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**E**NTER A  
NEW AGE IN  
AIRCRAFT  
ENGINE  
MAINTENANCE



**PBS-4100**<sup>TM</sup>  
PORTABLE BALANCING SYSTEM

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*MTI Instruments, Inc.*

# The PBS-4100 Portable Balancing System

MTI Instruments sets a new standard in aircraft engine maintenance with the PBS-4100. On the flight line or in the test cell for the fastest possible "one-shot" balancing and advanced vibration diagnostics - the PBS-4100 is the one system that does it all.

In use at major airlines worldwide since 1986, MTI Instrument's portable balancing systems are recommended equipment for maintenance of engines built by all major manufacturers.

Easy to use and supported by a full selection of accessories, the PBS-4100 saves time and fuel while reducing engine overhauls.



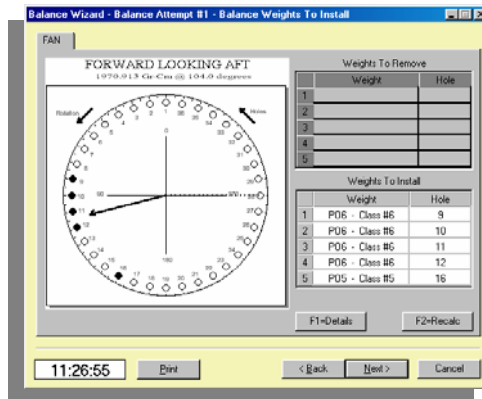
# PBS-4100™ Portable Balancing System

## Fast, accurate balancing

When an engine has a vibration problem, you want to fix it fast. 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. Only the PBS-4100 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.



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

And the balance solution is more accurate than can be obtained consistently by any other method. In fact, the PBS-4100 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.

# Expert Balancing at your fingertips

You don't need years of experience or knowledge of computers to operate the PBS-4100. A series of clear instructions and prompts appear 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-4100 without running an engine.

**Easy to use:** The PBS-4100 includes many features that make life easier for mechanics and engine troubleshooters. It is rugged, portable and easy to connect to engine sensors. MTI can provide cable sets for any type of



Photo courtesy of Pratt & Whitney

hookup, connecting directly to engine sensors or via aircraft wiring (AVM, ARINC 600 connectors, etc.).

With its unique tachometer signal conditioning circuitry, the PBS-4100 can accept the unprocessed N1 signal from most engine types. It can also operate with any type of ground test tachometer. The PBS-4100 can be used with all types of vibration sensors - a portable charge amplifier is available if needed. Tachometers and vibration sensors are also available as auxiliary equipment.



Photo courtesy of General Electric Co.

The PBS-4100 balances all current engine models and makes; new engine types are easily added.

## **Used with all engine Types**

The PBS-4100 system can be used with any engine type in your fleet. Select the engine type from an on-screen menu and the PBS-4100 automatically customizes its screen display and recalls data files for that type. New engine types can be added easily.

## **Eliminates guesswork**

The PBS-4100 performs all functions automatically, eliminating human error that can occur when data points are recorded and processed manually. The PBS-4100 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.

## **Complete Documentation Capability**

All balancing and diagnostic information is stored by engine 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.

# PBS-4100 solves tough balancing problems

The PBS-4100 system is often able to balance engines that have been ruled "unbalanceable" by other methods, saving the cost of engine removal and teardown.

## **Two-Plane Balancing**

The PBS-4100 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.

## **Multispeed Balancing**

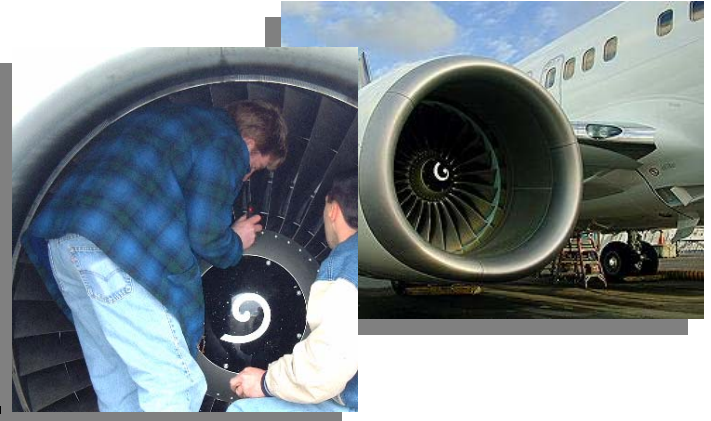
The PBS-4100 is able to balance engines that exhibit vibration peaks at more than one engine speed. You may specify a set of up to 20 speeds at which you wish to reduce vibration. The

PBS-4100 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.

**Multichannel** The PBS-4100 accepts two vibration channels simultaneously. As an option, the instrument can be configured to accept up to four channels and a second tachometer signal.

## **System Expandability**

The PBS-4100 can be expanded to meet your future balancing needs. New software features are being developed continually and are made available for easy installation to increase system capabilities and accommodate new engine designs.



Airlines keep more planes flying when they use the PBS-4100. Balancing is done faster and more accurately than ever before.

## Customer comments about the PBS-4100:

"The PBS-4100 is great when I have to get an engine balanced before curfew. I can balance an engine in less than half the time it used to take."

"We are trim balancing more engines now because the PBS-4100 is so fast. It's easier to work a trim balance into our maintenance schedule. Our fleet average vibration levels are way down

and we're getting far fewer crew squawks."

"The key factor for us is that we can use the same piece of equipment for all our aircraft. No matter what engine we add to our fleet, we're sure the PBS-4100 will be able to handle it."

"The oscilloscope feature is very handy for zeroing in on bad cables and sensors."

"A very user-friendly instrument.. easy to learn . . . the practice mode is great for training."

"We bought the PBS-4100 on the basis of estimated savings in fuel costs for ground tests. It saved us the fuel, but the real payback has been its ability to balance engines that previously we would have pulled off the wing."

"We evaluated every system on the market and found that the PBS-4100 is the best unit for engine balancing. We intend to equip all our maintenance bases with PBS-4100s."

# Advanced balancing and diagnostic capabilities

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

## 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.

<b>Type</b>	Acceleration only, deceleration only, accel/decel or decel/accel	<b>Channels</b>	Uses all installed and enabled data channels. Any channel may be enabled or disabled individually.
<b>Data Collection</b>	A high speed digital signal processor constantly collects vibration and speed data from all enabled channels.	<b>Displays</b>	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.

## FREQUENCY SPECTRUM ANALYZER

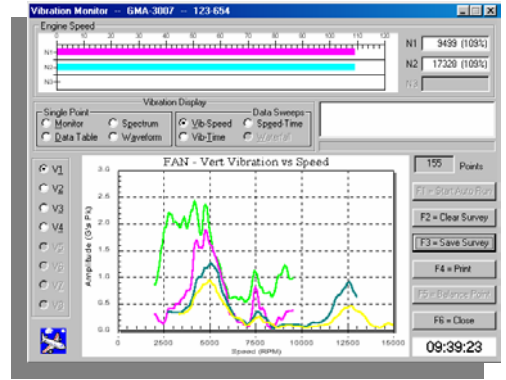
Provides a high-resolution frequency spectrum that breaks the vibration signal into its components. This reveals which engine systems are causing vibration problems.

<b>Type</b>	High-resolution 400 or 800 line spectrum with resolution enhancement.	<b>Spectrum Display</b>	X-Y plot of vibration amplitude vs. frequency. Both plot axes can be expanded for better resolution, including auto scaling and zoom.
<b>Channels</b>	Uses all enabled data channels. Any channel may be enabled or disabled individually.	<b>Waterfall Display</b>	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.
<b>Frequency Range</b>	10 to 10,000 Hz		

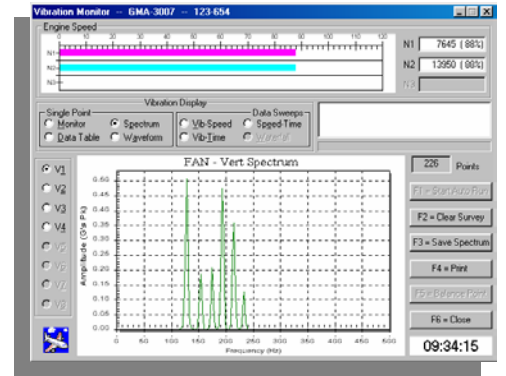
## DIGITAL OSCILLOSCOPE AND VOLTMETER

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.

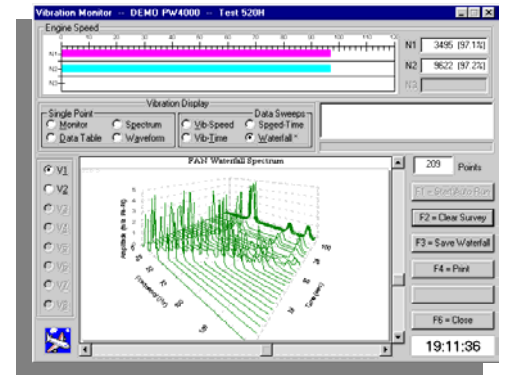
<b>Type</b>	Free running data acquisition provides real-time display. Users may select time and voltage axis ranges including auto range functions. Zoom mode allows detailed view of wave shape.	<b>Readouts</b>	Digital display of volts (pk-pk, rms, and dc) Amplitude for each channel.
<b>Channels</b>	Switch between any of the enabled vibration channels.	<b>Voltage and Time Axis</b>	Auto ranging or user definable voltage axis settings.
		<b>Speed Display</b>	Continuous display of current engine speed in rpm and % of full speed.



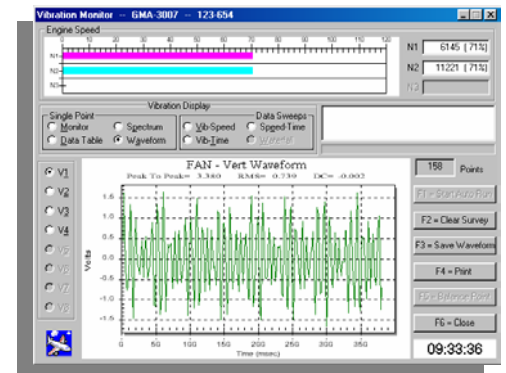
The vibration survey helps the user select the engine speeds at which balancing is required.



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



Waterfall spectra identify changes during speed changes.



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	<b>CFMI:</b> CFM56-2,3,5,7 <b>GE:</b> 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) <b>Honeywell:</b> ALF502, LF507, TFE731 (all models) <b>P&amp;W:</b> 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. <b>Rolls-Royce:</b> RB211-22B, RB211-524B/C/D, RB211-524G/H, Trent (all models) RB211-535C/E4, Tay (all models), Spey <b>Rolls-Royce-Allison:</b> <b>GMA3007</b> <b>IAE:</b> V2500 (all models)

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

## VIBRATION SIGNALS

Vibration Channels	4
Type	Differential, ac coupled (5 Hz)
Voltage Range	0 to $\pm 10$ V peak
Resolution	12-bit A/D ( $\pm 10$ 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 (standard); N2/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 4 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 manufacturer's part number. User can add own weight classes.

## GENERAL

Power	115/230 V $ac \pm 10\%$ /50-400 Hz $\pm 10\%$ autosensing, autoswitching
Weight	Data Acquisition Unit: 20 lb. (9 kg) Computer: 6 lb. (3 kg)
Dimensions	DAU: 10 x 16 x 29 cm) (25 x 41 x 29 cm) Computer: 11 x 8.5 x 2.2 in.
Temperature	0 to 50°C (operation) -20 to 60°C (storage)
Relative Humidity	20 to 80% (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

- Portable color printer
- Two-channel charge amplifier
- Vibration sensors
- Connection cables for all aircraft and engine types
- Padded shipping/storage cases
- Training course



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

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MTI Instruments is a world leader in advanced technology products for manufacturing, computer and aerospace industries. MTI has gained world-wide recognition with over 40 years of experience designing and manufacturing leading-edge products.

The PBS-4100 line of products are sold around the world to engine manufacturers, engine and aircraft maintenance organizations, commercial airlines and military organizations.