GE PVIB, YVIB Vibration Monitor Modules

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17 PVIB, YVIB Vibration Monitor Modules

17.1 Vibration Monitoring Overview

17.1.1 Mechanical Vibration Standards

ISO 7919-4:2009 provides the standard for evaluation of machine vibration by measurements on the rotating shafts. The broad-band vibration is measured radially or transverse to the shaft axis of the Heavy Duty Gas Turbines (HDGTs) with fluid-film bearings. The frequency range is from one hertz to three times the maximum normal operating frequency. Eddy-current transducers are located orthogonal to each other, pointed radially at the shaft. Traditionally, either narrow-band or spectral analysis is used to monitor the mechanical vibration. The typical peak-to-peak, relative-vibration displacement values for a newly commissioned 3600 rpm machine is 3.15 mils.

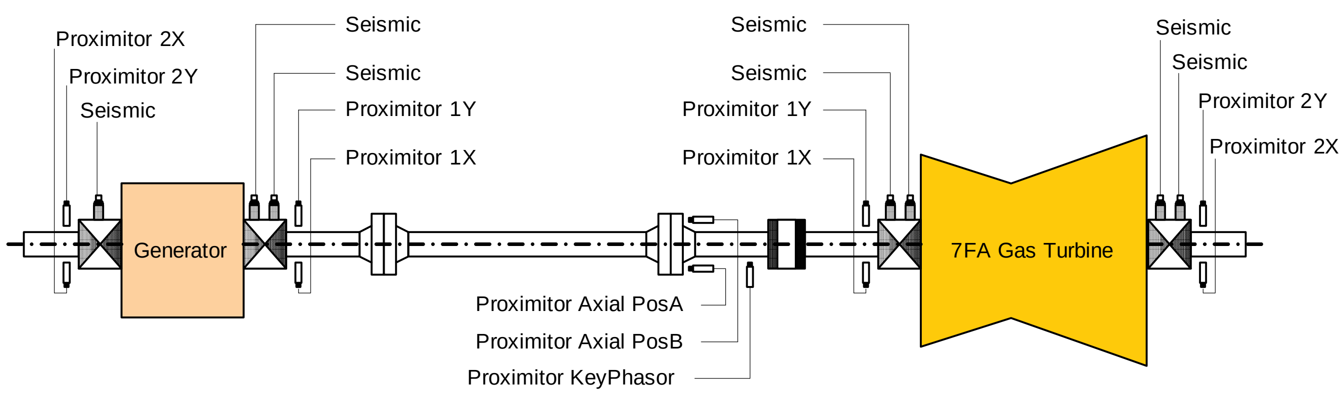
ISO 10816-4:2009 defines a standard for the evaluation of machine vibration by measurements on the non-rotating parts. The broad-band vibration is measured radially or transverse to the shaft axis on all main bearing housings or pedestals and in the axial direction on thrust bearings. The measurement system must be capable of measuring broad-band vibration over a frequency range from 10 hertz to at least 500 hertz or six times the maximum normal operating frequency, whichever is greater. The common measurement parameter for assessing machine vibration severity is the broad-band root mean square (r. m.s.) velocity measurement. The vibration consists mainly of one frequency component, which is the rotating frequency. Typical values for bearing housing or pedestal vibration velocity for a newly commissioned gas turbines is 0.177 inches / sec.

17.1.2 Heavy-duty Gas Turbine (HDGT) Vibration Monitoring

The 7FA diagram is representative of most HDGT installations driving a generator. Journal or fluid-film bearing vibration, eccentricity, and rotor expansion are monitored with eddy-current sensors (Proximitors*****). These sensors are radially mounted with respect to the shaft axis, and are used for monitoring shaft movement on both sets of generator bearings and both sets of gas turbine bearings.

The Mark VIe Vibration Module, PVIB or the Safety version, YVIB use the signal feedback from the sensors to provide the following:

- Gap or relative distance between the shaft surface and the eddy-current head
- Broad-band peak-to-peak changes in shaft position relative to the sensor
- Vibration magnitude 1X rotating at shaft rpm and location relative to Keyphasor*****
- Vibration magnitude 2X rotating at twice shaft rpm and location relative to Keyphasor



Two eddy-current sensors (Proximitors) monitor the differential expansion in the shafts longitudinal direction that is caused by generator and turbine loading. The YVIB or PVIB provides position information for the user.

A single eddy-current sensor (Proximitor) is used to monitor the key slot or the actual key in the shaft. The once per revolution key slot / pedestal provides the reference point for the Vibration 1X/2X magnitudes. The YVIB or PVIB also uses the Keyphasor input to calculate the shaft rotation speed in rpm.

Seismic sensors are mounted to the generator and gas turbine bearing housings or pedestals. One is mounted on the non-load side of the generator and two are mounted on the load side. Two seismic sensors are mounted on both sides of the gas turbine. The seismic sensors are mounted on the bearing housing to sense the radial vibration caused by the rotating shaft or any bearing issues. With firmware version 5.01 or later and Enhanced mode enabled, the YVIB or PVIB monitors the seismic sensors to provide the root mean square (RMS) velocity measurement of the bearing housing. Legacy mode uses ½*Pk-Pk for this function.

17.1.3 Land Marine Gas Turbines (LMGTs) Vibration Monitoring

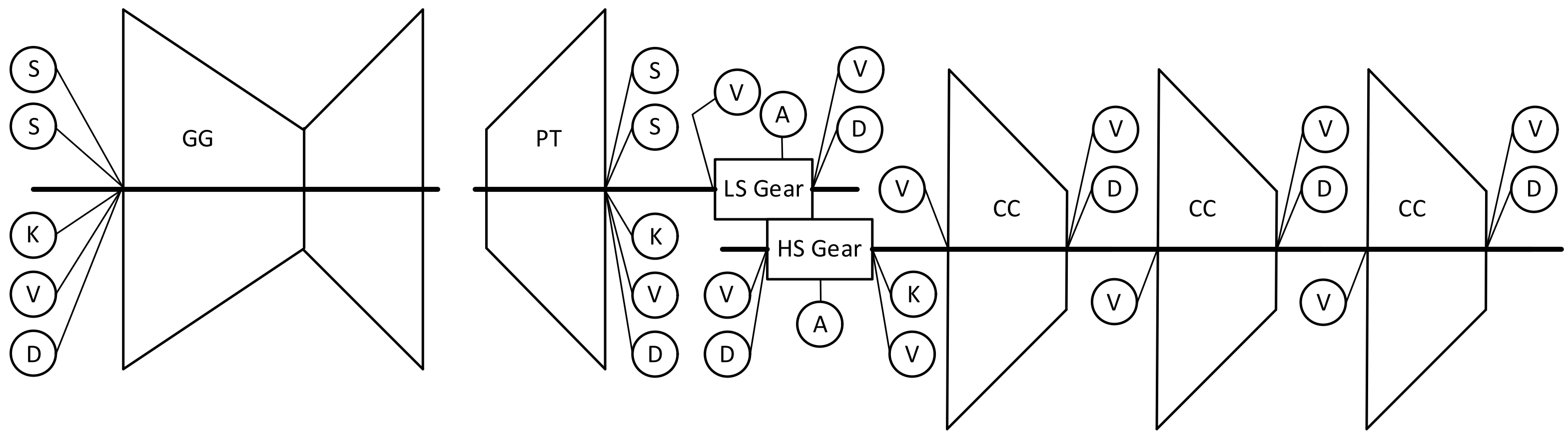
LM gas turbines are applied in the Oil & Gas industry for driving compressors in transporting gas down pipelines and power generation. The YVIB Safety and PVIB vibration IO modules are approved for use with the LM2500 SAC and LM2500 DLE gas turbine vibration applications.

LM applications use accelerometers mounted to the case of the compressor rear frame and the power turbine frame. The acceleration signal is integrated and filtered in a charge amplifier provided external to the Mark VIe Vibration product. The integrated acceleration or velocity signal is monitored by the YVIB (safety version) or PVIB Vibration I/O module. For this application, a broad-band root mean square (RMS) velocity measurement from the sensors is required, as well as monitoring of compressor and power turbine vibration components at a defined shaft frequency, using tracking filters and customer-supplied RPM feedback signals from controller blockware/application code.

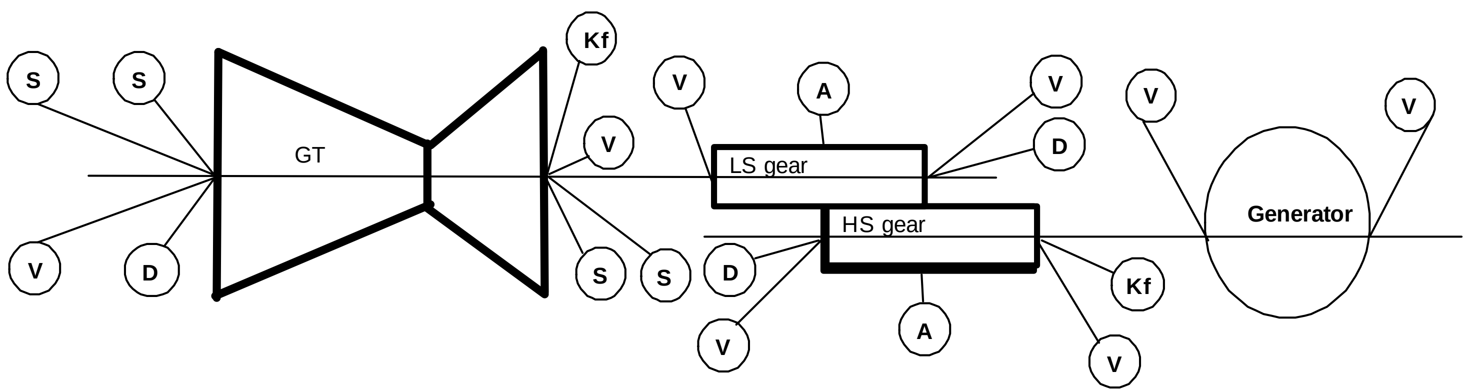
Index for Application Diagrams

Sensor Tag	Measure	Sensor Type	Prox. Type	Function	Sensor Filter Capability
S	Seismic vibration	Metrix 5486C-008	na	Monitoring & Protection	10 – 1000 Hz
V	X-Y radial vibration	Bently Nevada 330101 (3300 XL 8mm probe)	Bently Nevada 330100 (3300 Proximity transducer)	Monitoring & Protection	5 – 1200 Hz
D	Dual axial displacement	Bently Nevada 330101 (3300 XL 8mm probe)	Bently Nevada 330100 (3300 Proximity transducer)	Monitoring & Protection	na
A	Accelerometer	Bently Nevada 330400-01-05	na	Monitoring	10 – 20000 Hz
Kf	KeyPhasor	Bently Nevada 330101 (3300 XL 8mm probe)	Bently Nevada 330100 (3300 Proximity transducer)	Monitoring	na

Use the table on the previous page to decode the letters within the following figures.

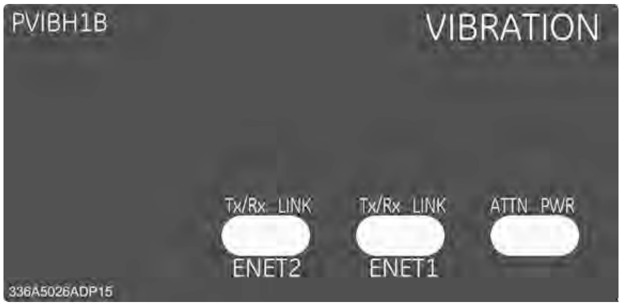


Two Shaft Gas Turbine Mechanical Drive Application Max Case



Single Shaft Gas Turbine Generator Drive Application Max Case

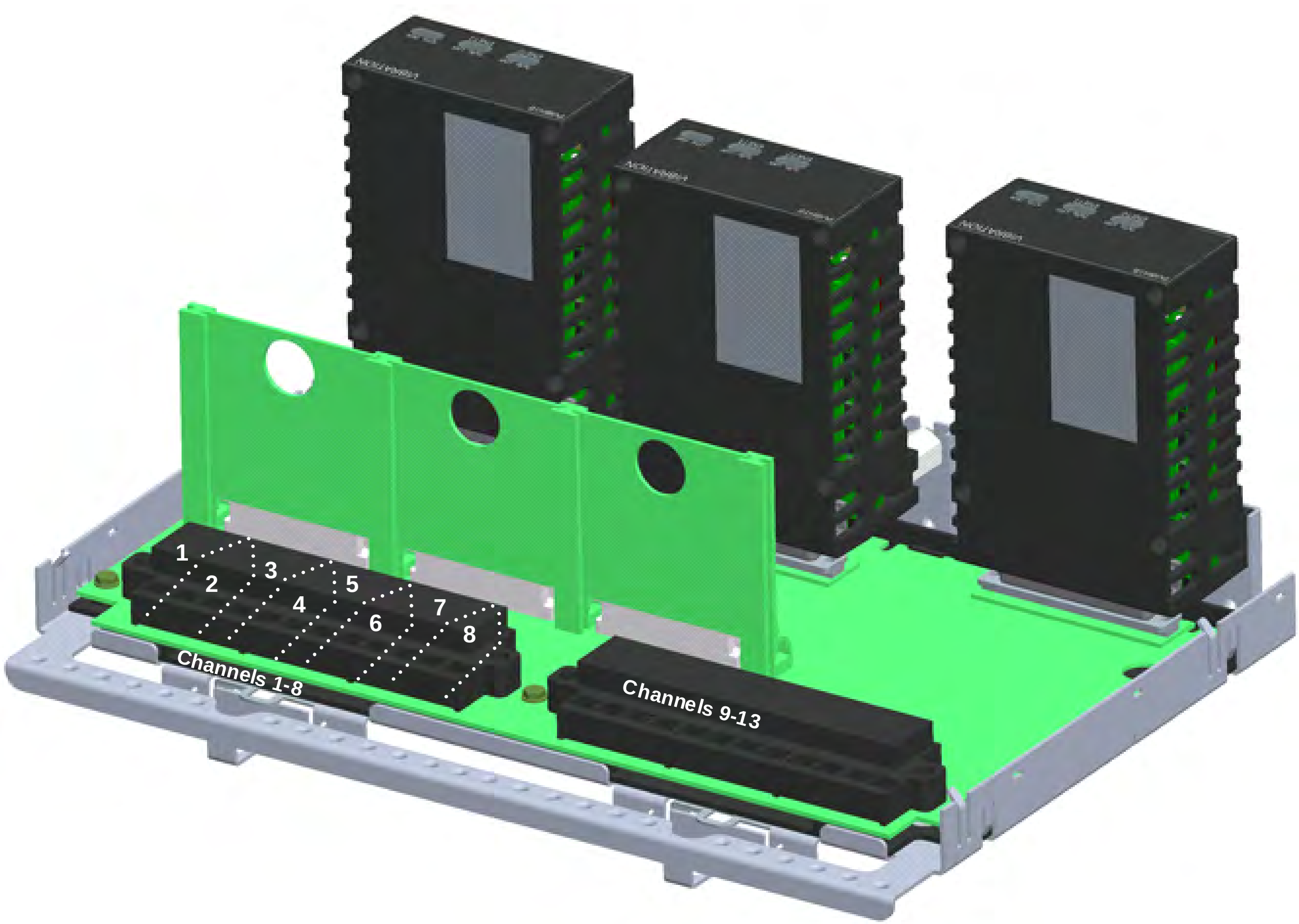
17.2 Mark VIe PVIB Vibration Monitor I/O Pack



The PVIB vibration monitoring module contains a local processor and data acquisition board, which are housed in an I/O pack. Either one or three I/O packs can be mounted on the TVBA terminal board, to provide either Simplex or TMR module redundancy. The TVBA provides two 24-point, barrier-type terminal blocks that accept two 3.0 mm2 (#12AWG) wires with 300 V insulation and spade or ring type lugs.

Captive clamps are provided for terminating bare wires. Signal flow between the terminal blocks and the I/O packs is conditioned with passive suppression circuits and electromagnetic interference protection. In addition, a pull-up bias is applied to signals for open circuit fault detection.

The PVIB can monitor 13 sensors, and has the flexibility to mix sensor types based on specific channel configuration and PVIB processor type. The I/O pack has two RJ-45 Ethernet connectors, one 3-pin power input, and a DC-37 pin connector that connects directly to the TVBA terminal board. Visual diagnostics are provided through indicator LEDs.



17.2.1 PVIB Compatibility

There are currently two versions of the I/O pack as follows:

- The PVIBH1A contains a BPPB processor board and two application boards. These internal boards have reached end of life.
- The PVIBH1B contains a BPPC processor board and a single application board. This I/O pack is supported with ControlST V06.01 or later. It provides support for Dual IONets at 10 ms frame period, an additional KeyPhasor input, and a Combustion Dynamics Monitoring (CDM) input.

PVIBH1A and PVIBH1B can be mixed on a TMR module, but cannot be configured for Enhanced signal mode unless all three packs are PVIBH1B. In this mixed TMR configuration, all three I/O packs must be upgraded to firmware version 5.01 or later. In addition, there are manual steps needed to correct some existing configuration because of the additional GAP12 capabilities that are introduced in firmware version 5.01. Refer to the section *PVIB I/O pack replacement* for detailed procedures.

Caution

An online replacement is only available for PVIB if the firmware version is 5.01 or later. It is recommended that the site perform a firmware upgrade during their next outage time frame to equip these I/O packs for any necessary online replacement should one fail.

Attention

PVIBH1A can be upgraded to firmware version 5.01 or later, however, configuration in the ToolboxST application is required to manually fixed some existing GAP12 configurations. Refer to the replacement procedure for detailed instructions.

With GAP12 on PVIBH1A, Gain adjustments of 2x and 8x are not valid.

For existing PVIBH1A applications where upgrading to PVIBH1B, the user may need to use the configurable low-pass filter to roll-off response to match the H1A for peak-to-peak calculations because PVIBH1B has an increased input signal bandwidth of 4500 Hz.

From the ToolboxST application, if the user chooses to configure a PVIBH1A with any of the options that are only available with the PVIBH1B, the following build errors (example) are generated.

Error	4:35:05 PM	PVIB-30 : OperatingMode parameter cannot be "Enhanced" with PVIBH1A modules. Please set the OperatingMode parameter to "Legacy".
Error	4:35:05 PM	PVIB-30 : Point GAP4_VIB4 cannot be configured as VibProx-KPH2 with PVIBH1A modules.
Error	4:35:05 PM	PVIB-30 : Point GAP12_KPH2 cannot be configured as KeyPhasor with PVIBH1A modules.
Error	4:35:05 PM	PVIB-30 : Point GAP1_VIB1 cannot be configured with CDM Sensors with PVIBH1A modules.

The following table provides a summary of differences for the PVIBH1A and PVIBH1B I/O pack versions.

Summary of Differences in PVIB Versions

Revision	Processor ‡	Application Board(s)‡	PVIB Firmware Version	ToolboxST Version	Mark VIe Controller Firmware Version	Enhanced Signal Mode	IONets	Channels / Sensor Types
PVIBH1A	BPPB	BAFA KAPA	Any	Any	Any	No	Dual IONets only if frame rate is slower than 10 ms	13 / (H1A is different) *Supported Sensor Types*
PVIBH1B	BPPC	BBAA	≥ 5.01 bundled on ControlST V06.01 or later	≥ 4.04 is required minimum version	≥ 4.04 is required minimum version	Yes	Dual is supported even at 10 ms rate	13 / (H1B is different) *Supported Sensor Types*
‡These boards are internal to the I/O pack and are not replaceable.								

The following table displays the available sensor types per channel with respect to the two different version of PVIB.

PVIB Supported Sensor Inputs

Sensor Type	Typical Application	PVIB Channel	
		PVIBH1A	PVIBH1B
Accelerometer	Aero-derivative gas turbines	1 - 8	1 - 8
Combustion Dynamics	Heavy-duty gas turbines	N/A	1 - 8
Proximitors (Vibration)	Radial or axial measurements of turbine-driven generators, compressors, and pumps.	1 - 8	1 - 8
Velomitor*	Structural Vibration (mounted to case)	1 - 8	1 - 8
Pedestal or slot-type Keyphasor	Rotor velocity and phase measurements	13	12, 13
Seismics	Structural Vibration (mounted to case)	1 - 8	1 - 8
Proximitors (Position)	Axial measurements	1-13	1-13

The PVIB I/O pack is compatible with the Vibration Terminal Board (TVBA) with simplex or TMR module redundancy.

PVIB and TVBA Compatibility

Terminal Board	Description
TVBAH1A	Does not have buffered outputs
TVBAH2A	Provides buffered outputs and output connections
TVBAH1B	Vibration terminal board without buffered outputs; WNPS function integrated into terminal board and PVIB I/O pack S-position is lined up vertically with R and T positions.
TVBAH2B	Vibration terminal board with buffered outputs; WNPS function integrated into terminal board and PVIB I/O pack S-position is lined up vertically with R and T positions.

Note Refer to the section *TVBA Compatibility* for additional information.

17.2.2 PVIB Specifications

Item	PVIB Specification
Orderable Part Numbers	Contact your nearest GE sales or service office, or an authorized GE sales representative.
Input Signal Bandwidth	PVIBH1A: 1150 Hz PVIBH1B: 4500 Hz
Number of Channels	13 sensor inputs are supported. Refer to the table *Supported Sensor Inputs*
Buffered Outputs (only with TVBAH2A and TVBAH2B)	Amplitude accuracy is 0.1 % for signal to GE Bently Nevada 3500 system
	A -11 V dc ±5% bias is added to output when a seismic probe used.
	Sinks a minimum of 3 mA when interfacing a velomitor
Accuracy	Refer to these tables: *Accuracy Vibration Inputs*, *Accuracy Position Inputs*
Probe Power	-24 V dc from the -28 V dc bus, from the WNPS daughterboard Each probe supply is current limited with 12 mA load per transducer
Probe Signal Resolution	Minimum of 14-bit resolution for full scale ranges defined
Open Circuit Detection	Open circuit is defined as a gap voltage that is > 1.0 V for Proximity, Accelerometer, Keyphasor, and CDM BN at terminals > -1.0 V for Velomitor at terminals < -1.0 V for CDM PCB at terminals < -3.0 V for Seismic at terminals
Common Mode Voltage	Minimum of 5 V dc
CMRR at 50/60 Hz	-50 dB
Size	8.26 cm high x 4.19 cm wide x 12.1 cm deep (3.25 in x 1.65 in x 4.78 in)
Technology	Surface-mount
† Ambient rating for enclosure design	PVIBH1B is rated from -40 to 70°C (-40 to 158 °F) PVIBH1A is rated from -30 to 65°C (-22 to 149 °F)

Note † For further details, refer to the *Mark VIe and Mark VIeS Control Systems Volume I: System Guide* (GEH-6721_Vol_I), the chapter *Technical Regulations, Standards, and Environments*.

17.2.3 PVIB Installation

➢ **To install a new PVIB module into an existing Mark VIe panel**

1. Securely mount the desired terminal board.
2. Directly plug the PVIB I/O pack(s) into the terminal board connectors (JR1 for Simplex pack, all three for TMR packs).
3. Mechanically secure the I/O packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 pin connector between the I/O pack and the terminal board. The adjustment should only be required once in the service life of the product. Spacers are needed for the S-pack in a TMR set.
4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. For the TVBAH#A, verify that the WNPS daughterboard(s) (one per I/O pack) are seated properly in the connector. (TVBAH#B does not have a WNPS daughterboard; the N28 function is integrated into the terminal board.)
6. Apply power to the I/O pack by plugging in the connector on the side of the I/O pack. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.
7. Use the ToolboxST* application to configure the I/O pack as necessary. The following table provides links to some typical configurations examples, based on application (not necessarily any site-specific configuration).

Application	Configuration Example
In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft.	*Position Application Example*
In Heavy Duty turbine applications, a Keyphasor is used to calculate the position and rotating speed of a rotating shaft.	*Keyphasor Application Example*
In Heavy Duty turbine applications, Vibration Displacement algorithms report a filtered air gap value, and peak-to-peak displacement value, and an optional vibration phasor relative to a specified Keyphasor channel.	*Vibration Displacement Application Example*
In LM turbine applications, Velocity sensors are mounted on bearing housings or machine casing to provide measurements of vibration.	*Velocity Application Example*
In Heavy Duty turbine applications, Combustion Dynamics Monitoring is used.	*CDM Application Example*

17.2.4 Operation

The following features are common to the distributed I/O modules:

- *BPPx Processor*
- *Processor LEDs*
- *Power Management*
- *ID Line*
- *I/O Module Common Diagnostic Alarms*

17.2.5 PVIB I/O Pack Replacement

➢ **To replace a PVIB I/O pack**

Caution

Follow all site safety procedures.

1. Remove the power plug located in the connector on the side of the failed I/O pack.
2. Unplug the Ethernet cable(s) from the failed I/O pack, and mark the positions of the removed cable(s).
3. Loosen the two mounting nuts on the I/O pack threaded shafts.
4. Unplug the I/O pack.
5. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
6. Plug the Ethernet and power cables back into the I/O pack.

Use the following table to determine the correct replacement procedures for the I/O pack firmware.

PVIB I/O Pack Replacement Use Cases

Module Redundancy	Failed Hardware Form	New Hardware Form
Simplex	PVIBH1A	PVIBH1A PVIBH1B
	PVIBH1B	PVIBH1B
TMR	PVIBH1A	PVIBH1A PVIBH1B (mixed with other PVIBH1As does not allow enhanced mode) PVIBH1B (all three are now H1Bs)
	PVIBH1B	PVIBH1B

➢ **To replace with the same PVIB firmware/configuration**

1. If the Auto-Reconfiguration feature is enabled, the Mark VIe controller detects the newly installed I/O pack running with a different configuration than what is in the TooblоxST application, and a reconfiguration file is automatically downloaded from the controller to the new I/O module.
2. If Auto-reconfiguration is not enabled, use the ToolboxST application to download the existing configuration to the new I/O pack.

➢ To upgrade only one PVIB I/O pack (H1A to H1B) in a TMR set (offline)

Attention

Enhanced features are not available on mixed H1A/H1B TMR sets.

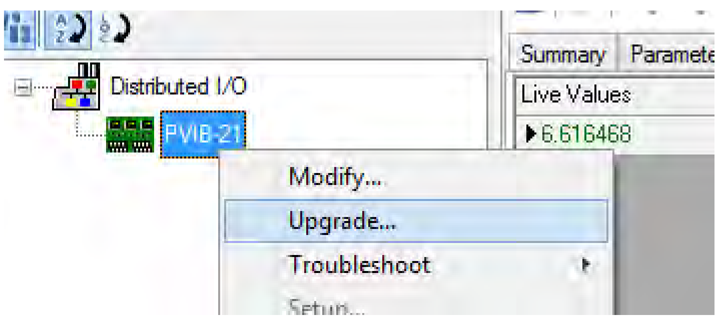
Caution

An online replacement is not available for PVIB if the firmware of the existing I/O packs is not minimum version 5.01. It is recommended that the site perform a firmware upgrade during their next outage time frame to equip their I/O packs for any necessary online replacement should a I/O pack fail. The necessary firmware is available on the ControlST 6.02 or later DVD.

1. Do not enable Enhanced mode. In addition, review the PVIB Compatibility information for other configurations that are only available when using all PVIBH1B I/O packs on the same terminal board.
2. Complete steps in the procedure *To Upgrade hardware forms in a PVIB module*.

➢ To Upgrade hardware forms (from H1A to H1B) in a Simplex PVIB module or all three PVIBs in a TMR module

1. The site's ControlST software must be minimum V04.04. Verify the version and upgrade the site if needed.
2. The PVIB must have an installed firmware version of 5.01 or later on the computer that is running ToolboxST application. Verify the available version and install new software if needed. The necessary firmware is available from the ControlST 6.02 or later DVD.
3. From the ToolboxST application, run an I/O report to identify the current configuration for the PVIB module. This is important because some manual reconfiguration may be required after upgrade.
4. From the ToolboxST Component Editor, Tree View, right-click the PVIB and select **Upgrade**.



5. Click **OK** to go offline with the ToolboxST application.
6. Refer to the I/O report generated prior to Upgrade and the Gap 9–12 configuration.

Gap 9–12 Before Upgrade (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-12 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type2	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP9_POS1	PVIB21_GAP09	PosProx	0.2	5	1	Disable	8	1x
GAP10_POS2	PVIB21_GAP10	PosProx	2.0	6	2	Enable	9	4x
GAP11_POS3	PVIB21_GAP11	PosProx	0.2	7	3	Disable	10	1x
GAP12_POS4	PVIB21_GAP12	PosProx	2.0	8	4	Enable	11	4x

7. GAP12_POS4 configuration is reset to defaults after the upgrade and renamed GAP12_KPH2. It will need to be manually reconfigured, and have the variable reattached after the upgrade. The variable has been moved from Gap 9-12 tab to KPH tab. Use the following screens as examples for making this correction.

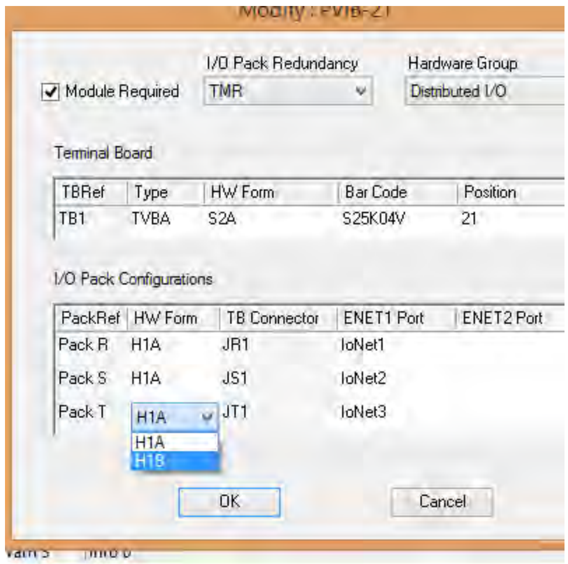
GAP12 in the KPH tab After Upgrade Before Correction (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

	Name	Connected Variable	VIB_Type3	Scale	Scale_Off	KPH_Thrshld	KPH_Type	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
▸	GAP12_KPH2		Unused	0.2	0.0	2.0	Slot	2.0	Disable	10.0	1x
	GAP13_KPH1	PVIB21_GAP13	KeyPhasor	.5	6.0	2.0	Pedestal	2.0	Enable	-2.0	4x

8. If running a ToolboxST application that is a version prior to V06.01, then make the changes to the PVIB configuration as detailed in the section, *PVIB Reconfiguration After Firmware Upgrade, when using an older version of ToolboxST application*.

9. From the Component Editor, modify the hardware form of the PVIBH1B I/O pack(s).



10. Perform a build and download. Build errors will display if invalid configurations are chosen.

17.2.5.1 PVIB Reconfiguration After Firmware Upgrade, when using an older version of ToolboxST application

After performing an Upgrade of the PVIB firmware in the ToolboxST application, changes are displayed in the Log. If ToolboxST is earlier than 6.01 version, existing configurations for LMlpcutoff (Gap 1-3 tab), VIB_Type4 (Gap 1-3 tab), and VIB_Type (Gap 4-8 tab) are changed to default values. It is necessary for the user to take the following steps to restore these configurations.

Warning	9:43:36 AM	Invalid parameter value (VibProx-KPH) found during upgrade. Replaced value with parameter's default value (Unused).
Warning	9:43:36 AM	Invalid parameter value (VibProx-KPH) found during upgrade. Replaced value with parameter's default value (Unused).
Warning	9:43:36 AM	Invalid parameter value (3_0) found during upgrade. Replaced value with parameter's default value (2.5Hz).
Warning	9:43:36 AM	Invalid parameter value (3_0) found during upgrade. Replaced value with parameter's default value (2.5Hz).
Warning	9:43:36 AM	Invalid parameter value (4_0) found during upgrade. Replaced value with parameter's default value (2.5Hz).
Warning	9:43:36 AM	PVIB-21: GAP12_POS4 configuration is lost. Please configure GAP12_KPH2.
Info	9:43:36 AM	LanModule PVIB-21 upgraded from version V04.06.04C to V05.01.01B.
Info	9:43:37 AM	Upgrade completed with 0 errors and 6 warnings.

➢ To fix the GAP 1-3 and GAP 4-8 configurations

1. Refer to the I/O report (that the prior procedure asked you to generate prior to Upgrade) and the Gap 1-3 and Gap 4-8 configuration.

Gap 1-3 Before Upgrade (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-12 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type4	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain	LMlpcutoff
GAP1_VIB1	PVIB21_GAP01	VibLMAccel	.1	1	4	Disable	10.0	1x	4_0
GAP2_VIB2	PVIB21_GAP02	VibProx	.3	2	5	Enable	10.0	1x	3_0
GAP3_VIB3	PVIB21_GAP03	VibProx-KPH	.5	3	6	Enable	10.0	4x	3_0

Gap 4-8 Before Upgrade (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-12 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP4_VIB4	PVIB21_GAP04	VibProx-KPH	0.5	5.0	8	Enable	11.0	8x
GAP5_VIB5	PVIB21_GAP05	VibProx	0.4	6.0	7	Disable	9.0	4x
GAP6_VIB6	PVIB21_GAP06	VibSeismic	1.3	7.0	6	Enable	7.0	2x
GAP7_VIB7	PVIB21_GAP07	VibVelomitor	1.6	8.0	5	Disable	5.0	4x
GAP8_VIB8	PVIB21_GAP08	PosProx	1.9	9.0	4	Enable	3.0	1x

2. Navigate to the **Gap 1-3** tab and notice that items have been reset to default values.

Gap 1-3 After Upgrade

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type4	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain	LMlpcutoff
GAP1_VIB1	PVIB21_GAP01	VibLMAccel	.1	1	4	Disable	10.0	1x	2.5Hz
GAP2_VIB2	PVIB21_GAP02	VibProx	.3	2	5	Enable	10.0	1x	2.5Hz
GAP3_VIB3	PVIB21_GAP03	Unused	.5	3	6	Enable	10.0	4x	2.5Hz

3. From the **Gap 1-3** tab, make the following corrections to reset the original values where they were replaced with default values.

• Any sensors configured for VibProx-KPH will be marked Unused after the upgrade. They will need to be set to VibProx-KPH1 manually.
• The values of LMlpcutoff for GAP1_VIB1, GAP2_VIB2, and GAP3_VIB3 will be automatically set to 2.5 Hz after the upgrade. They will need to be manually reset to their renamed original values after the upgrade (3_0 becomes 3.0Hz).

Gap 1-3 Corrected (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type4	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain	LMlpcutoff
GAP1_VIB1	PVIB21_GAP01	VibLMAccel	.1	1	4	Disable	10.0	1x	4.0Hz
GAP2_VIB2	PVIB21_GAP02	VibProx	.3	2	5	Enable	10.0	1x	3.0Hz
GAP3_VIB3	PVIB21_GAP03	VibProx-KPH1	.5	3	6	Enable	10.0	4x	3.0Hz

4. Navigate to the **GAP4_VIB4** tab and notice that the VIB_Type for **VibProx-KPH** has been set to **Unused** after the Upgrade.

GAP 4-8 After Upgrade

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP4_VIB4	PVIB21_GAP04	Unused	0.5	5.0	8	Enable	11.0	8x
GAP5_VIB5	PVIB21_GAP05	VibProx	0.4	6.0	7	Disable	9.0	4x
GAP6_VIB6	PVIB21_GAP06	VibSeismic	1.3	7.0	6	Enable	7.0	2x
GAP7_VIB7	PVIB21_GAP07	VibVelomitor	1.6	8.0	5	Disable	5.0	4x
GAP8_VIB8	PVIB21_GAP08	PosProx	1.9	9.0	4	Enable	3.0	1x

5. Set the **VIB_Type** for what was VibProx-KPH to now be **VIBProx-KPH1**.

GAP 4-8 Corrected (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

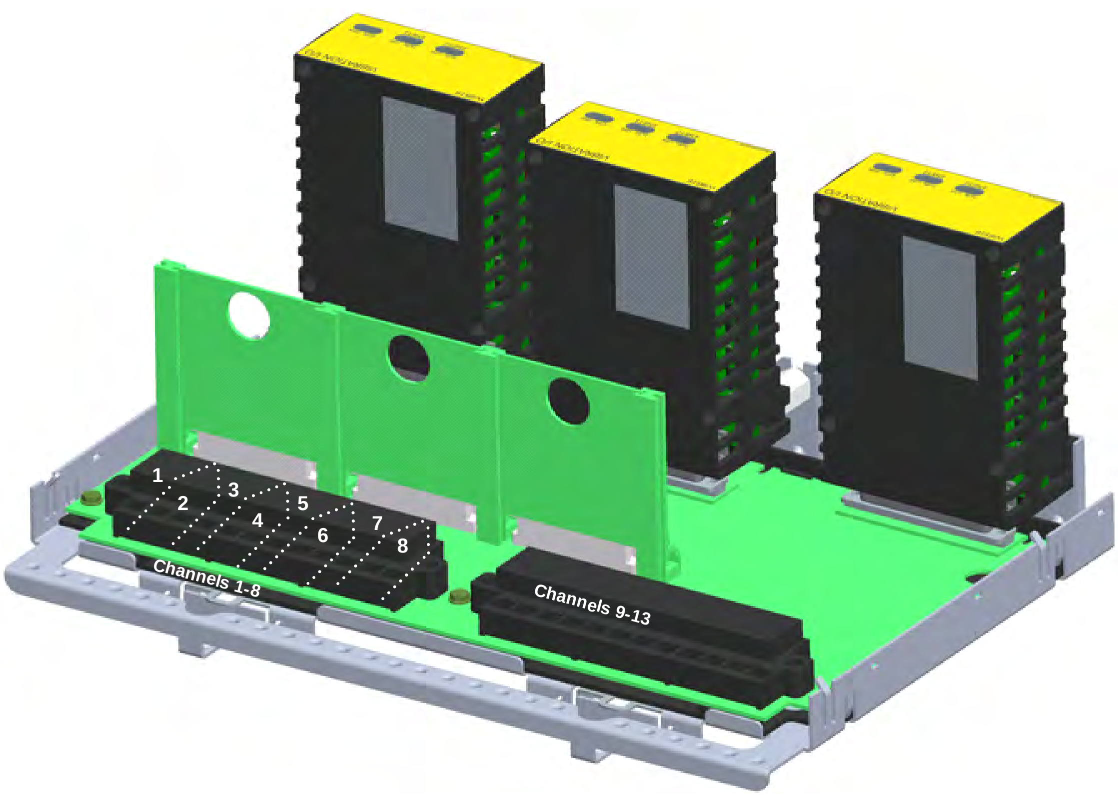
	Name	Connected Variable	VIB_Type	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
▶	GAP4_VIB4	PVIB21_GAP04	VibProx-KPH1	0.5	5.0	8	Enable	11.0	8x
	GAP5_VIB5	PVIB21_GAP05	VibProx	0.4	6.0	7	Disable	9.0	4x
	GAP6_VIB6	PVIB21_GAP06	VibSeismic	1.3	7.0	6	Enable	7.0	2x
	GAP7_VIB7	PVIB21_GAP07	VibVelomitor	1.6	8.0	5	Disable	5.0	4x
	GAP8_VIB8	PVIB21_GAP08	PosProx	1.9	9.0	4	Enable	3.0	1x

17.3 Mark VIeS YVIB Vibration Monitor I/O Pack

The YVIB vibration monitoring module contains a local processor and data acquisition board, which are housed in an I/O pack. Either one or three I/O packs can be mounted on the TVBA terminal board, to provide either Simplex or TMR module redundancy. The TVBA provides two 24-point, barrier-type terminal blocks that accept two 3.0 mm2 (#12AWG) wires with 300 V insulation and spade or ring type lugs.

Captive clamps are provided for terminating bare wires. Signal flow between the terminal blocks and the I/O packs is conditioned with passive suppression circuits and electromagnetic interference protection. In addition, a pull-up bias is applied to signals for open circuit fault detection.

The YVIB can monitor 13 sensors, and has the flexibility to mix sensor types based on specific channel configuration and YVIB processor type. The I/O pack has two RJ-45 Ethernet connectors, one 3-pin power input, and a DC-37 pin connector that connects directly to the TVBA terminal board. Visual diagnostics are provided through indicator LEDs.



17.3.1 YVIB Compatibility

The YVIB I/O pack contains an internal processor board. The following table lists the available versions of the YVIB.

YVIB Version Compatibility

I/O Pack	Processor Board	Compatible (Supported) Firmware	ControlST Software Suite Versions
YVIBS1A	BPPB	V04.06	Supported in V04.06 and all later versions
YVIBS1B	BPPC	V05.01 and later	Supported in V06.02 and later versions

Attention

YVIBS1A and YVIBS1B cannot be mixed on a TMR module.

Attention

If upgrading to YVIBS1B with an existing YVIBS1A configuration, use the ToolboxST application to correct the GAP12 configuration. Refer to the replacement procedure *To replace a YVIB I/O pack* in the section *YVIB I/O Pack Replacement*.

After upgrading existing YVIBS1A applications to YVIBS1B, the user may need to use the configurable low-pass filter to roll-off responses to match existing peak-to-peak calculations. This is because the YVIBS1B has an increased input signal bandwidth of 4500 Hz.

The YVIB I/O pack is compatible with the Vibration (TVBA) terminal board.

YVIB Terminal Board Compatibility

Terminal Board	Description	I/O Pack Redundancy		
		Simplex	Dual	TMR
TVBAS1A	Does not have buffered outputs. IEC 61805 certified with YVIB.	Yes	No	Yes
TVBAS2A	Provides buffered outputs and output connections. IEC 61805 certified with YVIB.	Yes	No	Yes
TVBAS2B	Safety vibration terminal board with buffered outputs; N28 function integrated into terminal board and YVIB S-position is lined up vertically with R and T positions.	Yes	No	Yes

Note Refer to the section *TVBA Compatibility* for additional information.

I/O pack redundancy refers to the number of I/O packs used in a signal path, as follows:

- Simplex uses one I/O pack.
- TMR uses three I/O packs.

The following table provides a summary of differences between the YVIBS1A and YVIBS1B.

Summary of YVIB Version Differences

I/O Pack	Processor Board†	Application Board(s)†	Enhanced Signal Mode‡	Channels	Sensor Types
YVIBS1A	BPPB	BAFA KAPA	No	13	Refer to the table *YVIB Supported Sensor Inputs*
YVIBS1B	BPPC	BBAA	Yes	13	Refer to the table *YVIB Supported Sensor Inputs*
† These boards are internal to the I/O pack and are not replaceable. ‡ YVIBS1B supports an additional KeyPhasor* input, a CDM input, and other enhanced processing capabilities.					

The following table displays the available sensor types per channel for YVIBS1A and YVIBS1B.

YVIB Supported Sensor Inputs

Sensor Type	Typical Application	YVIB Channel	
		YVIBS1A	YVIBS1B
Accelerometer	Aero-derivative gas turbines	1 - 8	1 - 8
Dynamic pressure probe	Land-Marine (LM) and Heavy-duty gas turbines (HDGT)	N/A	1 - 8
Proximitors* (Vibration)	Radial or axial measurements of turbine-driven generators, compressors, and pumps.	1 - 8	1 - 8
Velomitor*	Structural Vibration (mounted to case)	1 - 8	1 - 8
Pedestal or slot-type Keyphasor	Rotor velocity and phase measurements	13	12, 13
Seismics	Structural Vibration (mounted to case)	1 - 8	1 - 8
Proximitors (Position)	Axial measurements	1-13	1-13

17.3.2 YVIB Specifications

Item	YVIB Specification
Orderable Part Numbers	Contact your nearest GE sales or service office, or an authorized GE sales representative.
Number of Channels	13 sensor inputs are supported. Refer to the table *YVIB Supported Sensor Inputs*
Buffered Outputs (only with TVBAS2A and TVBAS2B)	Amplitude accuracy is 0.1 % for signal to Bently Nevada* 3500 system
	A -11 V dc ±5% bias is added to output when a seismic probe used
	Sinks a minimum of 3 mA when interfacing a velomitor
Accuracy	Refer to these tables: *Accuracy Vibration Inputs*, *Accuracy Position Inputs*
Functional Safety ***Refer to the Mark VIeS Safety Control Functional Safety Instruction Guide (GEH-6723) for safety instructions.***	YVIBS1A: Vibration functions are low and high demand SIL 2 capable when deployed with HFT=1. (1oo2 and 2oo3 architectures). YVIBS1B: Vibration functions shall be low and high demand SIL 3 capable when deployed with HFT=1. (1oo2 and 2oo3 architectures).
Probe Power	-24 V dc from the -28 V dc bus, from the WNPS daughterboard Each probe supply is current limited with 12 mA load per transducer
Probe Signal Resolution	Minimum of 14-bit resolution for full scale ranges defined
Open Circuit Detection	Open circuit is defined as a gap voltage that is > 1.0 V for Proximity, Accelerometer, Keyphasor, and CDM BN at terminals > -1.0 V for Velomitor at terminals < -1.0 V for CDM PCB at terminals < -3.0 V for Seismic at terminals
Common Mode Voltage	Minimum of 5 V dc
CMRR at 50/60 Hz	-50 dB
Size	8.26 cm high x 4.19 cm wide x 12.1 cm deep (3.25 in x 1.65 in x 4.78 in)
Technology	Surface-mount
† Ambient rating for enclosure design	YVIBS1A and YVIBS1B are rated from -30 to 65°C (-22 to 149 °F)

Note † For further details, refer to the *Mark VIe and Mark VIeS Control Systems Volume I: System Guide* (GEH-6721_Vol_I), the chapter *Technical Regulations, Standards, and Environments*.

17.3.3 YVIB Installation

➢ **To install a new YVIB module into an existing Mark VIeS panel**

1. Securely mount the desired terminal board.
2. Directly plug the YVIB I/O pack into the terminal board connectors.
3. Mechanically secure the I/O packs using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 pin connector between the I/O pack and the terminal board. The adjustment should only be required once in the service life of the product.

Note The I/O pack mounts directly to a TVBA terminal board. This TMR-capable terminal board has three DC-37 pin connectors and can also be used in simplex mode if only one YVIB is installed to JR1.

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4. Plug in one or two Ethernet cables depending on the system configuration. The I/O pack will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. For the TVBAS#A, verify that the WNPS daughterboard(s) (one per I/O pack) are seated properly in the connector. (TVBAS2B does not have a WNPS daughterboard; the N28 function is integrated into the terminal board.)
6. Apply power to the I/O pack by plugging in the connector on the side of the I/O pack. It is not necessary to remove power from the cable before plugging it in because the I/O pack has inherent soft-start capability that controls current inrush on power application.
7. Use the ToolboxST* application to configure the I/O pack. The following table provides links to some typical configurations examples based on application (not necessarily any site-specific configuration).

Application	Configuration Example
In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft.	*Position Application Example*
In Heavy Duty turbine applications, a Keyphasor is used to calculate the position and rotating speed of a rotating shaft.	*Keyphasor Application Example*
In Heavy Duty turbine applications, Vibration Displacement algorithms report a filtered air gap value, and peak-to-peak displacement value, and an optional vibration phasor relative to a specified Keyphasor channel.	*Vibration Displacement Application Example*
In LM turbine applications, Velocity sensors are mounted on bearing housings or machine casing to provide measurements of vibration.	*Velocity Application Example*
In Heavy Duty turbine applications, Combustion Dynamics Monitoring is used.	*CDM Application Example*

17.3.4 Operation

The following features are common to the distributed I/O modules:

- *BPPx Processor*
- *Processor LEDs*
- *Power Management*
- *ID Line*
- *I/O Module Common Diagnostic Alarms*

17.3.5 YVIB I/O Pack Replacement

➢ **To replace a YVIB I/O pack**

1. Follow all site safety procedures.
2. Remove the power plug located in the connector on the side of the failed I/O pack.
3. Unplug the Ethernet cable(s) from the failed I/O pack, and mark the positions of the removed cable(s).
4. Loosen the two mounting nuts on the I/O pack threaded shafts.
5. Unplug the I/O pack.
6. Plug in the replacement I/O pack. Make sure the I/O pack connector is fully seated on all sides, then properly tighten mounting nuts.
7. Plug the Ethernet and power cables back into the I/O pack.

Use the following table to determine the correct replacement procedures for the I/O pack firmware.

YVIB I/O Pack Replacement Use Cases

Module Redundancy	Failed Hardware Form	New Hardware Form
Simplex	YVIBS1A	*YVIBS1A* *YVIBS1B*
	YVIBS1B	*YVIBS1B*
TMR	YVIBS1A	*YVIBS1A* *YVIBS1B* (all three must be replaced with S1Bs)
	YVIBS1B	*YVIBS1B*

➢ **To replace a YVIB I/O pack with the same firmware/configuration:** use the ToolboxST application to download the existing configuration to the new I/O pack.

Attention

Do NOT upgrade the firmware of any YVIBS1A to a version beyond V04.06.03C. Making this mistake is extremely difficult to reverse, and would be best if the site then upgrades to YVIBS1B.

➢ To upgrade YVIB hardware forms (S1A to S1B)

Attention

Redundant Safety I/O packs mounted on the same terminal board must all be of the same hardware form, and running the same firmware version.

Do NOT attempt this replacement unless having enough I/O packs with the newer hardware form available, including spares.

It is also recommended to backup the ToolboxST .tcw file prior to upgrading the system.

1. The site's ControlST software must be minimum V06.01. Verify the version and upgrade the system if needed.
2. Install the YVIBH1B I/O pack firmware from the ControlST V06.02 or later DVD.
3. Run an I/O report to capture the current configuration of the YVIB I/O module.
4. From the Component Editor, modify the hardware form of the YVIB I/O pack.
5. From the ToolboxST Component Editor, perform a YVIB firmware Upgrade.
6. From the Component Editor, make the changes to the YVIB configuration.
7. Refer to the I/O report generated prior to Upgrade and the Gap 9–12 configuration.

Gap 9–12 Before Upgrade (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-12 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type2	Scale	Scale_Off	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP9_POS1	PVIB21_GAP09	PosProx	0.2	5	1	Disable	8	1x
GAP10_POS2	PVIB21_GAP10	PosProx	2.0	6	2	Enable	9	4x
GAP11_POS3	PVIB21_GAP11	PosProx	0.2	7	3	Disable	10	1x
GAP12_POS4	PVIB21_GAP12	PosProx	2.0	8	4	Enable	11	4x

8. GAP12_POS4 configuration is reset to defaults after the upgrade and renamed GAP12_KPH2. It will need to be manually reconfigured, and have the variable reattached after the upgrade. The variable has been moved from Gap 9-12 tab to KPH tab. Use the following screens as examples for making this correction.

Gap 9–11 and KPH tabs After Upgrade Before Correction (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type3	Scale	Scale_Off	KPH_Thrshld	KPH_Type	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP12_KPH2		Unused	0.2	0.0	2.0	Slot	2.0	Disable	10.0	1x
GAP13_KPH1	PVIB21_GAP13	KeyPhasor	.5	6.0	2.0	Pedestal	2.0	Enable	-2.0	4x

KPH tab After Upgrade After Correction (example)

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Connected Variable	VIB_Type3	Scale	Scale_Off	KPH_Thrshld	KPH_Type	TMR_DiffLimt	GnBiasOvride	Snsr_Offset	Gain
GAP12_KPH2	PVIB21_GAP12	PosProx	2.0	8	2.0	Slot	4.0	Enable	11	4x
GAP13_KPH1	PVIB21_GAP13	KeyPhasor	.5	6.0	2.0	Pedestal	2.0	Enable	-2.0	4x

9. Perform and build and download from the ToolboxST Component Editor. Build errors will display if invalid configurations are chosen.

17.4 PVIB or YVIB Functions

17.4.1 Vibration Monitoring Hardware

Internal to the PVIB or YVIB I/O pack is application-specific hardware that provides signal conditioning to center and amplify signals for improved analog-to-digital resolution. Each of the 13 differential amplifier inputs has a digital analog converter (DAC) bias adjustment to null the dc content of the signal to better center the signal for the analog-to-digital (A/D) input range. The DAC bias command is stored in the microprocessor to be used in the gap calculation for the Proximitor sensors.

Each input channel has a configurable gain that allows the vibration signal to be amplified. Refer to the *configuration* section for a detailed listing of available gains based on channel number and I/O pack board revision (H1B supports an additional Keyphasor on channel 12). Analog processing provides A/D conversion, digital-to-analog (D/A) conversion, and the digital pre-processing of sensor inputs. Sensor inputs are digitally filtered, and then the sampled signals and the filtering information is passed on to PVIB microprocessor memory. Channels 1 through 8 and 13 (and 12 if H1B) use a multi-pole anti-aliasing filter with a band-pass frequency range of 7 kHz.

There is a tracking filter that is used to determine the vibration content of a turbine caused by a given rotation speed. This same internal application hardware also runs the high-frequency section of the tracking filter and the 1x and 2x functions. The 1x vibration is the peak-to-peak magnitude of the radial movement in sync with the turbine shaft speed. The 1x calculation also provides the phase relationship of the vibration phasor relative to the Keyphasor. The 2x calculation provides the radial vibration component that is at twice the speed of the shaft.

The internal hardware of the PVIBH1A or YVIBS1A is different than PVIBH1B or YVIBS1B. The H1B or SIB provides an additional Keyphasor input (channel 12) and support for Combustion Dynamic Monitoring (CDM) sensors, as well as the ability to run in an Enhanced mode that offers additional input resolution and other features.

17.4.1.1 Accuracy of Vibration Inputs

Accuracy of Vibration Inputs for PVIBH1A and YVIBS1A

Vibration Inputs	Measurement	Range		Frequency	Accuracy
		V dc + V ac	V ac portion		
Proximity	Displacement	+1 to -20 V peak	0 to 4.5 V pp	10 to 200 Hz	±0.030 V pp† (1% at 3 V pp†)
				200 to 700 Hz	±0.150 V pp† (5% at 3 V pp†)
Seismic	Velocity	+1 to -1 V peak	0 to 1.00 V peak	10 to 200 Hz	Max [2% reading, ±.008 V peak]
				200 to 700 Hz	Max [5% reading, ±.008 V peak]
Velomitor	Velocity	-8.75 to 15.625 V peak	0 to 3.625 V peak	10 to 200 Hz	Max [2% reading, ±.008 V peak]
				200 to 700 Hz	Max [5% reading, ±.008 V peak]
Accelerometer	Velocity (tracking filter)	-8.75 to -11.5 V peak	0 to 1.5 V peak	10 to 350 Hz	±0.015 V peak
† V pp - V peak-peak					

Accuracy of Vibration Inputs for PVIBH1B and YVIBS1B

Vibration Inputs	Measurement	Range		Default Hardware Gain	Default Hardware Offset	Accuracy @ min & max frequency range
		(V dc + V ac)	(V ac portion)			
Eddy-Current or Proximity (channels 1 - 8)	Displacement	-20.0 to 0.0 V peak	0 to 3.0 V pp	1x	10	+/-0.020 Vpp @ 10 Hz +/-0.023 Vpp @ 200 Hz
						+/-0.023 Vpp @ 200 Hz +/-0.056 Vpp @ 700 Hz
Seismic (channels 1 - 8)	Velocity	-2.5 to +2.5 V peak	0 to 1.0 V peak	4x	0	+/-0.010 Vp @ 10 Hz +/-0.012 Vp @ 200 Hz
						+/-0.012 Vp @ 200 Hz +/-0.034 Vp @ 700 Hz
Velomitor (channels 1 - 8)	Velocity	-17.0 to -7.0 V peak	0 to 5 V peak	2x	12	+/-0.010 Vp @ 10 Hz +/-0.020 Vp @ 200 Hz
						+/-0.020 Vp @ 200 Hz +/-0.130 Vp @ 700 Hz
Accelerometer (channels 1 - 3)	Velocity	-12.5 to -7.5 V peak	0 to 2.5 V peak	4x	10	+/-0.010 Vp @ 10 Hz +/-0.025 Vp @ 350 Hz
Bently Nevada CDM	Dynamic Pressure	-15.0 to -5.0 V peak	-5.0 to 5.0 V peak	2x	10	+/-0.010 Vp @ 10 Hz +/-0.132 Vp @ 1000 Hz
PCB CDM	Dynamic Pressure	5.0 to 15.0 V peak	-5.0 to 5.0 V peak	2x	-10	+/-0.010 Vp @ 10 Hz +/-0.132 Vp @ 1000 Hz
The accuracies specified are worst case numbers, and assume the Vibration module sample frequency is in sync with the input waveform frequency, preventing the A/D sample point from moving along the waveform and reading the actual peak value. The worst case accuracy is based on missing the maximum peak V ac measurement per the table by half the sample period relative to the input fundamental frequency.						

17.4.1.2 Accuracy of Position Inputs

Accuracy of Position Inputs for PVIBH1A and YVIBS1A

Position Inputs	Measurement	Range	Frequency	Accuracy
Position	Displacement (Gap)	-0.5 to -20 V dc	N/A	±0.2 V dc (1% of full scale)
Keyphasor	Displacement (Gap)	-0.5 to -20 V dc	N/A	±0.2 V dc (1% of full scale)
	Speed	N/A	2 to 20,000 rpm	±0.1 % of full scale speed
	Phase ***Phase is only calculated when RPM is greater than approximately 250 RPM.***	N/A	Up to 333 Hz	±1 degree for 1x **
			333 to 667	±2 degrees for 2x
** 1x vibration component with respect to key slot				

Accuracy of Position Inputs for PVIBH1B and YVIBS1B

Position Inputs	Measurement	Range	Frequency	Accuracy
Position	Displacement (Gap)	-0.5 to -20 V dc	N/A	+/-0.020 Vpp @ 10 Hz
Keyphasor	Displacement (Gap)	-0.5 to -20 V dc	N/A	+/-0.020 Vpp @ 10 Hz
	Speed	N/A	2 to 20,000 RPM	+/-0.1% of full scale speed
	Phase ***Phase is only calculated when RPM is greater than approximately 250 RPM.***	N/A	Up to 333 Hz	+/-0.5 degree
			333 to 667 Hz	+/-1 degree
** 1x vibration component with respect to key slot				

17.4.1.3 Tracking Filters

The following table defines differences in the tracking filters with versions of the I/O pack.

Item	PVIBH1A / YVIBS1A	PVIBH1B / YVIBS1B
Center frequency	Prior to ControlST V06.01: The center frequency was 50% larger than configuration setting. With ControlST V06.01 or later: The H1A or SIA functions the same as H1B or S1B	-3dB bandwidth correctly matches configuration settings to meet application requirements.
Filter roll off	Prior to ControlST V06.01: Window attenuation limited to -30 dB / octave With ControlST V06.01 or later: The H1A or SIA functions the same as H1B or S1B	Window attenuation increased to -36 dB / octave to meet application requirements.
1X / 2X channels	Use channel 13 only for phase reference	Can base phase measurements off of channel 12 or 13.

17.4.1.4 Wideband Filters and Velocity Conditioning

The following table defines differences in the Wideband Filters & Velocity Conditioning with versions of the I/O pack.

Item	PVIBH1A / YVIBS1A	PVIBH1B / YVIBS1B
Supported Sensors	Velomitors and Seismics only	Velomitors, Seismics & LM Accelerometers with integrated outputs
Maximum octave attenuation	-48 dB for all filter configurations	-60 dB for all filter configurations
Output of wideband filter	Can only be mapped to Peak-to-peak algorithm.	Can either be assigned to an RMS calculation or Peak-to-peak algorithm, using VIB_CalcSel
Notes	Peak-to-peak algorithm uses a scan period based on the GAP13_KPH1 key-phasor speed. If there is no key-phasor input, 160 ms scan period is the default.	Peak-to-peak algorithm and RMS calculation use a Scan time of data. Update rate is equal Frame Rate. ISO for Vibration calls for RMS calculations

17.4.1.5 CDM Sensors

PVIBH1B and YVIBS1B add support for CDM sensors (not available with H1A and S1A). From the **Parameters** tab, CDM_scan_period is a selectable scan period for CDM sensor inputs.

Item	PVIBH1A / YVIBS1A	PVIBH1B / YVIBS1B
Supported sensors	None because CDM is not supported by PVIBH1A / YVIBS1A	Inputs 1-8 support the following: Bently Nevada CDM Sensor (CDM_BN_ChgAmp) PCB CDM Sensor (CDM_PCB_ChgAmp)
Maximum octave attenuation	N/A	-60 dB for all filter configurations
Output of wideband filter	N/A	Can either be assigned to an RMS calculation or Peak-to-peak algorithm, using VIB_CalcSel
Scan period selection	N/A	Peak-to-peak or RMS scan period configured by the CDM_Scan_ Period parameter.
LM 1x tracking filter support	N/A	Peak-to-peak output supported for up to 3 frequency selections (Inputs 1-3 only)

17.4.2 Vibration Monitoring Firmware

The following subsections provide details for common firmware features using in vibration monitoring applications. For application-specific firmware use cases and procedures, refer to the section *Vibration Monitoring Application Examples*.

17.4.2.1 Signal Space Inputs for Sensor Types, with Firmware Version 5.01 or Later

Note n = input number

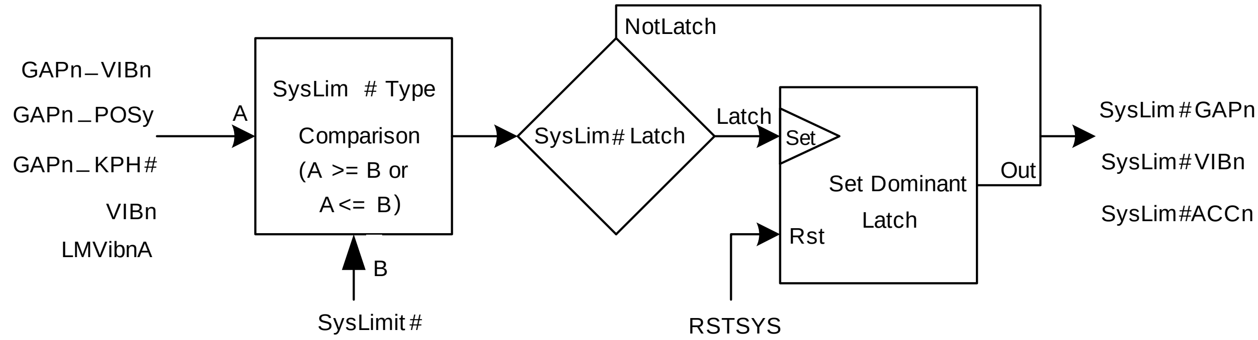
Sensor Type	GAPn_VIBn	GAPn_POSy (y = 1-3)	GAP12_KPH2 GAP13_KPH1	VIBn	VIB_1Xn Vib1xPHn VIB_2Xn Vib2xPHn	LMVibnA LMVibnB LMVibnC
PosProx	Inputs 1-8	Inputs 9-11	Inputs 12-13			
VibProx	Inputs 1-8			Inputs 1-8		
VibProx-KPHx	Inputs 1-8			Inputs 1-8	Inputs 1-8	
VibLMAccel	Inputs 1-8			Inputs 1-8		Inputs 1-3
VibSeismic	Inputs 1-8			Inputs 1-8		Unused (H1A)
						Inputs 1-3 (H1B)
VibVelomitor	Inputs 1-8			Inputs 1-8		Unused (H1A)
						Inputs 1-3 (H1B)
CDM_BN_ChgAmp (H1B Only)	Unused (H1A)			Unused (H1A)		Unused (H1A)
	Inputs 1-8 (H1B)			Inputs 1-8 (H1B)		Inputs 1-3 (H1B)
CDM_PCB_ChgAmp (H1B Only)	Unused (H1A)			Unused (H1A)		Unused (H1A)
	Inputs 1-8 (H1B)			Inputs 1-8 (H1B)		Inputs 1-3 (H1B)
KeyPhasor			Inputs 13 (H1A)			
			Inputs 12-13 (H1B)			

17.4.2.2 System Limits

GAP, VIB, and LM 1x Tracking Filters each support System Limits for configurable limit checking. This function returns a Boolean value indicating whether the limit has been exceeded, with optional latching behavior. This function is intended to simplify application logic by moving common functionality into the PVIB/YVIB configuration.

All system limits are implemented the same way, regardless of which input we are describing. System limits checks are executed at Frame Rate, on the value in signal space after it has been converted to the correct units. Based on the configuration, the system limits check will behave as greater than set point (>=) or less than set point (<=), and the result can be latching or non-latching. System Limit latches are SET dominant, so the results of the checks will be TRUE as long as the signal exceeds the set point.

Note Latching system limits are reset using the RSTSYS pin on the SYS_OUTPUTS block.



System Limits Implementation

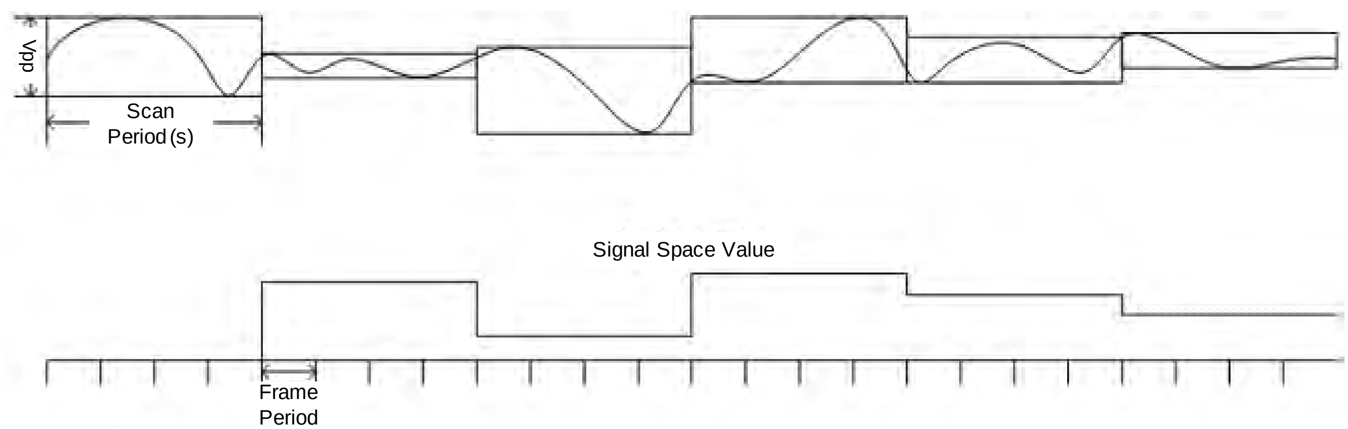
From the ToolboxST application, Component Editor, I/O pack, **Parameters** tab, there is a global System Limit disable parameter, **SystemLimits**. When this parameter is set to *Disable*, all system limits in the PVIB/YVIB are set to False, and a diagnostic alarm is generated.

Configuration of System Limits

Item	Description	Choices
SysLimit#	Set point for the System Limit check. Value is expressed in EU for that point.	Textfield
SysLim#Enabl	Enable or Disable this specific System Limit check. Value is an enumerated type.	Enable or Disable
SysLim#Latch	Configure whether system limits should latch TRUE. Value is an enumerated type.	Latch or NotLatch
SysLim#Type	Configure whether system limits checks are greater than set point or less than set point. Value is an enumerated type.	<= or >=

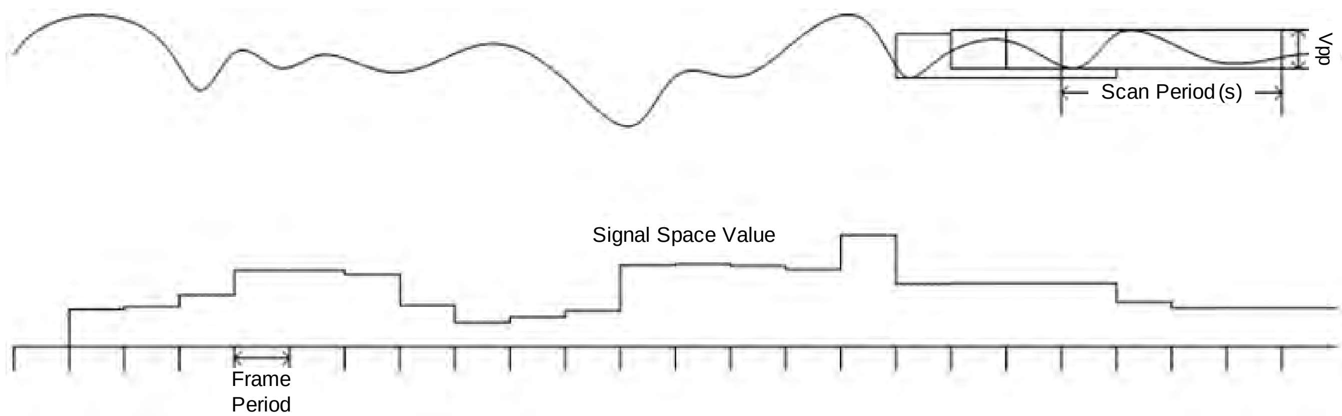
17.4.2.3 Legacy Peak-Peak Algorithm

The default vibration algorithm, which is the only vibration algorithm implemented by the PVIBH1A/YVIBS1A, is a windowed peak detection function. A window size (scan period) is determined by the current rotor speed on GAP13_KPH1. If there is no keyphasor input, 160 ms scan period is the default. As new input data is processed, it fills the window in. When the window is full, we calculate the peak-peak measurement, scale it, and send it to signal space. The window is then emptied and needs to be completely filled again before a new peak-peak value is computed. For this reason, the effective update rate is the scan period, not frame rate.



17.4.2.4 Enhanced Peak-Peak Algorithm

The enhanced peak-peak algorithm (only available with PVIBH1B or YVIBH1B) performs the same operation as the legacy peak-peak algorithm, but it executes using a sliding window, rather than a fixed window. New input data displaces old data in the windowed peak detection function. Window size (scan period) is determined by rotor speed on GAP13_KPH1. If there is no key-phasor #1 input, 160 ms scan period is the default. CDM sensors always use CDM_Scan_Period as defined in the configuration. As new data is processed, data older than the window size is displaced. At frame rate, the data within the window is used to calculate the peak-peak measurement value, which is scaled and sent to signal space. Since the window is continuously updated, the effective update rate is frame rate.



Enhanced Peak-Peak Algorithm

17.4.2.5 Enhanced RMS Algorithm

The Enhanced RMS algorithm (PVIBH1B and YVIBH1B only) uses the same sliding scan window logic as the Enhanced Peak-Peak algorithm. Data is passed through a 1-pole high-pass filter with a cutoff frequency of 0.1Hz. This removes sensor biasing voltage from the RMS value. The RMS calculation is performed on the windowed data. Window size (scan period) is determined by rotor speed on GAP13_KPH1. CDM sensors always use CDM_Scan_Period as defined in the configuration. As new data is processed, data older than the window size is displaced. At frame rate, the data within the window is used to calculate an RMS value, which is scaled and sent to signal space. Since the window is continuously updated, the effective update rate is frame rate.

Public Information

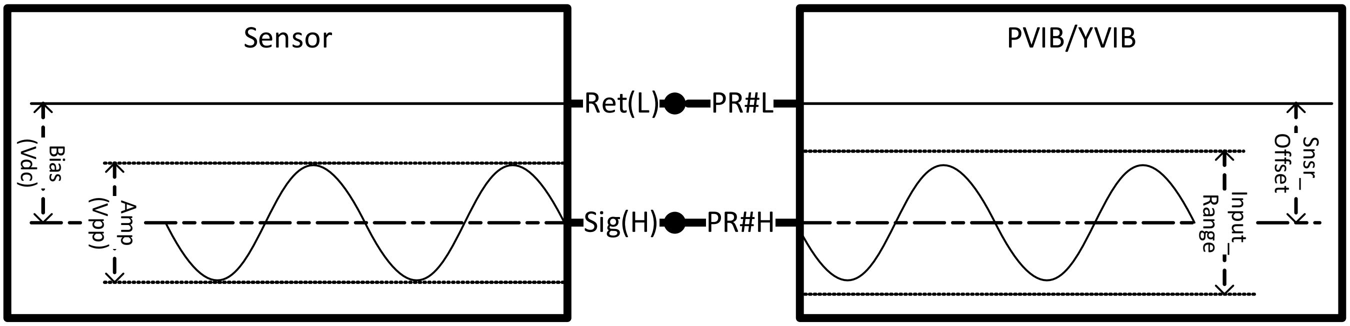
17.4.2.6 Default Sensor Gain and Bias

Each sensor has a default Gain and DC Sensor bias which is based on firmware requirements. These values are chosen based on sensor data sheets and traditional field usage.

Sensor Type	Default Gain	Default Snsr_Offset	Vin_{Min} (Volts)	Vin_{Max} (Volts)
PosProx	1x	9	-19	1
VibLMAccel	2x	10	-15	-5
VibProx	1x	9	-19	1
VibProx_KPH1	1x	9	-19	1
VibProx_KPH2	1x	9	-19	1
VibSeismic	4x	0	-2.5	2.5
VibVelomitor	2x	12	-17	-7
Keyphasor	1x	9	-19	1
CDM_BN_Chg_Amp	2x	10	-15	-5
CDM_PCB_Chg_Amp	2x	-12	7	17
GnBiasOvride = TRUE	G	S	((-10V/G) - S)	((10V/G) - S)

17.4.2.7 Sensor Gain and Bias Override

Depending on the specific application of a sensor, a different gain or DC bias may be needed. The PVIB/YVIB provides a configurable override for the default values for Gain and Sensor Bias through the **GnBiasOvride** parameter. Setting GnBiasOvride = Enable will replace the default Gain and Sensor Offset with the configured Gain and Snsr_Offset parameters.



Use of Gain and Snsr_Offset in PVIB/YVIB

The sensor inputs relate to the PVIB/YVIB Snsr_Offset and Input_Range values. Input_Range is a value determined by Gain through the following formula:

$$Input\_Range = \frac{20V_{pp}}{Gain}$$

Input_Range is centered on -Snsr_Offset, which allows us to define the valid input voltage range with the following formulas:

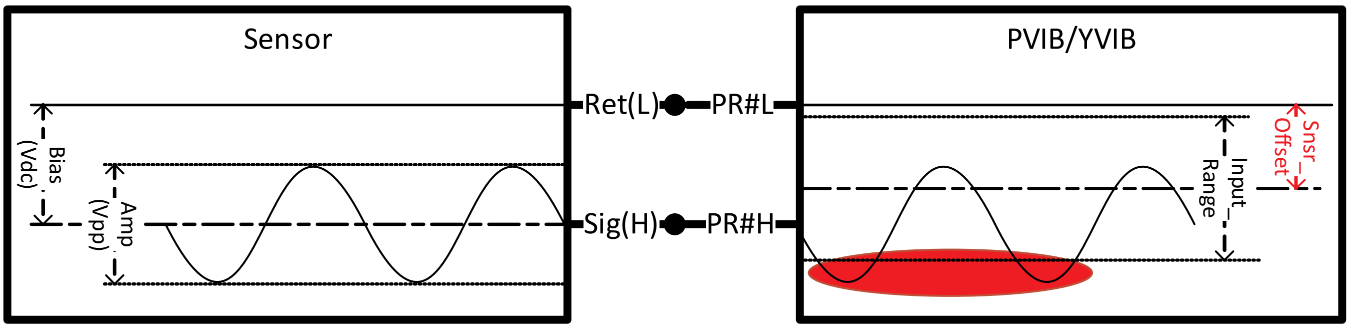
Maximum Input Voltage Definition

$$Vin_{Max} = \frac{10V}{Gain} - Snsr\_Offset$$

Minimum Input Voltage Definition

$$Vin_{Min} = \frac{-10V}{Gain} - Snsr\_Offset$$

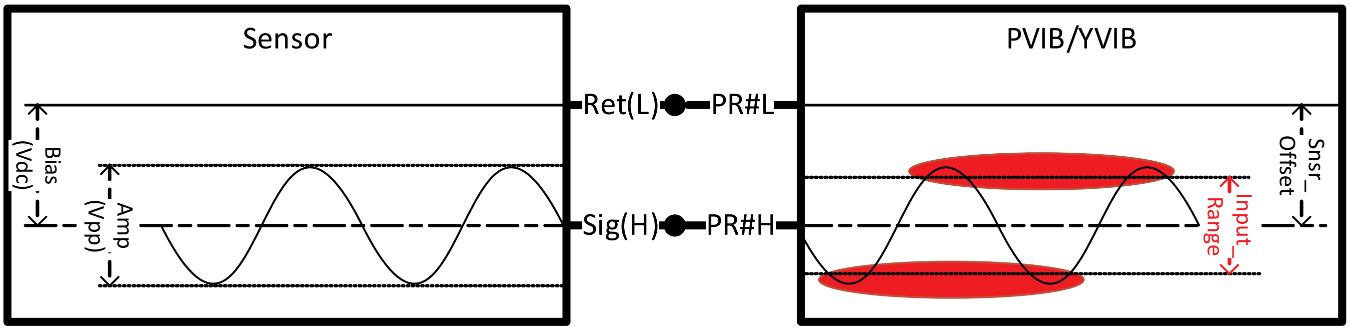
It is critical that the values of **Gain** and **Snsr_Offset** are chosen correctly to avoid saturating the A/D Converter on that input channel, which results in clipping the signal. Consider the following case, where Input Range is correctly determined, but **Snsr_Offset** is too low.



Input Clipping due to Snsr_Offset

The bottom of the Input waveform exceeds the VinMin value for this configuration. This will result in this signal being clipped off, since the A/D Converter will saturate and return only VinMin. Second, VinMax greatly exceeds the high peak of this input signal. This won't result in an error, but it indicates that the measurement window isn't well adapted to this input. Increasing **Snsr_Offset** will reposition the measurement window, bringing VinMax closer to the input high peak, as well as lowering VinMin below the input low peak.

Consider this case, where the selected **Gain** is too high.



Input clipping due to Gain

The **Snsr_Offset** is selected appropriately, but the Input_Range is too narrow. As a result, input signal amplitude exceeds Input_Range and we will read clipped values at both the high and low end. Verifying that Input_Range exceeds the sensor input AC amplitude is the most important factor in determining **Gain**.

In order to use the **GnBiasOvride** correctly, select a **Gain** such that Input_Range exceeds the AC amplitude of the input signal (Equation 1), and then select a **Snsr_Offset** to ensure that the measurement window defined by VinMax and VinMin contains the sensor input completely (*Max.* and *Min.* Voltage Definitions).

17.4.2.8 PVIB and YVIB Firmware Changes

The following is a list of changes made to the PVIBH1A and PVIBH1B, and YVIBS1B (not S1A) with firmware V05.01 and later.

- VibProx-KPH is renamed to VibProx-KPH1, to reflect that it uses KPH1 as source for 1x/2x tracking filters.
- LM Accelerometers are supported for Inputs 4-8, without computation of LM Tracking Filters.
- LM Tracking Filter refactored as -36 dB/oct Butterworth Filters.
- LM 1x Tracking Filters are recomputed as 6-pole filters with the correct cutoff points.
- ToolboxST Component Editor, Tab ‘Gap 9-12’ is renamed ‘Gap 9-11’ to reflect GAP12_POS4 becoming a possible Keyphasor input.
- New Parameters added to configure CDM Sensors.
- N28 Low power now affects Velomitor and CDM Bently Nevada Charge Amp health.
- Sensor out of range and Open circuit conditions hold input health low for 3 seconds after recovery.
- Default Sensor Gains and Offsets are changed, as an example: Prox biasing is -9 V dc by default, not -10 V dc. This is because the default bias value of 9 has been optimized for signal input range of +1 to -19 volts instead of optimizing for the actual BN sensor 50 ml setting.
- New Build Validation rules added to PVIB to ensure valid mixed TMR module operation with PVIBH1A and H1B packs.
- YVIB does not support mixed TMR module operation with YVIBS1A and S1Bs

17.4.2.9 PVIBH1B and YVIBS1B Firmware Enhancements

The following is a list of functional improvements made to the newer versions of PVIB and YVIB.

- LM Tracking Filters are computed for Velomitor, Seismic, and CDM sensors for Inputs 1-3 in the H1B and SIB only.
- Wideband Filters support 10-Pole Filters in the H1B and SIB only.
- Input passband increased from 1150 Hz to 4500 Hz with H1B and S1B only.

17.4.3 Vibration Monitoring Application Examples

The PVIB and YVIB modules support a variety of sensor types and applications. Refer to the tables *Supported Sensor Inputs* and *Signal Space Inputs for Sensor Types* for the relevant I/O pack for valid sensor inputs and modes.

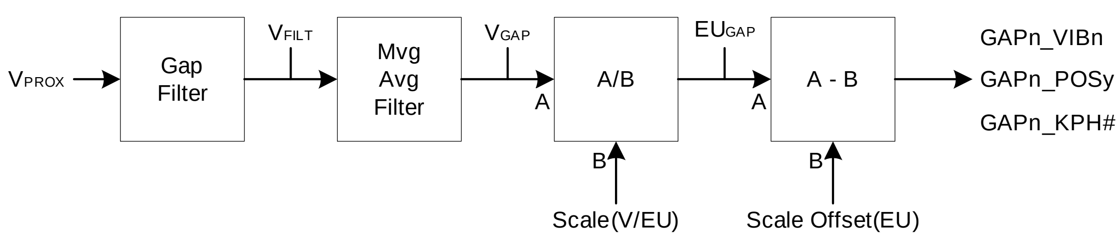
17.4.3.1 Position

Inputs 1-13 support Proximitor sensors to collect air gap value. In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft. Position algorithms report a filtered air gap value.

Input Processing

The signal space values GAPn_VIBn, GAPn_POSy, GAPn_KPH# are the filtered engineering units (EU) values.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU. For Position applications, Gap values have a Scale Offset parameter **Scale_Off** applied after scaling.



In this application example, SysLim1GAPn, SysLim2GAPn provide System Limit status for GAPn_VIBn value as True/False.

Position Configuration

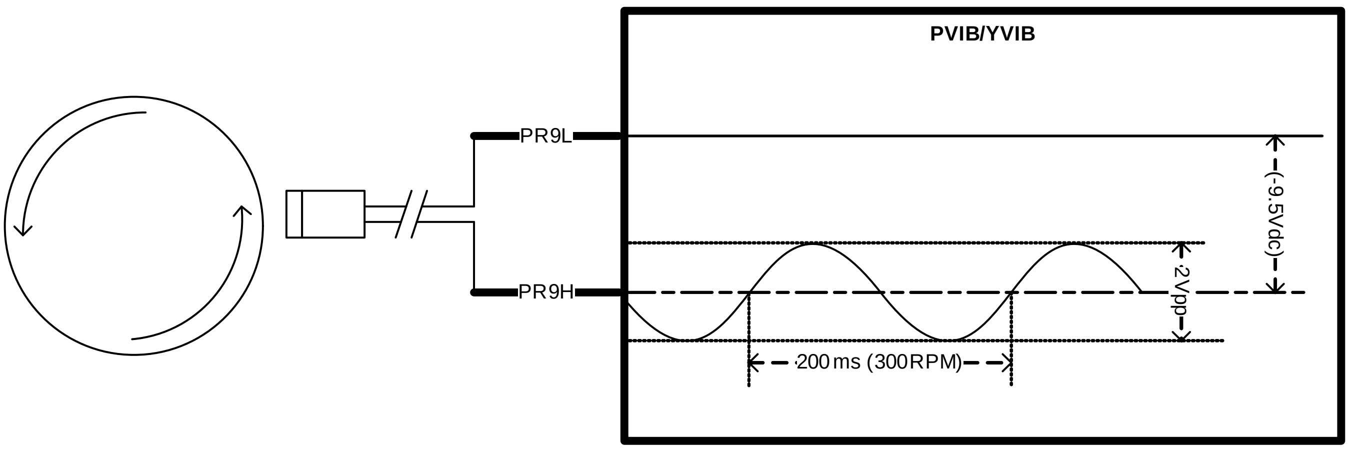
GAPn_VIBn, GAPn_POSy, GAPn_KPH#:
VibType - PosProx is used for Position applications.
Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.

Scale_Off is a scale offset parameter used to remove the nominal Gap value from the measured Gap value. Units are engineering units (EU).

TMR_DiffLimt is a TMR voter disagreement detection diagnostic alarm threshold for GAPn_VIBn, GAPn_POSy, or GAPn_KPH# value. The keyphasor value is expressed as absolute difference in EU. Refer to the *Keyphasor* section for an explanation of how this value is calculated.

GnBiasOvride, Gain, Snsr_Offset – See *Gain/Bias Override*
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See *System Limits feature*

Position Application Example



Proximitor voltage inputs to a PVIB/YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 9 as a PosProx input.

Example Proximitor Specifications

Scale Factor	200mV/mil
Nominal Gap Setting	50 mils

Channel 9 is configured for the following behaviors:

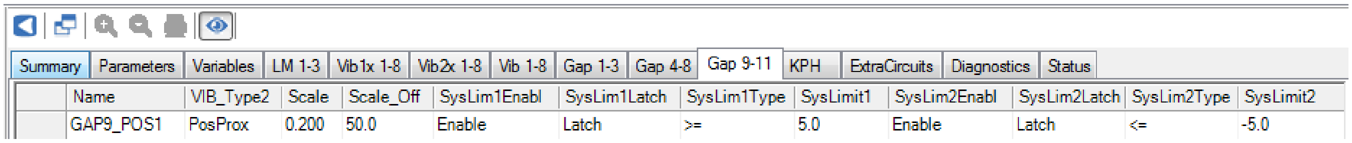
- Return GAP9_POS1 as mils.
- Remove the nominal Gap value from GAP9_POS1.
- Set SysLim1GAP9 to LATCH True if GAP9_POS1 ≥ 5 mils.
- Set SysLim2GAP9 to LATCH True if GAP9_POS1 ≤ -5 mils.

➢ To configure GAP9_POS1

1. From the ToolboxST Component Editor, navigate to the **Gap 9-11** tab.
2. Select GAP9_POS1, and click the *Show Advanced Parameters* icon.

Note the Advanced Parameters are used if setting up system limits.

3. Configure it to match the following example.



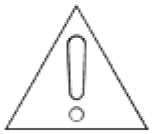
Name	VIB_Type2	Scale	Scale_Off	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1	SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
GAP9_POS1	PosProx	0.200	50.0	Enable	Latch	>=	5.0	Enable	Latch	<=	-5.0

If the PVIB firmware is receiving valid sensor data, then this is expected:

- Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will not affect either the 5Hz, 2Vpp vibration or the DC component of 9.5Vdc. The DC portion of the wave will be converted to 47.5 mils, and the AC portion of the wave will be converted to ±5.0 mils. We will remove 50.0 mils from the scaled wave, so the GAP9_ POS1 value will be -2.5 ± 5.0 mils.
- SysLim1GAP9 is false and SysLim2GAP9 is true. Since SysLim2GAP9 is latching, it will remain true until the GAP9_ POS1 signal is ≥ -5.0 and system limits are commanded to reset.

17.4.3.2 Keyphasor

Inputs 12-13 support Keyphasor sensors to collect air gap value and shaft rotation speed. In Heavy Duty turbine applications, a Keyphasor is used to calculate the position and rotating speed of a rotating shaft. Keyphasor algorithms report a conditioned air gap value and shaft rotation speed.



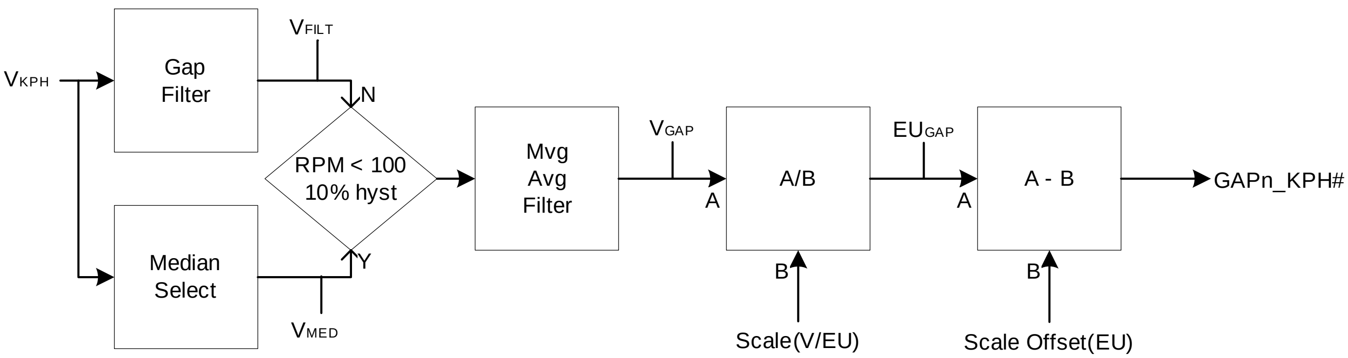
Attention

PVIBH1A only supports 1 Keyphasor on Input 13. PVIBH1B/YVIBS1B support 2 Keyphasors on Inputs 12 and 13.

Keyphasor Input Processing

GAPn_KPH# – The conditioned Position or Gap value in engineering units (EU).

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. At low speeds (100 RPM with 10% hysteresis), the Gap values bypass the filter, instead using a median selection. This allows for visual inspection of the Gap signal to show the Keyphasor edge more clearly at low speeds, removing the time delay and distortion associated with the filter. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU.



GAPn_KPH# Signal Path (Keyphasor)

Scale_Off is the Scale Offset parameter used to remove the nominal Gap value from the measured Gap value. Units are engineering units (EU).

SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_KPH# value as True/False.
RPM_KPH# - The calculated shaft rotation speed in RPM.

Shaft rotation speed is calculated by detecting the time between Keyphasor transitions. Since there is only a single transition per shaft rotation, shaft rotation speed is computed once per rotation, however this requires two rotations of data for the computation. This value requires at least two full rotations before it can be computed.

At rotating speeds above 1000 RPM, RPM_KPH# is computed as the average of the speed over 4 rotations. This impacts the rate at which the RPM_KPH# signal will respond to changes in speed.

Note Only RPM_KPH1 is used by the Wideband Vibration to perform Scan Filtering.

Keyphasor Configuration

GAPn_KPH#:

VibType - KeyPhasor is used for Keyphasor applications.
Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.

Scale_Off – Scale Offset to remove from measured Gap value. Units are engineering units (EU).

KPH_Thrshld – Keyphasor detection threshold for GAPn_KPH#. Value is expressed as absolute difference in Volts.

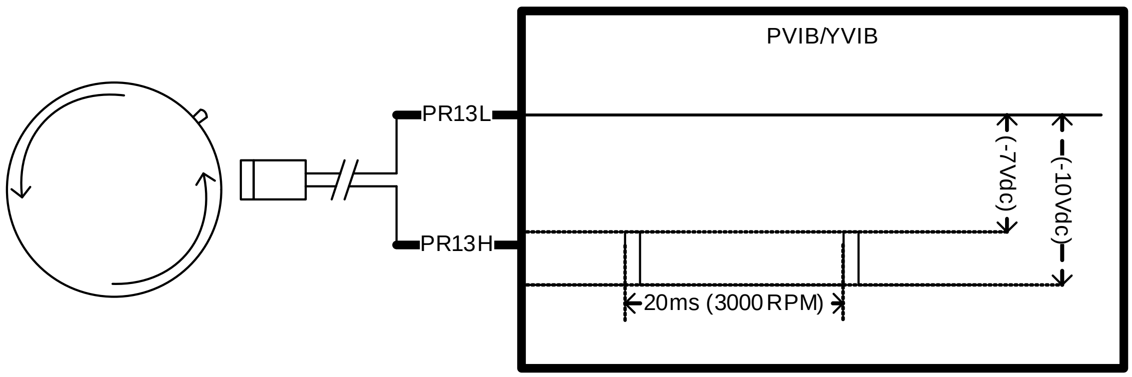
KPH_Type – Keyphasor type selection. Values are Slot, indicating the shaft has a slot or trough, or Pedestal, indicating the shaft has a key above the shaft surface. Slot detection looks for a sharply increasing distance for the key. Pedestal looks for a sharply decreasing distance for the key.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_KPH# value. Value is expressed as absolute difference in EU.

GnBiasOvride, Gain, Snsr_Offset – see *Gain/Bias Override*

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See *System Limits feature*

Keyphasor Application Example



Keyphasor Sensor Monitoring Pedestal key

Keyphasor voltage inputs to a PVIB/YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 13 as a KeyPhasor input. The shaft has a pedestal type key with a height of 15 mils above the shaft surface, so we will detect a lower air gap when the key passes by the sensor.

Example Keyphasor Specifications

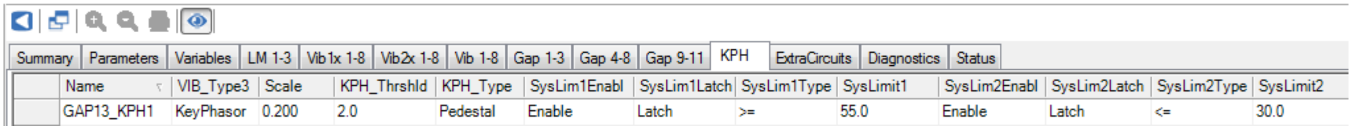
Scale Factor	200mV/mil
Nominal Gap Setting	50 mils

We will configure Channel 13 for the following behaviors:

- Return GAP13_KPH1 as mils.
- Configure the sensor as a Pedestal type Keyphasor with a threshold of 10 mils.
- Set SysLim1GAP13 to LATCH True if GAP13_KPH1 $\geq$ 55 mils.
- Set SysLim2GAP13 to LATCH True if GAP13_KPH1 $\leq$ 30 mils.

➢ To configure GAP13_KPH1

1. From the ToolboxST Component Editor, navigate to the **KPH** tab.
2. Select GAP13_KPH1, and click the *Show Advanced Parameters* icon.
3. Configure it to match the following example.



Name	VIB_Type3	Scale	KPH_Thrshld	KPH_Type	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1	SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
GAP13_KPH1	KeyPhasor	0.200	2.0	Pedestal	Enable	Latch	>=	55.0	Enable	Latch	<=	30.0

If the PVIB firmware is receiving the data after this configuration, we would expect:

• Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz, since RPM is well above the 100RPM cutoff for median values. This will cut away nearly all of the Pedestal effect on Gap value, though the average Gap value will tend to be slightly lower than the shaft Gap. The normal DC level will be converted to 50.0mils, so the GAP13_KPH1 value will be slightly less than 50.0 mils.
• At low speeds, the Gap filter is bypassed and we can see the transition when the Pedestal clearly by monitoring the value of GAP13_KPH1. For this reason, it is important to take operating speed into account when using GAP13_KPH1 values.
• SysLim1GAP13 and SysLim2GAP13 are false, since (30.0 ≤ 50.0) and (50.0 ≤ 55.0). At low speeds, the Pedestal transitions will be much closer to the SysLim2GAP13 setpoint. For this reason, it is important to consider the operating speed when using System Limits on the Keyphasor channel. The Key will only be filtered out of the GAP13_KPH1 value when we approach running speed.
• RPM_KPH1 value is 3000 RPM. This value will be refreshed with the latest RPM measurement once every rotation, which is every 20 ms for this example.

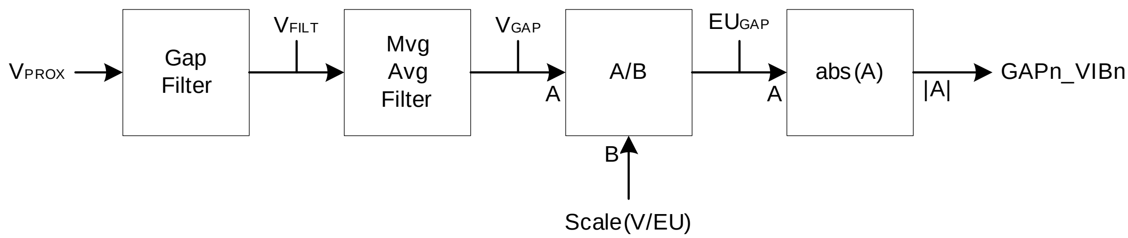
17.4.3.3 Vibration Displacement

Inputs 1-8 support Proximitor sensors to collect air gap, wideband vibration, and 1x/2x vibration vectors relative to a specified Keyphasor channel. In Heavy Duty turbine applications, Proximitors are used to monitor the position of a rotating shaft. Vibration Displacement algorithms report a filtered air gap value, and peak-to-peak displacement value, and an optional vibration phasor relative to a specified Keyphasor channel.

Vibration Displacement Input Processing

GAPn_VIBn – The filtered Position or Gap value in engineering units (EU).

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. Gap Values are converted from Volts to EU. For Vibration Displacement applications, Gap values are magnitude quantities, so they are always positive.



VIBn – Wideband Vibration Displacement (Peak-Peak) in engineering units (EU).

Wideband vibration information is passed through a variable scan period peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

Wideband Vibration Scan Period

Shaft speed (RPM)	Scan period (ms)
0 – 60	160
60-480	2000
480-2250	250
>2250	160

Attention

Peak Detection function always uses KPH1 RPM, even when the sensor is configured to use KPH2 for 1x/2x Vibration Phasor calculations.

The output of the peak detection function (V_{PK-PK}) is passed through an adjustable 1-pole, low-pass filter prior to scaling. V_{PK-PK} is converted from Volts to EU. For PVIBH1B systems, a lower latency peak detection function can be enabled by changing the OperatingMode parameter to Enhanced. This function will update every frame, instead of every scan period. See Enhanced Vibration Algorithms for additional information.

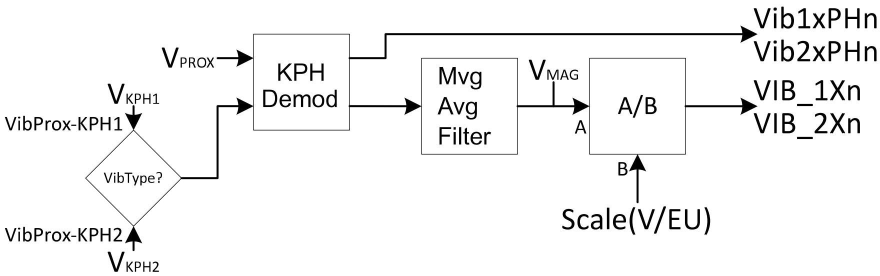
Note Sensors monitoring position of rotating elements typically measure Peak-to-Peak. RMS calculations can be used instead if needed.

VIB_1Xn, VIB_2Xn – Vibration Phasor Magnitude (Peak-Peak) for 1st/2nd harmonic of Keyphasor frequency in engineering units (EU).

Vib1xPHn, Vib2xPHn – Phase Angle between Keyphasor and VIB_1Xn/VIB_2Xn vibration phasor in degrees.

Public Information

1x/2x Vibration Phasor function measures the peak-to-peak displacement component at both the Keyphasor frequency (VIB_1Xn) and twice the frequency (VIB_2Xn). The VIB_Type selection determines which Keyphasor is used as the source for this function. Selecting VibProx will disable this function, selecting VibProx-KPH1 will enable the 1x/2x Tracking Filter operation relative to KPH1 (Channel 13), and selecting VibProx-KPH2 will enable the 1x/2x Tracking Filter relative to KPH2 (Channel 12)



SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False.
SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False. See *System Limits feature* for more information.

Vibration Displacement Configuration

GAPn_VIBn:

VibType - VibProx, VibProx-KPH1, and VibProx-KPH2 are used for Vibration Displacement.

Note VibProx-KPH1 enables the 1x/2x Tracking Filter operation relative to KPH1 (Channel 13) and VibProx-KPH2 enables the 1x/2x Tracking Filter relative to KPH2 (Channel 12)

Attention

VibProx-KPH2 is not supported by the PVIBH1A / YVIBS1A.

Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/mils.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in EU.
GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See *System Limits feature*

Note Scale_Off, LMlpcutoff – Unused for this sensor type.

VIBn:

VIB_CalcSel – Select calculation method for VIBn value between Peak Displacement and RMS Displacement.

Note Sensors monitoring position of rotating elements typically measure Peak-to-Peak.

Attention

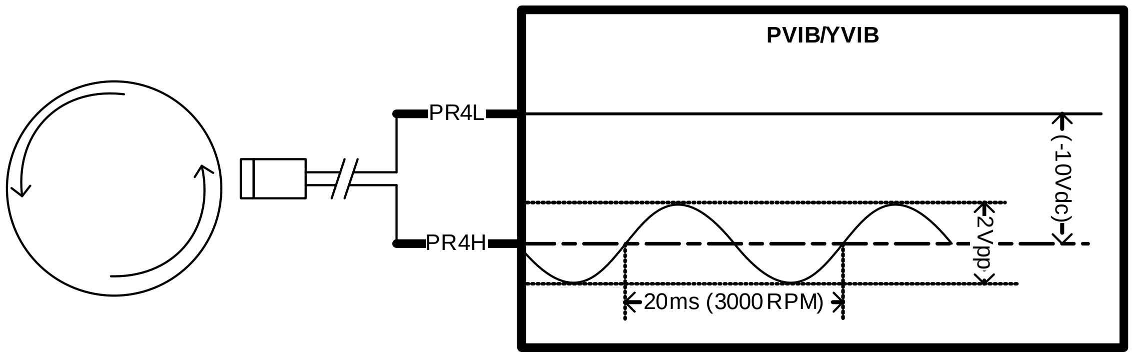
VIB_RMS is not supported by the PVIBH1A / YVIBS1A.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See *System Limits feature*

Note FilterType, Fltrhpattn, Filtrhpcutoff, Fltrlpattn, Filtrlpcutoff – Unused for this sensor type.

Vibration Displacement Application Example

In the following figure (*Vibration Displacement Sensor*), Proximitor voltage inputs to a PVIB/YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 4 as a VibProx input (no Keyphasor).



Vibration Displacement Sensor

Example Proximitor Specifications

Scale Factor	200mV/mil
Nominal Gap Setting	50 mils

We will configure Channel 4 for the following behaviors:

- Return GAP4_VIB4 and VIB4 signals as mils.
- Set SysLim1GAP4 to LATCH True if GAP4_VIB4 ≥ 55 mils.
- Set SysLim2GAP4 to LATCH True if GAP4_VIB4 ≤ 45 mils.
- Set SysLim1VIB4 to True if VIB4 ≥ 8 mils
- Set SysLim2VIB4 to LATCH True if VIB4 ≥ 15 mils

➢ To configure GAP4_VIB4

1. From the ToolboxST Component Editor, navigate to the **Gap 4-8** tab.
2. Select GAP4_VIB4, and click the *Show Advanced Parameters* icon.
3. Configure it to match the following example.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	VIB_Type	Scale	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1	SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
GAP4_VIB4	VibProx	0.200	Enable	Latch	>=	55.0	Enable	Latch	<=	45.0

4. Click the **Vib 1-8** tab.
5. Select VIB4 and click the *Show Advanced Parameters* icon.
6. Configure it to match the following example.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	VIB_CalcSel	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1	SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
VIB4	VIB_Pk-Pk	Enable	NotLatch	>=	8.0	Enable	Latch	>=	15.0

If the PVIB firmware is receiving the data successfully after competing this configuration, then the following occurs:

• Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the 50Hz, 2Vpp vibration by nearly 40:1, and the DC component of 10Vdc will be unaffected. The DC wave will be converted to 50mils, and the 40:1 reduced AC wave will be converted to ±0.125 mils, so the GAP4_VIB4 value will be 50 ± 0.125 mils.
• SysLim1GAP4 and SysLim2GAP4 are false, since (45.0 ≤ 49.875) and (50.125 ≤ 55.0).
• Vibration Displacement is unaffected by the DC component of the signal. The 50Hz, 2Vpp AC portion will be passed through a peak detection with 160 ms scan period, which will capture 8 cycles. The Peak-to-Peak value will return 2Vpp, which will be converted to 10mils, so VIB4 value will be 10mils.
• SysLim1VIB4 will be true, since VIB1 ≥ 8.0 mils. SysLim2VIB4 is false.

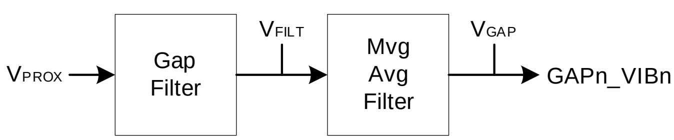
17.4.3.4 Velocity

Inputs 1-8 support Velomitors, Seismeic velocity, and Accelerometers with integrated outputs to collect wideband velocity. Inputs 1-3 also collect velocity magnitude relative to a specified rotor speed. In LM turbine applications, Velocity sensors are mounted on bearing housings or machine casing to provide measurements of vibration. Tracking filters for Inputs 1-3 can provide the magnitude of vibration at a specified frequency.

Velocity Input Processing

GAPn_VIBn – Sensor biasing voltage in Volts.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. For Velocity sensors, the gap value is not scaled, and it will remain in Volts. This value can be used to monitor sensor health.



VIBn – Wideband Velocity (½*pk-pk or RMS) in engineering units (EU).

Wideband velocity information is passed through 1-pole, high-pass filter with a fixed cutoff frequency of .1Hz. This removes static information prior to wideband filtering. This data is passed through the wideband filter, which can be configured as a low-pass, high-pass, or band-pass filter. The high-pass and low-pass filters can be configured for 2, 4, 6, 8, or 10 pole Butterworth filters with a user-defined cutoff (-3dB) point.

Attention

10-pole filters are not available with PVIBH1A modules.

Wideband Filters are not executed for VibLMAccel sensors in PVIBH1A modules.

RMS Velocity is not available with PVIBH1A modules.

Depending on the value of the VIB_CalcSel for each input, the filtered data will be used to provide Peak velocity within the scan period, or RMS Velocity within the scan period.

For Peak velocity calculations, the wideband filter output is sent through a variable length peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

The output of the peak detection function (VPK) is passed through an adjustable 1-pole, low-pass filter prior to scaling. VPK is converted from Volts to EU.

Note For PVIBH1B systems, a lower latency peak detection function can be enabled by changing the OperatingMode parameter to Enhanced. This function will update every frame, instead of every scan period. See Enhanced Vibration Algorithms for additional information.

Wideband vibration information is passed through a variable scan period peak detection function. The length of the peak detection is determined by the Keyphasor 1 detected speed in RPM.

Wideband Vibration Scan Period

Shaft speed (RPM)	Scan period (ms)
0 – 60	160
60-480	2000
480-2250	250
>2250	160

Attention

Peak Detection functions and Capture Buffers always uses RPM_KPH1 speed.

The data in the buffer is used to compute an RMS voltage (V_{RMS}) over that capture length, which is passed through an adjustable 1-pole, low-pass filter prior to scaling. V_{RMS} is converted from Volts to EU.

Note Sensors monitoring velocity typically measure RMS. Peak calculations can be used instead for legacy applications.

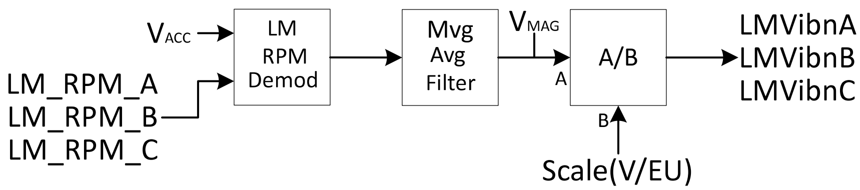
Note RMS calculations are only available with PVIBH1B / YVIBS1B systems, and can only be enabled by changing the OperatingMode parameter to Enhanced.

LMVibnA, LMVibnB, LMVibnC – Magnitude of 1X harmonic relative to specified rotor shaft in Engineering Units (EU). This function is available for Inputs 1-3 only.

1X LM Tracking Filters measure the ½*pk-pk velocity component at a specified shaft speed in RPM. The PVIB/YVIB module receives the shaft speed through the variables LM_RPM_A (for LMVib1A, LMVib2A, and LMVib3A), LM_RPM_B (for LMVib1B, LMVib2B, and LMVib3B), and LM_RPM_C (for LMVib1C, LMVib2C, and LMVib3C). The calculation is the same for all 9 inputs, with only the input channel or shaft speed source changing. Values are converted from Volts to EU.

Attention

PVIBH1A only supports the 1xLM tracking filters in VibLMAccel.



SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False.
SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False. SysLim1ACCn, SysLim2ACCn – System Limit status for LMVibnA/B/C value as True/False.
ACC1, ACC2, and ACC3 correspond to LMVib1A, LMVib1B, and LMVib1C.
ACC4, ACC5, and ACC6 correspond to LMVib2A, LMVib2B, and LMVib2C.
ACC7, ACC8, and ACC9 correspond to LMVib3A, LMVib3B, and LMVib3C.

Velocity Input Configuration

GAPn_VIBn:

VibType - VibLmAccel, VibVelomitor, and VibSeismic are used for Velocity.

Attention

VibLmAccel does not support wideband filtering in the PVIBH1A.

VibVelomitor and VibSeismic do not support LM 1X Tracking Filters in the PVIBH1A.

Scale – Conversion from Volts to engineering units (EU). Typically, units are Volts/ips.

LMlpcutoff – LM 1X Tracking Filter low-pass cutoff. Effective LM 1X Tracking Filter bandwidth is twice the value of this field.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in Volts.

GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

Note Scale_Off – Unused for this sensor type.

VIBn:

VIB_CalcSel – Select calculation method for VIBn value between Peak Velocity and RMS Velocity.

Note Sensors monitoring velocity typically measure RMS. Legacy PVIB applications will use Peak Velocity.

Note If OperatingMode is Legacy, this value is ignored and legacy Peak-to-Peak algorithm is used.

Attention

VIB_RMS is not supported by the PVIBH1A / YVIBS1A.

VibLMAccel does not support Wideband Filters in PVIBH1A / YVIBS1A.

10-pole filters are not supported in PVIBH1A / YVIBS1A.

FilterType – Select Wideband Filter type for Velocity data. Selections are None, Lowpass, Highpass, Bandpass.

Filtrhpcutoff, Filtrlpcutoff – Cutoff (-3dB) point for high-pass and low-pass filters, respectively.

Fltrhpattn, Fltrlpattn – Attenuation for high-pass and low-pass filters, expressed as number of poles to use in Butterworth filters. Selections are 2-pole, 4-pole, 6-pole, 8-pole, and 10-pole.

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.

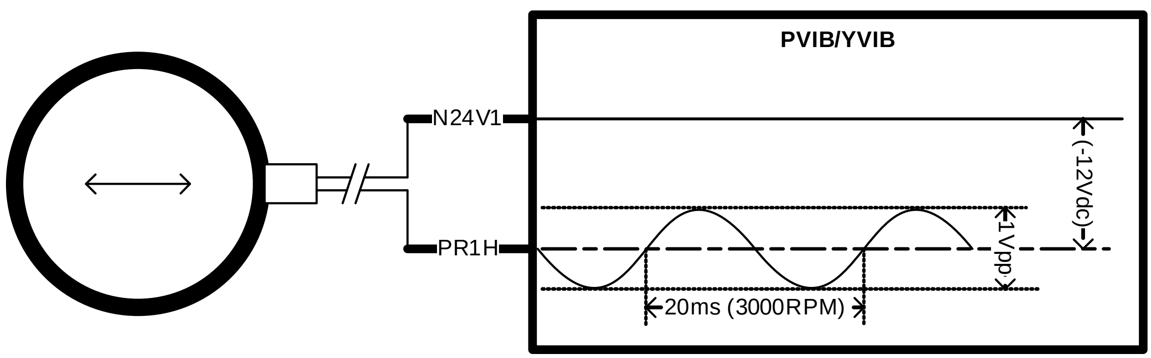
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

LMVibnA, LMVibnB, LMVibnC:

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for LMVibnA/B/C value. Value is expressed as absolute difference in EU.

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

Velocity Application Example



In this example, Velomitor voltage inputs to a PVIB/YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 1 as a VibVelomitor input.

Example Velomitor Specifications

Scale Factor	100mV/ips
Frequency Response	6 Hz to 750 Hz

We will configure Channel 1 for the following behaviors:

- Utilize the RMS Velocity algorithm for computing VIB1 signal.

Note RMS Computation is not available with PVIBH1A systems. Refer to Peak Velocity mode.

- Return VIB1 signal in inches/sec.
- Apply 8-pole low-pass and high-pass wideband filters to pass only inputs within Velomitor frequency response.
- Set SysLim1VIB1 to True if VIB1 ≥ 3 inches/sec
- Set SysLim2VIB1 to LATCH True if VIB1 ≥ 5 inches/sec
- Utilize LM_RPM_A to return LMVib1A as Peak Velocity at shaft speed (3000RPM) with a filter bandwidth of 5Hz.

Note LM 1X Tracking Filters will not operate with PVIBH1A for Velomitor sensors.

Navigate to "Parameters" tab. Set OperatingMode parameter to Enhanced.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8

Name	Value	Description
OperatingMode	Enhanced	Enable enhanced algorithms for PVIBH1B packs

Navigate to "Gap 1-3" tab. Select GAP1_VIB1.

Set VIB_Type parameter to VibVelomitor.
Set Scale to "0.100" (Units are V/ips).

Set LMlpcutoff parameter to 2.5Hz. If the LM 1X Tracking Filter is not desired, then this setting does not matter.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Ga

Name	VIB_Type4	Scale	LMlpcutoff
GAP1_VIB1	VibVelomitor	0.100	2.5Hz

Navigate to the **Vib 1-8**tab. Select VIB1.

Set VIB_CalcSel parameter to VIB_RMS.
Set FilterType to Bandpass. Set Filtrhpcutoff to "6.0" Hz.
Set Filtrlpcutoff to "750.0" Hz.
Set Fltrhpattn and Fltrlpattn to 8-pole.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	VIB_CalcSel	FilterType	Filtrhpcutoff	Fltrhpattn	Filtrlpcutoff	Fltrlpattn
VIB1	VIB_RMS	Bandpass	6.0	8-pole	750.0	8-pole

Click to Show Advanced Parameters.
Set SysLim1Enabl and SysLim2Enabl parameters to Enable.
Set SysLim1Latch to NotLatch and SysLim2Latch to Latch.
Set SysLim1Type and SysLim2Type to ">=".
Set SysLim1 to "3.0" ips and SysLimit2 to "5.0" ips.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1	SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
VIB1	Enable	NotLatch	>=	3.0	Enable	Latch	>=	5.0

Navigate to the **Variables** tab. Select LM_RPM_A and attach a variable containing the rotor speed of 3000 RPM to it. If the LM 1X Tracking Filter is not desired, omit this step.

Summary | Parameters | Variables | LM 1-3 | Vib1x 1-8 | Vib2x 1-8 | Vib 1-8 | Gap 1-3 | Gap 4-8 | Gap 9-11 | KPH | ExtraCircuits | Diagnostics | Status

Name	Direction	Data Type	Connected Variable	Device Tag	Description
LM_RPM_A	AnalogOutput	REAL	Rotor_Speed		Speed A(RPM), calculated externally to the PVIB

If the PVIB firmware is correctly receiving the data, we would expect:

• Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the 50Hz, 1Vpp vibration by nearly 40:1, and the DC component of -12Vdc will be unaffected. Since the units for GAP1_VIB1 are always Volts, and the 40:1 reduced AC wave will be ±0.025 volts, the GAP1_VIB1 value will be -12 ± 0.025 Volts.
• For Vib values, the DC removal filter will eliminate the DC component of -12 V. The 50Hz, 1Vpp AC portion will pass through the wideband filter unaffected and be sent to a 160ms capture window, which will capture 8 cycles. The RMS value computed for this input (ideal sine wave) will return .353VRMS, which will be converted to inches/sec, so VIB1 value will be 3.53 inches/sec. • SysLim1VIB1 will be true, since VIB1 ≥ 3.0 ips. SysLim2VIB1 is false.
• LMVib1A value is the magnitude of the 1X harmonic of the rotor speed in LM_RPM_A, which is 3000RPM. Since the input wave is an ideal sine wave with a frequency of 3000RPM, the value of LMVib1A will be 5.0 inches/sec.

17.4.3.5 Combustion Dynamics Monitoring (CDM)

Inputs 1-8 support CDM sensors to collect wideband dynamic pressure. Inputs 1-3 also collect dynamic pressure magnitude relative to a specified frequency in RPM. Combustion Dynamics applications rely on the higher bandwidth and enhanced algorithms which are only implemented in the PVIBH1B/YVIBS1B.

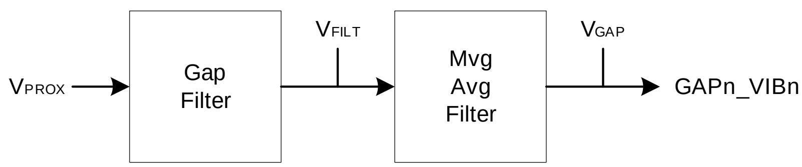
Attention

CDM Sensors are only supported on the PVIBH1B/YVIBS1B.

CDM Input Processing

GAPn_VIBn – Sensor biasing voltage in Volts.

Gap values are filtered through a 2-pole, low-pass filter with a fixed cutoff frequency of 8 Hz. The output of the gap filter is passed through a rolling average filter prior to scaling. For CDM sensors, the gap value is not scaled, and it will remain in Volts. This value can be used to monitor sensor health.



VIBn – Wideband Dynamic Pressure (pk-pk or RMS) in engineering units (EU).

Wideband dynamic pressure information is passed through 1-pole, high-pass filter with a fixed cutoff frequency of .1Hz. This removes static pressure prior to wideband filtering. This data is passed through the wideband filter, which can be configured as a low-pass, high-pass, or band-pass filter. The high-pass and low-pass filters can be configured for 2, 4, 6, 8, or 10 pole Butterworth filters with a user-defined cutoff (-3dB) point.

Depending on the value of the VIB_CalcSel for each input, the filtered data will be used to provide pk-pk dynamic pressure within the scan period, or RMS dynamic pressure within the scan period.

For pk-pk dynamic pressure calculations, the wideband filter output is sent through a variable length pk-pk detection function. The length of the pk-pk detection is determined by the CDM_Scan_Period value in configuration.

The output of the pk-pk detection function (VPK-pk) is passed through an adjustable 1-pole, low-pass filter prior to scaling. VPK-pk is converted from Volts to EU.

Note A lower latency pk-pk detection function can be enabled by changing the **OperatingMode** parameter to Enhanced. This function will update every frame, instead of every scan period.

For RMS dynamic pressure calculations, the wideband filter output is captured into a variable length buffer. The length of the RMS calculation is determined by the CDM_Scan_Period value in configuration.

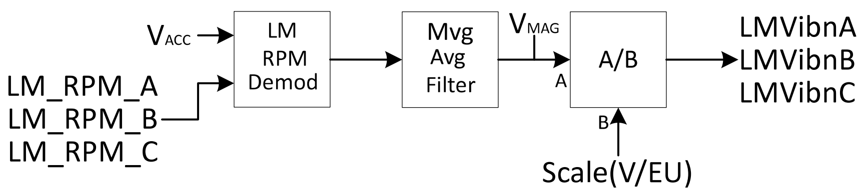
The data in the buffer is used to compute an RMS voltage (VRMS) over that capture length, which is passed through an adjustable 1-pole, low-pass filter prior to scaling (this filter cannot be disabled). VRMS is converted from Volts to EU.

Note Sensors monitoring dynamic pressure typically measure RMS. Peak calculations can be used instead for legacy applications.

Note RMS calculations are only available with PVIBH1B systems, and can only be enabled by changing the OperatingMode parameter to Enhanced. See Enhanced Vibration Algorithms for additional information.

LMVibnA, LMVibnB, LMVibnC – Magnitude of 1X harmonic relative to specified frequency (RPM) in Engineering Units (EU). This function is available for Inputs 1-3 only.

1X LM Tracking Filters measure the peak velocity component at a specified frequency in RPM. The PVIB module receives the frequency through the variables LM_RPM_A (for LMVib1A, LMVib2A, and LMVib3A), LM_RPM_B (for LMVib1B, LMVib2B, and LMVib3B), and LM_RPM_C (for LMVib1C, LMVib2C, and LMVib3C). The calculation is the same for all 9 inputs, with only the input channel or shaft speed source changing. Values are converted from Volts to EU.



SysLim1GAPn, SysLim2GAPn – System Limit status for GAPn_VIBn value as True/False.
SysLim1VIBn, SysLim2VIBn – System Limit status for VIBn value as True/False.
SysLim1ACCn, SysLim2ACCn – System Limit status for LMVibnA/B/C value as True/False.
ACC1, ACC2, and ACC3 correspond to LMVib1A, LMVib1B, and LMVib1C.
ACC4, ACC5, and ACC6 correspond to LMVib2A, LMVib2B, and LMVib2C.
ACC7, ACC8, and ACC9 correspond to LMVib3A, LMVib3B, and LMVib3C.

CDM Configuration

GAPn_VIBn:

VibType – CDM_BN_ChgAmp, CDM_PCB_ChgAmp are used for CDM applications.

Note CDM_PCB_ChgAmp expects a positively biased sensor and will use a pull-down to N28 for open circuit detection. CDM_BN_ChgAmp expects a negatively biased sensor, and will use a pull-up to P28. There is a TVBA jumper to select pull-up or pull-down voltage that must be in the correct position.

CDM_Probe_Gain – CDM Probe gain, typically expressed in pico-coulombs/PSI.
CDM_Amp_Gain – CDM Charge Amplifier gain, typically expressed in mV/ pico-coulomb.

Note CDM_Probe_Gain and CDM_Amp_Gain are hidden from view until a CDM Sensor is added.

LMlpcutoff – LM 1X Tracking Filter low-pass cutoff. Effective LM 1X Tracking Filter bandwidth is twice the value of this field.
TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for GAPn_VIBn value. Value is expressed as absolute difference in Volts.
GnBiasOvride, Gain, Snsr_Offset – See Gain/Bias Override
SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

Note Scale, Scale_Off – Unused for this sensor type.

VIBn:

VIB_CalcSel – Select calculation method for VIBn value between Peak Dynamic Pressure and RMS Dynamic Pressure.

Note Sensors monitoring dynamic pressure typically measure RMS.

If OperatingMode is Legacy, this value is ignored and legacy Peak algorithm is used.

FilterType – Select Wideband Filter type for Dynamic Pressure data. Selections are None, Lowpass, Highpass, Bandpass.

Filtrhpcutoff, Filtrlpcutoff – Cutoff (-3dB) point for high-pass and low-pass filters, respectively.

Fltrhpattn, Fltrlpattn – Attenuation for high-pass and low-pass filters, expressed as number of poles to use in Butterworth filters. Selections are 2-pole, 4-pole, 6-pole, 8-pole, and 10-pole.

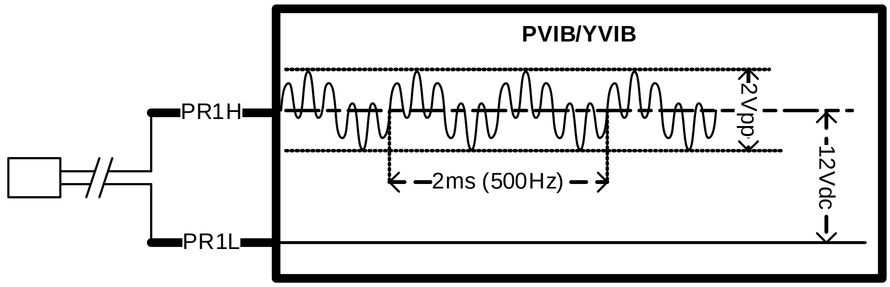
TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for VIBn value. Value is expressed as absolute difference in EU.

SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

LMVibnA, LMVibnB, LMVibnC:

TMR_DiffLimt – TMR Voter Disagreement Detection Diagnostic alarm threshold for LMVibnA/B/C value. Value is expressed as absolute difference in EU. SysLimit#, SysLim#Enabl, SysLim#Latch, SysLim#Type – See System Limits feature

CDM Application Example



In this example, PCB CDM voltage inputs to a PVIB/YVIB application are measured at the terminal board screws. Assume this sensor is connected to Channel 1 as a CDM_PCB_ChgAmp input.

For this example, the input waveform is two 1 VPK-PK pure tones (500Hz sine wave and 2500Hz sine wave) summed together. This is for illustrative purposes only, and is not indicative of true sensor inputs.

Example PCB Sensor Specifications

PCB Probe Gain	5.0 pC/PSI
PCB Amp Gain	20.0 mV/pC
Frequency Response	200 Hz – 4 kHz

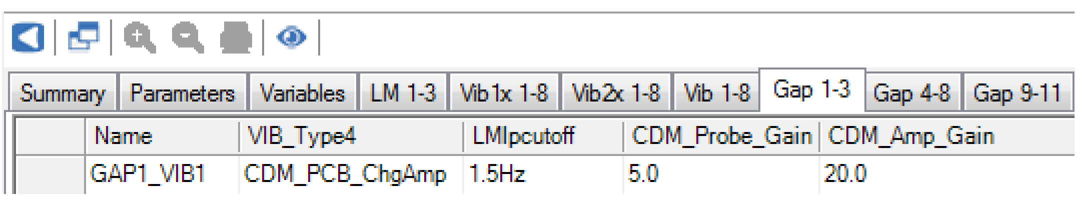
We will configure Channel 1 for the following behaviors:

- Utilize the RMS Dynamic Pressure algorithm for computing VIB1 signal.
- Return VIB1 signal in PSI.
- Apply 10-pole low-pass and high-pass wideband filters to pass only inputs within PCB Sensor frequency response.
- Utilize LM_RPM_A to return LMVib1A as Peak Dynamic Pressure at 2500 Hz (150000 RPM = 2500 Hz * 60 RPM / Hz) with a filter bandwidth of 3Hz.

- Set CDM_Scan_Period to 640 ms

➢ **To configure Channel 1**

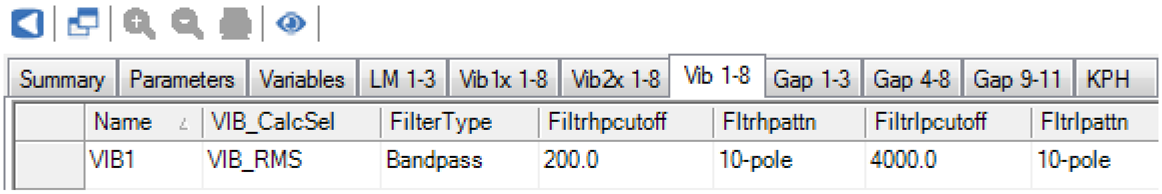
1. From the **Parameters** tab, set **OperatingMode** to Enhanced and set **CDM_Scan_Period** to 640 ms.
2. From the **Gap 1-3** tab, select GAP1_VIB1 and make the following configuration changes as displayed in the following screen.



Note These parameters will appear when a CDM sensor is selected in the VIB_Type parameter.

3. Navigate to the **Vib 1-8** tab. Select VIB1. Click to Show Advanced Parameters.

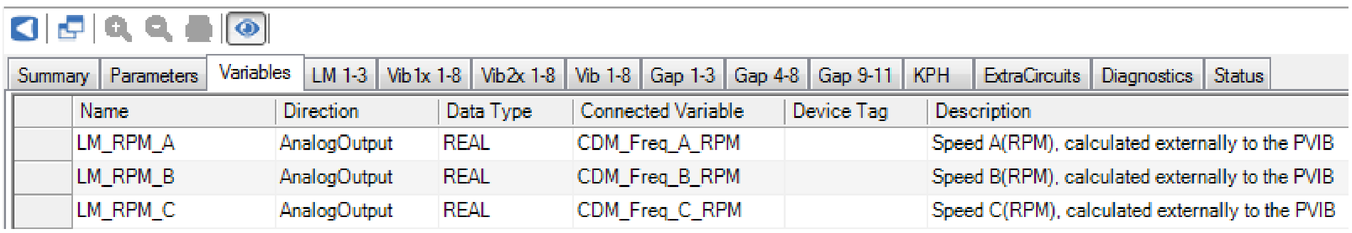
4. To set the Wideband filter, make the configuration changes as displayed in the following screen.



Name	VIB_CalcSel	FilterType	Filtrhpcutoff	Fltrhpattn	Filtrlpcutoff	Fltrlpattn
VIB1	VIB_RMS	Bandpass	200.0	10-pole	4000.0	10-pole

5. If the LM 1X Tracking Filter is desired, then navigate to the **Variables** tab. Select LM_RPM_A and attach a variable containing the 1x Harmonic frequency of 150000 RPM to it.

Note LM 1x Tracking Filter frequency input is always RPM, even for CDM applications. Be sure to convert the target frequency from Hertz to RPM.



Name	Direction	Data Type	Connected Variable	Device Tag	Description
LM_RPM_A	AnalogOutput	REAL	CDM_Freq_A_RPM		Speed A(RPM), calculated externally to the PVIB
LM_RPM_B	AnalogOutput	REAL	CDM_Freq_B_RPM		Speed B(RPM), calculated externally to the PVIB
LM_RPM_C	AnalogOutput	REAL	CDM_Freq_C_RPM		Speed C(RPM), calculated externally to the PVIB

If the PVIB firmware is receiving the data correctly after this configuration, then the following is expected:

• Gap values are passed through a 2-pole, low-pass filter with a cutoff frequency of 8 Hz. This will attenuate the AC waveform by at least 4000:1, and the DC component of 12VDC will be unaffected. Since the units for GAP1_VIB1 are always Volts, and the 4000:1 reduced AC wave will be ±0.0005 volts, the GAP1_VIB1 value will be -12 ± 0.0005 Volts.
• The DC removal filter will eliminate the DC component of -12V. The 500Hz, 1 V_{PK-PK} and 2500Hz, 1 V_{PK-PK} AC waves will pass through the wideband filter unaffected and be sent to a 160ms capture window, which will capture 80 cycles (scan period * frequency of the lowest principle). The RMS value computed for this input (sum of ideal sine waves) will return 0.5 V RMS, which will be converted to PSI. Therefore the VIB1 value will be 5.0 PSI RMS.
• LMVib1A value is the magnitude of the 1X harmonic of the rotor speed in LM_RPM_A, which is 2500Hz (150000 RPM). Since the input wave is the sum of two ideal sine waves, one of which is at 2500 Hz with a magnitude of 1 V_{PK-PK} , the value of LMVib1A will be 10 PSI_{PK-PK}.

17.4.4 Component Editor

17.4.4.1 Parameters

Parameter	Description	Choices
SystemLimits	Allows user to temporarily disable all system limit checks for testing purposes. Setting this parameter to Disable will cause a diagnostic alarm to occur.	Enable (default) Disable
OperatingMode	Legacy is the backwards compatibility mode for PVIBH1A Enhanced enables enhanced algorithms for PVIBH1B and YVIBS1B that are not compatible with PVIBH1A, including Low Latency Peak-Peak Algorithm and Vibration RMS Algorithm	Legacy (default) Enhanced
Vib_PP_Fltr	First order filter time constant (sec) — cannot be disabled	0.01 to 2 (default is 0.10)
MaxVolt_Prox	Maximum Input Volts (pk-neg), healthy Input, Prox	-4 to 0 (default is -1.5)
MinVolt_Prox	Minimum Input Volts (pk-neg), healthy Input, Prox	-24 to -16 (default is -18.5)
MaxVolt_KP	Maximum Input Volts (pk-neg), healthy Input, Keyphasor	-4 to 0 (default is -1.5)
MinVolt_KP	Minimum Input Volts (pk-neg), healthy Input, Keyphasor	-24 to -16 (default is -22.0)
MaxVolt_Seis	Maximum Input Volts (pk-pos),healthy Input,Seismic:Values > 1.25 require use of GnBiasOvride	0 to 2.75 (default is 1.0)
MinVolt_Seis	Minimum Input Volts (pk-neg),healthy Input,Seismic:Values < -1.25 require use of GnBiasOvride	-2.75 to 0 (default is -1.0)
MaxVolt_Acc	Maximum Input Volts (pk),healthy Input,Accel	-12 to 1.5 (default is -8.5)
MinVolt_Acc	Minimum Input Volts (pk-neg),healthy Input,Accel	-24 to -1 (default is -11.5)
MaxVolt_Vel	Maximum Input Volts (pk),healthy Input,Velomitor	-12 to 1.5
MinVolt_Vel	Minimum Input Volts (pk-neg),healthy Input,Velomitor	-24 to -1
MaxVolt_CDM_BN	Maximum Input Volts (pk),healthy Input,CDM Bently Nevada	-12 to 24
MinVolt_CDM_BN	Minimum Input Volts (pk-neg),healthy Input,CDM Bently Nevada	-24 to 12
MaxVolt_CDM_PCB	Maximum Input Volts (pk),healthy Input,CDM PCB	-12 to 24
MinVolt_CDM_PCB	Minimum Input Volts (pk-neg),healthy Input,CDM PCB	-24 to 12
CDM_Scan_Period	The scan period for CDM sensor inputs in seconds Only assign as 0.01 increments	0.01 to 2.0

17.4.4.2 Variables

Variables	Description	Direction and Datatype
L3DIAG_xxxx_x	I/O Pack Diagnostic Indicator where Pxxx or Yxxx is the name of the I/O pack and R, S, or T is the redundancy of pack	Input BOOL
LINK_OK_xxxx_x	IONet Link Okay Indicator where Pxxx or Yxxx is the name of the I/O pack and R, S, or T is the redundancy	Input BOOL
ATTN_xxxx_x	I/O Pack Status Indicator where Pxxx or Yxxx is the name of the I/O pack and R, S, or T is the redundancy	Input BOOL
PS18V_xxxx_x	I/O Pack 18 V Power Supply Indication where Pxxx or Yxxx is the name of the I/O pack and R, S, or T is the redundancy	Input BOOL
PS28V_xxxx_x	I/O Pack 28 V Power Supply Indication where Pxxx or Yxxx is the name of the I/O pack and R, S, or T is the redundancy	Input BOOL
IOPackTmpr_	I/O Pack Temperature at the processor where R, S, or T is the redundancy	Input BOOL
RPM_KPH1	Speed (RPM)of KP#1,calculated from input#13	Analog Input REAL
RPM_KPH2	Speed (RPM)of KP#2,calculated from input#12 (PVIBH1B only)	Analog Input REAL
LM_RPM_A	Speed A(RPM), calculated externally to the I/O Pack	Analog Output REAL
LM_RPM_B	Speed B(RPM), calculated externally to the I/O Pack	Analog Output REAL
LM_RPM_C	Speed C(RPM), calculated externally to the I/O Pack	Analog Output REAL
SysLim1GAPx where x = 1 to 13	Boolean set TRUE if System Limit 1 exceeded for Gap x input	Input BOOL
SysLim2GAPx where x = 1 to 13	Boolean set TRUE if System Limit 2 exceeded for Gap x input	Input BOOL
SysLim1VIBx where x = 1 to 8	Boolean set TRUE if System Limit 1 exceeded for Vib x input	Input BOOL
SysLim2VIBx where x = 1 to 8	Boolean set TRUE if System Limit 2 exceeded for Vib x input	Input BOOL
SysLim1ACCx where x = 1 to 9	Boolean set TRUE if System Limit 1 exceeded for Accelerometer x input	Input BOOL
SysLim2ACCx where x = 1 to 9	Boolean set TRUE if System Limit 2 exceeded for Accelerometer x input	Input BOOL

17.4.4.3 Probe Nominal Settings

Probe Type	Gain †	Snsr_Offset (Vdc)	Scale (typical value)
Proximity	1x	9	200 mv/mil
Seismic	4x	0	150 mv/ips
Velomitor	2x	12	100 mv/ips
Accelerometer	2x	10	150 mv/ips
Keyphasor	1x	9	200 mv/mil
Bently Nevada CDM	2x	10	170 mv/psi
PCB CDM	2x	-12	170 mv/psi
†These are the default settings used if GnBiasOvride=Disable.			

17.4.4.4 LM 1–3

[ ] = defaults

Name	Direction	Data Type	Description	TMR_DiffLimit	SysLim1E-nabl	SysLim1-Latch	SysLimit1Type	SysLimit1
LMVib#A ↓ LMVib#C	AnalogInput	REAL	Magnitude of 1X harmonic relative to LM_RPM_A, B, or C calculated from input#1, 2, or 3 (9 total inputs)	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=] , <=	System Limit 1 – Vibration in mils (prox) or Inch/sec (seismic,acel) [50] -100 to 100

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=] , <=	System Limit 2 – Vibration in mils (prox) or Inch/sec (seismic,acel) [0] -100 to 100

17.4.4.5 Vib1x 1-8

Name	Direction	Data Type	Description
VIB_1X1	AnalogInput	REAL	Magnitude of 1X harmonic relative to key phasor speed calculated from input#1
↓	↓	↓	↓
VIB_1X8	AnalogInput	REAL	Magnitude of 1X harmonic relative to key phasor speed calculated from input#8
Vib1xPH1	AnalogInput	REAL	Angle of 1X harmonic relative to key phasor calculated from input#1
↓	↓	↓	↓
Vib1xPH8	AnalogInput	REAL	Angle of 1X harmonic relative to key phasor calculated from input#8

17.4.4.6 Vib2x 1-8

Name	Direction	Data Type	Description
VIB_2X1	AnalogInput	REAL	Magnitude of 2X harmonic relative to key phasor speed calculated from input#1
↓	↓	↓	↓
VIB_2X8	AnalogInput	REAL	Magnitude of 2X harmonic relative to key phasor speed calculated from input#8
Vib2xPH1	AnalogInput	REAL	Angle of 2X harmonic relative to key phasor calculated from input#1
↓	↓	↓	↓
Vib2xPH8	AnalogInput	REAL	Angle of 2X harmonic relative to key phasor calculated from input#8

17.4.4.7 Vib 1-8

[ ] = defaults

Name	Direction	Data Type	Description	VIB_CalcSel	TMR_DiffLimt	Filter Type	Filtrhpcutoff
VIB1	AnalogInput	REAL	Vibration displacement (pk-pk) or velocity (pk), AC component of input#1	[VIB_Pk-Pk] Vib_RMS ‡	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100	Filter used for Velomitor and Seismic only [None], Low Pass, High Pass, Band Pass	High Pass 3db point (cutoff in Hz) [6] 4 to 300
↓	↓	↓	↓				
VIB8	AnalogInput	REAL	Vibration displacement (pk-pk) or velocity (pk), AC component of input#8				
‡Vib_RMS is only valid when OperatingMode is Enhanced and when using a PVIBH1B or YVIBS1B							

fltrlpattn	Filtrlpcutoff	fltrlppattn	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1
Slope or attenuation of high pass filter after cutoff [2-pole], 4-pole, 6-pole, 8-pole, 10-pole	Low Pass 3db point (cutoff in Hz) [500] 15 to 4300	Slope or attenuation of low pass filter after cutoff [2-pole] 4-pole, 6-pole, 8-pole, 10-pole	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=], <=	System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [50] -100 to 100

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=], <=	System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [0] -100 to 100

17.4.4.8 Gap 1-3

[ ] = defaults

†is only valid with PVIBH1B or YVIBS1B

‡ LM Tracking Filter magnitude value may be inaccurate at 160, 320 ms frame periods.

Name	Direction	Data Type	Description	VIB_Type4	Scale	Scale_Off	TMR_ DiffLimit
GAP1_VIB1	AnalogIn- put	REAL	Average Air Gap (for Prox) or DC volts(for others),DC component of input#1	Type of vibration probe, group 4 †CDM_BN_ChgAmp, †CDM_PCB_ ChgAmp, PosProx, [Unused], ‡VibLMAccel, VibProx, VibProx-KPH1, VibProx-KPH2, VibSeismic, VibVelomitor	Volts/- mil or Volt- s/ips [0.2] 0 to 2	Scale offset for Prox position only, in mils [0] 0 to 90	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100
GAP2_VIB2	AnalogIn- put	REAL	Average Air Gap (for Prox) or DC volts(for others),DC component of input#2				
GAP3_VIB3	AnalogIn- put	REAL	Average Air Gap (for Prox) or DC volts(for others),DC component of input#3				

GnBiasOvride	Snsr_Offset	Gain	LMIpcutoff	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1
Gain Bias Override [Disable], Enable	Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvride is enabled [10] ±13.5	Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], 2x, 4x, 8x	Low pass 3dB point (cutoff Hz) for LM tracking filters 1.5Hz, 2.0Hz, [2.5Hz], 3.0Hz, 3.5Hz, 4.0Hz, 4.5Hz, 5.0Hz	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=] , <=	System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2	CDM_Probe_Gain	CDM_Amp_Gain
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=] , <=	System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100	PCB Probe Gain, pico-coulombs per psi [17] 1 to 100	PCB Charge amplifier Gain, millivolts per pico-coulomb [10] 1 to 100

17.4.4.9 Gap 4-8

[ ] = defaults
†is only valid with PVIBH1B or YVIBS1B

Name	Direction	Data Type	Description	VIB_Type	Scale	Scale_Off	TMR_ DiffLimit
GAP4_VIB4	AnalogIn- put	REAL	Average Air Gap (for Prox) or DC volts(for others),DC component of input#4	Type of vibration probe, group 1 †CDM_BN_ChgAmp, †CDM_PCB_ ChgAmp, PosProx, [Unused], VibLMAccel, VibProx, VibProx-KPH1, VibProx-KPH2, VibSeismic, VibVelomitor	Volts/- mil or Volt- s/ips [0.2] 0 to 2	Scale offset for Prox position only, in mils [0] 0 to 90	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100
↓	↓	↓	↓				
GAP8_VIB8	AnalogIn- put	REAL	Average Air Gap (for Prox) or DC volts(for others),DC component of input#8				

GnBiasOvr- ide	Snsr_Offset	Gain	SysLim1E- nabl	SysLim1- Latch	SysLim1Type	SysLimit1
Gain Bias Override [Disable], Enable	Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvride is enabled [10] ±13.5	Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], 2x, 4x, 8x	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=] , <=	System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2	CDM_Probe_Gain	CDM_Amp_Gain
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=] , <=	System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100	PCB Probe Gain, pico-coulombs per psi [17] 1 to 100	PCB Charge amplifier Gain, millivolts per pico-coulomb [10] 1 to 100

17.4.4.10 Gap 9-11

[ ] = defaults

Name	Direction	Data Type	Description	VIB_Type2	Scale	Scale_Off	TMR_ DiffLimit
GAP9_POS1	AnalogInput	REAL	Average Air Gap,DC component of input#9	Sensor Type, group 2 [Unused], PosProx	Volts/mil or Volts/ips [0.2] 0 to 2	Scale offset for Prox position only, in mils [0] 0 to 90	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100
GAP10_POS2	AnalogInput	REAL	Average Air Gap,DC component of input#10				
GAP11_POS3	AnalogInput	REAL	Average Air Gap,DC component of input#11				

GnBiasOvride	Snsr_Offset	Gain	SysLim1Enabl	SysLim1Latch	SysLim1Type	SysLimit1
Gain Bias Override [Disable], Enable	Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvride is enabled [10] ±13.5	Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], 2x, 4x, 8x	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=] , <=	System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=] , <=	System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100

17.4.4.11 KPH

[ ] = defaults

† is only valid with PVIBH1B or YVIBS1B

Name	Direction	Data Type	Description	VIB_Type3	Scale	Scale_Off	TMR_ DiffLimit	KPH_Thrshld
GAP12_KPH2	AnalogInput	REAL	Average Air Gap,DC component of input#9	Sensor Type, group 3 [Unused], PosProx, † KeyPhasor	Volts/-mil or Volt-s/ips [0.2] 0 to 2	Scale offset for Prox position only, in mils [0] 0 to 90	Difference Limit for Voted TMR Inputs in Volts or Mils [2] -100 to 100	Voltage difference from gap voltage where keyphasor triggers [2.0] 1.0 to 5.0
GAP13_KPH1	AnalogInput	REAL	Average Air Gap,DC component of input#10	Sensor Type, group 3 [Unused], PosProx, KeyPhasor				

KPH_Type	GnBiasOvr-ide	Snsr_Offset	Gain	SysLim1E-nabl	SysLim1-Latch	SysLim1Type	SysLimit1
[Slot], Pedestal	Gain Bias Override [Disable], Enable	Amount of bias voltage (dc) to remove from input signal used to max. A/Ds signal range used only when GnBiasOvride is enabled [10] ±13.5	Resolution of input signal (net gain unchanged), select based on expected range, use only if GnBiasOvride is enabled [1x], ‡ 2x, 4x, ‡ 8x	Enable System Limit 1 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 1 Check Type [>=] , <=	System Limit 1 – GAP in negative volts (Velomitor) or positive mils (Prox) [90] -100 to 100

‡Gain 2x and Gain 8x are **Never** valid on GAP12_KPH2.

SysLim2Enabl	SysLim2Latch	SysLim2Type	SysLimit2
Enable System Limit 2 [Disable], Enable	Latch the alarm [Latch], NotLatch	System Limit 2 Check Type [>=] , <=	System Limit 2 – GAP in negative volts (Velomitor) or positive mils (Prox) [10] -100 to 100

17.4.5 PVIB or YVIB Diagnostics

Note Details of the individual diagnostics are available from the ToolboxST application. The diagnostic signals can be individually latched and then cleared from the ToolboxST Component Editor, or by using the RSTDIAG signal on SYS_OUTPUTS block, or through the WorkstationST Alarm Viewer.

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and most of the processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set
- Each vibration input has hardware limit checking based on preset (configurable) high and low levels near the end of the operating range. If this limit is exceeded, a logic signal is set. The logic signal, L3DIAG_xxxx, refers to the entire board. There are diagnostic alarms for this (Alarm 33-45).
- Each input has system limit checking based on configurable high and low levels. The Sys_Outputs block can be used to reset any latched system limits. System limits can be used to drive process alarms through users application code.

17.5 PVIB or YVIB Specific Diagnostic Alarms

The following alarms are specific to the PVIB or YVIB I/O pack.

32

Description Channel [ ] A/D Converter Calibration Failure

Possible Cause The I/O pack failed to auto-calibrate when powered on.

Solution Replace the I/O pack.

33-45

Description TVBA Analog Input [ ] exceeded limits

Possible Cause

- The terminal point voltage is outside of limits for the sensor type.
- The Bias level (DC offset), Gain, or sensor limits are improperly set for the sensor/channel.
- Open connection between sensor and terminal board

Solution

- Verify that the sensor configuration is correct.
- Check for the proper voltage at the terminal board point on the sensor.
- Check the electrical continuity between sensor and terminal board.
- Replace the I/O pack or terminal board.

46

Description Channel [ ] D/A Converter Calibration Failure

Possible Cause The board failed to auto-calibrate when powered on.

Solution Replace the I/O pack.

47

Description Initialization Error Detected

Possible Cause An I/O pack has failed.

Solution Replace the I/O pack.

48

Description Internal data transfer error - Expected ID [ ] Read ErrCntr/ID [ ]

Possible Cause There is an I/O pack failure or software process conflict that may be cleared by a hard reset.

Solution

- Cycle power on the I/O pack.
- Replace the I/O pack.

49

Description Internal hardware failure - Status [ ]

Possible Cause An I/O pack has failed.

Solution Replace the I/O pack.

50

Description Channel [ ] DC Isolation Test Failure

Possible Cause The I/O pack failed to auto-calibrate when powered on.

Solution Replace the I/O pack.

51

Description I/O pack processor failure - Status [ ]

Possible Cause The I/O pack failed.

Solution Replace the I/O pack.

52-64

Description TVBA Analog Input [ ] Open Circuit ([ ] Volts)

Possible Cause An open circuit has been detected on the terminal board based on the sensor type.

Solution

- Check the wiring between the terminal board and the sensor.
- Check the sensor for proper operation.
- Replace the terminal board.

65

Description Negative 28 Volt Power Low ([ ] Counts)

Possible Cause

- WNPS daughterboard failure (for TVBAH#A or S#A)
- Failure of N28 power supply on TVBAS2B or TVBAH#B
- I/O pack P28 voltage is low
- The terminal board has failed

Solution

- Check the power to the I/O pack.
- Replace the WNPS daughterboard.
- Replace the terminal board.
- Replace the I/O pack.

66

Description Dual Ethernets not supported with 10 ms frame rate

Possible Cause The second Ethernet port is connected, but not supported for a 10 ms frame rate with PVIBH1A.

Solution

- Remove the second Ethernet connection to the PVIBH1A.
- Increase the frame rate to 20ms.
- Upgrade to PVIBH1B.

67

Description Pack internal reference voltage out of limits

Possible Cause The I/O pack failed to auto-calibrate when powered on.

Solution Replace the I/O pack.

68

Description Internal daughterboard temperature limit exceeded ([ ] °F)

Possible Cause

- The cabinet temperature is too high.
- The I/O pack overheated.
- If the cabinet temperature is within the specified temperature limits, the I/O pack internal daughterboard temperature sensor may have failed.

Solution

- Check the environmental controls applied to the cabinet containing the I/O pack. Operation will continue correctly beyond these temperature limits, but long-term operation at elevated temperatures may reduce equipment life.
- If the I/O pack internal daughterboard temperature sensor failed, then replace the I/O pack.

Public Information

69

Description Channels 1, 5, 9, 13 ADC Failure. Status [ ]

Possible Cause The I/O pack failed.

Solution Replace the I/O pack.

70

Description Channels 2,6,10 ADC Failure. Status [ ]

Possible Cause The I/O pack failed.

Solution Replace the I/O pack.

71

Description Channels 3,7,11 ADC Failure. Status [ ]

Possible Cause The I/O pack failed.

Solution Replace the I/O pack.

72

Description Channels 4,8,12 ADC Failure. Status [ ]

Possible Cause The I/O pack failed.

Solution Replace the I/O pack.

73

Description 1x2x Phase Calibration Level [ ] Failure on Channel [ ]

Possible Cause The I/O pack failed to auto-calibrate when powered on.

Solution Replace the I/O pack.

74

Description Current Operating Mode is incompatible with this hardware

Possible Cause The selected Operating Mode is not supported by this module. This is likely caused by installing a PVIBH1A to replace a PVIBH1B without updating ToolboxST. This alarm may be accompanied by Voter Disagreement diagnostics.

Solution

- Change the Operating Mode parameter to Legacy.
- Replace this module with a PVIBH1B.

75-87

Description Channel [ ] Sensor type is not supported with this hardware

Possible Cause The selected sensor type (VIB_Type) is unsupported by this module. This is likely caused by installing a PVIBH1A to replace a PVIBH1B without updating ToolboxST. This channel will default to Unused behavior.

Solution

- Change the VIB_Type for the indicated channel to a value supported by all hardware forms being used. Review the documentation to see which sensor types can be used for each hardware form.
- Replace this module with a PVIBH1B.

88-95

Description Channel [ ] Wideband Filters do not support [ ]-pole filter attenuation. Falling back to [ ]-pole filter attenuation.

Possible Cause The filter attenuation selection for Fltrhpattn and/or Fltrlpattn is not supported by this module. This is likely caused by installing a PVIBH1A to replace a PVIBH1B without updating ToolboxST. This channel will run with the closest match it can support, rather than disable the filter.

Solution

- Change the Fltrhpattn and/or Fltrlpattn for the indicated channel to a value supported by all the hardware forms being used. Review the documentation to see which attenuation values can be used for each hardware form.
- Replace this module with a PVIBH1B.

192-221

Description Input Signal [ ] Voting Mismatch, Local=[ ], Voted=[ ]

Possible Cause

- There is a voter disagreement between the R, S, and T I/O packs.
- The I/O pack is not seated on the terminal board correctly.
- The I/O pack has failed.

Solution

- Adjust the parameter **TMR_DiffLimt** or correct the cause of the difference.
- Re-seat the I/O pack to the terminal board.
- Replace the I/O pack.

17.6 TVBA Vibration Input

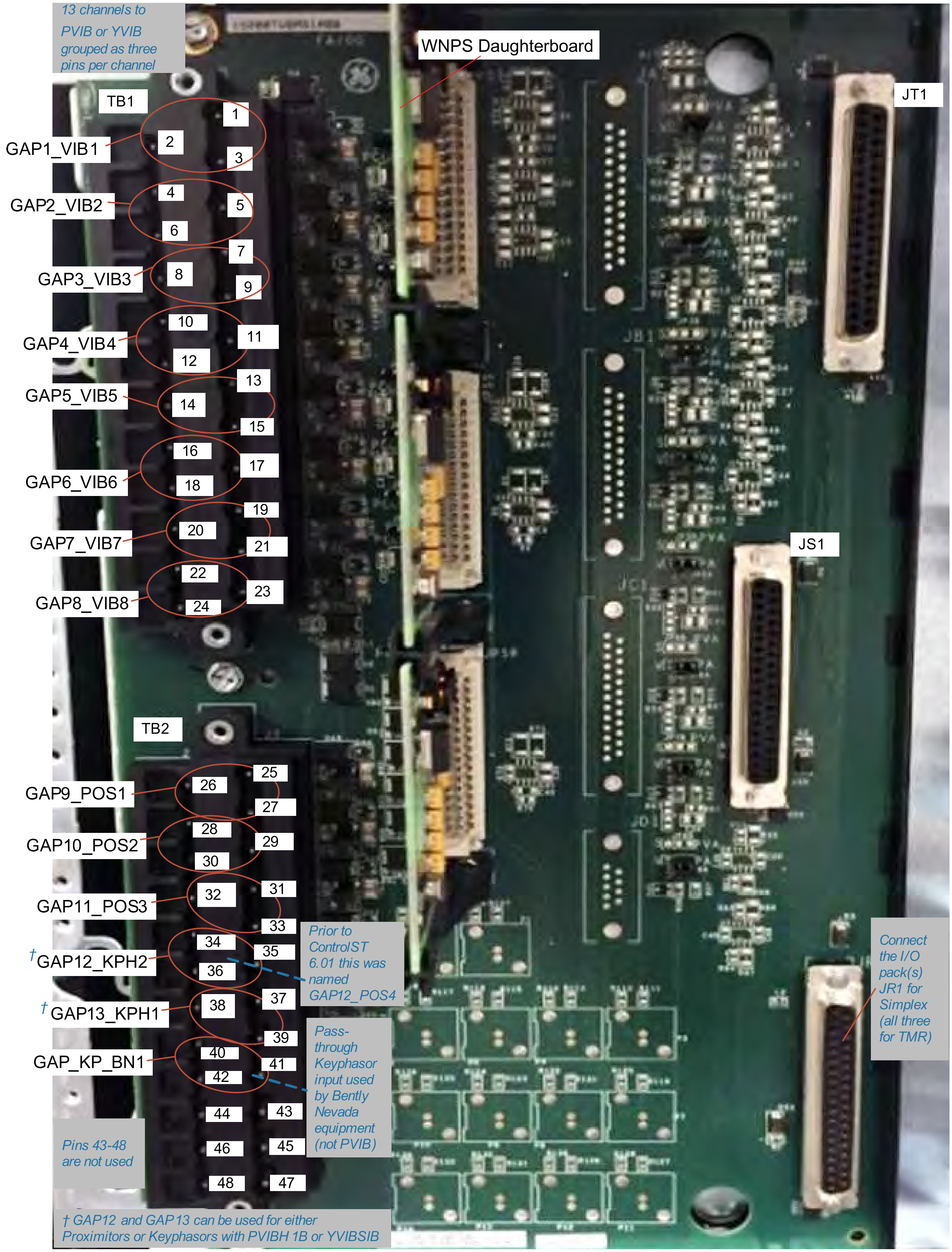
The Vibration Input (TVBA) terminal board acts as a signal interface board for the Mark VIe PVIB or Mark VIeS YVIB I/O packs. The TVBA provides a direct vibration interface to Eddy-current (position & velocity), seismic (velocity), Velomitors (velocity) and accelerometers with integrated outputs (velocity) sensors. The TVBA also provides a dynamic pressure interface to charge amplifiers.

The terminal board input signals entering through the two 24-point screw terminals are protected against high voltages due to electrical disturbances via transient suppression. Powering the different sensors and detecting open circuits is accomplished by jumpers JPxA located to the left of the 37-pin I/O pack connectors and JPxC located to the right of the 24-point screw terminals.

The input signals are passed on to the I/O packs through 37-pin connectors located on the right side of the TVBA. The TVBA can be used for either simplex or TMR applications. TMR applications fan the signal to three I/O packs.

Buffered outputs of the input signals are provided to 9 and 25 pin DIN connectors to feed the Bently Nevada***** 3xxx monitoring system. A bayonet nut connection (BNC) connection for each buffered output is also included to feed third party monitoring equipment. To configure the output buffers for the proper sensor, use the JPxB jumpers that are located to the left of the 37-pin I/O pack connectors. The I/O pack inputs channels 1 through 13 and channels 1 through 14 are routed to buffered outputs for external use. These BNC and DIN connectors, and the jumper are only available on TVBAH2A, TVBAH2B, TVBAS2A, and TVBAS2B.

Power is obtained from customer supplied +28 V through the I/O pack. The -28 V power needed to supply the Bently Nevada sensors is from the WNPS daughter board for the TVBAH#A terminal boards only, one used for simplex and three used for TMR configurations. The removable daughterboard(s) convert the sourced +28 V power to -28 V power.



TVBAH1A Terminal Board

TVBAH2B Terminal Board

17.6.1 TVBA Compatibility and Attributes

The I/O pack and the negative power supply daughterboard (WNPS) work with the TVBA terminal boards to provide all sensor input checks. The following terminal board revisions work with the I/O pack.

Terminal Board	Compatibility	Buffered Output Circuits, DIN, and BNC Connectors	WNPS Connectors	IEC61508 Safety Certified	Allows Mixing of I/O Pack Revisions†
TVBAH1A	PVIBH1A and PVIBH1B	No	Yes	No	Yes
TVBAH2A	PVIBH1A and PVIBH1B	Yes	Yes	No	Yes
TVBAH1B‡	PVIBH1A and PVIBH1B	No	No	No	Yes
TVBAH2B‡	PVIBH1A and PVIBH1B	Yes	No	No	Yes
TVBAS1A	YVIBS1A and YVIBS1B	No	Yes	Yes	No
TVBAS2A	YVIBS1A and YVIBS1B	Yes	Yes	Yes	No
TVBAS2B‡	YVIBS1A and YVIBS1B	Yes	No	Yes	No

†Mixing I/O pack revisions on a TMR module does not allow for Enhanced mode of operation.

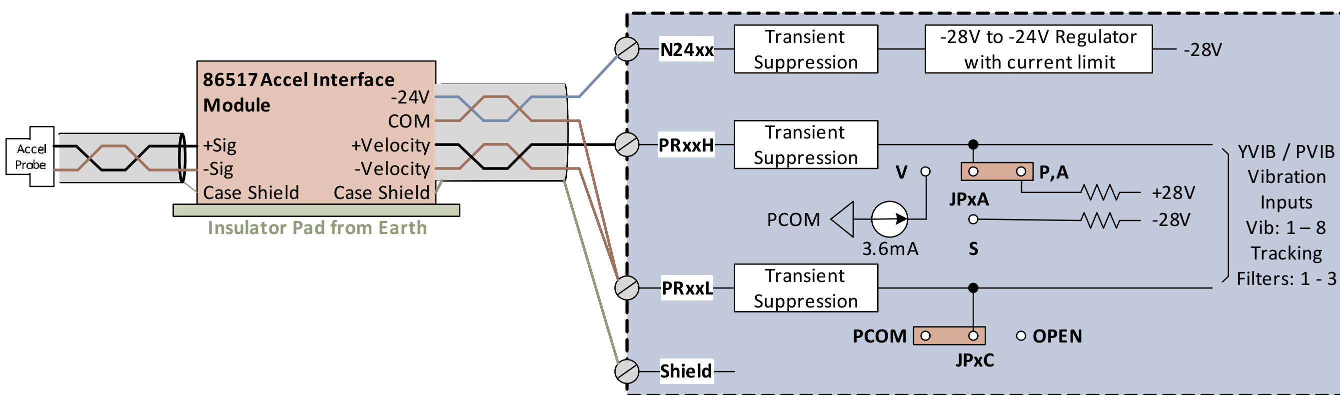
‡N28 power is generated internally to TVBAH#B and TVBAS2B.

17.6.2 TVBA Installation, Operation, and Jumper Configuration

The TVBA accepts 14 sensor inputs that are wired directly to two 24-point I/O terminal blocks. Each block is held down with two screws accepting up to #12 AWG wires. A shield termination attachment point is located adjacent to each terminal block. The I/O pack can only process 13 of the 14 channels. The 14th channel is forwarded to the buffered output stage for use by the Bently Nevada equipment (with TVBAH2A, H2B, S2A, or S2B).

17.6.2.1 Accelerometers with Integrated Outputs

The TVBA supports accelerometers with integrated outputs on channels 1, 2 and 3 only when the Tracking filters are required. If broadband rms vibration is all that is required, then all eight channels are available to use. For example, Oil & Gas LM1600, LM2500 or LM6000 gas turbine applications use the Bently Nevada 86517 sensor. The 86517 is powered by -24 V and the velocity output is connected to the vibration inputs: PRxxH and PRxxL. Tie the shield on the Mark VIe end and leave the shield open on the sensor side preventing ground loops.

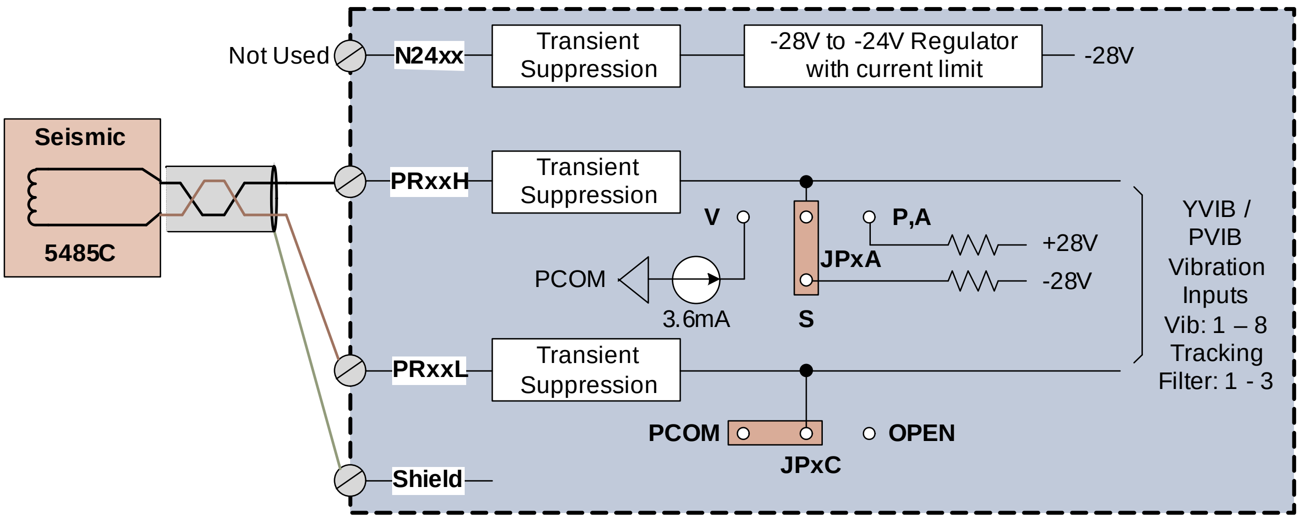


The IO variable name, VIBx

JPxA jumper is in the “P,A” position providing a +28 V weak pull-up for sensor failure detection and the JPxC jumper is in the “PCOM” position to provide a closed circuit for the -28 V power applied to the sensor through the WNPS -28 V daughterboard for TVBAH#A or TVBAS#A terminal boards only. JPxB is set in the 'PVA' position (for H2A, H2B / S2A, S2B boards).

17.6.2.2 Seismic Sensors

The TVBA can input a maximum of eight seismic sensor inputs on channels 1 through 8. Seismic sensors are usually moving-coil type probes that require no power. The heavy-duty gas turbines (HDGTs) use the Metrix 5235B, 5475C or 5485C sensors on the bearing housings to measure the non-rotating vibration. The Metrix 5485C or similar sensor's output is connected directly to the PRxxH and PRxxL inputs. The seismic output is centered at 0 V dc. With a sensitivity range of 100 to 200 mV/in/sec. Tie the shield on the Mark VIe end and leave the shield open on the sensor side.

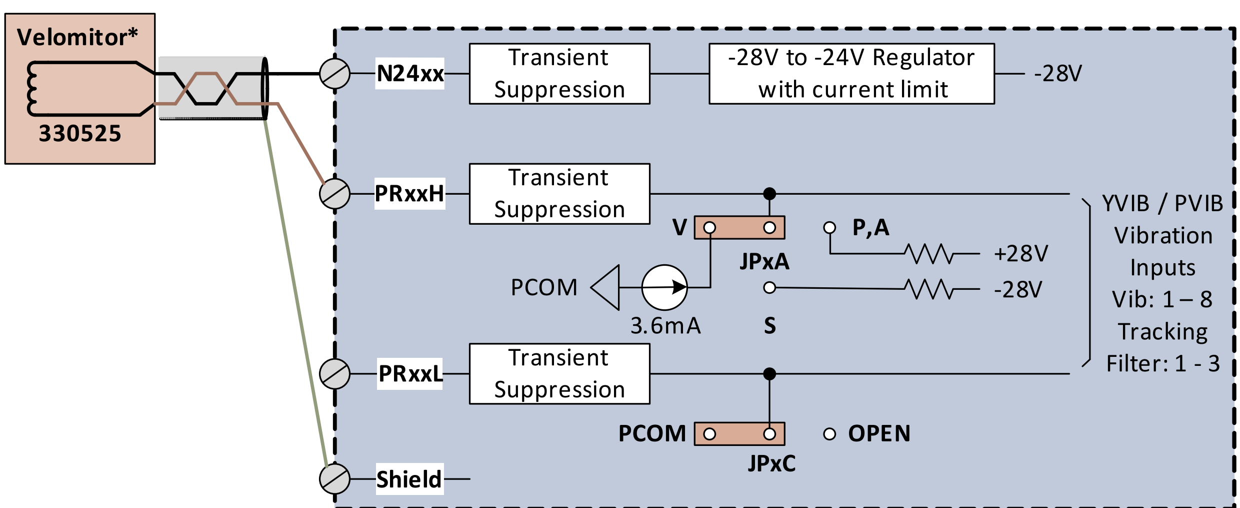


JPxA jumper is in the 'S' position providing a -28 V weak pull-down for sensor failure detection and the JPxC jumper is in the 'PCOM' position to allow the corresponding buffered output to be scaled the same as the signal input.

JPxB is set in the 'S' position (for H2A, H2B / S2A, S2B boards).

17.6.2.3 Velomitor Sensors

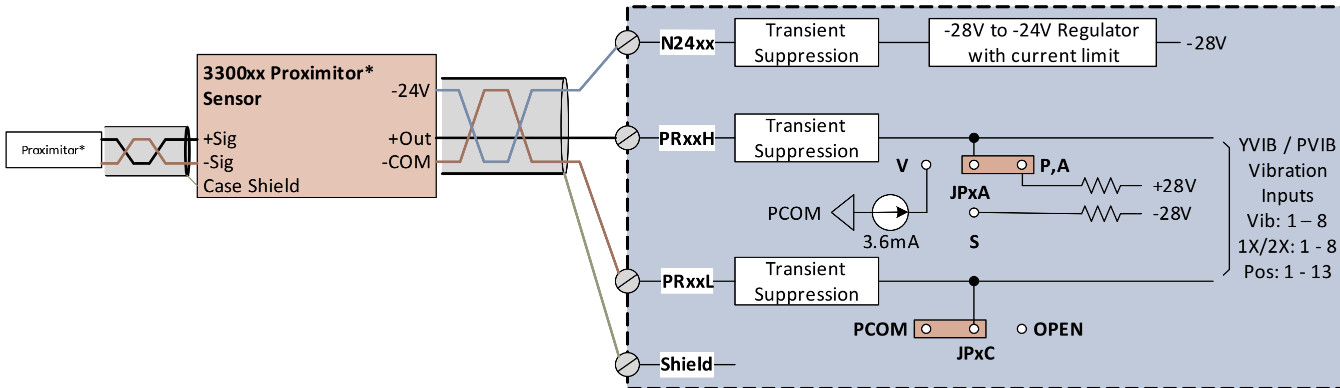
The TVBA accepts a maximum of eight Velomitor sensors on channels 1 through 8. The Bently Nevada 190501 and 3305xx product line are a constant-current device requiring a -24 V power sourced from the WNPS power supply daughterboard(s) for TVBAH#A and TVBAS#A terminal boards only to drive the current. The two-wire termination of this sensor uses the N24xx and PRxxH screw points. The velocity or AC content of the Velomitor is riding on top of a negative DC bias in the -8 to -12 V dc range generated by the sensor. The shield is tied to chassis at the control end and left open on the sensor side to prevent circulating ground currents. The sensor device usually has a sensitivity of 100 mV/in/sec.



JPxA jumper is in the ‘V’ position providing a 3.6 mA current diode driven by a -24 V source, N24xx. The JPxC jumper is in the ‘PCOM’ position providing a return for the -24 V power source. JPxB is set in the 'PVA' position (for H2A, H2B / S2A, S2B boards).

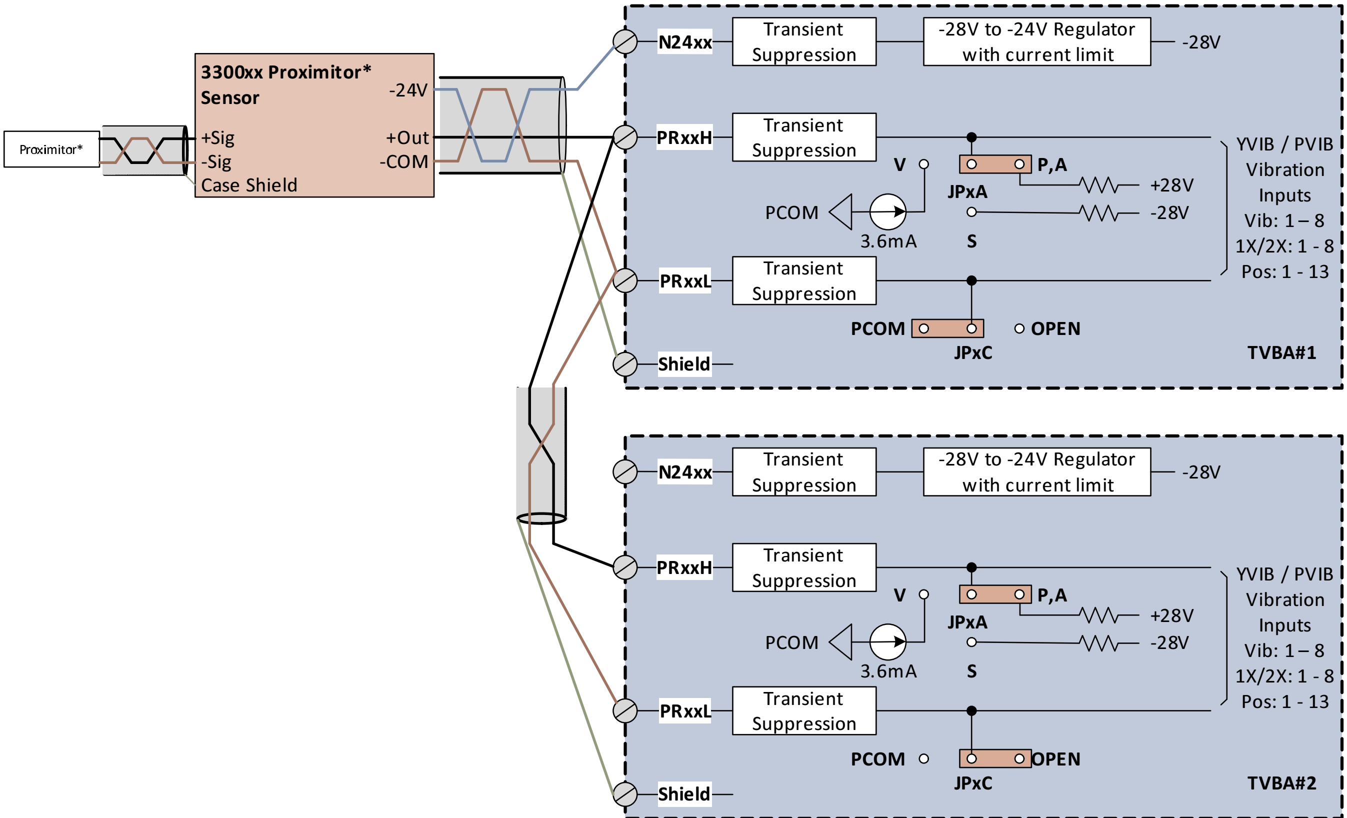
17.6.2.4 Eddy-current or Proximitor Sensors for Position and Velocity

The TVBA provides a maximum of 13 channels to connect an Eddy-current sensor to the terminal blocks. Channels 1 through 8 can condition both position and velocity information from the sensor and channels 9 through 13 can input only position information between the terminal screws PRxxH and PRxxL. The Bently Nevada Proximitor 3300 family and Metrix Model 5533 are -24 V powered devices with the output signal proportional to the gap between the rotating shaft and the head of the probe. Velocity information is extracted from the AC content riding on top of the DC gap signal. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.



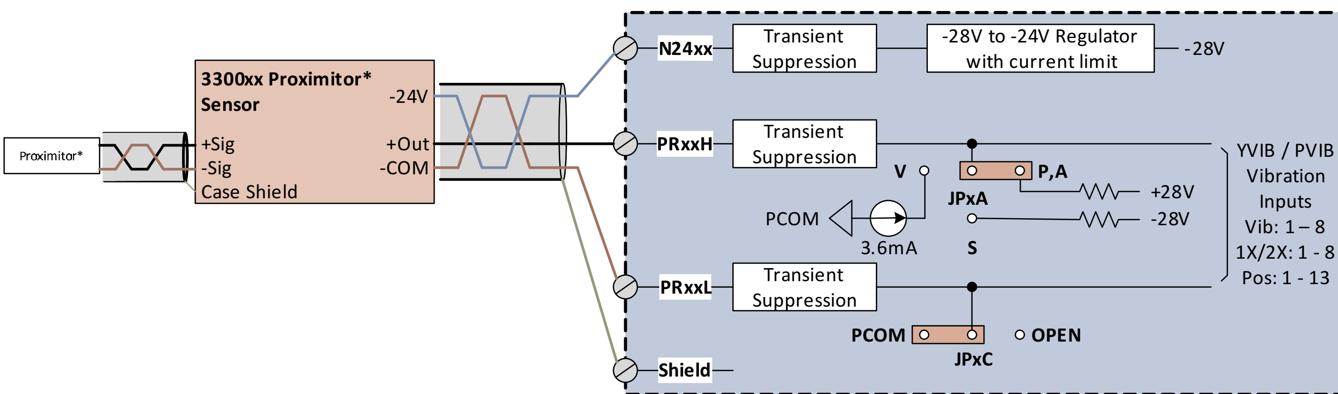
JPxA jumper is in the ‘P,A’ position providing a +28 V weak pull-up for sensor failure detection and the JPxC jumper is in the ‘PCOM’ position to provide a return for the -24 V power supply sourced from the -28 V WNPS daughter-boards on the TVBAH#A and TVBAS#A terminal boards only, and a low-side for the signal output of the sensor. JPxB is set in the 'PVA' position (for H2A, H2B / S2A, S2B boards).

The user can parallel the eddy-current signal to a second TVBA, but the N24xx power output would not be used from the second TVBA and JPxC would be in the “OPEN” position.



17.6.2.5 Eddy-current or Proximitor Sensors for Keyphasor

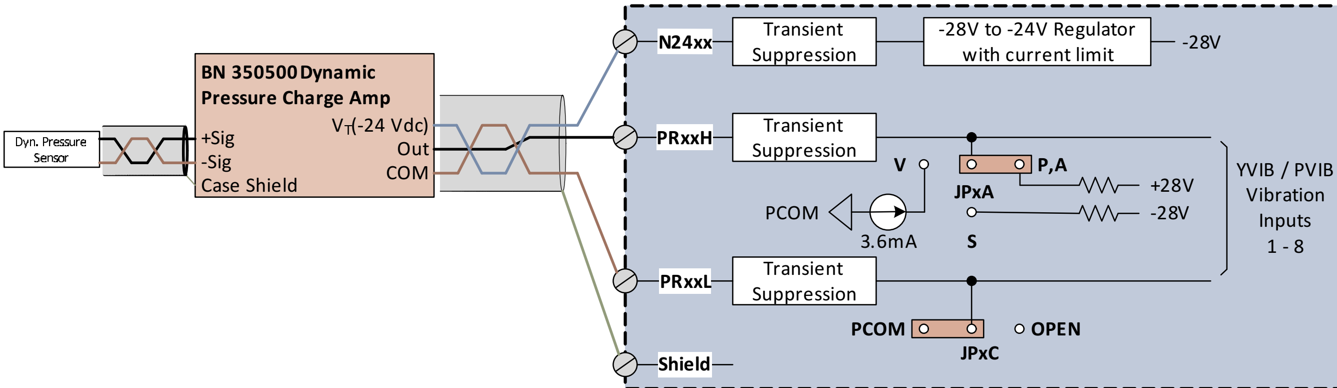
The TVBA provides channels 12 and 13 to connect an Eddy-current or Proximitor sensor used for a Keyphasor function. The Bently Nevada Proximitor 3300 family or Metrix Model 5533 are -24 V powered devices with the output signal proportional to the gap between the rotating shaft and the head of the probe. Velocity information is extracted from the AC content riding on top of the DC gap signal. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.



JPxA jumper is in the ‘P,A’ position providing a +28 V weak pull-up for sensor failure detection and the JPxC jumper is in the ‘PCOM’ position to provide a return for the -24 V power supply sourced from the -28 V WNPS daughter-boards for the TVBAH#A and TVBAS#A terminal boards only, and a low-side for the signal output of the sensor. JPxB is set in the 'PVA' position (for H2A, H2B / S2A, S2B boards).

17.6.2.6 Bently Nevada 350500 Charge Amplifier

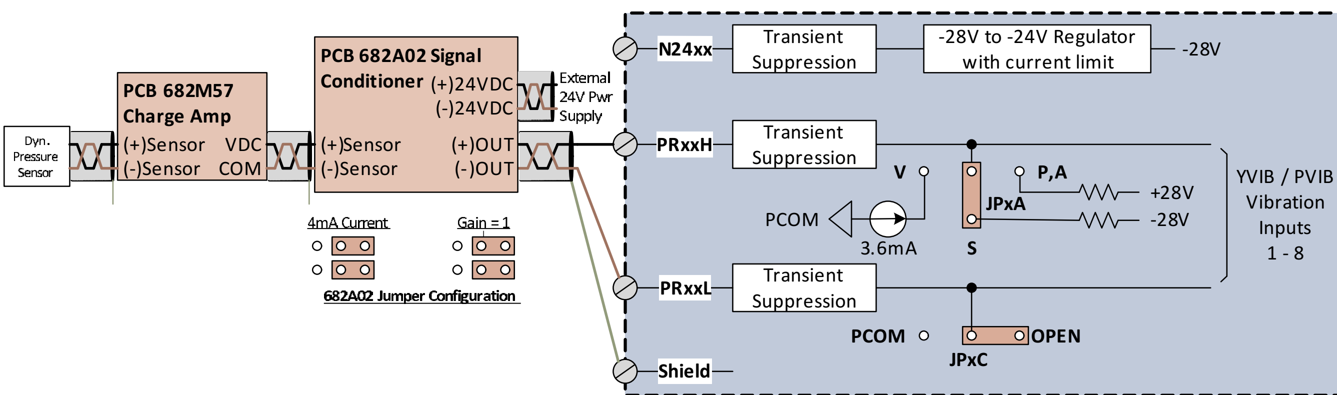
The TVBA vibration terminal board also supports the Bently Nevada 350500 charge amplifier used with dynamic-pressure sensors examining the combustion dynamics of the LM2500 DLE gas turbines. The TVBA can input combustion dynamics information on channels 1 through 8 where the I/O pack can provide band-passed, root-mean-squared (r.m.s.) dynamic-pressure data for the LM2500 DLE combustion. The charge amplifier is powered with -24 V and the AC dynamics output is riding on top of a negative DC bias signal that is used by the I/O module for signal health. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.



JPxA jumper is in the 'P,A' position providing a +28 V weak pull-up. The JPxC jumper is in the 'PCOM' position to provide a return for the -24 V power supply sourced from the -28 V WNPS daughter-boards on the TVBAH#A and TVBAS#A terminal boards only, and a low-side for the signal output of the charge amplifier. JPxB is set in the 'PVA' position (for H2A, H2B / S2A, S2B boards).

17.6.2.7 PCB Piezotronics 682A02 Signal Conditioner

The PCB 682A02 signal conditioner can be connected to the TVBA terminal board for channels 1 through 8. The PCB system which is used with the Mark VIe PAMC combustion dynamics monitoring I/O is powered with +24 V instead of -24 V as applied to the Bently Nevada systems. The 682A02 signal conditioner is powered externally by a +24 V source. The 682A02 converts the 24 V power to a 4mA constant-current source to power the PCB 682M57 charge amplifier. The 682A02 'Out' connects to the TVBA PRxxH/L terminal block screws. The AC dynamic pressure signal is riding on top of a 10 – 13 V dc bias voltage used to determine the health of the combustion sensing system. The shield is tied to chassis at the control end and left open on the sensor end to prevent circulating ground currents.



JPxA jumper is in the 'S' position providing a -28 V weak pull-down. The JPxC jumper is in the 'OPEN' position to provide a true differential input eliminating ground current loops with the external power supply. JPxB is set in the 'S' position (for H2A, H2B / S2A, S2B boards).

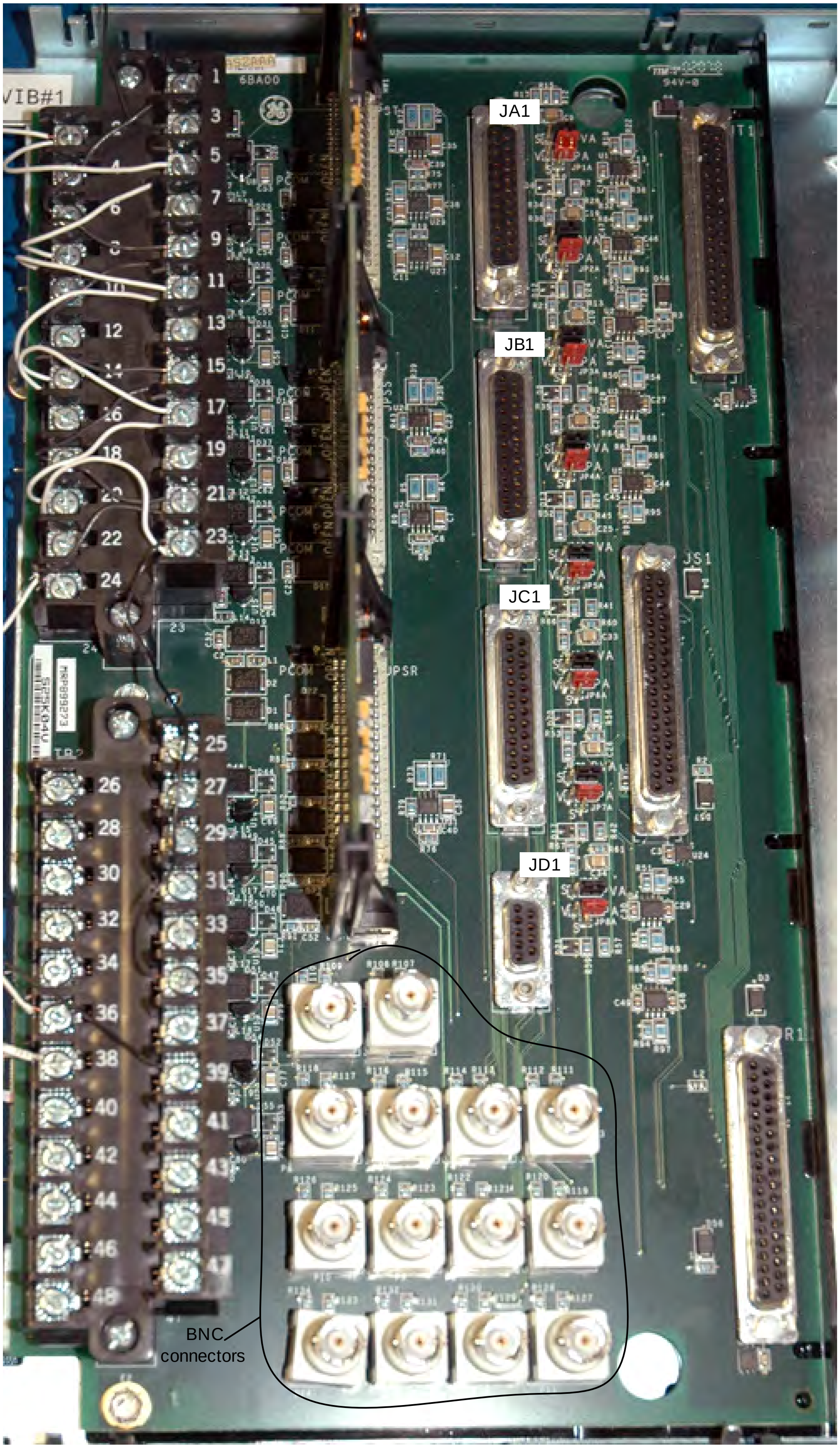
17.6.2.8 Customer Terminal Points

Channel	Signal Name	Pin #	Description
GAP1_VIB1	N24V01	1	-24 V power supply output for channel #1
	PR01H	2	Input #1 signal high side to I/O pack and buffered output
	PR01L	3	Input #1 signal low side to I/O pack and buffered output
GAP2_VIB2	N24V02	4	-24 V power supply output for channel #2
	PR02H	5	Input #2 signal high side to I/O pack and buffered output
	PR03L	6	Input #2 signal low side to I/O pack and buffered output
GAP3_VIB3	N24V03	7	-24 V power supply output for channel #3
	PR03H	8	Input #3 signal high side to I/O pack and buffered output
	PR03L	9	Input #3 signal low side to I/O pack and buffered output
GAP4_VIB4	N24V04	10	-24 V power supply output for channel #4
	PR04H	11	Input #4 signal high side to I/O pack and buffered output
	PR04L	12	Input #4 signal low side to I/O pack and buffered output
GAP5_VIB5	N24V05	13	-24 V power supply output for channel #5
	PR05H	14	Input #5 signal high side to I/O pack and buffered output
	PR05L	15	Input #5 signal low side to I/O pack and buffered output
GAP6_VIB6	N24V06	16	-24 V power supply output for channel #6
	PR06H	17	Input #6 signal high side to I/O pack and buffered output
	PR06L	18	Input #6 signal low side to I/O pack and buffered output
GAP7_VIB7	N24V07	19	-24 V power supply output for channel #7
	PR07H	20	Input #7 signal high side to I/O pack and buffered output
	PR07L	21	Input #7 signal low side to I/O pack and buffered output
GAP8_VIB8	N24V08	22	-24 V power supply output for channel #8
	PR08H	23	Input #8 signal high side to I/O pack and buffered output
	PR08L	24	Input #8 signal low side to I/O pack and buffered output
GAP9_POS1	N24V09	25	-24 V power supply output for channel #9
	PR09H	26	Input #9 signal high side to I/O pack and buffered output
	PR09L	27	Input #9 signal low side to I/O pack and buffered output
GAP10_POS2	N24V10	28	-24 V power supply output for channel #10
	PR10H	29	Input #10 signal high side to I/O pack and buffered output
	PR10L	30	Input #10 signal low side to I/O pack and buffered output
GAP11_POS3	N24V11	31	-24 V power supply output for channel #11
	PR11H	32	Input #11 signal high side to I/O pack and buffered output
	PR11L	33	Input #11 signal low side to I/O pack and buffered output
GAP12_KPH2	N24V12	34	-24 V power supply output for channel #12
	PR12H	35	Input #12 signal high side to I/O pack and buffered output
	PR12L	36	Input #12 signal low side to I/O pack and buffered output
GAP13_KPH1	N24V13	37	-24 V power supply output for channel #13
	PR13H	38	Input #13 signal high side to I/O pack and buffered output
	PR13L	39	Input #13 signal low side to I/O pack and buffered output
GAP_KP_BN1	N24V14	40	-24 V power supply output for channel #14
	PR14H	41	Input #14 signal high side to buffered output ONLY
	PR14L	42	Input #14 signal low side to buffered output ONLY
		43 - 48	No connections

17.6.2.9 TVBAH2A or S2A Buffered Outputs

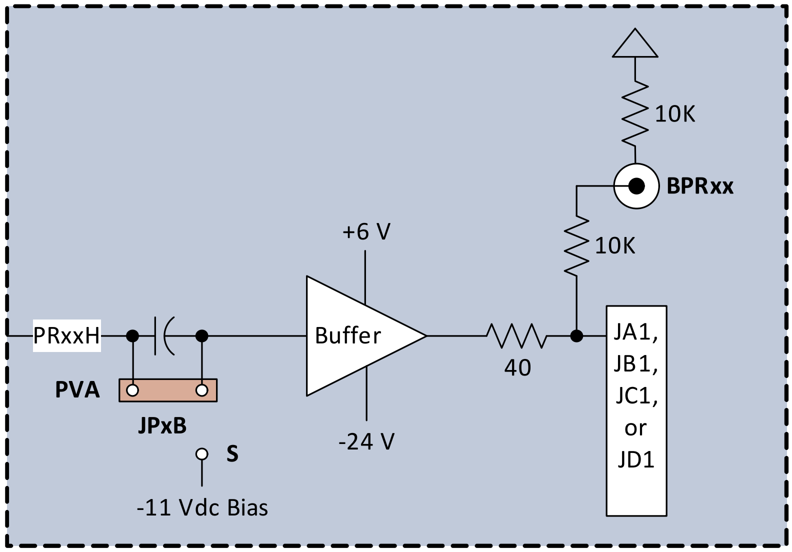
With the TVBAH2A or S2A, each channel provides additional outputs other than the standard 37-pin connection. The signal output is buffered from the signal used by the I/O module to prevent any corruption caused by third-party hardware connected to the output.

Each channel is output on a BNC connector with 10 kilo-ohms between the buffer out and BNC signal pin and 10 kilo-ohms isolation between signal low and the Mark VIe control power common, PCOM.



TVBA_2A Terminal Board

Each channel is also output through a 25-pin or 9-pin connectors JA1, JB1, JC1 and JD1 designed to interface with the Bently Nevada 3500 monitoring system. The TVBA buffered source impedance is approximately 40 ohms.



Jumper, JPxB

The jumper, JPxB where x = 1 through 14 is used to configure the output for either seismic outputs with a -11 V dc bias voltage added to the velocity signal or positioned to output Proximitor, Velomitor or accelerometer with integrated output signals.

17.6.2.10 Bently Nevada Buffered DB Connector Points

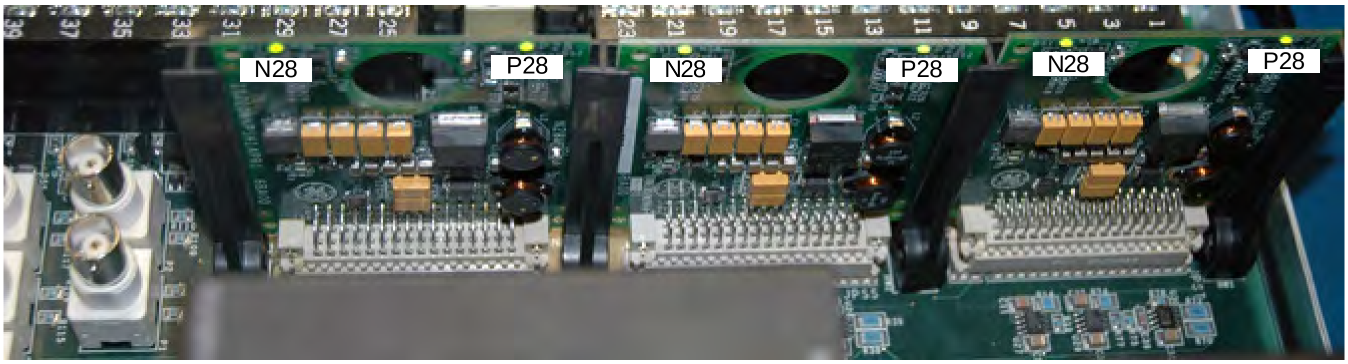
Signal Name	Connector	Pin #
BPR01	JA1	3
PCOM	JA1	2
BPR02	JA1	7
PCOM	JA1	6
BPR03	JA1	11
PCOM	JA1	10
BPR04	JA1	23
PCOM	JA1	24
BPR05	JB1	3
PCOM	JB1	2
BPR06	JB1	7
PCOM	JB1	6
BPR07	JB1	11
PCOM	JB1	10
BPR08	JB1	23
PCOM	JB1	24
BPR09	JC1	3
PCOM	JC1	2
BPR10	JC1	7
PCOM	JC1	6
BPR11	JC1	11
PCOM	JC1	10
BPR12	JC1	23
PCOM	JC1	24
BPR13	JD1	1
PCOM	JD1	3

Public Information

Signal Name	Connector	Pin #
BPR14	JD1	5
PCOM	JD1	9

17.6.2.11 WNPS Power Supply Daughterboard

Three redundant external power supplies provide the power for the TVBAH#A and TVBAS#A only. The WNPS function is integrated into the TVBAH#B and TVBAS2B terminal boards. If one power supply goes down, the offline power supply can be replaced without bringing down the terminal board and sensor power. To maintain this feature, the TVBA has three removable daughterboards to provide the +28 Vdc to -28 V dc power conversion. The daughterboards can be removed while the TVBA is online by disconnecting the I/O pack power (R, S or T), and removing the WNPS. Indicator LEDs display the status of the P28 power in and the N28 power out.



The WNPS uses the corresponding channel (R, S, or T) 28 V bus to manufacture the required power for the vibration probes and on any board chips requiring power. A monitor feed for each -28 V supply should be fed back to the I/O pack for monitoring. The TVBA combines three -28 sources using diodes from the daughterboards to create the TVBA N28 bus. A TVBA configured with the TMR daughterboards provide enough current to supply 14 Proximitors at 18 mA, 14 buffered outputs at 12 mA, with one channel shorted at approximately 200 mA for a total of 540 mA without failure. Current sharing by the supplies make this condition possible. A TVBA with a single WNPS is not expected to handle this condition.

17.6.3 TVBA Specifications

Requirement	Limits
Input Options	
Number of channels supporting position or gap inputs	13
Number of channels supporting velocity or dynamic pressure sensor inputs	8
Number of channels supporting Key Phasor inputs	2
Sensors Supported	1) Eddy-current or Proximitor
	2) Accelerometer with integrated output
	3) Seismic
	4) Velomitor
	5) Charge Amplifier
Sensor Power Options	
Number of negative 24 V dc, N24 outputs to power sensors	14
N24 Nominal Voltage	-24.5 V dc
	(-23 to -26) V dc
N24 maximum current	12 mA
Buffered Outputs	
Number of buffered outputs	14
Buffer Gain Accuracy	+/-0.1%
DB9 and DB25 Connector Output Load requirements to achieve less than 10% overshoot	1500 ohms minimum
	1000 pF maximum
BNC Connector Load requirements to achieve less than 10% overshoot	2 Mohm minimum
	1000 pF maximum
WNPS Negative Power Supply Daughter Board	
Number of WNPS boards used on TVBA to providing N24 power from redundant P28 power sources R, S & T.	3
Nominal Output Voltage	-28 V dc
	(-26.6 to -29.4) V dc
Output Voltage Ripple	280 mV pk
Maximum Output Current	400 mA
Terminal Screws	
Wiring Sizes	22 to 12 AWG
Torque	9.6 in-lb (1.085 N-m)

17.6.4 Diagnostics

The TVBA terminal board provides weak pull-up and pull-down circuits configured based on the jumper position to allow the Vibration I/O Pack (PVIB or YVIB) to detect an open circuit. The I/O pack creates the diagnostic alarm (fault) if any one of the inputs has an out-of-range voltage.

Each connector between the TVBA and the I/O pack has its own ID device that is interrogated by the Vibration pack. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the R, S and T connector location. When this chip is read by the I/O pack and a mismatch is encountered, a hardware incompatibility fault is created.

Public Information

Notes