



Trendmaster[®]

Goes

Pro

A Proven Performer Enters its Third Generation

In both our First Quarter 2003 and First Quarter 2004 issues of ORBIT, we provided brief overviews of the new capabilities and enhancements being added to our Trendmaster[®] System. We also promised a more in-depth look in an upcoming issue of ORBIT.

Here, we provide that as-promised look at Trendmaster Pro – the latest generation of our Trendmaster System. We also provide an overview for those not familiar with the Trendmaster platform.



Trendmaster[®]
Timeline

1
9
8
9 | ***Trendmaster***[®] 2000
Stand-alone / DOS

1
9
4 | ***Trendmaster***[®] 2000 for Windows[®]
Stand-alone / Windows[®] NT

2
0
3 | ***Trendmaster***[®] Pro
System 1[®] / Windows[®] 2000



If you happen to be an existing Trendmaster user or are already familiar with the system, you may wish to simply read the sidebar at right and then jump ahead to the “Trendmaster Architecture” section beginning on page 35. If, however, you would benefit from a quick tutorial on what Trendmaster does and where it fits in the overall scheme of your condition monitoring strategy, keep reading here.

Asset Categories

All equipment assets are not created equal. Some – such as large, un-spared process compressors – have the entire plant process stream flowing through them, and represent enormous lost production costs when they don’t run. Others, such as the hundreds of small pumps, motors, blowers, fans, fixed equipment and other assets that populate a typical plant, are spared or have a minor impact on plant output when they fail, but represent appreciable collective maintenance costs and can benefit from some form of condition monitoring. Still other assets simply don’t merit much more than a “tighten the bolts, change the oil” approach without any routine condition monitoring. And finally, there is that class of assets that falls somewhere in the middle – benefiting from continuous monitoring, requiring more than intermittent manually gathered data, but not able to justify the expense of monitoring system architectures typically applied only to the most critical equipment assets.

Table 1 summarizes the four broad asset categories most frequently used by customers when considering the type of condition monitoring to apply.

Trendmaster® Pro – What are the major changes from Trendmaster® 2000 for Windows®?

✦ *Dynamic Scanning Modules*

Signal Processing Adapter (SPA) cards no longer reside in the host computer, and instead reside in an external mini-rack known as a Dynamic Scanning Module (DSM). The DSM connects to the host computer using conventional wired or wireless Ethernet. This provides more installation flexibility, compatibility with a greater variety of computers, and better options for reducing installation and wiring costs. The new DSM also provides numerous capabilities beyond those of the older embedded SPA cards, such as the ability to directly wire points into the system without the requirement for a Transducer Interface Module (TIM) (see page 43).

✦ *System 1® Compatibility*

Previously, the Trendmaster system used stand-alone Trendmaster® 2000 software. Today, we’ve integrated the support for Trendmaster data acquisition hardware into the System 1 platform, where it provides a common software environment for all equipment data, whether collected from a 3500 rack, portable data collector, or Trendmaster hardware.

✦ *New TIMs and Transducers*

While our new Trendmaster Pro system is backwards compatible with all previous generations of TIMs, transducers, and cabling, we have recently introduced several new transducers and TIMs, providing increased functionality, easier configuration, more mounting options, and ATEX approvals.

✦ *Acceleration Enveloping*

Selected TIMs and DSM Direct Input Cards now support acceleration enveloping. This enhanced signal processing can provide earlier warning of impending failures on rolling element bearings, gearboxes, and other machine elements. See our feature-length article on page 10 for more information. [↪](#)

OVER THE PAST 10-15 YEARS, THOSE ASSETS THAT FALL INTO THE **TIER 2 CATEGORY** HAVE BEEN AN **INCREASING SOURCE OF CONCERN** TO OUR CUSTOMERS

TABLE 1

CATEGORY	DESCRIPTION	ECONOMICS	RECOMMENDED MONITORING TECHNOLOGY				
Tier 1 "Critical"	Equipment assets that have large or total impact on plant output; equipment that represents significant repair costs; equipment that has significant safety ramifications if failure occurs. Failures can occur very suddenly and may not always give advance warning.	Failures are very expensive – often millions of dollars per day or event, due to lost production, environmental impact, or health and safety impact. Typical examples include large horsepower, large energy density machines with very large replacement and maintenance costs. Financial justification for monitoring these assets comprises lost production avoidance, reduced maintenance costs, and protection of life and environment.	<table border="1"> <tr> <td>METHOD</td> <td>Continuous, non-scanning (3500, 3300, 1701, etc.)</td> </tr> <tr> <td>TYPE</td> <td>Protection and condition monitoring</td> </tr> </table>	METHOD	Continuous, non-scanning (3500, 3300, 1701, etc.)	TYPE	Protection and condition monitoring
METHOD	Continuous, non-scanning (3500, 3300, 1701, etc.)						
TYPE	Protection and condition monitoring						
Tier 2 "Essential"	Equipment assets that have lesser impact on plant output; equipment with moderate repair costs; equipment that can have health- and safety-related implications if failure occurs. Failures can occur relatively quickly (minutes or hours), but usually with some advance warning.	Similar to economics of critical equipment assets, but of smaller magnitude. Typical examples include medium horsepower machines with moderate replacement and maintenance costs. Financial justification for monitoring these assets comprises the same factors as critical equipment, but usually of smaller magnitude.	<table border="1"> <tr> <td>METHOD</td> <td>Continuous, scanning (Trendmaster® Pro)</td> </tr> <tr> <td>TYPE</td> <td>Condition monitoring only (no protection*)</td> </tr> </table>	METHOD	Continuous, scanning (Trendmaster® Pro)	TYPE	Condition monitoring only (no protection*)
METHOD	Continuous, scanning (Trendmaster® Pro)						
TYPE	Condition monitoring only (no protection*)						
Tier 3 "General Purpose"	Equipment assets with little or no direct impact on plant output; equipment that represents limited repair costs; equipment that has minor safety ramifications if failure occurs. Failures generally occur with weeks or months of advance warning.	These typically include smaller assets, with small individual replacement and repair costs, and little or no costs related to lost production. However, due to the large number of such assets in many plants, they collectively comprise a large percentage of the annual maintenance costs and the financial justification for condition monitoring relies primarily on reducing maintenance costs.	<table border="1"> <tr> <td>METHOD</td> <td>Manual data collection (Snapshot™ family of portable instruments)</td> </tr> <tr> <td>TYPE</td> <td>Condition monitoring only (no protection)</td> </tr> </table>	METHOD	Manual data collection (Snapshot™ family of portable instruments)	TYPE	Condition monitoring only (no protection)
METHOD	Manual data collection (Snapshot™ family of portable instruments)						
TYPE	Condition monitoring only (no protection)						
Tier 4	Equipment that is not related to the process in any fashion and has no direct impact on plant performance.	Similar to Tier 3, but even less important equipment assets with small individual replacement and repair costs, and no costs related to lost production. The ramifications and costs of failure do not exceed the costs to monitor (or have excessive payback periods), and a run-to-failure or planned maintenance (rather than predictive maintenance) approach is deemed the most cost-effective.	<table border="1"> <tr> <td>METHOD</td> <td>None</td> </tr> <tr> <td>TYPE</td> <td>None</td> </tr> </table>	METHOD	None	TYPE	None
METHOD	None						
TYPE	None						

* A relatively small number of Tier 2 assets may benefit from basic machinery protection as well. Bently Nevada provides our 1900 series monitors for use in such circumstances. These small, stand-alone devices provide basic continuous machinery protection capabilities and are appropriate for machines where only one, or a few, measurement points can adequately address the asset's protection requirements. 1900 series monitors include an option for direct interface to a Trendmaster® Pro system.

While these categories incur different names by different customers, and may have slightly differing attributes, we have found that a classification system with four tiers is the most common. We have also found that the decision regarding the particular category to which an asset should be assigned will vary from customer to customer. However, variation usually occurs in the middle categories rather than at the extreme ends. The assets that are critical are

generally readily apparent to operations, maintenance, and plant management alike. Likewise, the assets that are simply too unimportant to merit any kind of condition monitoring program are often readily apparent. It is the continuum of assets between these two extremes that can be most difficult to categorize, and will often require a methodical analysis process that considers the economics of each machine and its service.

Trendmaster® – Targeting Tier 2 “Essential” Equipment Assets

Historically, we have found that equipment in Tiers 2-3 has been addressed by a manual data collection program utilizing a portable instrument to take periodic readings and measurements. However, over

the past 10-15 years, those machines that fall into the Tier 2 category in our table have been an increasing source of concern to our customers, who are not always able to meet their objectives using a manual data collection strategy. They have expressed needs such as the following:

WHAT CUSTOMERS SAY ...

- ⊗ *“Failure on these equipment assets seems to be related to process conditions, but by gathering data only once a month or so, it is impossible to establish any kind of meaningful correlation or cause/effect understanding. I may be able to identify the parts that are failing, but can’t always stop them from failing by getting to root cause.”*
- ⊗ *“I catch some failures, but others spring up faster than my data collection interval can cover, and I can’t afford to collect data more frequently by hand.”*
- ⊗ *“I’d like to collect data, but the places I need to make measurements on these equipment assets are too hazardous or inaccessible.”*
- ⊗ *“The facility is remote and/or un-staffed. It is too expensive to send someone in just to manually collect data.”*
- ⊗ *“These assets don’t warrant the same type of system as my critical assets, but I don’t feel like I have any alternative if I want continuous monitoring.”*
- ⊗ *“I take portable readings, but I’m not happy with the variation I get with hand-held transducers from one day to the next. I think permanently mounted transducers would provide better results.”*
- ⊗ *“My labor costs are rising and my staff is shrinking. I need to automate portions of my condition monitoring program because I can’t afford to use people solely to collect data – I need them to focus on fixing identified problems and improving reliability.”*
- ⊗ *“I want to address more than just rotating machinery with my condition monitoring program – I have to maintain fixed equipment in my plant that includes electrical as well as process equipment. I would like a system that could cost effectively bring all my machinery and fixed equipment asset information together into a common tool.”*

AIMED AT THE CATEGORY OF ASSETS WE’VE DESIGNATED **TIER 2**,
 THE TRENDMASTER **IDEA** WAS **SIMPLE**

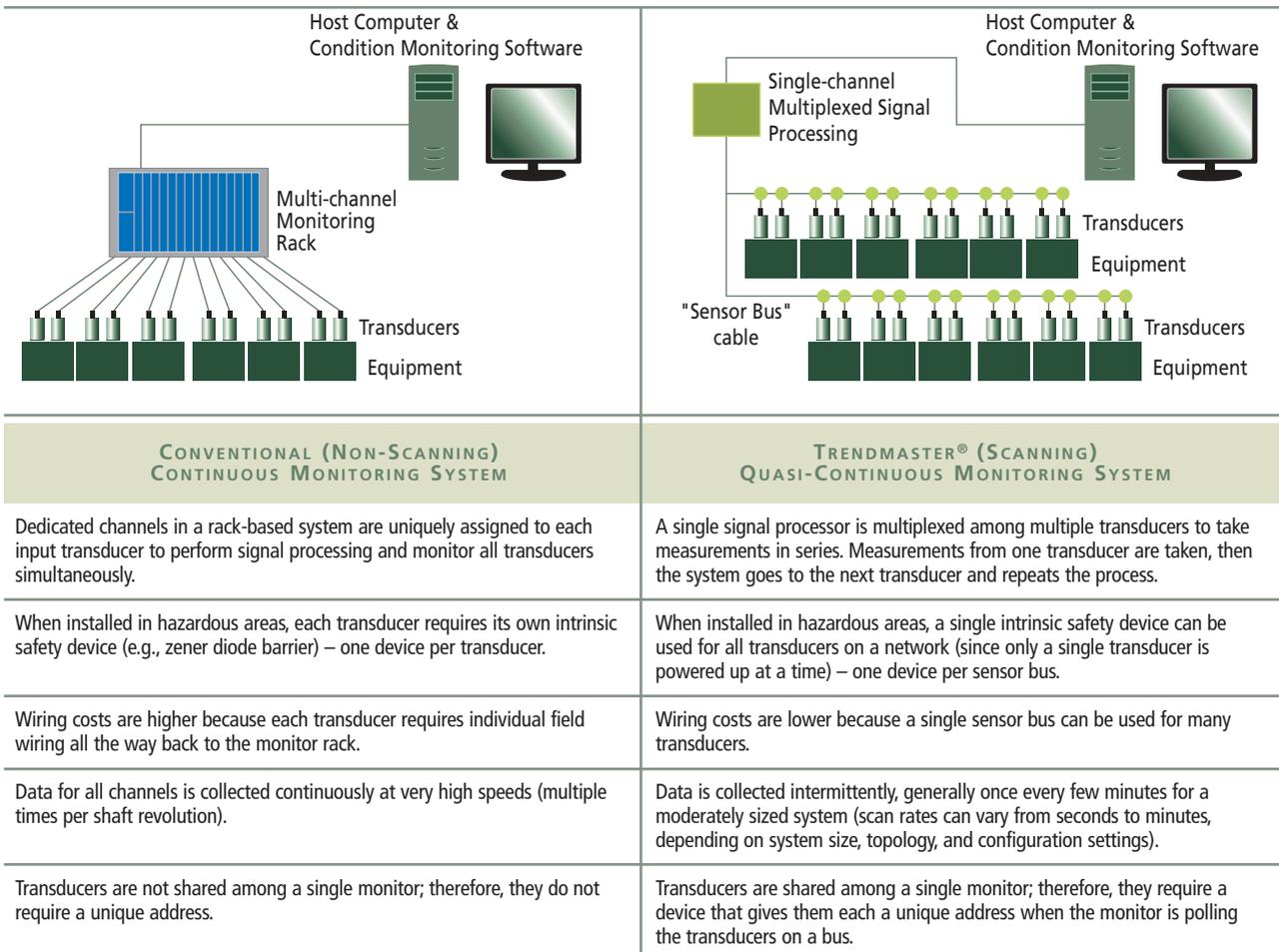
These types of industry needs first prompted Bently Nevada to develop the Trendmaster® 2000 system back in 1989. Aimed at the category of assets we've designated Tier 2, the Trendmaster idea was simple:

1. Permanently mount low-cost transducers on the equipment and find innovative mounting methods that are easy and inexpensive, yet reliable.
2. String these transducers together using a special network, allowing multiple transducers to share the same multi-drop cabling.

3. Instead of individual monitor channels dedicated to each transducer, "share" a single monitor across all transducers in the system using a multiplexing (switching) scheme that polls the transducers on the network, one at a time.
4. Provide low-cost options for intrinsically safe operation of the transducers and cabling, allowing their use in hazardous areas.

Figure 1 shows the contrast between a conventional continuous monitoring system (such as our 3500 Series) and the Trendmaster system's scanning approach.

FIGURE 1



Trendmaster – Finding the Balance

Clearly, Trendmaster represents a less expensive solution for permanent monitoring by using its innovative sensor bus and quasi-continuous scanning architecture. Some might be tempted to conclude that Trendmaster is just as appropriate for high-speed, critical, multi-case machine trains (Tier 1) as it is for “essential” machinery (Tier 2). However, the failure mechanisms of Tier 1 machines can occur very rapidly and require a system that is protecting the machine with every single shaft revolution. Furthermore, diagnostics on these machines are often more complex than those of smaller “essential” machines with only a few bearings and simpler rotor dynamics. For this reason, Bently Nevada continues to advocate, and customers continue to prefer, our continuous machinery protection systems (such as the 3500 series) for Tier 1 assets. When coupled with 3500’s built-in TDI communications processor for high-speed, parallel data capture from all transducers simultaneously, such an architecture provides the data acquisition speed needed for diagnostics on these machines, and provides a level of alarming and shutdown protection commensurate with the critical nature of these machines.

In summary, we advocate that the Trendmaster system can be applied on any class of asset (Tier 2-4) except “critical” (Tier 1). However, the economics of the situation will generally dictate that “essential” (Tier 2)

is the most appropriate category for Trendmaster applications. In the petrochemical industries, Tier 2 frequently includes pumps and motors, particularly those that can have bearing or seal failures that progress relatively rapidly and can result in not just broken machines, but possibly fires or the release of hazardous substances. Additionally, other machines often included in Tier 2 include cooling tower fans, heat exchanger fin fans, blowers, small single-stage steam turbines, fixed equipment, and others. We have also seen widespread deployment of Trendmaster systems in the cement industry, in pharmaceutical plants, in the mining industry, in power generation facilities for “balance of plant” assets – and anywhere else that online mechanical health monitoring of important assets is warranted.

Trendmaster – The Architecture

In Figure 1, we briefly contrasted the Trendmaster architecture with that of a conventional continuous monitoring system. We intentionally over-simplified the diagrams to quickly summarize the fundamental differences between our scanning and non-scanning offerings.

The following two pages show a more detailed diagram of the Trendmaster® Pro architecture. Beginning on page 38, we’ll explain the function and capabilities of each of the main components in the architecture diagram.

WE ADVOCATE THAT THE **TRENDMASTER** SYSTEM CAN BE

APPLIED ON **ANY** CLASS OF ASSET EXCEPT **“CRITICAL”**

MONITORING IS IN THE WIND



Did you know that our new Wind Turbine Monitoring System is based on the Trendmaster Pro platform? To learn more about these machines and how our Trendmaster Pro system can reduce maintenance costs and unplanned outages, see our feature-length article beginning on page 20 in this issue of ORBIT. [↪](#)

Other Desktop Applications

Import/export data to/from your favorite spreadsheet, database, and other applications using System 1's open architecture.



System 1 Display

Display software can be used on any PC in your enterprise, allowing personnel to view relevant System 1 data and information. A web-enabled version is even available, allowing the use of a web browser instead of our stand-alone display software.



Networkable Solutions

Full support for your existing Local or Wide Area Ethernet Networks allows easy connection of System 1 and display clients.

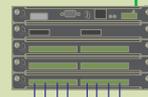


Connectivity to Plant Control and Automation Systems

System 1 software can exchange relevant data with Process Control and Automation systems using a variety of industry-standard protocols such as OPC, DDE, Modbus, and others. In addition, an integrated Modbus port in each DSM can be used for directly connecting DSMs to a process control system, without the need for System 1 software.

Low- and High-Frequency Measurements

Special transducers, proTIMs, and Direct Input Card capabilities exist for measuring extremely low-frequency vibration (such as on air-cooled heat exchanger fans) and high-frequency vibration (such as when acceleration enveloping measurements are desired).



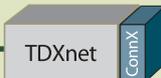
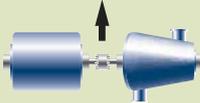
Signal Processing Adapter (SPA) Cards

SPA cards are installed in the DSM chassis and sequentially sample their connected points from TIMs. Each SPA card can accommodate two Trendmaster lines of 255 points each. Up to four SPA cards can reside in a single DSM chassis. By using separate Trendmaster lines for X, Y, and phase measurement points on a machine, parallel sampling of all 3 points can be configured for orbit plots and other data presentation formats that use multiple simultaneous measurements.



Machinery Protection Systems

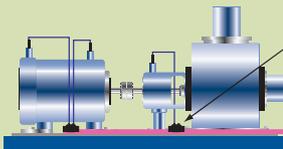
Continuous machinery protection systems can be connected to System 1 software using a compatible communications processor such as Bently Nevada's TDI, TDe, TDXnet, FMIM, and others. This allows a completely integrated condition monitoring platform for all your assets, whether addressed by our Trendmaster Pro scanning architecture, continuous machinery protection, or portable data collectors.



Up to 255 points
● ● ●

Transducer Interface Modules (TIMs)

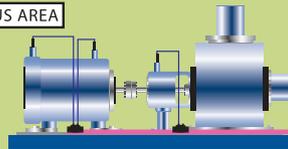
TIMs assign a unique address to each connected point in the system, allowing it to interface to a Trendmaster Sensor Bus Cable.



Hazardous Areas Isolation

The system's unique design allows a single galvanic isolator or pair of zener barriers to provide intrinsic safety for an entire Trendmaster line. Up to 64 points (when zener barriers are used) and up to 254 points (when galvanic isolators are used) can be supported on each line. This allows you to deploy Trendmaster® Pro in hazardous areas without the expense of individual I.S. devices for each point.

HAZARDOUS AREA



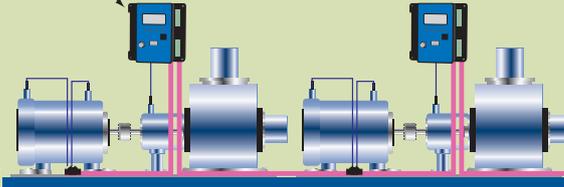
1900 Series Monitors

When a Tier 2 asset warrants continuous machinery protection, our 1900 Series monitors can be used in place of TIMs to provide not just the interface to a Trendmaster line and associated DSM for data collection, but also self-contained alarm setpoints, relays, and display capabilities, suitable for auto-shutdown applications.

Line Extension

While Trendmaster cable can be run up to 4000 feet without line extension devices, cable runs in excess of several thousand feet are often best addressed by remotely mounting a DSM near the cluster of measurement points and then using wireless (or existing wired) Ethernet to connect the DSM to the System 1 host computer. In situations where conventionally wired Trendmaster cable is preferred, a Line Extender Module can be used to locate TIMs up to 8000 feet from a DSM.

Up to 255 points
● ● ●



Local or Remote Access

Whether across the plant using wireless ethernet, or across the world using WAN or telephone modem, you can connect to your System 1 software from anywhere.

System 1 Host Computer

System 1 software is the repository for all data collected by Trendmaster hardware as well as other connected devices such as continuous machinery protection systems, portable data collectors, and other process, automation, and condition monitoring data sources.

Wireless

The Ethernet connection between a DSM and host computer can use off-the-shelf wireless networking components, allowing tremendous flexibility in topology and significantly reducing wiring costs. DSMs can be easily located at distant locations (such as tank farms) without the costs associated with conventional hardwired connections.



Portable Data Collection

Our Snapshot™ family of portable data collectors are fully compatible with System 1 software. They can be used to collect data from assets that don't have Trendmaster or continuous condition monitoring systems, or to simply augment your online data from a particular asset with additional offline measurements.

Dynamic Scanning Module (DSM)

A DSM is the interface between bussed and direct-wired measurement points and the host computer running System 1 software. It performs the actual signal processing and sampling using a variety of input card types. A DSM also houses an Ethernet communications card for wired (copper or fiber optic) or wireless communications with the host computer. A single host computer can support up to 150 DSMs.

Trendmaster® Sensor Bus Cable

Trendmaster cable is specially designed for routing in cable trays or using other means without the need for solid or flexible conduit.

Direct Wiring

In some instances, directly wiring points to a DSM can be more cost-effective than using TIMs. Up to four Direct Input Cards can be installed in a DSM, each supporting up to eight industry-standard transducer inputs. Both Direct Input and Signal Processing Adapter cards (used for Trendmaster TIM lines) can be mixed within the same DSM chassis.

T-Connections

T-connections give you more flexibility in your cabling topology by allowing you to split a single Trendmaster line into multiple branches. ProTIM and flexiTIM devices can be used to provide TIM functions and a t-connection. Stand-alone t-connectors are also available when a line split is required in locations without a proTIM or flexiTIM nearby.

Transducers

A wide variety of proximity probe, velocity, acceleration, temperature, pressure, seal leak, and general process variable (i.e., 4 to 20 mA or 1 to 5 Vdc) input capabilities and transducers exist, most with special adaptations for rapid, low-cost, yet robust installation.

Other Assets

Using the wide variety of transducers and associated TIMs, your Trendmaster® Pro system can easily incorporate other assets you wish to monitor – not just rotating machinery.

Trendmaster System Validation

Our Snapshot CE portable data collector not only functions as a full-featured vibration data collection and analysis instrument, it also functions as a test and configuration instrument to ensure your Trendmaster hardware is functioning properly.

LEGEND

-  I.S. Isolation Device
-  T-Connection
-  Line Extension
-  Transducer
-  TIM, flexiTIM, or proTIM
-  Trendmaster® Pro Sensor Bus Cable
-  Transducer Cable
-  Ethernet
-  Fiber Optic Cable

**A TRENDMASTER PRO SYSTEM
CONSISTS OF...**

- 1 *Transducers*
- 2 *Transducer Interface Modules*
- 3 *Cabling and Accessories*
- 4 *Dynamic Scanning Module(s)*
- 5 *Host Software (System 1®)*

**COMPATIBLE TRENDMASTER PRO
INPUT TYPES...**

- ✘ Vibration and position transducers including proximity probes, moving-coil and solid-state velocity transducers, and accelerometers
- ✘ Thermocouples and RTDs
- ✘ A special-purpose seal-leak detection transducer
- ✘ Oil condition sensors
- ✘ Pressure transducers
- ✘ Generic proportional current signals (e.g., 4-20 mA)
- ✘ Generic dynamic voltage signals from third-party transducers or monitor system buffered outputs
- ✘ Speed and phase reference (Keyphasor®) transducers

Trendmaster – The Components

Trendmaster Pro consists of five main components, and we consider each of these in order.

1 Transducers

Transducers are permanently mounted on the assets and make the fundamental condition measurements. The signals can be brought into the Trendmaster Pro system either via a Transducer Interface Module (TIM), or via direct wiring to an appropriate Dynamic Scanning Module (DSM) card. Also, if a signal for which dynamic data is not required is already being brought into a process control system and could provide valuable condition monitoring information, hard-wiring can be used as above, or circumvented altogether via an appropriate digital interface between the process control system and System 1 software. A very wide variety of transducers and input signal types are compatible with the Trendmaster Pro system, as shown in the table at left.

Generally, Trendmaster Pro can accept vibration measurements made with virtually any commercially available vibration transducer; however, the most cost-effective approach is to use transducers developed specifically for the Trendmaster Pro system. These address the simultaneous requirements of low cost, rapid and inexpensive mounting, hazardous area certification, compatibility with our newest TIMs, robust environmental design that doesn't require special housings, and performance characteristics that meet or exceed the diagnostic requirements of most Tier 2 and Tier 3 assets.

TRENDMASTER

CUSTOMERS CAN USE

PORTABLE DATA COLLECTION

TO COMPLEMENT THEIR

ONLINE PROGRAM

THE MOST **COST-EFFECTIVE** APPROACH IS TO

USE TRANSDUCERS **DEVELOPED SPECIFICALLY** FOR THE **TRENDMASTER PRO** SYSTEM

Frequently, rotating machines in Tier 2 and Tier 3 use rolling element bearings, and the appropriate vibration transducers will often be seismic (velocity or acceleration) rather than shaft-observing proximity probes. This article does not attempt to provide detailed information on every transducer com-

patible with the Trendmaster Pro system and confines itself to a summary of only our most recent seismic transducer offerings. For a more complete overview of all compatible transducers and associated TIMs, visit our website where a wealth of such information is available.

TRENDMASTER FAMILY OF ACCELEROMETERS	PRODUCT	DESCRIPTION	COMPATIBLE TIM TYPES	
	200150 ACCELEROMETER	This general-purpose accelerometer was previously housed in a plastic case but has been recently redesigned with a more robust stainless steel case. It is designed to address casing vibration measurements on the majority of Tier 2 and Tier 3 machines appropriate for inclusion in a Trendmaster Pro system. It is compatible with our new 200200 and 200250 proTIMs, as well as previous generation accel-to-velocity TIMs and flexiTIMs.	<ul style="list-style-type: none"> • 200250 proTIM-C • 200200 proTIM-R • 200100 Accel-to-Velocity flexiTIM • 89130 Accel-to-Velocity TIM • 89546 Accel-to-Velocity TIM (intrinsically safe version) 	
	200155 LOW-FREQUENCY ACCELEROMETER	The 200155 is visually identical to the 200150, but offers an extended low-frequency response intended for applications involving low-speed (below 600 rpm) machinery such as cooling towers and fin fans.	<ul style="list-style-type: none"> • 200250 proTIM-C • 200200 proTIM-R 	
	200157 HIGH-FREQUENCY ACCELEROMETER	This transducer is also visually identical to the 200150, but designed for applications where acceleration enveloping measurements are required in addition to the basic measurements provided by a 200150.	<ul style="list-style-type: none"> • 200250 proTIM-C • 200200 proTIM-R 	
	200350 & 200355 ACCELEROMETERS	These transducers are used when economic and/or performance considerations make it desirable to wire a seismic measurement point directly to a DSM, rather than using Trendmaster's multi-drop cable and a proTIM. This topic is discussed in more detail later in this article in the section on DSMs. The 200350 is used for conventional and acceleration enveloping applications. The 200355 is used primarily for low-frequency applications.	<ul style="list-style-type: none"> • Compatible only with DSM Seismic Direct Input Card 	

Learn more online at:

<http://www.bently.com/prod/products/trendmasterprotims.htm>

OUR **NEW proTIMS** ARE **EASIER** TO INSTALL AND TO CONFIGURE, **PROVIDE BETTER** SELF-DIAGNOSTIC CAPABILITIES, AND **CAN MIX AND MATCH** CHANNEL TYPES

2 Transducer Interface Modules (TIMs)

TIMs are analogous to the numbers on the front of a house, allowing people to distinguish it from others along the same street. In the same way, TIMs are used to assign a unique address to each transducer or signal input location along Trendmaster’s sensor bus. TIMs also provide selected signal processing functions for the basic transducer measurement. Over the years, TIMs have taken on several different

physical form factors, as shown in the summary table. With the introduction of the Trendmaster Pro system, we’re also pleased to introduce an entirely redesigned TIM package – proTIMs. Our new proTIMs are easier to install, easier to configure, provide better self-diagnostic capabilities, and can mix and match channel types. The result is better performance, lower installation costs, and lower costs of ownership.

TYPE	DESCRIPTION	COMPATIBILITY	
TIMs <i>1st Generation</i>	Available in both standard and intrinsically safe versions, these TIMs required a special tool to connect Trendmaster cabling to their connectors. They could be DIN-rail mounted, or mounted flat against a wall or junction box. However, they are not ATEX approved and are diminishing in use in favor of newer TIM designs such as flexiTIMs and proTIMs.	<ul style="list-style-type: none"> • Trendmaster Pro • Trendmaster 2000 	
flexiTIMs <i>2nd Generation</i>	This package introduced a 2-channel design, which was found to optimize installation costs in most applications. It also allowed the TIM to be easily mounted on a conduit body, facilitating installation without the requirement for junction boxes – further reducing installation costs.	<ul style="list-style-type: none"> • Trendmaster Pro • Trendmaster 2000 	
proTIMs <i>3rd Generation</i>	Our newest TIM package retains the 2-channel design of flexiTIMs, but offers two different form factors for bulkhead or conduit mounting (200200 proTIM-C) or DIN-rail mounting (200250 proTIM-R). ProTIMs also feature various software-programmable configuration capabilities, eliminating manual DIP switches for address coding. Channel types can be mixed and matched for optimal installation flexibility and lower costs by ensuring you minimize “stranded” (unused) channels. You may choose between any of the following channel types: <ul style="list-style-type: none"> • Accel-to-Velocity (standard, low-frequency, or acceleration enveloping) • K-type Thermocouple • 2-, 3-, or 4-wire Platinum RTD 	<ul style="list-style-type: none"> • Trendmaster Pro • Trendmaster 2000 	

Learn more online at:
<http://www.bentley.com/prod/products/trendmasterprotims.htm>

CABLING FORMS THE **BACKBONE** OF THE SYSTEM,
 LINKING **THOUSANDS** OF MEASUREMENT **POINTS** TO A DYNAMIC SCANNING MODULE

3 *Cabling and Accessories*

Trendmaster Pro retains the same cabling as previous generations. Cabling forms the backbone of the system, linking thousands of measurement points to a Dynamic Scanning Module.

The cable has been designed for use with or without conduit, and, when used with appropriate zener barriers or galvanic isolators (both are available from Bently Nevada), is approved for use in Division 1 and Zone 0 hazardous areas. An innovative feature of Trendmaster is its ability to support multiple measurement points with a single galvanic isolator or pair of zener diode barriers – a feature that dramatically reduces installation costs and simplifies ongoing instrument and grounding system maintenance.

A variety of accessories are available, such as T-connectors, allowing virtually any desired network topology.

Also new to Trendmaster Pro is a more convenient approach for system testing and configuration.

Previously, a stand-alone, single-purpose TIM Tester instrument was required. Today, we've replaced the need for a separate instrument, and instead embedded the test and configuration functionality into our Snapshot™ for Windows® CE portable data collector. Why? We have found that Trendmaster customers use portable data collection to complement their online program. For example, when a machine exhibits the early signs of failure, a technician may be deployed to collect additional data with Snapshot CE, augmenting the data collected by the Trendmaster system. Or, the Trendmaster Pro system, using its embedded Decision SupportSM capabilities, might automatically determine that the machine needs to be balanced. Snapshot CE can be used to perform the field balancing calculations. Since most users will already have a Snapshot CE data collector for these purposes, it made sense to embed our TIM Tester functions in this same instrument. You can read more about the new TIM Tester capabilities in Snapshot CE on page 17 in our First Quarter 2004 issue of ORBIT.

GALVANIC ISOLATION



Zener barriers require a high-integrity earth ground connection that represents ongoing maintenance requirements, particularly in environments such as offshore platforms and others that give rise to corrosion and compromise the integrity of ground connections. Our new Galvanic Isolator is preferred by many customers when installing a Trendmaster Pro system in hazardous areas because it *eliminates* the need for a ground connection altogether by using transformer coupling rather than current-limiting diodes. The result is a safer installation that is less prone to degradation over time and requires no recurring maintenance. 



The original TIM Tester was a single-purpose device...



Now, TIM Tester functionality is built-in to our Snapshot CE portable data collector.

4 Dynamic Scanning Module

One of the most significant enhancements to Trendmaster in recent years is the introduction, in Trendmaster Pro, of our new Dynamic Scanning Module (DSM). A DSM is the bridge between a Trendmaster “sensor bus” and the host computer running System 1® software. Previously, a Trendmaster sensor bus terminated in a special set of data sampling cards (Signal Processing Adapters or SPAs) that resided inside a compatible PC. Today, the use of an external module (the DSM) to house an all-new SPA card allows considerably more installation flexibility than a card set inside the host computer.

The DSM also enhances performance and reduces installation costs – dramatically in some circumstances – by limiting the amount and type of wire that must be run because it uses standard Ethernet between itself and the host computer. This network cabling already exists in most plants and completely eliminates the need to install “home run” cabling between clusters of Trendmaster points and the host

computer. And, where cabling does not exist, off-the-shelf wireless Ethernet can also be used. For those customers that want conventional “hard-wired” network communications, conventional copper wire as well as fiber-optic cable can be used. Fiber-optic cable allows signal wiring to be installed in the same conduit as power wiring without being affected by noise and interference. This opens new possibilities for retrofit situations that help keep installation costs minimized.

Finally, we have specifically designed Trendmaster such that the required bandwidth on an existing Ethernet network within the plant is minimized. In almost all cases, Trendmaster can co-exist on existing plant networks rather than requiring its own dedicated network.

A single DSM can accommodate up to four signal input modules, in addition to a copper or fiber-optic Ethernet communications card. Currently, there are four different types of signal input cards as follows:

	TYPE	DESCRIPTION	COMPATIBLE TRANSDUCERS
DSM CARD TYPES	TIM Input Card	Replaces the role of previous-generation Signal Processing Adapters. Directly compatible with existing TIM cables and connectors. Each card can accept up to two Trendmaster sensor bus cables, with each sensor bus supporting a maximum of 255 points* (510 per card).	<ul style="list-style-type: none"> All previous-generation transducers and TIMs supported by Trendmaster 2000, Trendmaster 2000 for Windows®, as well as new proTIMs and their compatible transducers.
	Process Variable Direct Input Card	Allows up to 8 points of 4-20 mA signals to be directly wired into the Trendmaster Pro system, without the use of TIMs	<ul style="list-style-type: none"> Most industry standard “loop powered” 4-20 mA devices; the DSM supplies the required power.
	24 Volt Transducer Direct Input Card	Allows up to 8 points of –24V 3-wire voltage-mode transducers (generally, proximity probes or non current-mode accelerometers) to be directly wired into the Trendmaster Pro system, without the use of TIMs	<ul style="list-style-type: none"> 3300, 3300 XL, 3300 REBAM®, and 7200 Series proximity transducers 23732, 330400, and 330425 accelerometers
	Seismic Direct Input Card	Allows up to 8 points of 2-wire constant-current accelerometer or velocity signals to be directly wired into the Trendmaster Pro system, without the use of TIMs. Provides enhanced signal conditioning capabilities, including acceleration enveloping.	<ul style="list-style-type: none"> 200350 and 200355 accelerometers 330500, 330525, and 190501 Velomitor® piezo-velocity transducers
<p>* When intrinsically safe barriers are used, the number of TIMs supported will be less for each line. The total number of points supported is a function of cable length. Contact your Bently Nevada sales professional for additional information.</p>			

Learn more online at:
<http://www.bently.com/prod/products/trendmasterprodics.htm>

Also new to Trendmaster Pro is the ability to introduce signals into the system without the use of TIMs or sensor bus cabling. This can be done in two ways. One is through the use of the wide variety of importers in System 1 software, supporting protocols such as Modbus, OPC, and others. This method eliminates wiring altogether, allowing you to use data already resident in a process control or other automation system, and share it with Trendmaster Pro for condition monitoring purposes. Another method is through the use of Direct Input Cards, where compatible sensors are hardwired directly to a DSM.

Why have we introduced direct hardwiring in addition to TIMs – especially after discussing the reduction in installation costs that TIMs and a sensor-bus approach can yield?

We have found that, depending on the number of points and the amount of cable that needs to be run, it can sometimes be less expensive to deploy several DSMs, locate them in strategic areas where there are a cluster of measurement points, and directly wire points to the DSM without the use of TIMs and lengthy runs of sensor bus cables. Determining the least-cost option will be unique to each installation and is beyond the scope of this article. However, your Bently Nevada sales professional has a variety of tools available to assist you in comparing costs and determining the optimal architecture for your particular situation.

IN ALMOST ALL CASES,
TRENDMASTER CAN
CO-EXIST ON EXISTING
 PLANT **NETWORKS**
 RATHER THAN REQUIRING ITS
 OWN **DEDICATED**
 NETWORK

NEW MODBUS® INTERFACE FLEXIBILITY FOR DSMs

DSM

➔

Direct Connect

➔

Process Control System

For customers requiring only a basic trending system without advanced condition monitoring and Decision SupportSM features, Trendmaster Pro hardware can now be used *without* System 1[®] software. How? By using the integrated Modbus port in a DSM, allowing direct connection to a process control or automation system using this industry-standard protocol. This allows the process control system to acquire data directly from DSMs, perform all trending and alarming, and thus integrate basic equipment health statuses and trends with the other information in the process control system. While considerably less capable than Trendmaster implementations that use System 1 software, this new “direct connect” option represents a cost-effective, entry-level approach for facilities that want to start with a basic system and then progress to more sophisticated capabilities in the future. Also, both Modbus and System 1 connections can be used simultaneously, for those who need to send data to their condition monitoring platform and their process control system. [↻](#)



DECISION SUPPORT HELPS BRING THE **BENEFITS** OF CONDITION MONITORING DOWN TO THE MOST **DIRECT** AND **IMMEDIATE** LEVELS OF INTERVENTION IN YOUR PLANT – YOUR **OPERATIONS PERSONNEL**

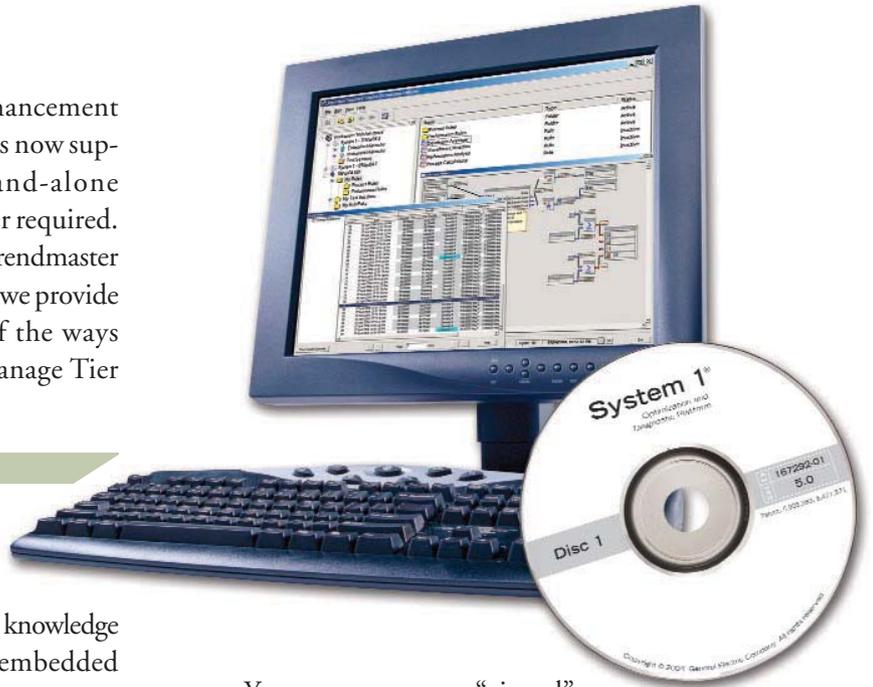
5 Host Software

Perhaps the single most dramatic enhancement to our Trendmaster platform is that it is now supported by System 1 software – stand-alone Trendmaster 2000 software is no longer required. System 1 delivers all the capabilities of Trendmaster 2000 software, plus many others. Here, we provide a partial summary detailing some of the ways System 1 improves your ability to manage Tier 2 equipment assets.

Decision SupportSM

No discussion of System 1 software is complete without describing its Decision SupportSM capabilities.

Decision Support allows you to embed knowledge and rules in System 1, and use that embedded intelligence to automatically analyze collected data – spectral content, waveform shape, trends, rate-of-change, alarm statuses, and any other data attribute. This provides 24/7 automated data interrogation, event detection, and user notification, allowing you to benefit from not only the basic alarming provided in System 1 software, but also advanced “intelligent” alarming and event detection based on sophisticated, user-configurable multi-parameter conditions.



You can even create “virtual” variables using a variety of mathematical and logical operators by combining measured data into entirely new derived measurements. These derived measurements can then be used like any directly measured variable.

The user-friendly rule writing environment of System 1 was specifically designed to relieve users of burdensome and complex programming languages. Writing new rules and embedding your equipment and process knowledge is as simple as building a graphical flow chart showing the criteria you want to use to detect a particular condition. Blocks of rules can be combined into larger blocks, allowing the creation of extremely sophisticated inference engines that are completely custom to your process, your plant, your operating procedures, and your equipment’s behavior and failure mechanisms. While such capabilities have long been available with our online software for “critical” equipment, this marks the first time we have made them available to the less-critical equipment that is

EQUALS LESS COST

WIRELESS

Trendmaster Pro has been specifically designed to take advantage of today’s tremendous selection of off-the-shelf wireless Ethernet products. This allows Dynamic Scanning Modules (DSMs) to be placed in virtually any location, without the constraint of a hardwired network connection for communication with System 1 software. Simply use the DSM’s Ethernet port to interface with appropriate wireless hardware, and you’re part of the network. Wired and wireless connections can seamlessly co-exist, allowing maximum flexibility in where and how you locate DSMs as part of your system. The result is faster, easier deployment of a Trendmaster Pro system, with lower installation costs than ever before. 



SYSTEM 1 COMBINES ALL EQUIPMENT ASSET CLASSIFICATIONS INTO A SINGLE CONDITION MONITORING PLATFORM

part of your condition monitoring program. Decision Support helps bring the benefits of condition monitoring down to the most direct and immediate levels of intervention in your plant – your operations personnel. For example, consider a plant that uses centrifuges to separate liquids and solids as part of their process. Centrifuges often fall into the “Tier 2” classification and are therefore good candidates for our Trendmaster Pro system. A typical centrifuge scenario is that they become unbalanced as solids build-up non-uniformly on the rotating components. Left undetected, this unbalance can cause premature failure of bearings, seals, and other components. Using Decision Support, unbalance can be easily detected and distinguished from other malfunctions. Operators can be notified immediately, and maintenance can be scheduled – often to simply wash the machine and remove the build-up. However, Decision Support can also be used to detect other problems such as bearing wear, foundation bolt looseness, misalignment, and motor winding problems. Timely, intelligent advisories can be provided to operators and maintenance personnel allowing them to take the right actions at the right time.

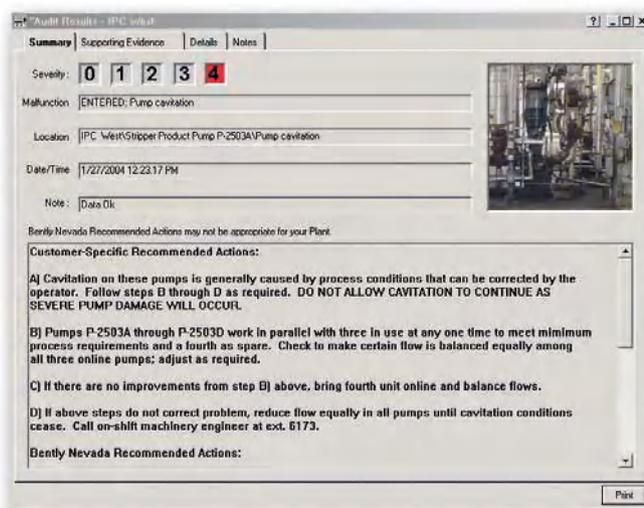
In addition to user-written rules, Bently Nevada also provides embedded knowledge in pre-configured “packages” for a wide variety of machines and malfunctions. These RulePaks can easily be augmented with your own rules.

While users can customize rules and inferences used to detect condition degradation, the notification methods and messages can also be customized.

When a condition has been detected (using our rules, your rules, or a combination of the two), you can decide exactly who to notify, when to notify them, how to notify them (cell phone, pager, e-mail, process control system annunciator, etc.), and what to tell them – using plain language rather than data and plots requiring specialized interpretation.

Common Environment

System 1 combines all equipment asset classifications into a single condition monitoring platform. Portable data collection, online scanning systems (i.e., Trendmaster Pro), protection systems, and manually collected notes and data can all be combined. This equates to fewer systems to learn, use, and maintain, lowering your costs and helping make the system more accessible to a wider variety of personnel in your plant who can contribute to the asset management function.



Now, automated data analysis and intelligent advisories can be extended to the equipment assets monitored by Trendmaster Pro – using System 1 software's powerful Decision SupportSM capabilities

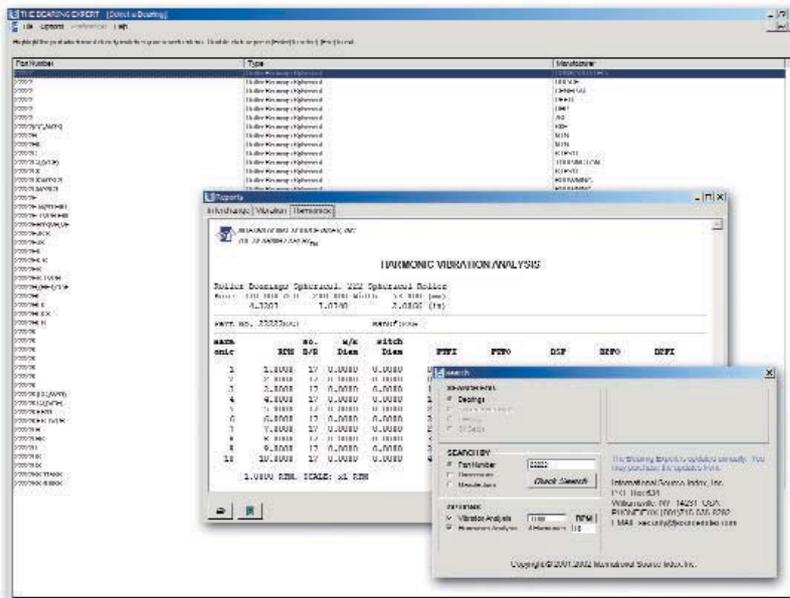
Because a single system and single database are used, multiple data collection methods and condition monitoring technologies can be combined. For example, it might be desirable to augment measurements made by Trendmaster Pro on a pump/motor set with some portable data collector readings taken on surrounding piping or other places where permanent measurements are not available. Data from our portable data collector can be easily integrated into the same database, plots, and reports used by the Trendmaster Pro system. If a separate tool is used to provide periodic alignment, this data can likewise be accessed using the DocuView™ features of System 1, allowing you to provide links from within System 1 to many other asset-related information sources. For example, right-clicking on the graphic showing the motor/pump set in the example

above could provide a list of related links such as websites with manufacturer data, documents in your own data control library with assembly drawings and maintenance manuals, logs and maintenance history data in your CMMS, pump curves, motor data sheets, and just about any other file, website, or application accessible from your corporate network.

Bearing Library

System 1 interfaces directly to The Bearing Expert™ software from International Source Index, Inc. This software is a constantly growing catalog of over one million rolling element bearings. Its integration with System 1 makes it easier for users to access bearing information, establish trends and spectral band alarms for specific frequency components, and perform diagnostics on those

DATA FROM OUR PORTABLE DATA COLLECTOR CAN BE EASILY INTEGRATED INTO THE SAME DATABASE, PLOTS, AND REPORTS USED BY THE TRENDMASTER PRO SYSTEM



Users can easily import frequencies for over one million rolling element bearings via The Bearing Expert™ software from ISI – a System 1-compatible application.

machines that use rolling element bearings. Also included in the database are widespread vibration and interchange data such as AFBMA (Anti-Friction Bearing Manufacturers Association) numbers, bearing diagrams/dimensions, manufacturers, part numbers, prefix and suffix descriptions, extended harmonics reporting, and cross-reference information.

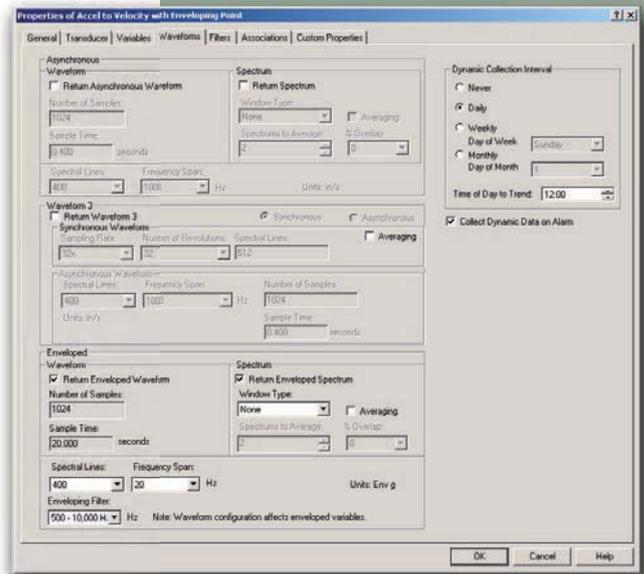
Acceleration Enveloping

System 1 is able to store, display, and process the acceleration enveloping data provided by compatible hardware – such as selected Trendmaster proTIMs, Trendmaster Pro Direct Input Cards, and Snapshot CE and IS data collection instruments. Acceleration enveloping is a powerful signal processing tool that can provide earlier warning of bearing failure and other malfunctions, and is particularly useful in rolling-element bearing machinery common to Tiers 2, 3, and 4. You can read more about acceleration enveloping in our feature-length article on page 10.

Summary

Trendmaster Pro is more than just a new name – it represents important enhancements that reduce installation and life-cycle costs, increase performance, and make it easier and more cost-effective than ever to include more assets in an online approach to condition monitoring. Bently Nevada provides not just the hardware and software elements needed for such a system, but also a broad scope of service offerings that can cover everything from economic studies that identify assets appropriate for inclusion in such a system, to planning and documenting the installation, to actually installing the system – we can even be contracted to use the system for you when your strategy is to outsource your condition monitoring activities entirely.

We encourage you to visit our website for additional information, or contact your nearest Bently Nevada sales professional. 



Seismic transducers can now be configured to return acceleration enveloping data in addition to other measurements.

TRENDMASTER PRO
IS MORE THAN JUST
A NEW NAME

Learn more online at:
<http://www.bently.com/prod/products/trendmasterpro.htm>