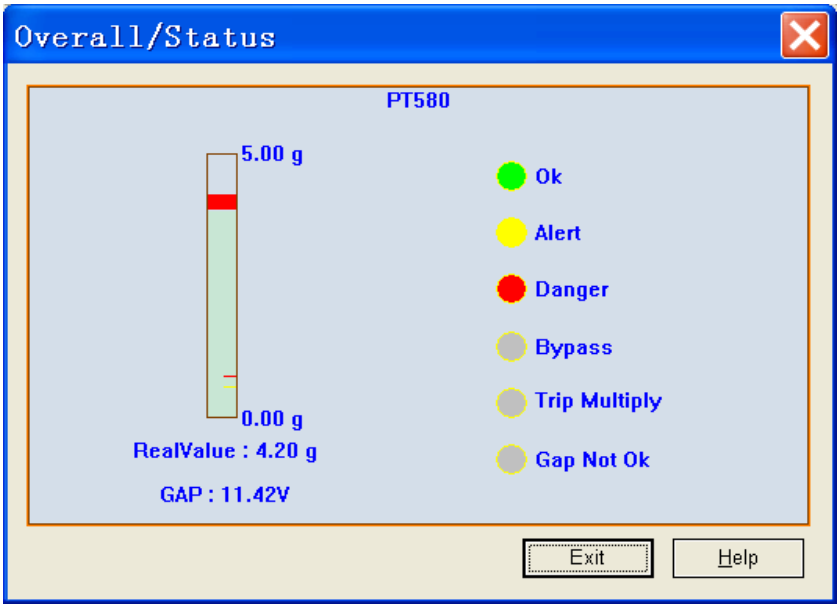
Step3: Click Zero (4mA) Calibration to download the current value to PT580. Finally, click Exit to quit from calibration status.



Click Help to view help topics.

Overall and status

Click Overall and status button or Operation->Overall and status menu on the main window.



The window will show real-time Overall, GAP, and channel status. The window is real-time. Moreover, status parameters such as OK, Alert, Danger, Bypass, and Gap Not Ok are displayed with different colors.

- ✓ OK
  Green: OK
  Gray: Not OK
- ✓ Alert
  Yellow: Alert
  Gray: Normal Status
- ✓ Danger
  Red: Danger
  Gray: Normal Status
- ✓ Bypass
  Red: Bypass
  Gray: Not Bypass
- ✓ Trip Multiply
  Red: Trip Multiply
  Gray: Normal
- ✓ Gap Not OK
  Red: Gap Not OK

Gray: Gap OK

Standard vs Advanced

Click Standard vs Advanced on the main window to open the following table which detailed introduce the distinction between standard edition and advanced edition.

Function	Standard	Advanced
Get Connected	√	×
Module Definition	√	√
System Setup	√	√
Zero Calibration(4mA)	√	√
Full Scale Calibration(20mA)	×	√
AD Calibration	×	√
Overall And Status	√	√
Diagnosis	√	×
Upload	√	√
Download	√	√
Open File	×	√
Save File	√	√
Module ID Setup	×	√
Communication Setup	×	√
Modbus Range Setup	×	√
Module Control	×	√
Relay Control	×	√
Factory Information	×	√
Overall Record	×	√
Channel Status Record	×	√
Help	√	√

√:Has the function.
×:Has no the function.

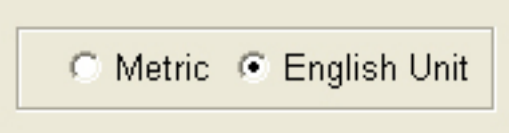
Exit

Click Operation->Advanced menu and then the following caution window appears. Customers should read information mentioned in this window carefully before using it. Customers without taking a professional training are not advised to operate PT580-CFG Advanced. Wrong settings on configuration parameters may damage PT580 unworkable.

Click Yes to enter into PT580-CFG Advanced.

Metric or English Unit

Metric and English Unit in main window are designed for different region. Upload and download functions about different units are all supported.



PT580-CFG Advanced Edition Operation

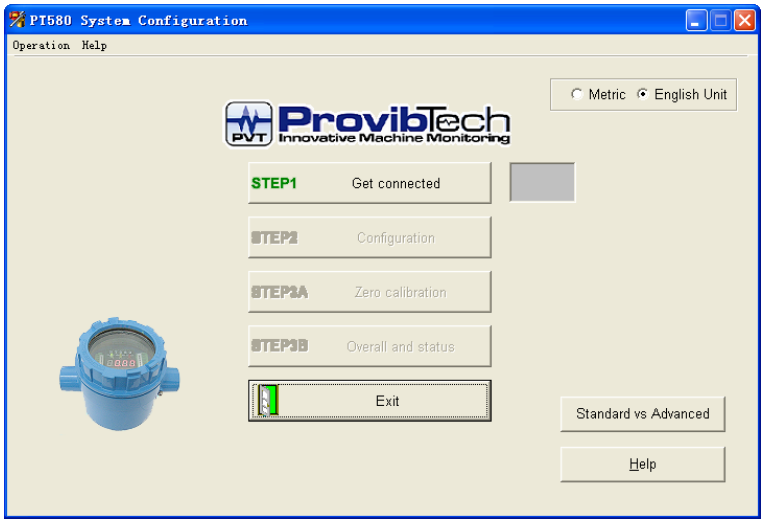
Start PT580-CFG Advanced

CAUTION:

The operation in this section may damage your PT580 if you operate it improperly.

Double-click shortcut icon of PT580-CFG on the desktop.

Few seconds later, you will see the main window for PT580-Standard.



Click Operation->Advanced menu to start the PT580-CFG Advanced.

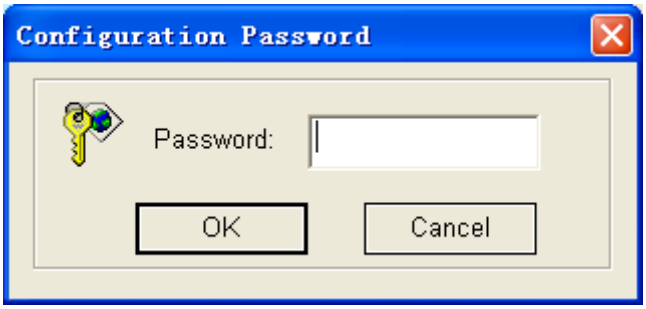
A window for caution will appear:

Click Yes to enter into the main window of PT580-CFG Advanced.

Password Activation

Configuration Password Activation

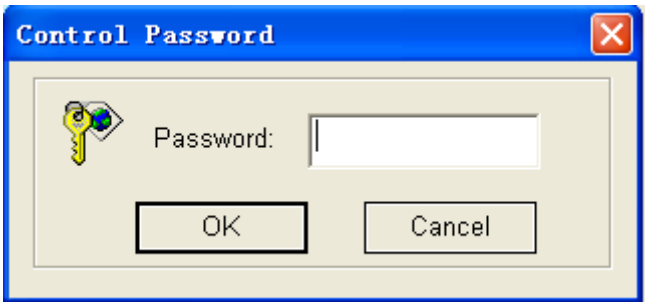
Click Security->Activate Configuration Setting to activate configuration password.



Default Configuration Password is “1234”.

Control Password Activation

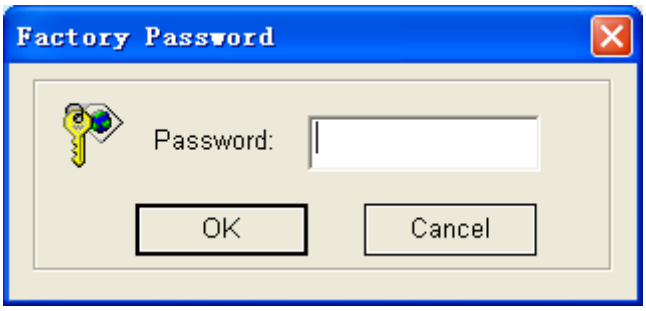
Click Security->Activate Control Setting to activate control password.



Default Control Password is no.

Factory Password Activation

Click Security->Activate Factory Setting to activate Factory Password.



Modify Configuration Password

Click Security->Modify Configuration Password to modify configuariation password setup.

Input the old password and new password (twice). Ensure the password you put in Confirm new password is identical with its counterpart in New password.The length of the password is restricted in eight characters.

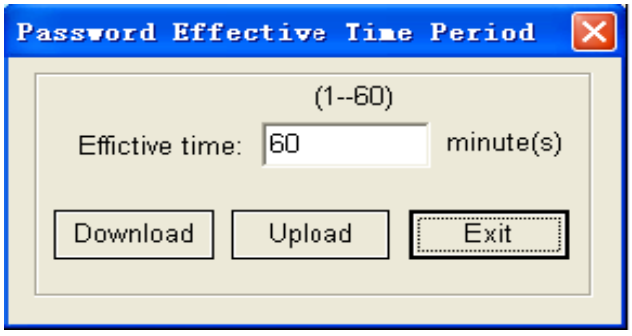
Modify Conrol Password

Click Security->Modify Control Password to modify control password setup.

Input the old password and new password (twice). Ensure the password you put in Confirm new password is identical with its counterpart in New password.The length of the password is restricted in eight characters.

Password Effective Time Period

Click Security->Password Effective Time Period to set the password effective time.

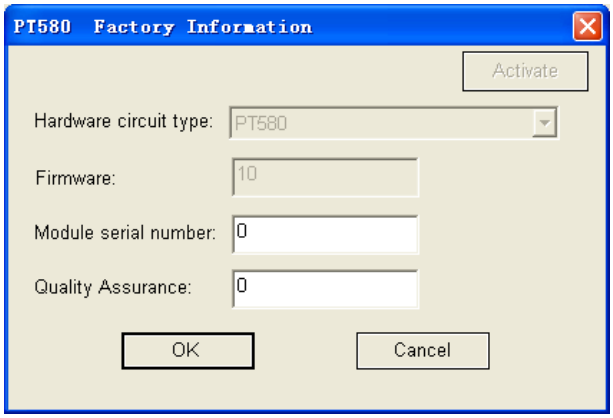


The password effective time is used when PT580-CFG downloads datas. You are capable of set ting the password efftive time period during which you don't have to enter the relevant password when each time you download datas from PT580-CFG. You can also upload data to check its value setted in PT580 Device.

Factory Information

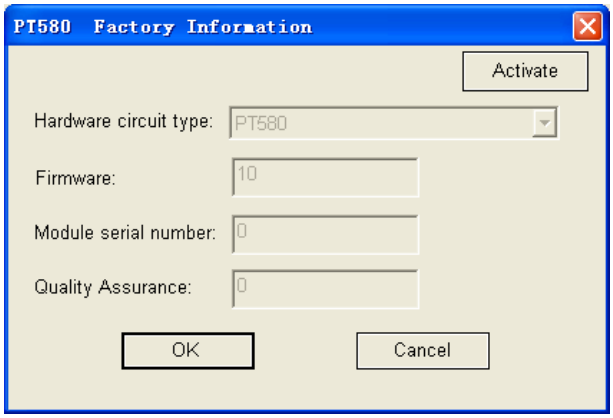
Click Calibration->Factory Information menu.

✓ If you have activated the Factory Password, you can change the relative factory information.



Or you should activate the Factory Password first. Just click Activate and then input Factory Password.

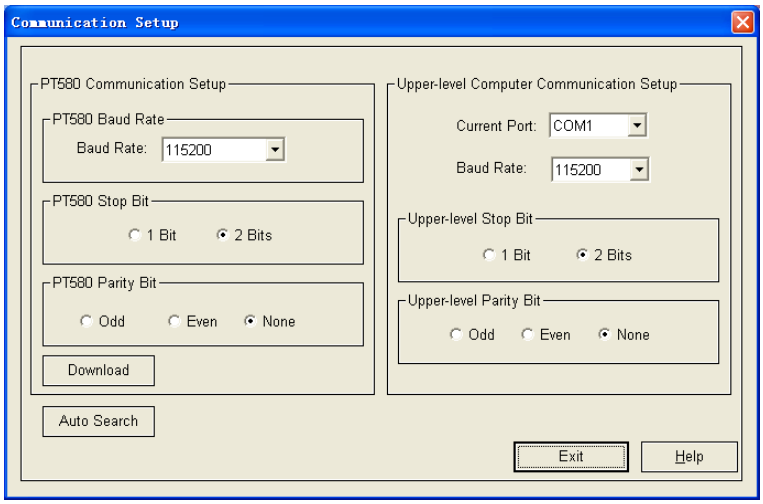
Configuration Software



Factory operator can change the Module serial number and Quality Assurance.

Communication Setup

Click Communication->Communication Setup in the main window and setup the following parameters:



✓ Connect PT580(you can refer to **System Wiring Diagram**)

✓ COM Port

If you are using RS232<->RS485 converter, select the current RS232 port on your Computer. If you are using USB<->RS485 converter, you need to install the USB TO RS485 driver.

Following the procedure to obtain the COM port number: My Computer -> Properties -> Hardware - > Device Manager -> Ports (COM&LPT). See more details in the previous section.

✓ Auto Search

PT580-CFG supplies a simple way in search of baud rate and COM port.

- Make sure that the PT580-CFG only connects to one PT580
- Enter correct Modbus ID (default 63)
- Click Communication -> Communication setup -> Auto search. The system will automatically find out the correct baud rate and COM port.

✓ Default setting:

- Baud rate: 9600
- Stop bit: 2
- Parity: None

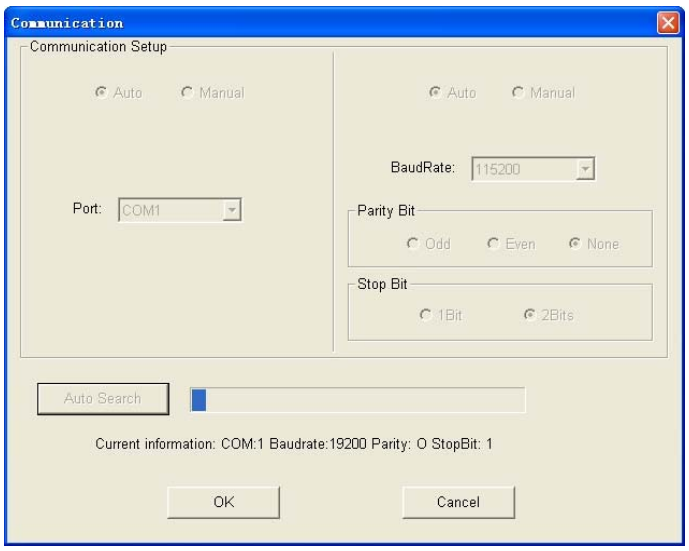
You can select the Port, Baud Rate, Stop Bit and Parity Bit as your needs.

If you want to change the Baud Rate, Stop Bit, Parity Bit, you can click Download to download Baud Rate, Stop Bit, and Parity Bit to PT580. Generally, we suggest you use the default value. Click Exit to write Port, Baud Rate, Stop Bit and Parity Bit into register.

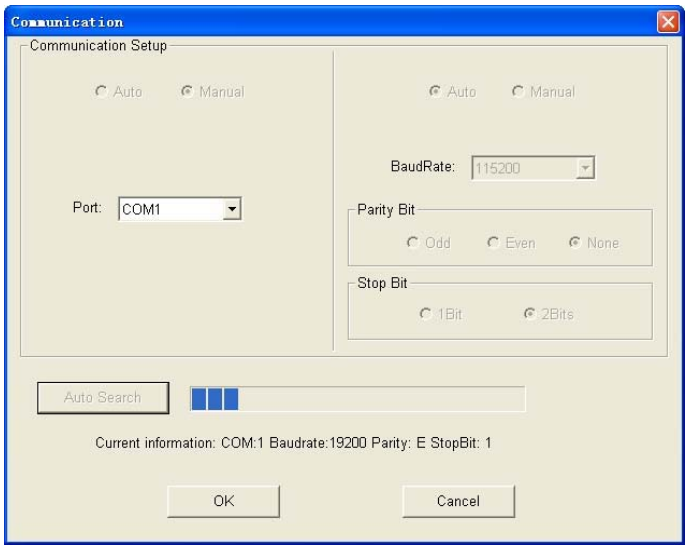
Auto Search

When PT580-CFG software cannot communicate with PT580, please check the COM Port first. **Ensure the COM port between computer and PT580 is well connected.** And then click Auto Search to start auto search.

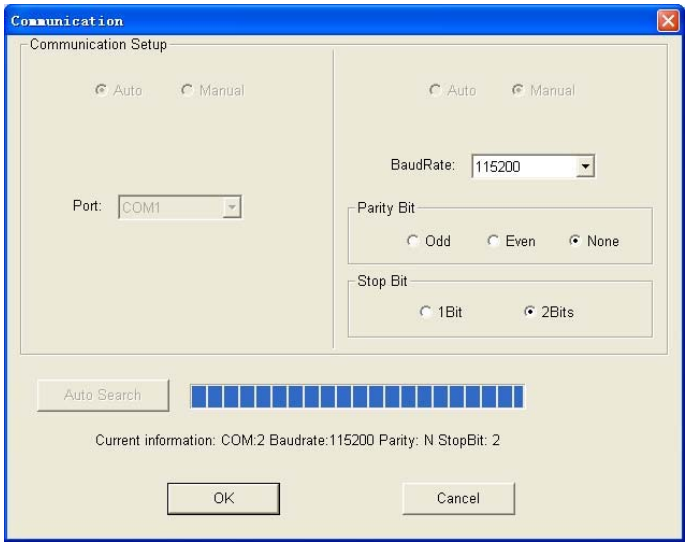
1. If you do not know parameters of Port, BaudRate, Parity Bit and Stop Bit, please mark Auto in window below. The searched information will be shown behind Current Information in the window



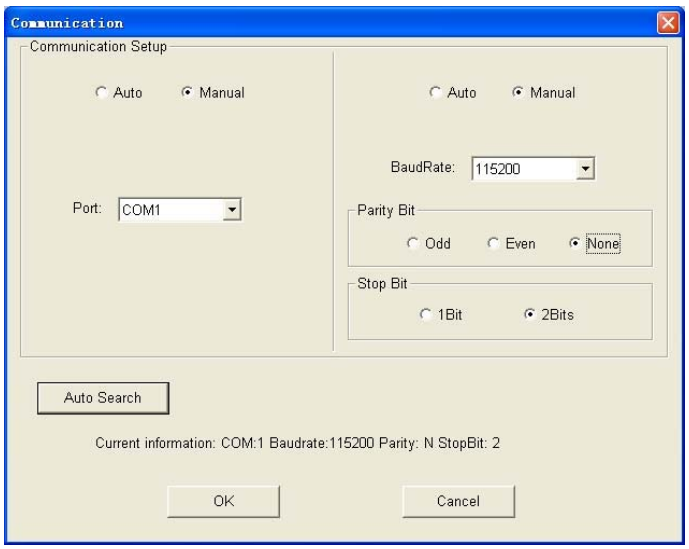
2. And if you have known Port but you don't know BaudRate, Parity Bit and Stop Bit, please mark Manual left-hand and choose the Port and then mark Auto right-hand. Click Auto Search at last.



3. And if you have known BaudRate, Parity Bit and Stop Bit but you don't know Port, mark Auto left-hand and Manual right-hand of the window, and then click Auto Search to start searching process.

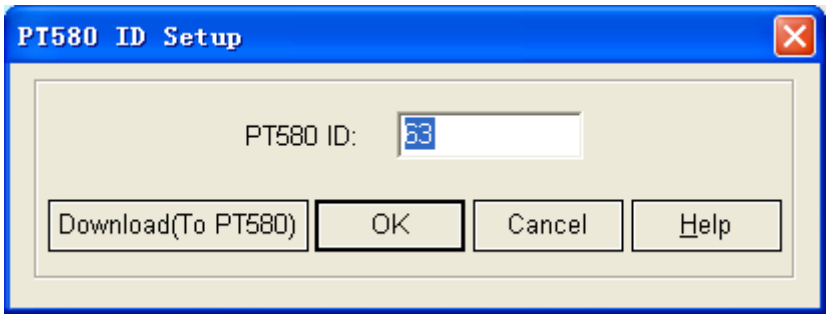


4. And if you have known BaudRate, Parity Bit, Stop Bit and Port, mark Manual in both sides of the window and then click Auto Search.



Module ID Set-up

Click Module-Configuration->Module ID Setup (see below); Setup the Modbus ID of PT580. Default is 63. You can appoint an ID and download to PT580.



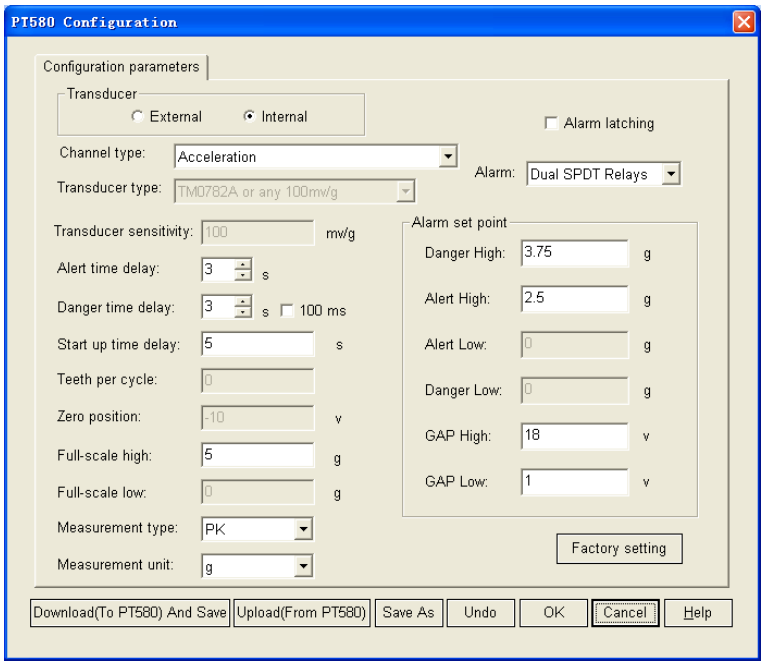
PT580 System Configuration

Click 

; upload the configuration parameters from PT580. Click Module-Configuration->Module Definition menu or click the PT580 photo on the main window.

System Default Setting

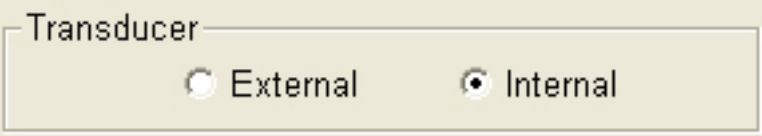
Click Module-Configuration->Module Definition menu or click PT580 picture directly on the main window.



- ✓ Channel Type: default is Acceleration input, Velocity output.
- ✓ Transducer location: internal or external. Default is internal

- ✓ ALERT time delay: default is 3S
- ✓ DANGER time delay: default is 3S
- ✓ System start up time delay: default is 5S
- ✓ Full-scale high: default is 5.00g
- ✓ Measurement type: default is PK
- ✓ Measurement unit: default is g
- ✓ Alarm latching: default is non-latching
- ✓ Alarm: Dual SPDT Relays, Single SPDT Relay, Single SPDT Triac, Dual SPDT Triacs, None. The default is Dual SPDT Relays. Factory Password is required.

- ✓ ALERT high: default is 3.75g
- ✓ DANGER high: default is 2.50g
- ✓ GAP high: default is 18.00V
- ✓ GAP low: default is 1.00V
- ✓ Transducer: The default transducer is Internal. Factory Password is required.

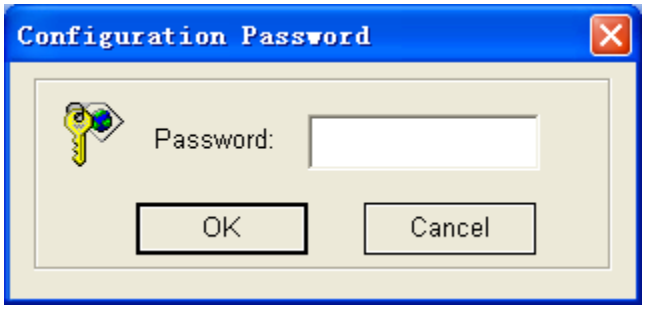


- ✓ Factory setting: Factory Password is required yet.

Download Parameters Setting

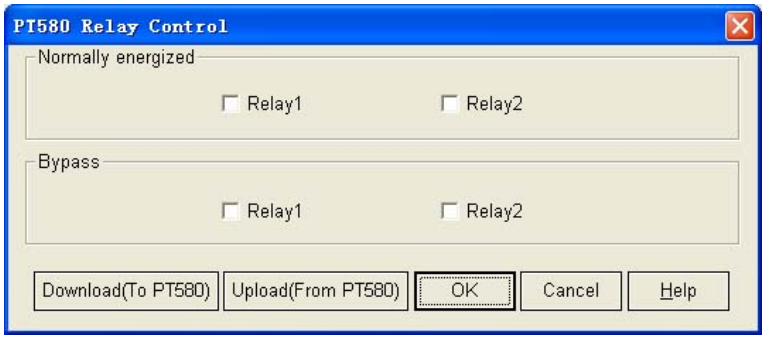
When you complete the setting, click 

, there will be a window asking for configuration password. Click OK. Then download the configuration data to PT580.



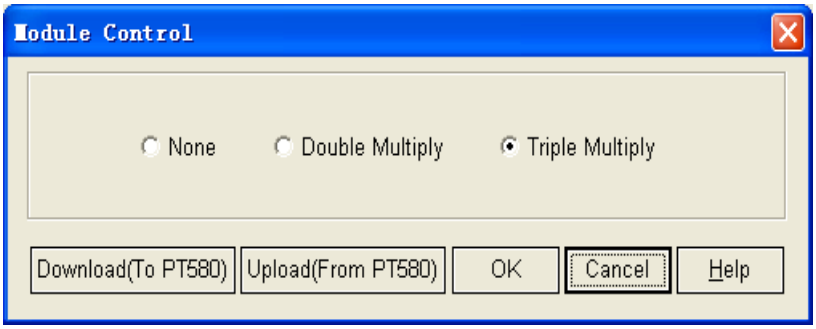
Relay Control

✓ Click Module-Configuration->Relay Control to set up the relay status.



Module Control

Click Module-Configuration->Module Control to set up the Module status. Default is Triple Multiply.



System diagnostics

Proportional full-scale range

Click Module-Configuration->Modbus Range Setup menu. This is the range of Modbus that corresponds to the full measurement scale. The default is 16384. For example, if the full scale measurement range is 25 mm/s, the current vibration is 12.5 mm/s, and the transmitted Modbus value is 8192.

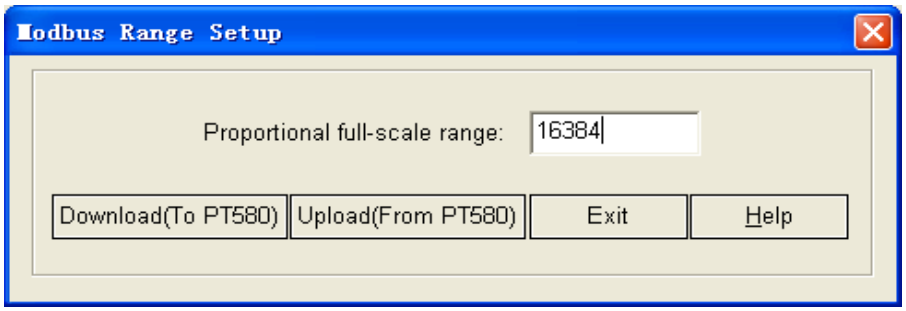
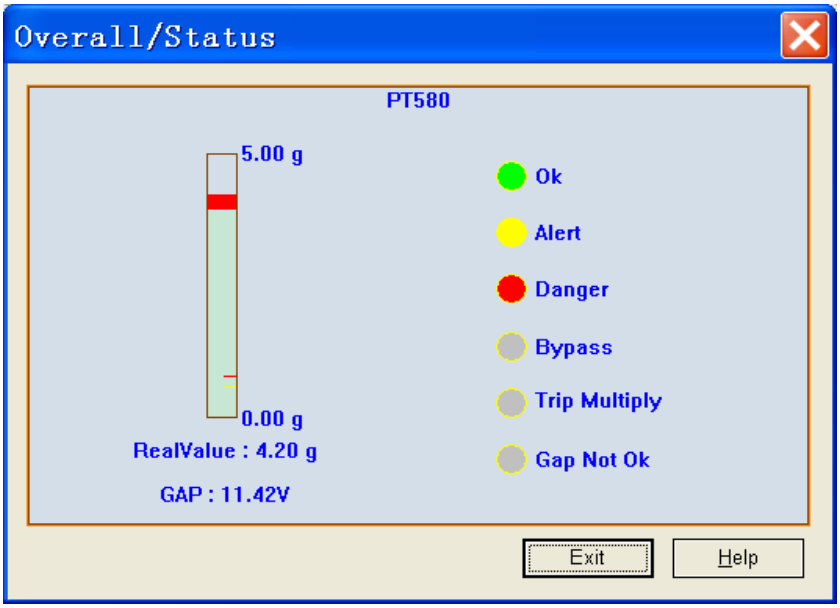


Table View of Overall and Status

Click Overall/Status->Real-time Overall And Status to see the overall, GAP, and status of OK, Alert and Danger. This is an assistance tool for field engineer to see the working status of the monitor. The window is intended for monitor diagnostics only.



The window will show real-time Overall, GAP, and channel status. The window is real-time. Moreover, status parameters such as OK, Alert, Danger, Bypass, Trip Multiply and Gap Not Ok are displayed with different colors.

✓ OK

Green: OK

Gray: Not OK

- ✓ Alert

  Yellow: Alert

  Gray: Normal Status

- ✓ Danger

  Red: Danger

  Gray: Normal Status

- ✓ Bypass

  Red: Bypass

  Gray: Not Bypass

- ✓ Trip Multiply

  Red: Trip Multiply

  Gray: Normal

- ✓ Gap Not OK

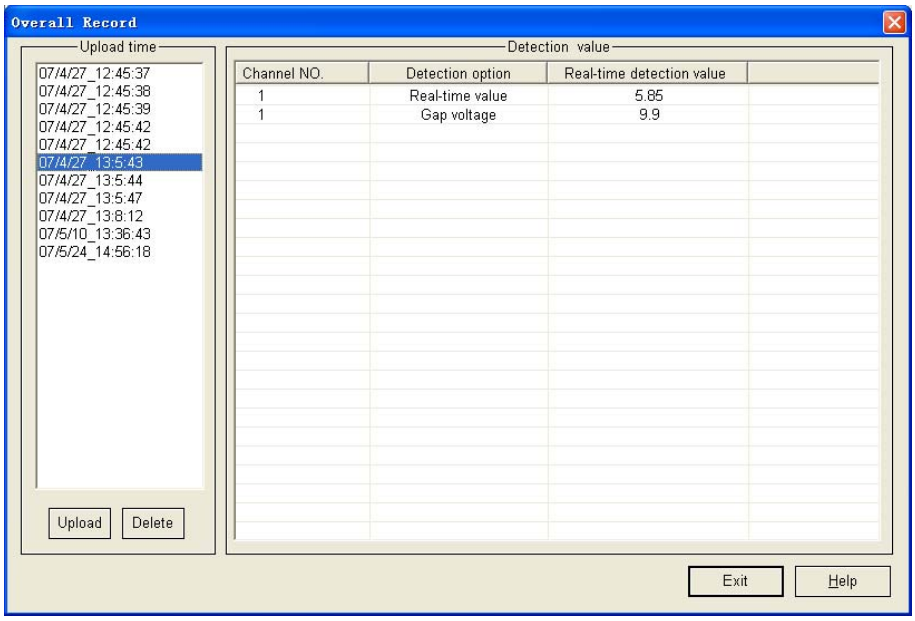
  Red: Gap Not OK

  Gray: Gap OK

For condition monitoring of the machine status with multiple PT580s, ProvibTech offers an on-line diagnostics and database software. PCM370 is designed for continually monitoring the status of the monitors. PCM370 will allow customer to monitor the plant, the machine train, and each measurement point with trend, bar graph, real-time trend, alarm list, system event list etc. See accessories section for more details.

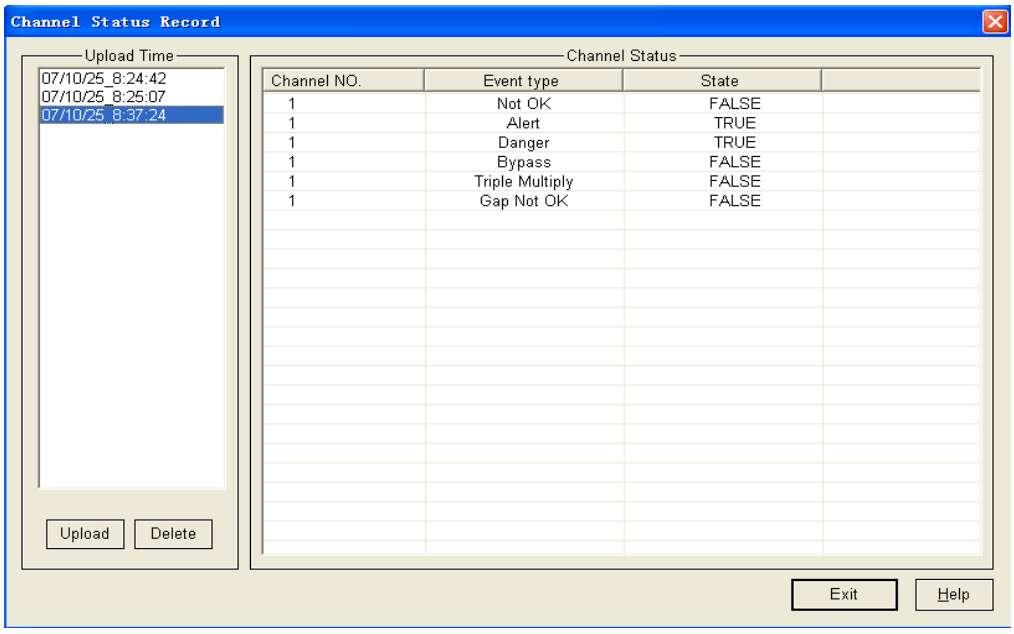
Overall and GAP Record

Click Overall/Status-> Overall Record menu, and then click Upload. A record of overall and gap with time stamp will be stored for further diagnostics.



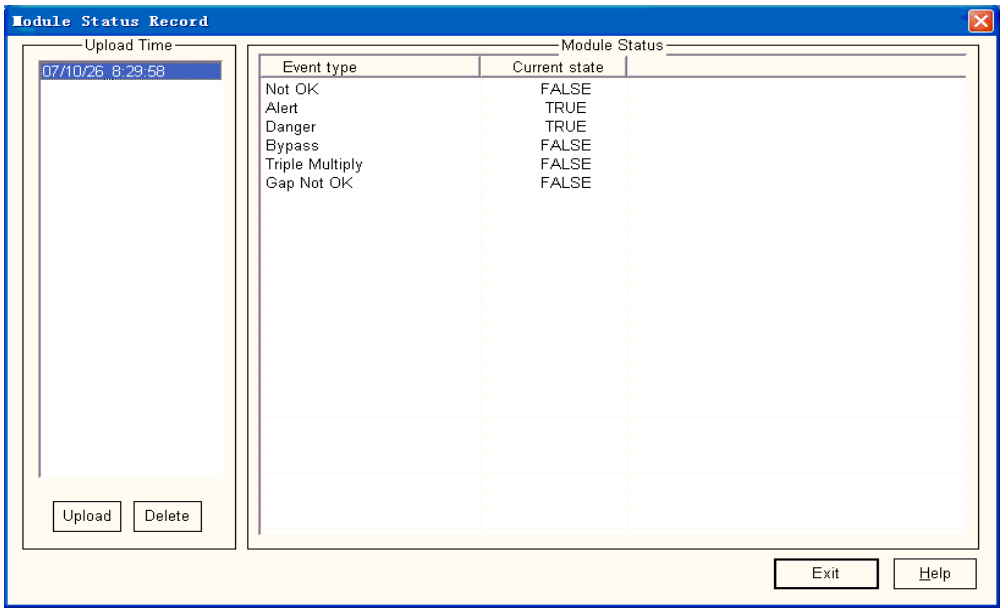
Status Record

Click Overall/Status->Channel Record menu, and then click Upload. A record of status with time stamp will be stored for further diagnostics.



Module (switch) Status

Click Overall/Status->Module Status menu, and click Upload. A record of status with time stamp will be stored for further diagnostics.



NOTE:

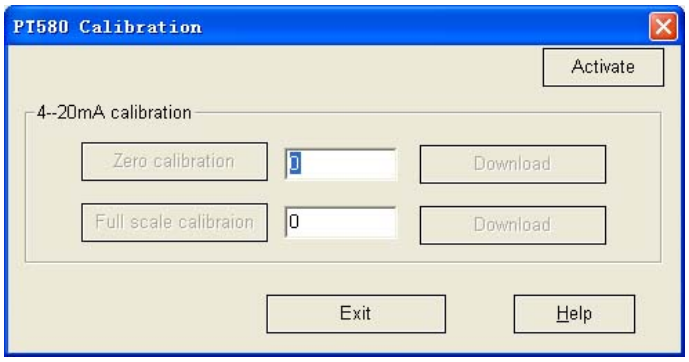
This is the same as **Status Record**. This window is intended to conform to multi-channel configuration and also for PCM370.

System Maintenance

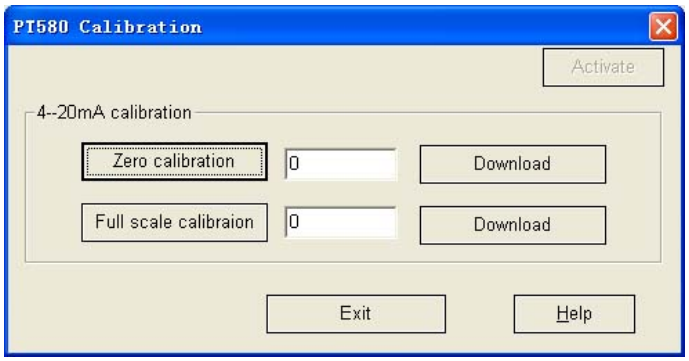
System Calibration

ZERO 4.0mA Calibration:

- ✓ Connect PT580 reference to the previous **System Wiring Diagram (configuration)**.
- ✓ Click Calibration -> 4-20mA Calibration For User menu.



If Activate is enabled, click this button and then enter the configuration password. After you do that, all calibration buttons are activated.



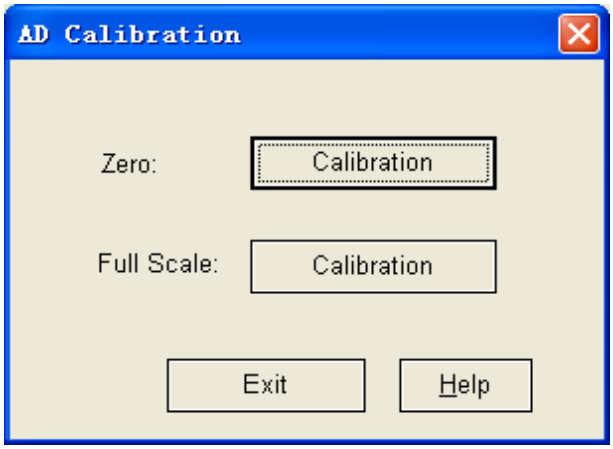
- ✓ Click Zero calibration.
- ✓ Put the mA value read from the current meter into the next field, and then click Download.

Full-scale 20mA Calibration:

- ✓ Following the 4.0mA calibration procedure.
- ✓ Click Full scale calibration.
- ✓ Put the mA value read from the current meter into the next field, and then click Download.

System A/D calibration (Factory Setting):

- ✓ This is not a field calibration procedure.
- ✓ Special tools and experience are required. Consult with ProvibTech for assistance.



Accessories

PCM370

PCM370 condition monitoring software is ideal for plant wide condition monitoring. PCM370 does not require any further hardware to communicate with PT580.

PCM370 will work with multiple PT580. The major features are:

- ✓ Machine view: with machine photos, status and overall are shown on the measurement point.
- ✓ Bar graph
- ✓ Trend plot
- ✓ Multi-channel recorder with live view
- ✓ Alarm list
- ✓ System event list
- ✓ Graph print
- ✓ Modbus communication
- ✓ Alarms output
- ✓ Any other Modbus device interface
- ✓ Other transmitter inputs

PT2060/98-PC

Touch panel PC with IP65 rating. Ideal to work with PCM370 and PT580-CFG.

Appendix Ⅰ. Quick Configuration Guide

Connect PT580 and the software

- ✓ See **System Wiring Diagram (configuration)**

LOAD USB-RS485 Converter driver

- ✓ Plug USB-RS485 Converter into a USB PORT on your computer
- ✓ Computer will find a new hardware and pop up following **Found New Hardware Wizard** window
- ✓ Insert USB-RS485 Converter driver CD into your computer CD ROM and click Next
- ✓ Wait few seconds computer will pop up following **Hardware Installation** window
- ✓ Click Continue Anyway
- ✓ Click Finish on the next **Completing the Found New Wizard** window

Install PT580-CFG software

- ✓ Please consult **PT580-CFG software Installation**

Find the COM port

- ✓ Make sure that the PT580-CFG only connects to one PT580
- ✓ Enter correct Modbus ID (default 63)
- ✓ Click Communication -> Communication setup -> Auto search. The system will automatically find out the correct baud rate and COM port.

Save the original PT580 setting

- ✓ Click Upload. Then File->save menu.

Modify the System setting

- ✓ Click the PT580 photo. Setup the system per requirement

System default setting

- ✓ Channel Type: default is Acceleration input, Velocity output.
- ✓ Transducer location: internal or external. Default is internal
- ✓ ALERT time delay: default is 3S
- ✓ DANGER time delay: default is 3S
- ✓ System start up time delay: default is 5S
- ✓ Full-scale high: default is 5.00g
- ✓ Measurement type: default is PK

Configuration Software

- ✓ Measurement unit: default is g
- ✓ Alarm latching: default is non-latching
- ✓ Alarm: Dual SPDT Relays, Singal SPDT Relays, Singal SPDT Triac, Dual SPDT Triac's, None. The default is Dual SPDT Relays. Factory Password is required.
- ✓ ALERT high: default is 3.75g
- ✓ DANGER high: default is 2.50g
- ✓ GAP high: default is 18.00V
- ✓ GAP low: default is 1.00V
- ✓ Transducer: The default transducer is Internal. Factory Password is required.
- ✓ Factory setting: Factory Password is required yet.

Configuration Password: 1234

Control Password: no

Appendix Ⅱ.Glossary

This glossary is a partial list of terms and definitions used in the field of rotating machinery measurement, monitoring, and analysis. These definitions are not universal, but are expressed in the context of this specialized field. In some instances, ProvibTech Corporation has redefined terms from other technical fields for its own purposes.

Alphabetical Index Abbreviations

* Absolute Vibration

Vibration of an object as measured relative to an inertial (fixed) reference frame. Accelerometers and velocity transducers measure absolute vibration typically of machine housings or structures; thus they are referred to as seismic transducers or inertial transducers.

* Acceleration

The time rate of change of velocity. For harmonic motion, this is often expressed as g or a. Typical units for acceleration are feet per second per second (ft/s2), meters per second per second (m/s2), or more commonly "g" (where g = acceleration of earth's gravity = 386.1 in/s2 = 32.17 ft/s2 = 9.81 m/s2). Acceleration measurements are generally made with piezoelectric accelerometers and are typically used to evaluate high frequency machine casing or bearing housing response characteristics.

* Accelerometer

An accelerometer is an inertial transducer which converts the acceleration characteristic of vibration into a proportional electric signal.

* Acceptance Region

Trend information of the 1X or 2X vibration vectors (amplitude and phase lag angle) presented in polar format, or the shaft average centerline position in Cartesian format. The user defines the normal Acceptance Region for each shaft radial vibration or position measurement on the machine, based on historical data for the machine under all normal operating conditions.

Some systems provide hardware and/or software alarm (Alert and Danger) set point capability. Alarm set points are set independently for maximum and minimum values of both amplitude and phase. Acceptance Region information is the most important indicator of a shaft crack.

* Aero-derivative

Aircraft jet engines that have been adapted and modified for industrial use.

* Aliasing

False frequency components caused by sampling a dynamic signal at too low a sampling frequency. The sampling frequency must be at least twice the highest frequency of interest or the highest frequency component in the signal. This effect can be eliminated by adjusting the sampling frequency, or using a low-pass filter on the signal prior to sampling (anti-aliasing.) The primary disadvantage of anti-aliasing (as is the case with virtually any type of filtering) is that phase and amplitude errors are incurred.

* Alignment

The positioning of machine components; bearings, rotors, casing, foundation, piping, etc., with respect to each other for efficient transfer of power. Various alignment requirements utilize different techniques of cold and hot machine measurement including optical, mechanical (dial indicators), electronic (proximity probes), and laser.

* Amplification Factor, Non-synchronous

A measure of the susceptibility of a rotor system vibration response to a non-synchronous harmonic exciting force at a rotor system natural frequency. Synchronous amplification factor differs from non-synchronous amplification factor due to the existence of destabilizing tangential forces which depend on shaft rotative speed. At high rotative speeds these destabilizing factors cause a decrease in system quadrature dynamic stiffness and result in a non-synchronous amplification factor higher than the synchronous amplification factor.

* Amplification Factor, Synchronous

A measure of the susceptibility of a rotor system vibration response to an imbalance-related exciting force when shaft rotative speed is equal to a rotor system natural frequency. A calculation technique is similar to measuring the Q of a filter (the center frequency divided by the bandwidth), i.e., the balance resonance speed divided by the difference between the speeds at the -3dB amplitude values. Caution should be used when applying this latter method because of the potential mechanical abnormalities of machinery vibration response.

In general, a high synchronous amplification factor indicates low system quadrature dynamic stiffness, whereas a low amplification factor generally indicates high system quadrature dynamic stiffness.

Due to several factors, amplification factor measured during machine startup is different from that measured during coast down. Also called machine Q, synchronous amplification factor differs from non-synchronous amplification factor by an amount related to the existence of a tangential force which depends on actual shaft rotative speed. See Dynamic Stiffness, Quadrature.

* Amplitude

The magnitude of periodic dynamic motion (vibration). Amplitude is typically expressed in terms of signal level, e.g., millivolts or milliamps, or the engineering units of the measured variable, e.g., mils, micrometres (for displacement), inches per second (for velocity), etc. The amplitude of a signal can be measured in terms of peak-to-peak, zero-to-peak, root mean square, or average.

* Amplitude and Phase Versus Time (APHT)

An acronym used to describe the trend plot of plot vibration amplitude and phase data. This data may be presented in both Cartesian and polar formats. Commonly used for 1X, 2X and nX vibration data.

* Anti-aliasing Filter

A low-pass filter which is used to eliminate false frequency components from the spectrum of a digitally sampled signal. See Aliasing.

* Anti-Swirl

A technique used in fluid handling machines to decrease or prevent the development of fluid circumferential flow around the rotor in bearings and seals, and to improve rotor stability.

* Asynchronous or Non-synchronous

Vibration frequency component which is different than shaft rotative speed. Sometimes used to mean any vibration frequency which is not an integer multiple or fraction of rotative frequency. See Synchronous.

* Attitude Angle

The included angle between the direction of the vector sum of all the unidirectional, steady state, radial loads (Preloads) on a rotor and a line connecting the bearing and shaft centers. Sometimes confused with Rotor Position Angle, since the preload historically and incorrectly, was considered to be primarily gravity on horizontal machines. See Rotor Position Angle and Eccentricity Ratio, Average.

* Average

An amplitude detection technique used for sine wave vibration signals; the half cycle average is 0.637 x zero-to-peak amplitude. Average amplitude detection is not used by ProvibTech because machinery vibration signals are most often non-sinusoidal in form and the peak-to-peak, or peak amplitude, cannot be correctly computed.

* Average Shaft Position

The static or average position of the shaft relative to a stationary component on the machine to which the probe is mounted. The most common application is rotor axial thrust position relative

to the thrust bearing. Another important application is shaft average radial position in the bearing. These measurements are made using the dc (position) component of the proximity probe signal. Two proximity probes mounted in an XY configuration are required for the two-dimensional radial position measurement.

* Axial

In the same direction as the shaft centerline.

* Axial Position

The average position, or change in position, of a rotor in the axial direction with respect to some fixed reference. Typically, the reference is the thrust bearing support structure or other casing member to which the probe is mounted. The probe may observe the thrust collar directly or some other integral, axial shaft surface, as long as it is within about 12 inches of the thrust bearing. Also called thrust position. See Differential Expansion.

* Balance-of-Plant Machinery

That group of rotating machinery which is not critical to any part of the overall plant process. Many of these machines operate in tandem or spared installations.

* Balance Resonance Speed

A shaft rotative speed (or speed region) which equals a natural frequency of the rotor system. When a rotor accelerates or decelerates through this speed region, the observed vibration characteristics are (1) a peak in the 1X Amplitude and (2) a more rapid change in the 1X vibration phase lag angle.

* Balancing

Adjusting the radical mass distribution of a rotor so that the mass centerline (principal inertia axis) approaches or coincides with the rotor rotational axis. This reduces the 1X lateral vibration of the rotor and the forces on the bearings due to imbalance inertia forces.

* Band-Pass Filter

A filter that has a single transmission band extending from a non-zero lower corner frequency to a finite upper corner frequency. The corner frequencies are the frequencies on either side of the center frequency where the amplitude is attenuated by 3dB. At the center frequency, the signal amplitude is not attenuated.

* Bandwidth

The span between the corner frequencies of a band-pass filter. Normally expressed in terms of frequency for constant bandwidth filters and as a percent of the center frequency for constant percentage (constant Q) filters. See Band-Pass Filter.

* Blade Passing Frequency

A potential vibration frequency on any bladed machine (turbine, axial compressor, fan, propeller, etc.). It equals the number of blades (on a disk or stage) times shaft rotative speed.

* Bode Plot

A pair of graphs in Cartesian format displaying the 1X vibration vector (phase and amplitude) response as a function of shaft rotative speed. The Y axis of the top graph represents 1X phase lag angle, while the Y axis of the bottom graph represents 1X amplitude. The common X axis represents shaft rotative speed. Sometimes called an imbalance response plot. Also used for 2X, 3X, ETC. .Vibration response vectors.

* Bow

A shaft condition such that the geometric shaft centerline is not straight. Usually the centerline is bent in a single plane due to gravity sag, thermal warpage, etc.; however, the bow may be three dimensional (corkscrew). Shaft bow can be detected by measuring the shaft relative displacement with a proximity probe(s) at rotor slow roll speed. See Eccentricity Peak-to-Peak.

* Calibration Weight

Used in rotor balancing procedures, a weight of known magnitude which is placed on the rotor at a known location, under known operating conditions, in order to measure the resulting change in machine 1X vibration response. In effect, such a procedure "calibrates" the rotor system (a known input is applied, and the resultant output is measured) for its susceptibility to imbalance. Sometimes called "trial weight"

* Campbell Diagram

A diagram used in rotating machinery design. A tool for selecting and checking shaft operational rotative speeds and other possible forcing function frequencies against the spectrum of natural frequencies to avoid resonances. The X axis represents the various possible excitation frequencies, i.e., rotative speed (1X), oil whirl (.40-.48X), blade or vane passing frequencies, gear mesh frequencies, etc. The Y axis represents the lateral and torsional natural frequencies. The term is sometimes used incorrectly to describe the Cascade Plot and Waterfall Plot. See torsional vibration

* Cartesian Format

A rectangular graphical format consisting of a vertical (Y) axis and a horizontal (X) axis. This format is used to graph the results of one variable as a function of another; e.g., vibration amplitude versus time (trend), amplitude versus frequency (spectrum) and nX amplitude versus shaft rotative speed (Bode).

* Cascade Plot

A graph in Cartesian format displaying amplitude versus frequency spectra at series shaft rotative speeds. Shaft rotative speed and amplitude are usually presented on two separate vertical axes. Frequency is measured on the horizontal (X) axis. This data format is used to evaluate the change in vibration frequency characteristics during machine transient conditions. See Waterfall Plot.

* Casing Expansion

A measurement of the axial position of the machine casing relative to a fixed reference, usually the foundation. The measurement is typically made with an LVDT installed on the foundation at the opposite end of the machine from the point where the casing is attached to the foundation. Changes in casing axial position are the result of thermal expansion and contraction of the casing during startup and shutdown. The measurement is usually incorporated as part of a TSI system.

* Center Frequency

For band-pass filters the arithmetic center of a constant bandwidth filter or the geometric center (midpoint on a logarithmic scale) of a constant percentage filter.

* Channel

A transducer and the instrumentation hardware to display its output signal.

* Cold Water Stands

An arrangement of piping and brackets installed along a machine foundation for hot alignment measurements. Proximity probes observe exposed shaft areas or targets on the machine casing from brackets through which water circulates. This provides a thermally stable reference for the alignment measurement.

* Communications Processor

An interface module used in an on-line monitoring system to communicate data from the monitor rack to the computer. ProvibTech Communications Processors include Dynamic Data Manager (steady state static data and steady state dynamic data), Transient Data Manager (steady state, transient static data and transient dynamic data), and Process Data Manager (process variable data).

* Constant Bandwidth Filter

A band-pass filters having a fixed frequency bandwidth regardless of center frequency.

* Constant Percentage Filter

A band-pass filters whose bandwidth is a fixed percentage of the center frequency. Also called constant Q filter.

* Critical Machinery

That group of rotating equipment which is absolutely necessary to a major part of the plant process. When critical machinery is not operating, that part of the process is not operating. Machines in this category are usually un-spared and are typically monitored continuously.

* Critical Speed(s)

In general, any shaft rotative speed which is associated with high (dangerous level) vibration amplitude. Often, critical speed is used to describe a shaft rotative speed equal to a rotor system natural frequency. This is more correctly called a balance resonance speed.

* Critical Speed Map

An XY (Cartesian) diagram used in rotating machinery design as a tool to approximate the effect of changes in bearings supports, and pedestal designs on system natural frequencies. The X axis represents bearing stiffness and the Y axis represents rotor system natural frequency.

* Cross Axis Sensitivity

The ratio of change in the signal output to an incremental change in the input along any axis perpendicular to the sensitive axis of an inertial (seismic) transducer.

* Cross Talk

Interference or noise in a transducer signal or channel which originates in another transducer or channel. When using proximity probes, cross talk can occur when the tips of two (or more) probes are too close together. The interaction of the probes' electromagnetic fields causes a noise component in each of the transducers' output signals. The frequency of the noise component is the difference (beat frequency) of the two proximate oscillator frequencies.

* Cycle

One complete sequence of values of a periodic quantity.

* Decibels

A numerical expression of the ratio of the power or voltage levels of electrical signals. dB = 10 log P1/P2 = 20 log V1/V2.

* Difference Analysis

A method for evaluating the change in a measurement variable. Two sets of data are collected at different points in time, or under different conditions, and are subtracted from each other.

* Differential Expansion

The measurement of the axial position of the rotor with respect to the machine casing at some distance from the thrust bearing. Changes in axial rotor position relative to the casing affect axial clearances and are usually the result of thermal expansion during startup and shutdown. The measurement is typically made with a proximity probe transducer mounted to the machine casing and observing an axial surface (e.g., collar) of the rotor. The measurement is usually incorporated as part of a TSI system.

* Differential Phase

A technique which measures the phase difference between vibration signals of a chosen single frequency at different longitudinal locations on a rotor system. It is used for location of the source of instability. The vibration signal whose phase leads all others usually indicates the transducer location closest to the source of the instability.

* Direct Data

Data or a signal, which represents the original transducer signal. Sometimes called unfiltered, raw, all pass, or overall data or signal.

* Displacement

The change in distance or position of an object relative to a reference. Machinery vibration displacement is typically a peak-to-peak measurement of the observed vibrational motion, and is usually expressed in units of mils or micrometres. Proximity probes measure displacement directly. Signal integration is required to convert a velocity signal to displacement.

* Dual Path

A signal conditioning technique used in vibration monitors whereby a single transducer input is processed through two separate signal conditioning paths in the monitor. Each signal conditioning path can have its own engineering units of measurement (e.g., displacement and velocity), optional filtering, alarm set points and displays.

* Dual Probe

A transducer set consisting of a proximity probe and velocity transducer installed radially at the same point (usually in a common junction box on the machine bearing housing). Four separate measurements are provided by this transducer system. The proximity probe measures (1) shaft relative radial position within the bearing clearance, and (2) shaft dynamic motion relative to the

bearing. The velocity transducer measures (3) machine casing absolute vibration. When the velocity signal is integrated to displacement and added to the shaft relative signal, the summation represents (4) shaft absolute motion.

* Dual Voting

A logical AND relationship between two independent monitor inputs; they must agree before any action is taken. For example, two transducer input signals must both exceed an amplitude set point (usually the Danger set point only) before an actual alarm condition is indicated by the monitor. If only one transducer input exceeds the set point, then no alarm is initiated in the monitor.

* Dynamic Data

Data (steady state and/or transient) which contain that part of the transducer signal representing the dynamic (e.g., vibration) characteristics of the measured variable. Typical dynamic data presentations include Orbit, Timebase, spectrum, Polar, Bode, Cascade, and Waterfall. From this data it is possible to derive static data such as amplitude, frequency filtered amplitude, and phase lag angle from the signal. See Steady State Dynamic Data and Transient Dynamic Data.

* Dynamic Stiffness

Spring stiffness of the mechanical system complemented by the dynamic effects of mass and damping which act against an applied dynamic force to limit vibration response.

* Dynamic Stiffness, Direct

The component of mechanical system Dynamic Stiffness, consisting of modal mass, stiffness, and cross couple damping terms, which collinearly opposes the applied force.

* Dynamic Stiffness, Quadrature

The component of a Dynamic Stiffness mechanical system Dynamic Stiffness in a fluid environment, consisting of 1) the viscous damping (the reaction of the fluid when the shaft presses on it); and 2) the fluid wedge support term (the reaction of the shaft when the fluid pushes on it). The latter is cross-coupled stiffness (tangential force component). Quadrature dynamic stiffness acts perpendicularly to the applied force (90 degrees out of phase).

* Eccentricity, Mechanical

The variation of the outer diameter of a shaft surface when referenced to the true geometric centerline of the shaft. Out-of-roundness. See Mechanical Runout.

* Eccentricity Peak-to-Peak

The measurement of shaft bow at slow roll speed. The shaft bow may be due to; (1) fixed mechanical bow, (2) temporary thermal bow, or (3) temporary bow due to any sort of sag or bow at rest, sometimes called gravity bow.

* Eccentricity Ratio, Average

A dimensionless quantity representing the average position of the shaft within the bearing (or seal). The average eccentricity ratio, obtained by dividing the distance between the average position of the shaft centerline and the bearing (seal) centerline by the radial clearance, can vary between zero and one. Zero represents the shaft concentric with the bearing (seal), and one represents the shaft in contact with the bearing (seal). A trend of decreasing eccentricity ratio can indicate a potential stability problem. See Rotor Position Angle and Attitude Angle.

* Eccentricity Ratio, Dynamic

A dimensionless quantity representing the instantaneous position of the shaft within the bearing (or seal). The dynamic eccentricity ratio, obtained by dividing the distance between shaft and bearing (seal) centerlines by the radial clearance, can vary between zero and one. Zero represents the shaft concentric with the bearing (seal), and one represents the shaft in contact with the bearing (seal). See Eccentricity Ratio, Average.

* Eddy Current

Electrical current which is generated in a conductive material when such material intercepts the electromagnetic field of a proximity probe.

* Electrical Runout

A noise component in the output signal of a proximity probe transducer system resulting from non-uniform electrical conductivity and magnetic permeability properties of the observed material. Also caused by local (spot) magnetic fields on the circumference of the shaft surface. A change in the Proximate output signal which does not result from a probe gap change (dynamic motion or change in average shaft position). The error repeats exactly with each shaft revolution. See Mechanical Runout.

* Element Passage Frequency

(EPx) For purposes of studying rolling element bearings, using either bearing housing transducers or the ProvibTech REBAM system, EPx is a symbolic indication of the rate at which rolling elements pass a fixed point on either the inner or outer race. Harmonics of the element passage frequency are then indicated as 2EPx, 3EPx, .., nEPx.

* Error

The difference between the indicated value and the true value of the measured variable. It is often expressed as relative error, i.e., as a percent of the output reading of the transducer.

* Essential Machinery

That group of rotating equipment which is critical to part of the plant process. When essential machinery is not operating, the overall plant is not operating to full capacity. Machines in this category can be spared or un-spared and are typically monitored continuously.

* Filter

Electronic circuitry designed to pass or reject a specific frequency band of a signal.

* Fluid Circumferential Average Velocity Ratio

A dimensionless ratio of the average rate of rotation of a fluid (in a bearing or seal clearance or in rotor to stator periphery) in the direction of shaft rotation divided by shaft rotative speed. Lambda times rotative speed is the angular velocity at which the fluid force rotates. Sometimes this is used as the ratio of oil (fluid) whirl frequency to rotative frequency (approximate value).

* Fluid Induced Instabilities

Rotor self-excited lateral vibrations (whirl and whip) due to fluid/solid interaction in bearings, seals, and other "cylinder within a cylinder" parts of a machine.

Whirl causes the shaft dynamic motion to be forward and circular (or elliptical), and at a frequency proportional to shaft rotative speed. The vibration frequency of whirl is a function of the fluid circumferential average velocity in the bearing, seal or rotor periphery. Typically whirl for bearings varies from 0.3X to 0.49X (just less than one-half of shaft rotative speed).

Whip occurs when whirl vibration frequency approaches a rotor system's natural frequency, most often the rotor first balance resonance. The mechanism is not limited to oil lubricated bearings, but can occur when any fluid (e.g., oil, steam, process gas, etc.) is enclosed within a small clearance area between two body surfaces, one of which is rotating and dragging the enclosed fluid into circumferential rotation. While the fluid average frequency is then usually below half rotative speed, changes may occur when the fluid is tangentially accelerated, for instance due to recirculation, or decelerated such as in anti-swirl seals.

* Forced Vibration

The response vibration of a mechanical system due to a forcing function (exciting force). Typically, forced vibration has the same frequency at that of the exciting force.

* Free Vibration

Vibration response of a mechanical system following an initial perturbation (change of position, velocity or force). Depending on the kind of perturbation, the mechanical system responds with free vibrations at one or more of its natural frequencies.

* Frequency

The repetition rate of a periodic vibration per unit of time. Vibration frequency is typically expressed in units of cycles per second (Hertz) or cycles per minute (to more easily relate to shaft rotative speed frequency). In fact, since many common machine malfunctions produce vibration which has a fixed relationship to shaft rotative speed, vibration frequency is often expressed as a function of shaft rotative speed. 1X is a vibration with a frequency equal to shaft rpm, 2X vibration is twice shaft rpm, 0.5X is a frequency equal to one-half shaft rpm, etc.

* Frequency Component

The amplitude, frequency and phase characteristics of a component of a dynamic signal.

* Frequency Response

The measured amplitude and phase response characteristics of a mechanical or electronic system with respect to frequency.

* g

The value of acceleration yielded by the force of earth's gravity, which varies somewhat with latitude and elevation. By international agreement, 9.8 m/s2 = 386 in/s2 = 32.17 ft/s2 has been chosen as the standard acceleration due to gravity.

* Gear Mesh Frequency

A potential vibration frequency on any machine which contains gears. It equals the number of gear teeth times shaft rotative speed.

* Harmonics

A series of vibration signal components whose frequencies are integer multiples of the fundamental, or lowest frequency, vibration component.

* Harmonic Vibration

Sinusoidal vibration with a single frequency component.

* Heavy Spot

A term used to describe the position of imbalance. It is the angular location of the imbalance vector (the summation of the mass imbalance distribution) at a specific lateral location (in one plane) on a rotor. See High Spot.

* Hertz

(Hz) Unit of frequency measurement in cycles per second.

* High Frequency

For purposes of studying rolling element bearings, a frequency range, typically above 5 kHz, used to measure the very high vibration frequencies associated with microscopic faults in bearing components.

While this technique may provide the earliest warning of impending bearing failure for some types of bearing faults, there are several other machine malfunctions which can produce vibrations in this range (e.g., cavitation, rubs, etc.) In addition, the high frequency measurement technique sometimes provides warnings too early, long before any maintenance (bearing replacement) needs to be considered.

* High-Pass Filter

A filter having a single transmission band extending from some finite lower corner frequency (defined as the point where amplitude is attenuated by 3 dB) to infinite frequency (or the upper frequency response limit of the transducer or instrument).

* High Spot

The term used to describe the response of the shaft due to imbalance force. It is the angular location on the shaft directly under the vibration probe when the shaft makes its closest approach to that probe. Also, the location on the shaft surface under a proximity probe when the 1X filtered vibration signal produced by the probe reaches its positive peak.

* Hysteresis

The difference in levels (dead band) between the trigger threshold and the reset designed to reduce false triggering.

* Inertially Referenced

Motion that is referenced to a mass whose inertia keeps it stationary, yielding absolute motion. Also describes a transducer with an internal inertial reference mass.

* Influence Vector

Used in balancing, the 1X vibration response vector due to a calibration weight, divided by the calibration weight vector at a particular shaft rotative speed. The measured vibration vector divided by the unbalance force vector represents the rotor's transfer function. If the description of the influence vector contains the shaft rotative speed term and the radius at which the calibration weight is placed on (or removed from) the rotor, the influence vector is the inverse of the synchronous dynamic stiffness vector. See Influence Vector, Direct and Influence Vector, Longitudinal.

* Influence Vector, Direct

An influence vector where the measured vibration vector and the unbalance force vector are at or near the same plane along the rotor axis.

* Influence Vector, Longitudinal

An influence vector where the measured vibration vector and the unbalance force vector are at different longitudinal planes along the rotor axis.

* Integrator

An electronic circuit that converts a velocity signals to a displacement signal or converts an acceleration signal to a velocity signal.

* Isotropic Supports

Rotor support systems that provide uniform dynamic stiffness in all radial/lateral directions.

* Keyphasor Pulse

That change in the output signal of the Keyphasor Transducer caused by the Keyphasor Event.

* Keyphasor Transducer

A transducer that produces a once-per-shaft-turn voltage pulse, called the Keyphasor signal. This signal is used primarily to measure shaft rotative speed and as a reference for measuring vibration phase lag angle. It is an essential element in measuring rotor slow roll bow/runout information.

The Keyphasor transducer is typically a proximity probe (recommended for permanent installations in which the probe observes a physical gap change event), an optical pickup (used for temporary installations in which the pickup observes a change in reflectivity event) or a magnetic pickup. Keyphasor is a ProvibTech registered trademark.

* Linearity (Calibration)

The closeness of a calibration curve to a specific straight line, expressed as the maximum deviation of any calibration point on a specified straight line, in any one calibration increment.

* Load Zone

An angular region around a rolling element bearing where there is maximum compressive force between the shaft and the outer race of the bearing. Probes for bearing activity measurement (REBAM) would normally be placed in this zone for best (or most sensitive) measurements. Also, the direction of steady state load on any, including fluid film, bearing. "Normal" load can result from the force of gravity (for horizontal machines), gear mesh forces, fluidic forces, etc.

* Low-Pass Filter

A filter having a single transmission band extending from zero frequency (or the lower frequency response limit of the transducer or instrument) to some finite upper corner frequency (defined as the point where amplitude is attenuated by 3 dB).

* LVDT

Acronym for Linear Variable Differential Transformer. A contacting displacement transducer consisting of a movable core and a stationary transformer. The core is attached to the part to be measured and the transformer is attached to a fixed reference. The most common application is casing expansion measurement where the core is attached to the casing and the transformer (LVDT housing) is attached to the machine foundation. Also used for valve position measurements.

* Mechanical Runout

A noise component in the output signal of a proximity probe transducer system; a probe gap change which does not result from either a shaft centerline position change or shaft dynamic motion. Common sources include out-of-round shafts, scratches, chain mark, dents, rust or other conductive build-up on the shaft, stencil mark, flat spots, and engravings. See Runout and Electrical Runout.

* Micro-inch

A unit of length or displacement equal to 10^-6 inches or 10^-3 mils.

* Micro-metre

A unit of length or displacement equal to 10^-6 metres. One micro-metre equals 0.0394 mil. Also called micron (obsolete).

* Micro-Prox

A high sensitivity ProvibTech Proximitor used to accurately and rapidly measure probe gap changes of a few micro-inches.

* Mil

A unit of length or displacement equal to 0.001 inch. One mil equals 25.4 micrometres.

* Mode Shape of the Rotor

The deflected shape of a rotor at a specific rotative speed caused by an applied specific forcing function such as imbalance. Note, this is a three dimensional presentation of rotor lateral (See Lateral Vibration) deflection in vibration mode along the shaft axis.

* Modulation, Amplitude (AM)

The process whereby variation in the amplitude of a vibration signal results in modulation of the amplitude of a carrier signal. AM is used when high frequency signal recordings are needed (i.e. gear mesh). AM tape recorders, also called direct, have a finite lower frequency response above zero (dc) Hertz. They capture dynamic data above the lower response frequency, but not the average shaft position data (dc voltage) which is available from a proximity probe signal.

* Modulation, Frequency (FM)

The process whereby variation in the amplitude of a vibration signal results in a variation a carrier frequency. FM tape recordings have a low frequency response down to dc (zero Hertz). This allows recording of proximity probe dc gap voltages which represent average shaft position.

* Narf

Acronym for Natural Axial Resonant Frequency; usually refers to axially compliant couplings.

* Natural Frequency

The frequency of free vibration of a system. The frequency at which a lightly damped system will oscillate upon momentary displacement from its steady position by a transient force. The natural frequencies of a multiple degree of freedom system are the frequencies of the normal modes of vibration. See Resonance.

* Nodal Point (Node)

A point of minimum (or zero) shaft deflection in a specific mode shape. May readily change location along the shaft axis due to changes in residual imbalance or other forcing functions, or due to changes in dynamic stiffness such as increased bearing clearance. This is often a location of minimum shaft absolute displacement. Vibration immediately on each side of the node is 180 degrees out of phase. See Pivotal/Conical Diagram under Mode Shape.

* Noise

Any component of a transducer signal which does not represent the variable intended to be measured.

* Non-symmetric (Anisotropic) Rotor

A rotor whose cross-section has two different geometric moments of inertia (for example, an elliptical cross-section) and/or the supports have different stiffness characteristics in the horizontal and vertical directions. See Symmetric Rotor.

* Notch Filter

A filter which has a single rejection band extending from a finite lower cutoff frequency greater than zero to a finite upper cutoff frequency. Frequencies within the rejection band are eliminated

or attenuated while frequencies outside the rejection band are retained. The opposite of a band-pass filter.

* Nulling

Subtraction of the shaft slow roll speed value for 1X electrical runout or mechanical runout vector component from the corresponding transducer signal nX vector component.

* Nyquist Plot

A type of graphical presentation in polar format used to evaluate the stability of an automatic control system. This term should not be used to describe a similar polar presentation of machine vibration vector data. See Polar Plot.

* Octave

A 2 to 1 ratio between two frequencies. An octave higher than some frequency F is 2F; an octave lower is one-half F.

* 1X

In a complex vibration signal, notation for the signal component that occurs at the rotative speed frequency. Also called synchronous.

* 1/2X, 1/3X, 2/5X, 4/9X, ETC.

In a complex vibration signal, notations for signal components having frequencies equal to fractions of rotative speed. Also called sub-harmonic and sub-synchronous.

* Optical Pickup

A non-contacting transducer which emits light from an internal infrared LED, and detects the level of reflected light with a phototransistor. The most common application of this pickup is as a temporary Keyphasor transducer, observing a once-per-turn change in shaft reflectivity (dark or light paint spot or small strip of highly reflective tape on the shaft).

* Orbit

The dynamic, two dimensional path of the centerline motion of a machine component, which is observed by XY transducers, in the plane of those transducers. When the transducers are XY shaft proximity probes, it is the shaft centerline lateral vibration, called precession. Observed with an oscilloscope in the X versus Y mode. Sometimes called orbital motion, or Lissajous presentation.

* Outer Race

For rolling element bearings, a generally cylindrical component which is positioned between the rolling elements and the bearing housing.

* Peak-to-Peak Value

The difference between positive and negative extreme values of an electronic signal or dynamic motion. See Amplitude.

* Period

The time required for a complete oscillation or for a single cycle of events. The reciprocal of frequency.

* Periodic Vibration

Oscillatory motion whose amplitude pattern repeats in time.

* Perturbation

Application of a forcing function to a system by means of an external device in order to study the system characteristics. Also called excitation.

* Perturbation Technique

A part of modal testing. A method of identifying the dynamic characteristics of a mechanical system (rotors in particular) by comparing a known input force to the measured response. The perturbation force may be at any frequency, including shaft rotative frequency, (as in the case of unbalance) and zero frequency (zero speed), as in the case of a steady state load.

The perturbation force may be applied in one direction only (unidirectional), or in two directions simultaneously, as in the case of a circular or elliptical force. If the non-synchronous perturbation force is applied to the rotating shaft in two axes simultaneously, it may be forward (in the direction of shaft rotation) or reverse (against the direction of rotation).

Direct perturbation of the rotating shaft by a rotating force input of known force amplitudes, phase and frequency across ranges of all of these, while measuring the motion response vectors of the rotor system at the same frequency, can yield the meaningful dynamic stiffness of a rotor system. This methodology can be applied for identification of nonlinear, non-symmetric, and discontinuous systems.

A "gong" test (impulse test) may yield some basic simple data. A unidirectional swept sine perturbation applied to the support system is an improvement over the "gong" test. Swept sine input to the rotor by a known displacement is another improvement, but the readout must be the response force vector which is very difficult to instrument accurately.

* Phase Lag Angle

The timing relationship, in degrees, between two vibration signals, or a Keyphasor pulse and a vibration signal; also, the phase difference between two signals such as the input force signal and output response signal. The "lag" corresponds to "minus" in mathematical formulations.

* Piezoelectric

Any material which provides a conversion between mechanical and electrical energy. For a piezoelectric crystal, if mechanical stresses are applied on two opposite faces, electrical charges appear on another pair of faces.

* Plant Summary Report

Information available from on-line computerized monitoring systems typically representing the status of all measured variables, monitors, alarms, and trends for a user-defined time period (usually the previous work shift or 24 hours).

* Polarity

In relation to transducers, the direction of output signal change (positive or negative) caused by motion toward or away from the transducer in its sensitive axis. Convention is that motion toward the transducer will produce a positive signal change.

* Polar Format

A graphical format consisting of a center reference point surrounded by concentric circles. Vector information is graphed on this format by plotting magnitude (vibration amplitude) as the length of a radial line, and phase (vibration phase lag angle) as the clock position of the line.

* Polar Plot

Polar format presentation of the locus of the 1X (or 2X,...) shaft vibration vector from a single channel as a function of shaft rotative speed. The Polar Plot is generated by in-phase and quadrature signals, usually during machine startup or coast down (transient operation). This plot is sometimes incorrectly called a Nyquist Plot.

* Preload

A unidirectional, radial (side) load due to external or internal mechanisms. Categorized as a "soft" or "hard" preload. A soft preload may shift in direction or magnitude, and can act to stabilize or destabilize the dynamic condition of the machine. A hard preload is usually fixed and acts to stabilize.

* Prime Spike

In the study of rolling element bearings, a frequency range which encompasses, as a minimum, the primary bearing fault frequencies and harmonics.

* Probe Gap

The physical distance between the face of a proximity probe tip and the observed surface. The distance can be expressed in terms of displacement mils, micrometres, or in terms of voltage (millivolts). Standard polarity convention dictates that a decreasing gap results in an increasing (less negative) output signal.

* Probe

Specifically, a proximity probe transducer, although sometimes used to describe any transducer.

* Probe Orientation

The angular location of a probe with respect to a polar coordinate system when viewed from the driver end of the machine. Typically, zero degrees are at top dead center (vertical) or at the horizontal right (3 o'clock) position on the coordinate system.

* Proximitor

A ProvibTech signal conditioning device which sends a radio frequency signal to an eddy current proximity probe, demodulates the probe output, and provides output signals proportional to both the average and dynamic probe gap distances. Also called an oscillator-demodulator. Proximitor is a ProvibTech registered trademark.

* Proximity Probe

A non-contacting device which measures the displacement motion and position of an observed surface relative to the probe mounting location. Typically, proximity probes used for rotating machinery measurements operate on the eddy current principle and measure shaft displacement motion and position relative to the machine bearing(s) or housing. See Relative Transducer.

* Q, Filter

Filter selectivity, i.e, the relative band of frequencies passed or rejected by the filter. The narrower the band of frequencies, the higher the Q, and the broader the band, the lower the Q. This is computed by Q = fc / delta-f where fc is the center frequency and delta-f is the bandwidth of the filter at the 3dB points.

* Q, Machine

Derived from Q, Filter. Used to describe the synchronous amplification factor of a rotor system. See Synchronous Amplification Factor.

* Radial

A direction on a machine which is perpendicular to the shaft centerline in the XY plane; usually refers to direction of shaft lateral or casing motion or measurement.

* Radial Vibration

Shaft dynamic motion or casing vibration which is measured in a direction perpendicular to the shaft axis.

* Raster Plot

A type of Cascade or Waterfall plot, usually with a skewed Y axis so that the plot has an isometric appearance.

* Real Time Analyzer

A term used to describe an instrument which displays a vibration frequency spectrum.

* REBAM

An acronym for Rolling Element Bearing Activity Monitor, which is a ProvibTech method and system for monitoring and analyzing the performance of rolling element bearings using eddy current transducers and Micro-PROX .

* Relative Vibration

Vibration measured relative to a chosen reference. Proximity probes measure shaft dynamic motion and position relative to the probe mounting, usually the bearing or bearing housing.

* Relative Transducer

A proximity probe observing shaft motion relative to the probe mounting, usually the bearing or bearing housing.

* Repeatability

The ability of a transducer or readout instrument to repeat measurements, under the same conditions, within narrow limits. Precision is the measure of repeatability.

* Resolution

The smallest change in applied stimulus that will produce a detectable change in the instrument output.

* Resonance

The condition in which a forcing frequency coincides with a natural frequency of the system. A resonance typically is identified by an amplitude peak, accompanied by a maximum rate of change of phase lag angle. See Balance Resonance Speed.

* Rod Drop

On a reciprocating compressor, the measurement of the position change of the piston rod relative to a fixed reference point as the piston drops in the cylinder due to piston rider ring deterioration. The position measurement can indicate either the average position of the rod over the full stroke or the instantaneous position of the rod at a specific point in the stroke.

* Rod Drop, Average Position

On a reciprocating machine, the measurement of the average position change of a piston rod over the full stroke of the piston relative to a fixed reference on the cylinder. This measurement is usually achieved by evaluating the average dc gap voltage change of a proximity probe mounted to the fixed reference.

* Rod Drop, Instantaneous Position

On a reciprocating machine, the measurement of the position change of a piston rod at one specific event during the full stroke of the piston, relative to a fixed reference of the cylinder. This measurement is usually achieved by evaluating the instantaneous dc gap voltage change of a proximity probe mounted to the fixed reference. Timing of the measurement is provided by a Keyphasor probe.

* Rolling Element Bearing

(Antifriction Bearing) A bearing which uses rolling elements (rollers or balls) to support the load of a rotating shaft and to minimize friction.

* Rolloff

The rate of attenuation of amplitude and phase with respect to frequencies above (or below) a certain point. Thus a low-pass filter is designed to provide amplitude and phase rolloff at high frequencies, and a high-pass filter is designed to provide rolloff at low frequencies. Commonly rated in dB per octave.

* Rolling Elements

Components in a rolling element bearing (generally rollers or balls) which support the rotating load of a shaft.

* ROMIS Rotating Machinery Information Systems and Services

ProvibTech's ROMIS product offerings include on-line and periodic monitoring systems and diagnostic instruments/systems which provide information for operations personnel, plant engineers, and rotating machinery specialists including: overall values, trends, correlation of performance-related variables, steady-state dynamic data, and transient dynamic data. ROMIS is applicable to transducer and monitoring systems, diagnostics and test equipment, and services.

* Root Mean Square (RMS)

Square root of the arithmetic average of a set of squared instantaneous values. Used as a measure of amplitude; rms equals 0.707 x peak (sine wave only). (0.707 = 1/squareroot (2)). See Amplitude.

* Rotor Position Angle

The angle between an arbitrary reference through the center of a bearing (typically vertical down in a horizontal machine) and the line connecting the bearing and shaft centers, measured in the direction of rotor rotation. Used to indicate the presence of abnormal preloads on a machine, but NOT the stability of the rotor/bearing system. See Attitude Angle.

* Rotor Vibration Region

As applied to the study of rolling element bearings, using either bearing housing transducers or the ProvibTech REBAM system, a low-pass frequency range which includes vibration signals of the principal frequency components due to rotor/rolling element defects, but excludes any significant frequency components due to internal bearing defects. Typically, this frequency range is from one-fourth times shaft rotative speed (1/4X) to approximately three times shaft rotative speed.

* RTD

An acronym for Resistance Temperature Detector; a sensor which measures temperature and change in temperature as a function of resistance.

* RUB

Machine malfunction consisting of contact between the rotating and stationary parts of a machine involving friction, impacting, and changes in system stiffness.

* Runout Compensation

Electronic correction of a transducer output signal for the error resulting from runout. See Nulling

* Scale Factor

The change in output per change in input (sensitivity) of a transducer. Also, the factor by which a signal must be increased or decreased to meet the input requirements of an instrument.

* Seismic Transducer

Any vibration transducer which measures the absolute vibration of an object. Accelerometers and velocity transducers measure absolute vibration, typically of machine housing or structures, and thus are both referred to as seismic, or inertial, transducers.

* Sensitivity

The ratio of the change in the output to a change in the input. A typical sensitivity for a proximity probe transducer is 200 millivolts per mil (7.84 volts per millimetre).

* Shaft Average Centerline Plot

Transient or trend plot of the shaft average radial centerline position within the bearing clearance, presented in Cartesian format. See Average Shaft Position.

* Shaft Rotative Speed

The frequency at which a shaft is rotating at a given moment, usually expressed in units of revolutions per minute (rpm); may also be expressed in radians per second (mostly for laboratory work). 100 rpm equals approximately 10 radians per second; (100 rpm = 100 PI/30 radians per second).

* Signal Attenuation

A desired reduction in amplitude of a signal without changing the frequency and phase. Also, the decrease in amplitude and phase that results from the transmission of vibration energy from one machine part to another (e.g., shaft to bearing housing).

* Signal Conditioner

A device placed between a signal source and a readout instrument to change the signal. Examples: attenuators, preamplifiers, signal converters (for changing one electrical quantity into another, such as volts to amps or analog to digital), and filters.

* Signal Gain

The increase (or decrease) in magnitude of a signal. Also, the amount of voltage amplification utilized to enlarge small electronic signals up to full scale range on instruments such as FM tape recorders. This nondimensional number is usually in even steps of 2, 5, and 10.

* Signature

Term sometimes applied to a vibration frequency spectrum which is distinctive and special to a particular machine or component, system or subsystem at a specific point in time, under specific machine operating conditions, etc. Often fails to include the basic signal measurement of phase. Used for historical comparison of mechanical condition over the operating life of the machine.

* Slow Roll Speed

Low rotative speed at which dynamic motion effects from such forces as imbalance are negligible. The speed at which shaft bow and runout can be measured.

* Spall

In rolling element bearings, a flake or chip of metal removed from one of the bearing races or from a rolling element. Spalling is evidence of serious bearing degradation and may be detected during normal bearing operation by observing increases in the signal amplitude of the high frequency or Prime Spike region vibration signals.

* Spectrum

Commonly a presentation of the amplitudes of a signal's components as a function of its frequency.

* Spectrum Plot

An XY plot in which the X axis represents vibration frequency and the Y axis represents vibration amplitude.

* Stability of a Mechanical System (Liapunoff Definition, Stability "In The Small")

A mechanical system is stable if external small perturbation of its regime will create a resultant small change of the previous steady state regime. The perturbation can be introduced by applying an impulse force or changing the initial conditions of displacement and/or velocity. A system is asymptotically stable if small perturbation causes a decaying transient response, leading to the previous steady state regime.

Note that these definitions refer to some quantitatively undefined "small" actions. If a mechanical system exhibits several steady state regimes of motion, the definitions apply equally to each one. Note also that, according to these definitions, oil whirl is stable (while the rotor undergoes instability).

* Stability of a Mechanical System (Practical Definition)

A mechanical system is stable if any practical perturbation results in a system response with amplitudes within acceptable, prescribed levels.1

* Stability of a Rotating Machine

A rotating machine is stable if, at operating speeds, the rotational motion of all rotating elements (shafts, disks, blades, etc.) and the steady equilibrium of non-rotating parts (supports, bearings, cases, foundations, etc.) are not accompanied by various modes of vibration with amplitudes exceeding prescribed acceptable levels. This definition also applies to machine startups and coast downs when shaft rotative speed is variable.

* Static Data

Data which describes the quantitative characteristics of the measured parameter. Static data can also include quantitative values describing the conditions under which the parameter was

measured. For predictive maintenance purposes, static data is typically presented in various forms of trend plot and displays/lists of current values. Examples of static data include vibration amplitude, phase lag angle, frequency, average shaft position, shaft rotative speed, time, date, monitor alarm and OK status.

* Steady State Data

Data (static and/or dynamic) acquired from a machine, at constant shaft rotative speed.

* Steady State Dynamic Data

Dynamic data acquired under steady state machine conditions. Typical data presentations include orbit, timebase and spectrum. This data can be instantaneously trended. See Dynamic Data and Steady State Data.

* Steady State Static Data

Static data acquired under steady state machine conditions. Example: shaft centerline position. See Static Data and Steady State Data.

* Strain Gauge

A transducer which reacts to changes in strain, typically through changes in resistance.

* Stress

A force acting on a body (e.g., shaft) per unit area. Usually measured in terms of lbs/in^2 or Newton/meter^2.

* Sub-harmonic

Sinusoidal component of a vibration signal that is a sub-multiple (integer fraction) of a fundamental frequency.

* Sub-synchronous

Component of a vibration signal which has a frequency less than shaft rotative speed.

* Super-harmonic

Sinusoidal component of a vibration signal that is an integer multiple of a fundamental frequency.

* Super-synchronous

Component of a vibration signal which has a frequency greater than shaft rotative speed.

* Suppression

The practice of using electronic circuitry to arithmetically subtract (suppress) the amplitude of an unwanted signal (noise). It is not recommended for vibration measurement and/or monitoring

because most noise sources are vector, not scalar, quantities.

* Sweep Frequency Filter

A type of bandpass filter which is automatically swept (tuned) through a frequency range of interest. An instrument which incorporates this type of filter can be used to generate a vibration frequency spectrum. A change in the frequency content of the measured signal during the time required to sweep through the frequency range will cause the spectrum to smear.

* Swirl Ratio

See Fluid Circumferential Average Velocity Ratio.

* Synchronous

The component of a vibration signal that has a frequency equal to the shaft rotative frequency (1X).

* Thermocouple

A temperature sensing device comprised of two dissimilar metal wires which, when thermally affected (heated or cooled), produce a proportional change in electrical potential at the point where they join.

* Threshold

The level at which a trigger or other function is initiated.

* Timebase Plot

A presentation of the instantaneous amplitude of a signal as a function of time. A vibration waveform can be observed on an oscilloscope in the time domain.

* Torque

A measure of the tendency of a force to cause rotation. Equal to the force multiplied by the perpendicular distance between the line of action of the force and the center of rotation.

* Torque, Average

The constant amplitude component of the moment (force couple) applied to a rotor, in order to sustain rotational speed, angular acceleration or load requirements.

* Torque, Dynamic

The instantaneous amplitude of the time-varying component of the moment applied to a rotor, typically resulting from a variation in driving load or torque.

* Torque, Static

The force times the perpendicular distance between the force's line of action and the center of rotation (moment) as applied to a structure (non-rotating).

* Torsional Vibration

Time variation of the angle of twist, typically measured in tenths of degrees pp.

* TorXimitorTM

A ProvibTech non-contacting, signal conditioning device which senses strain and outputs a signal proportional to torque. TorXimitorTM continuously measures dynamic as well as static torque. TorXimitorTM is a trademark of ProvibTech Corporation.

* Transducer

A device for translating the magnitude of one quantity into another quantity. The second quantity often has units of measure different from the first and serves as the source of a useful signal. Vibration transducers convert mechanical motion into a proportional electronic signal (typically a voltage-proportional signal).

* Transient Data

Data (static and/or dynamic) acquired under transient machine conditions (startup and coast-down).

* Transient Dynamic Data

Dynamic data acquired under transient machine conditions. Typical transient dynamic data presentations include Polar, Bode and Cascade. See Dynamic Data and Transient Data.

* Transient Static Data

Static data acquired under transient machine conditions. See Static Data and Transient Data.

* Transient Vibration

The temporarily sustained vibration of a mechanical system. It may consist of forced or free vibration or both. Usually transient vibration is associated with instantaneous changes in machine condition such as speed, load, etc.

* Trend Data

The periodic recording/storage of static and/or dynamic data for the purpose of observing changes as a function of time. Trend data is the most fundamental level of information in any predictive maintenance program.

* Trend Interval

The time period between consecutive data points on a Trend Plot.

* Trend Period

The complete time frame (beginning to end of data) of a Trend Plot

*Trend Plot

A presentation in Cartesian format or polar format of a plot with the measured variable versus time.

* Trigger

Any event which can be used as a timing reference. A trigger for an oscilloscope will initiate the sweep of the beam across the face of the CRT. A trigger signal for a digital vector filter is a Keyphasor pulse which serves to align the center frequency of the band-pass filter to shaft rotative speed. It provides a reference from which to measure shaft rotative speed, 1X amplitude and phase lag angle.

* Trip Multiplier

That function provided in a monitor system to temporarily increase the alarm (Alert and Danger) setpoint values by a specific multiple (usually two or three). This function is normally applied by manual (operator) action during startup to allow a machine to pass through high vibration speed ranges without monitor alarm indications. Such high vibration speed ranges may include system resonances and other normal transient vibrations. Also called set point multiplier.

* TSI

Acronym for Turbine Supervisory Instrumentation. A TSI system is a continuous monitoring system generally used on turbogenerator sets. It can include such measurement parameters as shaft radial vibration, shaft absolute vibration, axial position, differential expansion, case expansion, valve position, eccentricity peak-to-peak, zero speed, and shaft rotative speed. The system may also include a vector filter which measures vibration phase lag angle for each vibration frequency. The TSI system consists of measurement transducers, monitors, interconnecting wiring and usually strip chart recorders or a microprocessor-based monitoring/data acquisition system.

* 2X, 3X, ETC.

In a complex vibration signal, notation for signal components having frequencies equal to exact multiples of shaft rotative speed. Also called harmonic, super-harmonic, and super-synchronous.

* Unbalance

Unequal radial mass distribution on a rotor system; a shaft condition where the mass centerline (principal inertial axis) does not coincide with the geometric centerline. Also, the effective mass that causes rotor vibration.

* Valve Position

A measurement of the position of the process inlet valves on a machine, usually expressed as a percentage of the valve opening; zero percent is fully closed, 100 percent is fully open. The measurement is usually made with an LVDT and is incorporated as part of a TSI system.

* Vane Passing Frequencies

A potential vibration frequency on vaned impeller compressors, pumps, and other machines with vaned rotating elements. It is represented by the number of vanes (on an impeller or stage) times shaft rotative speed.

* Vector

A quantity which has both magnitude and direction. For a vibration vector, magnitude is expressed as amplitude (displacement, velocity, or acceleration) and direction as phase lag angle (degrees). For example, the 1X vibration vector measured at shaft operating speed, e.g., for balancing purposes, will be described as a magnitude (mils or micrometres) acting in a particular direction (degrees). The vector data presentation which is easiest to interpret is the polar format. See Acceptance Region and Polar Plot.

* Vector Filter

An electronic instrument that automatically adjusts a band-pass filter center frequency to coincide with the frequency determined by an external electronic input pulse (Keyphasor). Typically, a digital vector filter is used to automatically filter a vibration signal at rotative speed (1X) frequency, (or 2X or other single frequency) especially under transient rotor speed conditions. Among other functions, a vector filter provides the dc proportional signals (shaft centerline).

* Velocity

The time rate of change of displacement. Typical units for velocity are inches/second or millimeters/second, zero-to-peak. Velocity measurements are used to evaluate machine housing and other structural response characteristics. Electronic integration of a velocity signal yields displacement.

* Velocity Transducer

An electromechanical transducer, typically of inertial design, used for measuring bearing housing and other structural absolute vibration. Seismoprobe is a ProvibTech registered trademark for this type of velocity transducer.

* Velomitor®

A piezoelectric velocity sensor with no moving parts that contains an accelerometer crystal and a built-in amplifier/integrator. This type of seismic sensor is used for casing vibration measurements on rotating machinery equipped with rolling element bearings and frame vibration measurements on reciprocating machinery. It measures absolute vibration relative to free space. Also see Seismic Transducer.

* Vibration

The oscillatory (back and forth) motion of a physical object.

* Vibration Form

The characteristics of vibration signals which may be observed on an oscilloscope. Typical displays are timebase waveform and shaft Orbit. See Orbit and Waveform.

* Waterfall Plot

Similar to Cascade plot, except that one vertical axis is usually time instead of shaft rotative speed (rpm). See Cascade Plot.

* Waveform

A presentation or display of the instantaneous amplitude of a signal as a function of time. A vibration waveform can be observed on an oscilloscope in the timebase mode.

* Wobulator

A mechanical device which generates dynamic motion of an observed surface at a known amplitude and frequency. The surface is observed by a proximity probe for the purpose of calibration of a vibration monitor. ProvibTech's TK3-2 incorporates a wobulator.

* XY

Orthogonal (perpendicular) axes in a Cartesian coordinate system. Usually used as a reference for orthogonal (mutually perpendicular) radial vibration transducers. Y represents the vertical axis and X represents the horizontal axis.

* Zero-to-Peak Value

One-half of the peak-to-peak value. See Amplitude.

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