The PBS-4100R
Vibration and Balancing System

MTI Instruments sets a new standard in gas turbine engine testing with the PBS-4100R. Designed specifically for test cell use, the PBS-4100R provides extensive vibration monitoring and analysis capabilities along with the fastest possible "one-shot" balancing solutions. The PBS-4100R is the one system that does it all.

In use at major engine manufacturer and overhaul facilities around the world, MTI Instrument's line of PBS vibration and balancing systems are recommended equipment for maintenance of engines built by all major manufacturers.

Easy to use, the PBS-4100R saves time and fuel while reducing test cell occupancy time.

A complete Vibration System

Engine vibration testing is a complex task requiring the latest technology to ensure accuracy and efficiency. The PBS-4100R provides a complete solution to your vibration testing needs.

Collect vibration survey data *from a wide range of sensors quickly and accurately. Vibration readings are converted and presented in desired units.*

Display vibration data *in several different formats including tables, bar graphs and X-Y plots.*

Multiple Tracking filters *track rotor synchronous components and other frequencies of interest for all vibration channels.*

Alerts and Alarms *– Relay contacts can be programmed for alerts and alarms based upon vibration component readings.*

Analog outputs *can be used to send measured values to other test cell equipment.*

Long term testing *–Collect data over many days for endurance and performance testing. All data can be viewed during and after the test.*

Frequency Spectrums *– Displayed in real time for all channels to aid in diagnosing vibration problems.*

Waterfall Spectrums *– The PBS-4100R displays real time waterfall spectrums to pinpoint speed related issues.*

Balancing *– Quickly reduce vibrations by using the* ***WinPBS Balance Wizard.***

Digital Data Interface *– Easily connect the PBS-4100R to other test cell computers and networks. Download data and even control operation of the unit.*

MTI Instruments Inc.

A full-featured system to help you get the job done fast

The PBS-4100R has all the functions and capabilities to consistently make accurate vibration measurements and provide you with the data and information you need to complete your vibration testing.

Photo courtesy of General Electric Co.

Used with all engine Types *- The PBS-4100R system can be used with any engine type that you test. Select the engine type from an on-screen menu and the PBS-4100R automatically customizes its screen display and recalls data files for that type. New engine types can be added easily.*

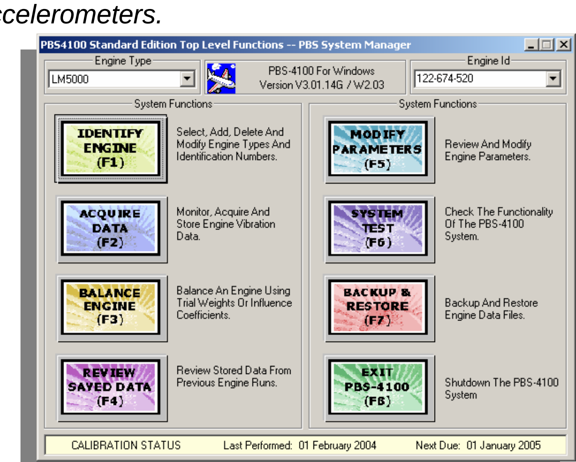
Complete Documentation Capability *- All balancing and diagnostic information is stored by engine type and serial number for easy reference. Summary reports indicate initial and final vibration levels at each speed for each channel. Detailed reports provide complete information on every balance operation, including data readings, trial weights, and balance solutions. All reports are generated automatically and can be used for trend analysis, record-keeping and management summaries.*

Real-Time data displays *of up to eight different vibration channels provide data instantly to tell you what the machine is doing. Data is collected for all vibration channels at least 10 times per second to ensure that nothing will happen without being detected. While the state-of-the-art Digital Signal Processor is collecting vibration data, users may view the data in several different formats without loosing any data. This means that you can monitor and save frequency spectrums while you are performing a vibration survey helping you to save time and fuel.*

Trim Balancing *- When vibration levels need to be reduced, the **WinPBS Balancing Wizard** gets the job done quickly and accurately. Stored influence coefficients ensure that the engines get balanced accurately and in the least amount of time. You may balance the engine using either the fan or turbine balance planes or both, and you can preview the results with the exclusive PREDICT feature.*

Save and Retrieve Data *- Any data that you acquire with the PBS-4100R can be saved and then viewed at a later date. Being able to review spectrum and survey data makes diagnosing vibration problems easy. Saved data may also be printed or transmitted digitally to your customers or other computers for review and analysis.*

A complete system *- With its unique tachometer signal conditioning circuitry, the PBS-4100R can accept the unprocessed N1 signal from most engine types. It can also operate with any type of ground test tachometer. The PBS-4100R can be used with all types of vibration sensors, and several designs of charge amplifiers are available if needed for use with accelerometers.*



The main menu provides easy access to all functions.

Expert Balancing at your fingertips

When an engine has a vibration problem, you want to fix it fast. And if balancing is required, you want it performed accurately and quickly. Traditional methods require multiple engine runs, consuming time and fuel. Other "automated" balancing systems require you to manually enter readings into a computer or to guess which specific balance weights to use.

***The PBS-4100R system** automatically collects vibration data, calculates a precise balance solution, and determines the specific balance weights required – in one shot, after only one engine run.*

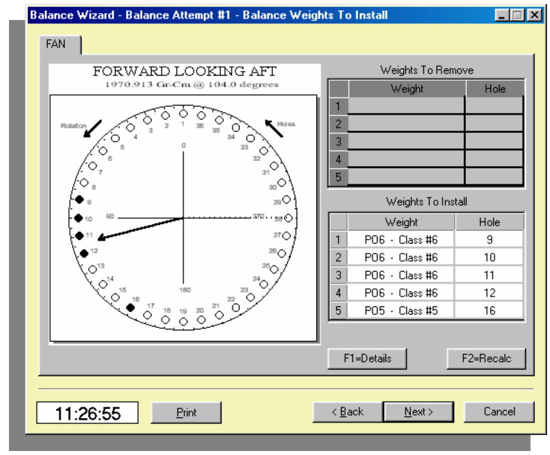
The high resolution color screen displays a diagram of the engine balance flange, showing the sizes, part numbers, and hole locations of weights to be installed. The process is so simple that time and fuel required for balancing are typically reduced by up to 80 percent.

And the balance solution is more accurate than can be obtained consistently by any other method. In fact, the PBS-4100R system actually improves its ability to calculate a quick, accurate solution every time it is used. It stores "influence coefficients" from each successive balance run and uses this information to fine-tune future balance calculations.

***Two-Plane Balancing** - The PBS-4100R can perform two plane balancing (both fan and turbine) at one speed or multiple speeds, an absolute requirement for many newer engine designs. It calculates solutions for both the fan and the turbine; you can choose to install balance weights in either or both planes.*

***Solve difficult balancing problems** - The PBS-4100 system is often able to balance engines that have been ruled "unbalanceable" by other methods. This ability to solve the tough jobs saves the cost of removing the engine from the test cell and the time and cost of additional rework.*

Knowing exactly where to install weights eliminates errors



One easy to read display shows the size and location of balance weights to install.

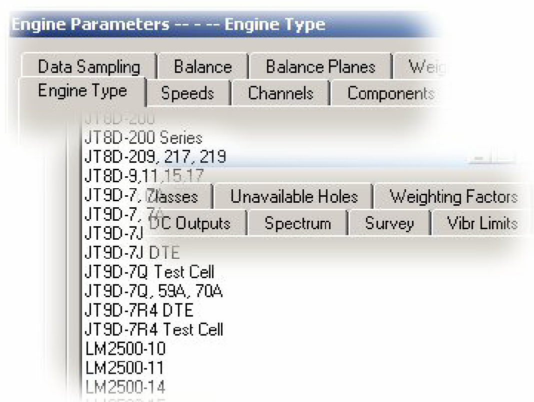
***Easy to use** - You don't need years of experience or knowledge of computers to operate the PBS-4100R. The **Balancing Wizard** provides a series of clear instructions and prompts on the display to guide you through the balance procedure. All data is recorded automatically and a full report is generated and stored. The system even has a practice mode which allows you to familiarize yourself with the PBS-4100R without running an engine.*

***Multispeed Balancing** - The PBS-4100R is able to balance engines that exhibit vibration peaks at more than one engine speed. You may specify a set of up to 20 speeds at which you wish to reduce vibration. The PBS-4100R will provide the optimum balance solution for the entire set. You also can bias the solution by assigning a higher priority to one or more speeds. With this capability you can ensure that the final vibration levels will be reduced within your specific operating range.*

***Eliminates guesswork** The PBS-4100R performs all functions automatically, eliminating human error that can occur when data points are recorded and processed manually. The PBS-4100R also uses sophisticated techniques to guarantee that an engine is balanced using the minimum number and size of weights. It even takes previously installed trim weights into account and will prevent you from exceeding the manufacturer's limit for total weight.*

Designed to meet your testing needs

The PBS-4100R has been designed to meet all of your testing needs. An extensive library exists of pre-programmed engine parameters for the most popular aircraft and industrial gas turbine models. These parameters reflect the most common and standard test parameters. However, users may modify the parameters to custom tailor the system to their particular testing requirements.



Engine parameters exist for most gas turbine designs

Multiple Engine Capability *- Only two clicks of the mouse are required to "re-program" the PBS-4100R for a different engine type. This means that changing-over is quick, easy, and error free. Consistency between tests is ensured because engine testing parameters are stored inside the PBS-4100R using access control passwords. Parameters are available for more than 150 different engine types and new models and special variants are easily established.*

Test Parameters *- There are over 250 individually settable parameters for each engine type to enable test flexibility and control. Parameters include operating speed ranges, sensor sensitivities, vibration readout units, trim balancing weight values, balance weighting factors and many more. Once established, the parameters for a specific engine type are used for every engine test. All factors can be password protected to ensure configuration control and test standardization.*

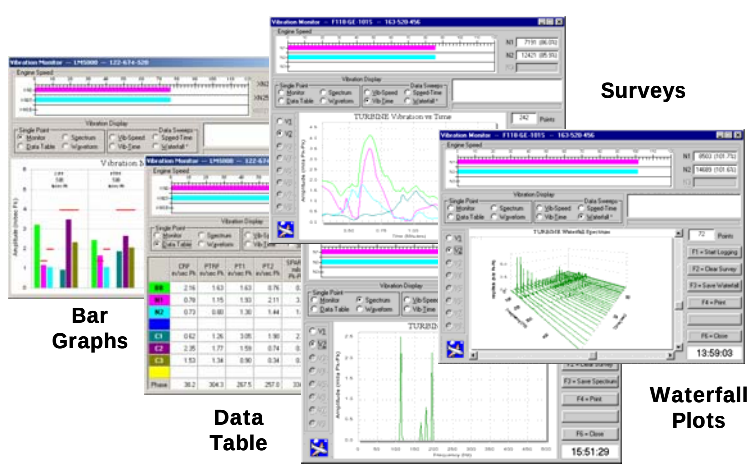
Vibration displayed the way you want

The PBS-4100R constantly acquires vibration and speed data from all enabled channels using its Digital Signal Processor. This means that you can view this data "real-time" in several different ways, and at the same time save it as well as print it out in your favorite format.

Bar Graphs *are a great way to watch the relationships between broadband and tracked vibration levels for all channels. The color coded bars provide instant indication of changing values.*

The Data Table *provides a tabulated listing of the values of all vibration reading and components. Phase of the vibration is also provided. This is a great display for printing "snapshots" at specific operating points.*

Spectrum Graphs *are used to identify the various components of a vibration signal. 400 or 800 line displays make identification of vibration sources easy.*



Frequency Spectrums

Waterfalls *are a powerful diagnostic tools to observe and document changes in frequency spectrum content as a function of engine speed or time.*

Surveys *illustrate the relationships between broadband and tracked component vibration levels and engine speed. Use them to identify high vibration speed points within the operating range.*

Exchange data easily

The PBS-4100R offers several standard and optional features to enable integration of vibration and speed data with other systems. Being able to exchange data with other systems can make engine testing more efficient, more accurate and can provide your customers with additional value and information.

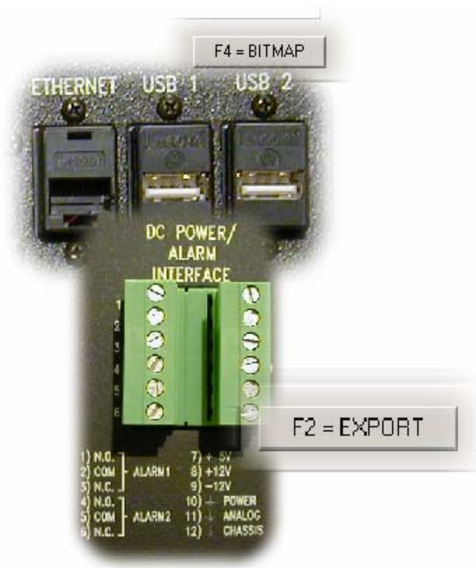
Digital Data Interface *- Transmit vibration and speed data collected by the PBS-4100R directly to other computers using a high speed Ethernet interface. Vibration data for all channels (broadband, rotor synchronous, filtered frequencies of interest and phase) is all available over the high speed link. Capture this data on other computers using LabView software or other Windows or Unix based programs using optional **WinPBS** software and immediately improve your productivity.*

Analog Outputs *– In cases where a digital data link is not practical, up to 32 channels of voltage or 4-20 mA current loop signals can be installed to send signals proportional to actual vibration, vibration component and speed readings to other equipment.*

Alerts and Alarms *are available on the PBS-4100R to indicate above-limit vibration levels to other test cell equipment. Limits are programmable on a per-channel and per-vibration component basis.*

Export Data *– The PBS-4100R can export vibration data for use in EXCEL and other numerical analysis programs. This is an excellent way to share raw data with engineering and other analytical groups.*

Bitmaps *can also be produced from many of the graphs generated by the PBS-4100R and sent as attachments in e-mails, to share test results with customers or members of your team.*



Several of the ways to easily exchange data

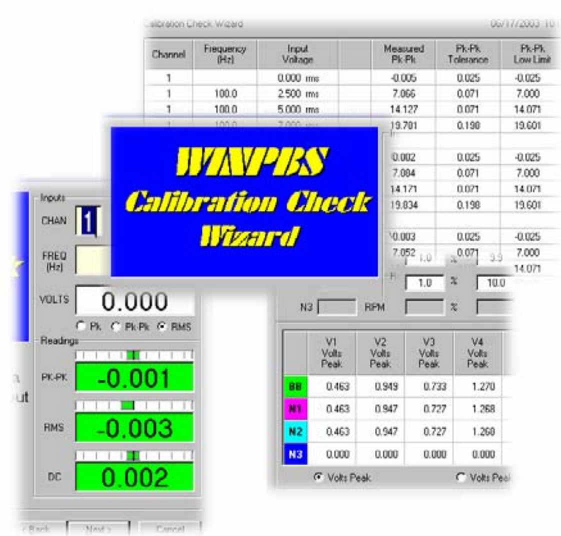
Maintain your PBS-4100R with built-in features

The PBS-4100R includes self-test and calibration tools to ensure your system remains accurate and available for all your testing. A System Test menu provides users with several functions to ensure system availability, reliability and accuracy.

The Hardware Check *function of the PBS-4100R quickly performs a test of all hardware components. Faults are isolated to the board level.*

The Signal Check *function of the PBS-4100R permits direct reading of every vibration and speed channel to aid in system testing and calibration. Each channel may be read in volts or frequency. Alternatively, standard engine testing parameters can be used and signal readout units are the same as during live engine tests.*

The Calibration Check *function of the PBS-4100R performs an automated accuracy check of every vibration channel in the system. It includes step-by-step instructions including connection diagrams. At the conclusion of the check, a summary table of actual readings and factory acceptance limits is displayed.*



Advanced balancing and diagnostic capabilities

The PBS-4100R system is more than an easy-to-use vibration and balance analyzer. It gives you a full range of diagnostic capabilities that identify engine problems.

VIBRATION SURVEY ANALYZER and TRACKING FILTER

Plots engine vibration (broadband, tracked N1 and optional N2/N3) across the entire engine speed range. It allows you to determine how much vibration is caused by engine unbalance and how much is caused by other factors. You won't waste hours trying to balance an engine when balancing won't solve the problem.

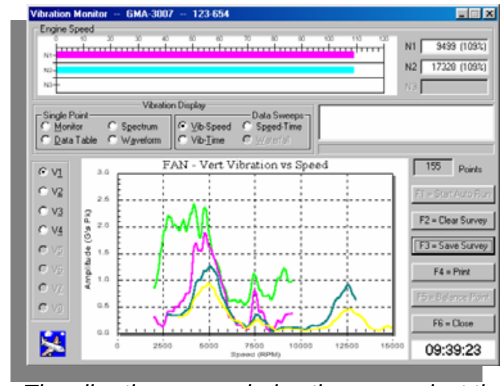
This feature also allows you to identify speeds where vibration peaks occur. The PBS-4100 provides a balance solution to reduce vibration at all peaks simultaneously.

Type Acceleration only, deceleration only, accel/decel or decel/accel

Data Collection A complete set of engine speeds and vibration data is collected 10 times per second irregardless of engine speed.

Channels Uses all installed and enabled data channels. Any channel may be enabled or disabled individually.

Displays Vibration vs. speed data displayed in color coded real-time graphics. Other selectable options of digital and bar graph formats. Broadband and components color coded.



The vibration survey helps the user select the engine speeds at which balancing is required.

FREQUENCY SPECTRUM ANALYZER

Provides a high-resolution, 400 or 800 line frequency spectrum that breaks the vibration signal into its components. This reveals which engine systems are causing vibration problems.

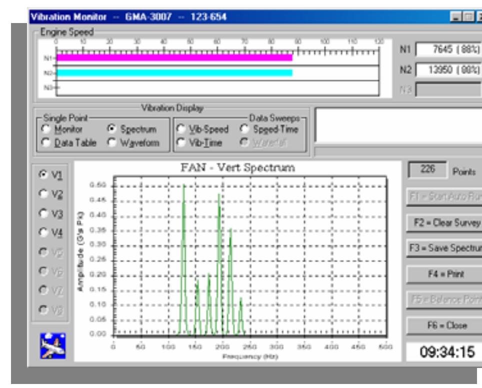
Type High-resolution 400 or 800 line spectrum with resolution enhancement.

Channels Uses all enabled data channels. Any channel may be enabled or disabled individually.

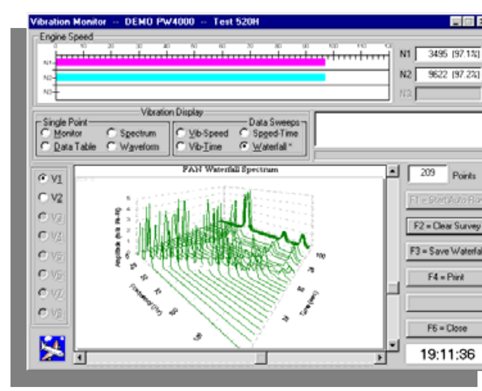
Frequency Range 10 to 10,000 Hz

Spectrum Display X-Y plot of vibration amplitude vs. frequency. Both plot axes can be expanded for better resolution, including auto scaling and zoom.

Waterfall Display Valuable 3D plot of spectrum vs. time. Viewing perspective can be changed and all plot axes can be expanded for better resolution, including auto scaling and zoom.



The 400 or 800 line frequency spectrum pinpoints the sources of engine vibration.



Waterfall spectra identify changes during speed changes.

DIGITAL OSCILLOSCOPE AND VOLTMETER

Provides a live display of the quality of vibration signals. You won't waste time working with bad data or trying to solve instrumentation problems through trial and error.

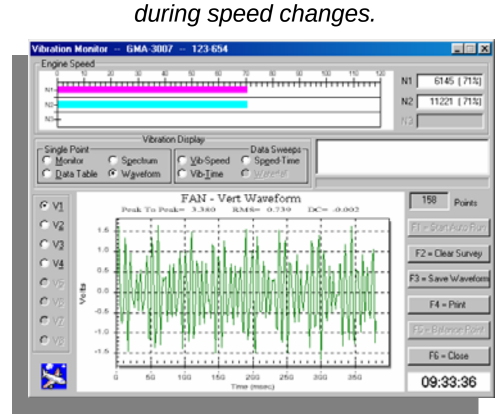
Type Free running data acquisition provides real-time display. Users may select time and voltage axis ranges including auto range functions. Zoom mode allows detailed view of wave shape.

Channels Switch between any of the enabled vibration channels.

Readouts Digital display of volts (pk-pk, rms, and dc) Amplitude for each channel.

Voltage and Time Axis Auto ranging or user definable voltage axis settings.

Speed Display Continuous display of current engine speed in rpm and % of full speed.



The oscilloscope display can be used to detect faulty sensors and other instrumentation problems.

Specifications

ENGINE TYPES

Manufacturers	CFMI, General Electric, Honeywell, Pratt & Whitney, Rolls-Royce, IAE, R-R-Allison and others
Models	**CFMI:** CFM56-2,3,5,7 **GE:** CF34-3, -8, -10, CF6-6, -50, -80A, -80C, GE-90-94, -115, CJ-610, CF-700, F101, F110-100, - 129, -132, -400, F118-101, LM-1500, 1600, 2500, 6000 (all versions) **Honeywell:** ALF502, LF507, TFE731 (all models) **P&W:** PT6, JT3D, JT8D (all small and large models), JT9D-7,-7Q,-7R4, PW2000 -2037, -2040, -2043, PW4000 (All Models), F-100 (all models), F-117, GG4 and other industrials. **Rolls-Royce:** RB211-22B, RB211-524B/C/D, RB211-524G/H, Trent (all models) RB211-535C/E4, Tay (all models), Spey **Rolls-Royce-Allison:** **GMA3007** **IAE:** V2500 (all models)

Many other marine, industrial and military engines also supported. Call MTII.

VIBRATION SIGNALS

Vibration Channels	8
Type	Differential, ac coupled (5 Hz)
Voltage Range	0 to ±10 V peak
Resolution	12-bit A/D (±10 V = 4096 bits)
Accuracy	Better than 1%
Frequency Range	5 Hz to 10 kHz
Input Impedance	1 M Ohms
Vibration Sensors	Uses existing engine pickups; also accepts ground test pickups.

SPEED SIGNALS

Channels	N1 & N2 (std); N3 (optional)
Type	Single-ended, ac coupled (5 Hz)
Speed Signal	Discrete 1/rev or automatically locates imbedded 1/rev reference on any N1 signal.
Sensor Type	Uses existing engine N1 signal from magnetic sensors or tach-generator. Also accepts optical tach, strobe, etc. with no adjustment.
Voltage Range	50 mV to 100 V peak, autoranging
Frequency Range	1 Hz to 15kHz
Accuracy	Better than 1%
Input Impedance	100 K Ohms

BALANCING

Balancing Methods	User Selectable: "One Shot" (stored influence coefficients) Trial Weight (baseline and trial weight run) Both methods calculate a weighted, least-squares solution over all engine speeds and active channels.
Balance Speeds	1 to 20 speeds simultaneously, 500-75,000 rpm range
Balance Channels	1 or 2 channels simultaneously (1 to 8 channels optional), typically used with fan and turbine pickups.
Balance Planes	1 or 2 (fan and turbine) simultaneously; accounts for uneven hole spacing and unavailable holes; can calculate balance weights for one plane that will effectively balance both planes.
Balance Weights	Up to 20 standard weight classes, displayed by class and part number. User can add own weight classes and specify custom-ground weights.

GENERAL

Power	115/230 V ac±10%/50-400 Hz±10% autosensing, autoswitching
Weight	35 lb. (16 kg)
Dimensions	19 inch rack mount EIA standard 8.75 inches high (267 cm) 24 inches deep (731.5 cm)
Temperature	0 to 55°C (operation) -20 to 70°C (storage)
Relative Humidity	5 to 95% Non condensing (operation) 5 to 90% (storage)
Vibration	3 to 200 Hz at 1.0 g (operation) 3 to 200 Hz at 1.5 g (storage)
Shock	5 g (operation); 80 g (storage)

OPTIONS AND ACCESSORIES

- Rack-mount charge amplifiers
- Vibration sensors
- Padded shipping/storage cases
- Training course

Contact MTI Instruments for more information about the PBS-4100R system or to discuss you particular needs.

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