GEI-100560

GE Industrial Systems

Board Specification

VTUR Turbine Control Board

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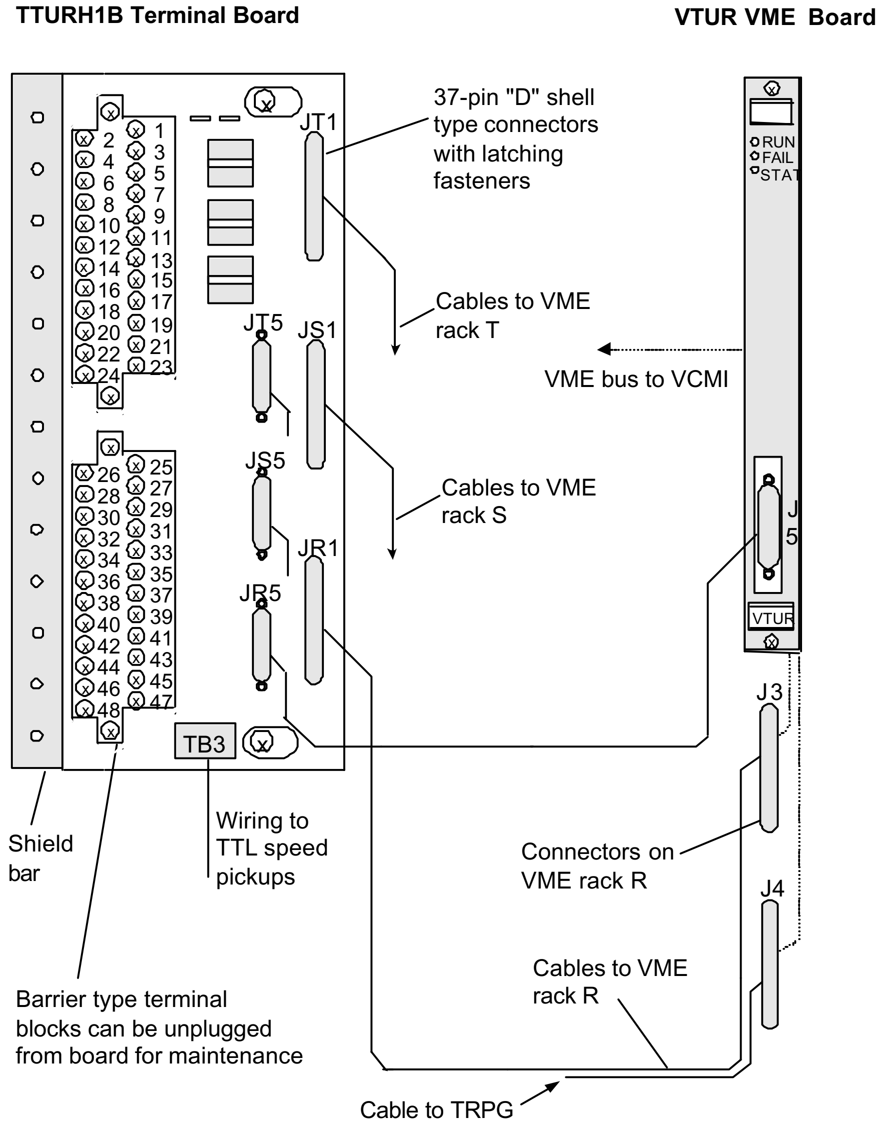
Functional Description

The turbine control board, VTUR controls three primary overspeed trip solenoids and automatic synchronizing. It also interfaces to four passive pulse rate devices, and monitors shaft voltage and current. The speed signal cable to VTUR uses the J5 plug on the front of the board, and the other signals use the J3 connector on the VME rack. Terminal board TTUR provides simplex signals through the JR connector, and fans out TMR signals to the JR, JS, and JT connectors. J4 on the VME rack connects to the TRPG terminal board described in the Primary Trip section.

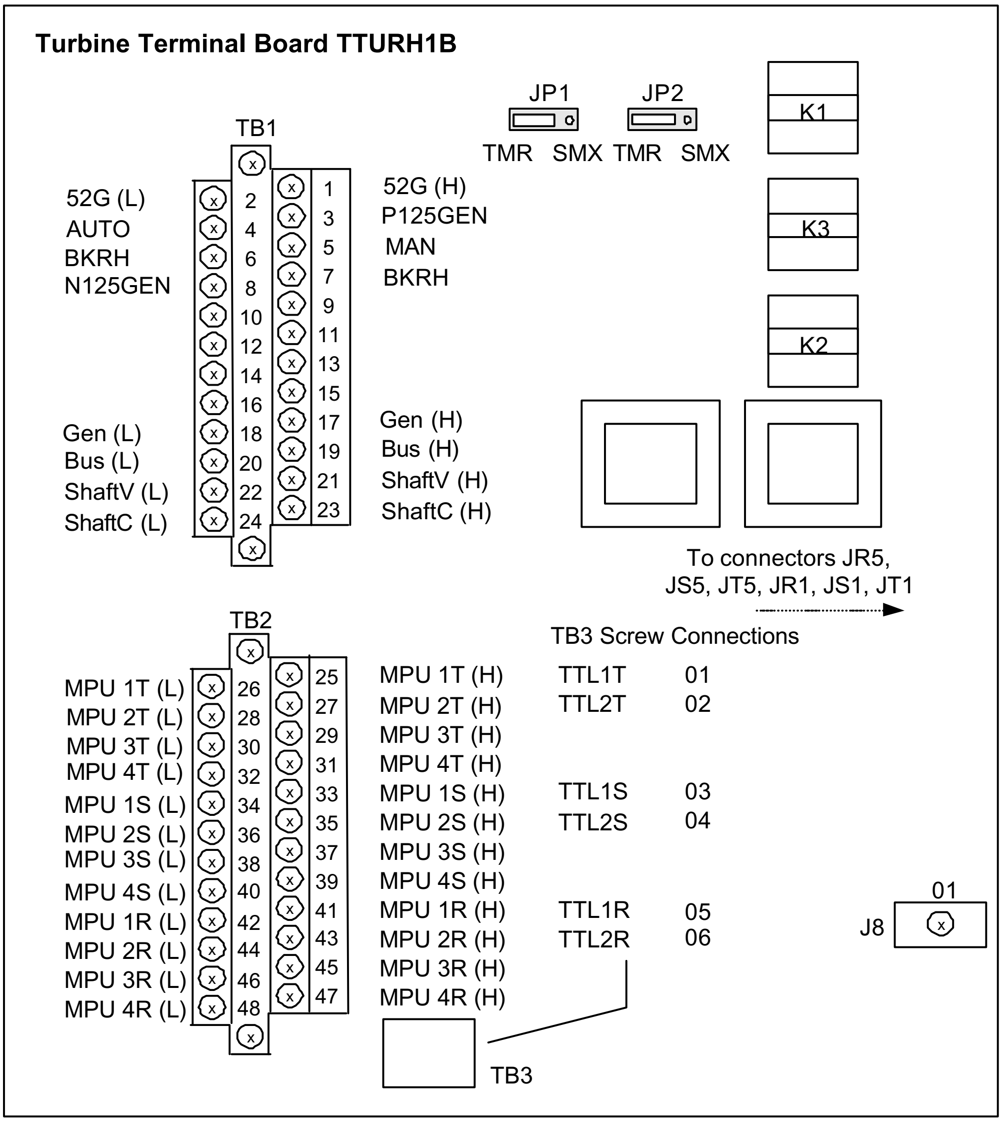
A two-slot version of this board (VTURH2) is available for driving six trip solenoids using two TRPG boards. VTURH2 only accepts eight flame detectors.



Turbine Control Terminal Board, Processor Board, and Cabling

Installation

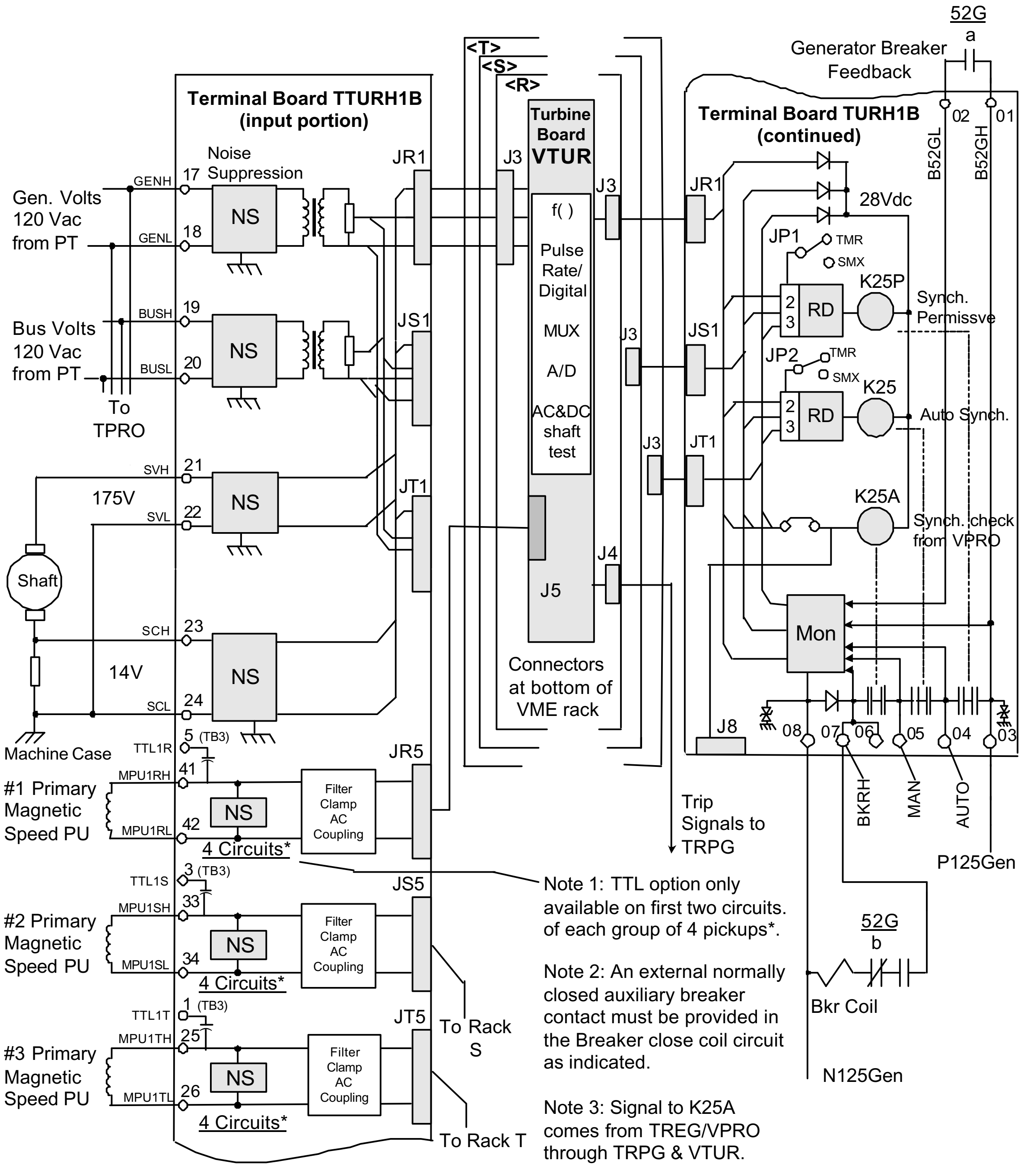
Magnetic pick ups, shaft pick ups, potential transformers, and breaker relays are wired to two I/O terminal blocks on TTUR. Each block is held down with two screws and has 24 terminals accepting up to #12 AWG wires. A shield termination strip attached to chassis ground is located immediately to the left of each terminal block. Jumpers JP1 and JP2 select either SMX or TMR for relay drivers K25 and K25P. TB3 is for optional TTL connections to active speed pickups; these require an external power supply.



TTUR Terminal Board

All three relays have two normally open contacts in series with the breaker close coil.

In TMR applications all inputs fan to the three control racks. Control signals coming into TTUR from R, S, and T are voted before they actuate permissive relays K25 and K25P. Relay K25A is controlled by the VPRO and TREG boards.

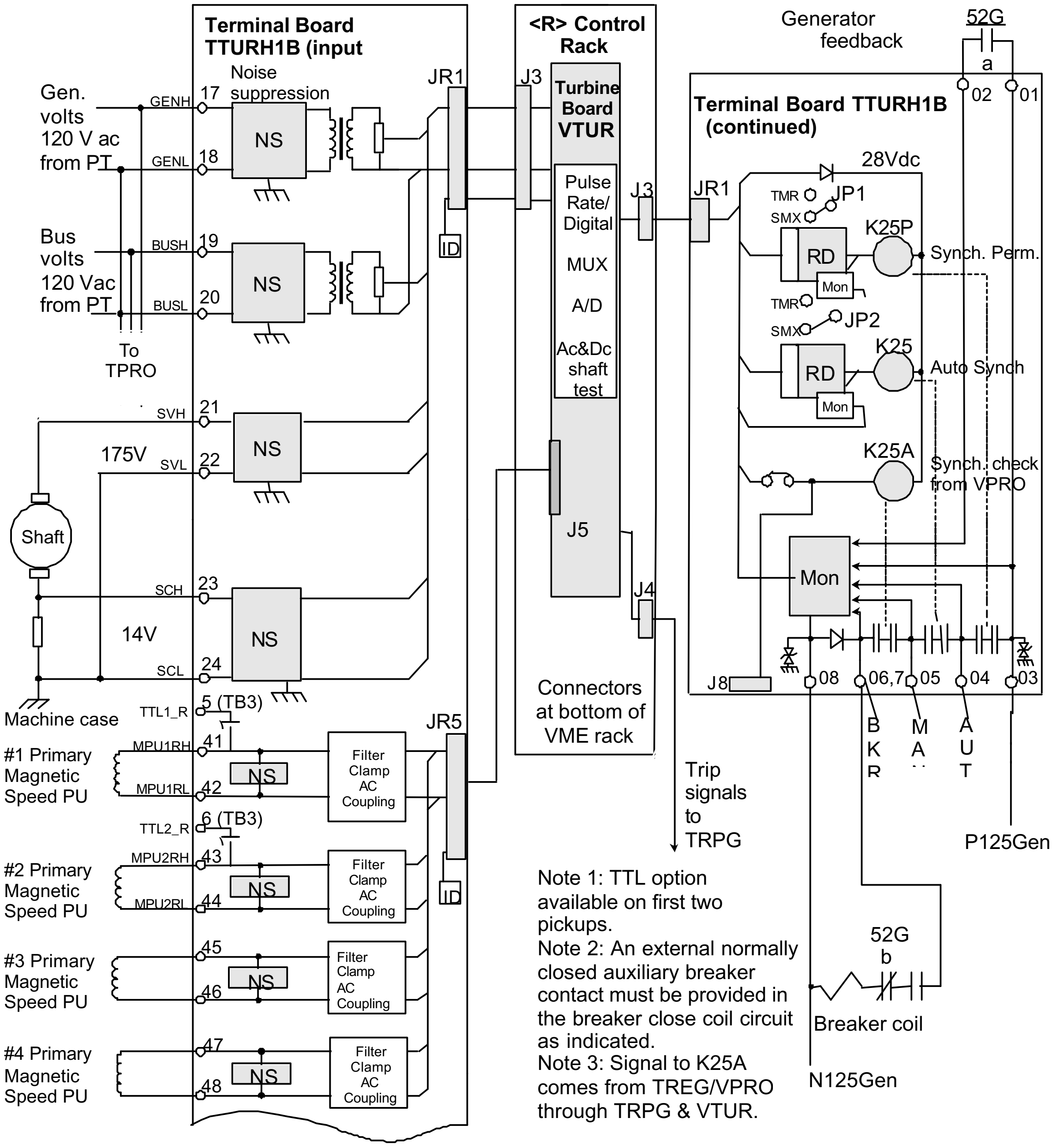


Turbine Control Inputs, Synchronizing, and Primary Trip Interface, TMR

Operation

Pulse rate to digital circuits are on the VTUR board. VTUR alarms high voltages and tests the integrity and continuity of the circuitry.

In the simplex application, up to four pulse rate signals may be used to measure turbine speed. Generator and bus voltages are brought into VTUR for automatic synchronizing in conjunction with the turbine controller and excitation system. TTUR has permissive generator synchronizing relays and controls the main breaker relay coil 52G. Shaft voltage is picked up with brushes and monitored along with the current to the machine case.



Turbine Control Inputs, Synchronizing, and Primary Trip Interface, Simplex

Features

The median speed signal is used for speed control and for the primary overspeed trip signal.

An interface is provided for four passive, magnetic speed inputs with a frequency range of 2 – 20,000 Hz. Using passive pickups on a 60-tooth wheel, circuit sensitivity allows detection of 2 rpm turning gear speed to determine if the turbine is stopped (zero speed). If automatic turning gear engagement is provided in the turbine control, this signal initiates turning gear operation.

The primary overspeed trip calculations are performed in the controller using algorithms similar to (but not the same as) those shown in the section on the VPRO Protection Module. The fast trip option used on gas turbines runs in VTUR and is described below.

A metal oxide varister (MOV) and a current limiting resistor are used in each circuit.

The normal primary overspeed trip is calculated in the controller and passed to the VTUR and then to the TRPG terminal board. TRPG contains magnetic relays for interface with the electrical trip devices (ETDs). TRPG works in conjunction with the TREG board to form the *Primary* and *Emergency* sides of the interface to the ETDs. Usually this applies to turbines which do not have a mechanical overspeed bolt and require a separate emergency overspeed (EOS) system. Three ETDs can be driven from each TRPG/TREG combination with the positive side of each solenoid connected to the TREG and the negative side connected to the TRPG.

Two different versions of the TRPG are available, with version 1 used for triple redundant (TMR) systems and version 2 used for Simplex systems. The only difference is that the TMR version has three voting relays per ETD circuit and the Simplex version has one relay per circuit. The VTUR board monitors the current flowing in its relay driver control line to determine its energize or de-energize vote/status of the relay coil. A normally closed contact from each relay on the TRPG board is monitored by the diagnostics to determine its proper operation.

Bearings can be damaged by the flow of electrical current from the shaft to the case. This current can occur for several reasons.

- A static voltage can be caused by droplets of water being thrown off the last stage buckets in a steam turbine. This voltage will build up until a discharge occurs through the bearing oil film.
- An ac ripple on the dc generator field can produce an ac voltage on the shaft with respect to ground through the capacitance of the field winding and insulation. Note that both of these sources are weak, so high impedance instrumentation is used to measure these voltages with respect to ground.
- A voltage may be generated between the ends of the generator shaft due to dis-symmetries in the generator magnetic circuits. If the insulated bearings on the generator shaft break down, the current will flow from one end of the shaft through the bearings and frame to the other end. Brushes can be used to discharge damaging voltage buildup, and a shunt should be used to monitor the current flow.

The turbine control continuously monitors the shaft to ground voltage and current, and alarms excessive levels. There is an ac test mode and a dc test mode. The ac test applies an ac voltage to test the integrity of the measuring circuit.

The dc test checks the continuity of the external circuit, including the brushes, turbine shaft, and the interconnecting wire.

Note The dc test is driven from the <R> controller only. If the <R> controller is down, this test cannot be run successfully.

Specifications

VTUR Board Specifications

Item	Specification
Number of inputs	TTUR: 12 passive speed pickups 1 shaft voltage and 1 shaft current measurement 1 generator and 1 bus voltage Generator breaker status contact VTUR: 4 passive speed pickups 1 shaft voltage and 1 current measurement 1 generator and 1 bus voltage Generator breaker status 8 flame detectors from first TRPG
Number of outputs	TTUR: Generator breaker coil, 5A at 125 V dc VTUR: Automatic synchronizing Primary trip solenoid interface, 3 outputs to TRPG Additional 3 trip outputs from second TRPG using VTURH2
Trip solenoids (TRPG)	Solenoids draw up to 1 A at 125 V dc and have a time constant of L/R = 0.1 sec.
Power supply voltage	TTUR: Nominal 125 V dc to breaker coil
MPU pulse rate range	2 Hz to 20 kHz
MPU pulse rate accuracy	0.05% of reading
MPU input circuit sensitivity	27 mV pk (detects 2 rpm speed)
Shaft voltage monitor	Signal is frequency of ± 5 V dc (0 – 1 MHz) pulses from 0 to 2,000 Hz
Shaft voltage wiring	Up to 300 m (984 ft), with maximum two-way cable resistance of 15 ohms
Shaft voltage dc test	Applies a 5 V dc source to test integrity of the external turbine circuit and measures dc current flow. Circuit computes a differential resistance between 0 and 150 ohms within ± 5 ohms and compares against shunt limit and brush limit. Readings above 50 ohms indicate a fault. Return signal is filtered to provide 40 dB of noise attenuation at 60 Hz.
Shaft voltage ac test	Applies a test voltage of 1 kHz to the input of the VTUR shaft voltage circuit (R module only). Shaft voltage monitor circuit on R, S, and T displays an offset of 1000 Hz from normal reading.
Shaft current input	Measures shaft current in amps ac (shunt voltage up to 0.1 V pp)
Generator and bus voltage sensors	Two single phase potential transformers, with secondary output supplying a nominal 115 V rms Each input has less than 3 VA of loading. Allowable voltage range for synch is 75 to 130 V rms. Each PT input is magnetically isolated with a 1,500 V rms barrier. Cable length can be up to 1,000 ft. of 18 AWG wiring.
Synchronizing measurements	Frequency accuracy 0.05% over 45 to 66 Hz range. Zero crossing of the inputs is monitored on the rising slope. Phase difference measurement is better than ± 1 degree.
Generator breaker circuits (synchronizing)	External circuits should have a voltage range within 20 to 140 V dc. The external circuit must include a NC breaker auxiliary contact to interrupt the current. Circuits are rated for NEMA class E creepage and clearance. 250 V dc applications require interposing relays.
Contact voltage sensing	20 V dc indicates high and 6 V dc indicates low. Each circuit is optically isolated and filtered for 4 ms.

Diagnostics

Diagnostic information includes feedback from the solenoid relay driver and contact, high flame detector voltage, slow synch check relay, slow auto synch relay, and locked up K25 relay. If any one of the signals goes unhealthy, a composite diagnostic alarm L3DIAG_VTUR occurs. The diagnostic signals can be individually latched and then reset with the RESET_DIA signal if they go healthy.

Terminal board connectors JR1, JS1, JT1, JR5, JS5, JT5 have their own ID device which is interrogated by the I/O board. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and plug location.

Automatic Synchronizing

All synchronizing connections are located on the TTUR terminal board. The generator and bus voltages are supplied by two, single phase, potential transformers (PTs) with a fused secondary output supplying a nominal 115 V rms. Measurement accuracy between the zero crossing for the bus and generator voltage circuits is 1 degree.

Turbine speed is matched against the bus frequency, and the generator and bus voltages are matched by adjusting the generator field excitation voltage from commands sent between the turbine controller and the EX2000 over the Unit Data Highway (UDH). A command is given to close the breaker when all permissives are satisfied, and the breaker is predicted to close within the calculated phase/slip window. Feedback of the actual breaker closing time is provided by a 52G/a contact from the generator breaker (not an auxiliary relay) to update the data base. An internal K25A synch check relay is provided on the TTUR; the independent backup phase/slip calculation for this relay is performed in the <P> Protection Module. Diagnostics monitor the relay coil and contact closures to determine if the relay properly energizes or de-energizes upon command.

Synchronizing Modes

There are three basic synchronizing modes. Traditionally, these modes are selected from a generator panel mounted selector switch:

- **Off** The breaker will not be closed by the Mark VI control. The check relay will not pickup.
- **Manual** The operator initiates breaker close, which is still subject to the K25A Synch Check contacts driven by VPRO. The manual close is initiated from an external contact on the generator panel, normally connected in series with a *Synch Mode in Manual* contact.
- **Auto** The system will automatically match voltage and speed, and then close the breaker at the right time to hit top dead center on the synchroscope. All three of the following functions must agree for this closure to occur:

  K25A synch check relay, checks the allowable slip/phase window, from VPRO.

  K25 auto synch relay, provides precision synchronization, from VTUR.

  K25P synch sequence permissive, checks the turbine sequence status, from VTUR.

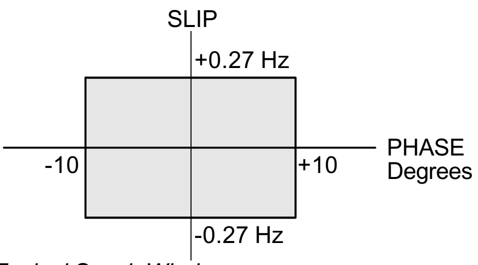
Details of the various checks are discussed in the following sections.

Synch Check

The K25A synch check function is based on phase lock loop techniques. The calculations for this function are done in the VPRO, but interfaces to the Breaker close circuit on the TTUR board. It performs limit checks against adjustable constants as follows:

- Generator undervoltage
- Bus undervoltage
- Voltage error
- Frequency error (slip), with a maximum value of 0.33 Hz, typically set to 0.27 Hz
- Phase error with a maximum value of 30 degrees, typically set to 10 degrees

In addition, synch check arms logic to enable the function and provides bypass logic for deadbus closure. The synch window is based on typical settings:

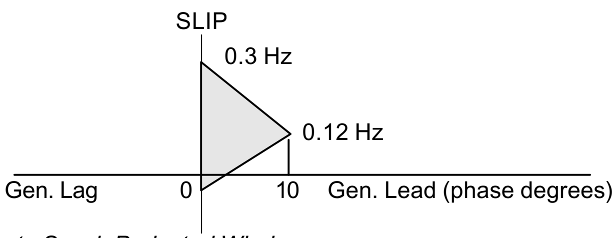


Typical Synch Window

Auto Synch

The Auto Synch K25 function uses zero voltage crossing techniques. It compensates for the breaker time delay, which is defined by two adjustable constants with logic selection between the two (for two breaker applications). The calculations, which are done on the VTUR board, include phase, slip, acceleration, and anticipated time lead for the breaker delay. Based on the measured breaker close time, the time delay parameter is adjusted, up to certain limits.

In addition, auto synch arms logic to enable the function and bypasses logic to provide for deadbus or manual closure. The auto synch projected synch window is where positive slip indicates the generator frequency is higher than the bus frequency.



Auto Synch Projected Window

The projected window is based on current phase, current slip, and current acceleration. The generator must currently be lagging and have been lagging for the last 10 consecutive cycles, and projected (anticipated) to be leading when the breaker actually reaches closure. Auto synch will not allow the breaker to close with negative slip; speed matching typically aims at around +0.12 Hz slip.

Synchronization Display

A special synchronization screen is available on the HMI with a real-time graphical phase display and control pushbuttons. The display items are listed in the following table.

Synchronizing Display Items

Synch Display	Description
Dynamic parameters	Voltages: Generator, bus, difference Frequencies: Generator, bus, slip (difference) Phase: Difference angle, degrees
Status indication	Mode: Synch OFF, MANUAL, AUTO Synch monitor: OFF, ON Dead bus breaker: Open/close Second breaker if applicable: Open/close Synch permissive: K25P Auto synch enabled Speed adjust: Raise/lower Voltage adjust: Raise/lower
Synch permissives	Generator voltage: OK/not OK Bus voltage: OK/not OK Generator frequency: OK/not OK Bus frequency: OK/not OK Difference volts: OK/not OK Difference frequency: OK/not OK Phase:K25 OK/not OK K25A OK/not OK
Limit constants	Upper and lower limits for the above permissives
Breaker performance	Diagnostics: Slow check relay Synch relay lockup Breaker #1 close time out of limits Breaker #2 close time out of limits Relay K25P trouble Breaker closing voltage (125 V dc) missing
Control pushbuttons	Synch monitor: ON, OFF Speed adjust: RAISE, LOWER Voltage adjust: RAISE, LOWER

Configuration

The following table defines the configuration choices and defaults. For details refer to GEH-6403, *Control System Toolbox for Configuring the Mark VI Turbine Controller.*

Typical VTUR Configuration

Parameter	Description	Choices
Configuration		
VTUR system limits	Select system limits	Enable, disable
SMredundancy	Select Simplex or TMR system	Simplex or TMR
AccelCalType	Select acceleration calculation type	Slow, medium, fast
FastTripType	Select Fast Trip algorithm	Unused, PR_Single, PR_Max
J3J5:IS200TTURH1A	TTUR connected to VTUR through J3 and J5	Connected, not connected
PulseRate1	Pulse rate input 1 - board point	Point edit (input FLOAT)
PRType	Select Speed or Flow type input	Unused, speed, flow, Speed_LM
PRScale	Select pulses per revolution	0 to 1,000
SysLim1Enable	Select system limit 1	Enable, disable
SysLim1Latch	Select whether alarm will latch	Latch, not latch
SysLim1Type	Select type of alarm initiation	>= or <=
SysLimit1	Select alarm level in GPM or RPM	0 to 20,000
SysLim2Enable	Select system limit 2 (as above)	Enable, disable
TMRDiffLimit	Difference limit for voted PR inputs EU	0 to 20,000
ShVoltMon	Shaft voltage monitor - board point	Point edit (input FLOAT)
SysLim1Enable	Select System Limit 1	Enable, disable
SysLim1Latch	Select whether alarm will latch	Latch, not latch
SysLim1Type	Select type of alarm initiation	>= or <=
SysLimit1	Select alarm level in frequency	0 to 100
SysLim2Enable	Select system limit 2 (as above)	Enable, disable
ShCurrMon	Shaft current monitor - board point	Point edit (input FLOAT)
ShuntOhms	Shunt resistance	0 to 100
Shunt limit	Shunt maximum ohms	0 to 100
Brush limit	Shaft brush maximum ohms	0 to 100
SysLim1Enable	Select system limit 1	Enable, disable
SysLim1Latch	Select whether alarm will latch	Latch, not latch
SysLim1Type	Select type of alarm initiation	>= or <=
SysLimit1	Select alarm level in amps	0 to 100

SysLim2Enable	Select system limit 2	Enable, disable
GenPT_KVolts	Generator potential transfomer - board point	Point edit (input FLOAT)
PT_Input	PT input in kVrms for PT output	0 to 1,000
PT_Output	PT output in Vrms, nominal 115 V rms	0 to 150
SysLim1	Select alarm level in kVrms	0 to 1,000
SysLim2	Select alarm level in kVrms	0 to 1,000
BusPT_Kvolts	Bus potential transformer - board point	Point edit (input FLOAT)
Ckt_Bkr	Circuit breaker - board point	Point edit (input BIT)
System Frequency	Select frequency in Hz	50 or 60
CB1CloseTime	Breaker 1 closing time, ms	0 to 1,000
CB1 AdaptLimit	Breaker 1 self adaptive limit, ms	0 to 1,000
CB1 AdaptEnabl	Select breaker 1 self adaptive limit	Enable, disable
CB1FreqDiff	Breaker 1 special window frequency difference, Hz	0 to 10
CB1PhaseDiff	Breaker 1 special window phase difference, degrees	0 to 30
CB2CloseTime	Breaker 2 closing time, ms (as above)	0 to 1,000
J4:IS200TRPGH1A	TRPG terminal board, 8 flame detectors	Connected, not connected

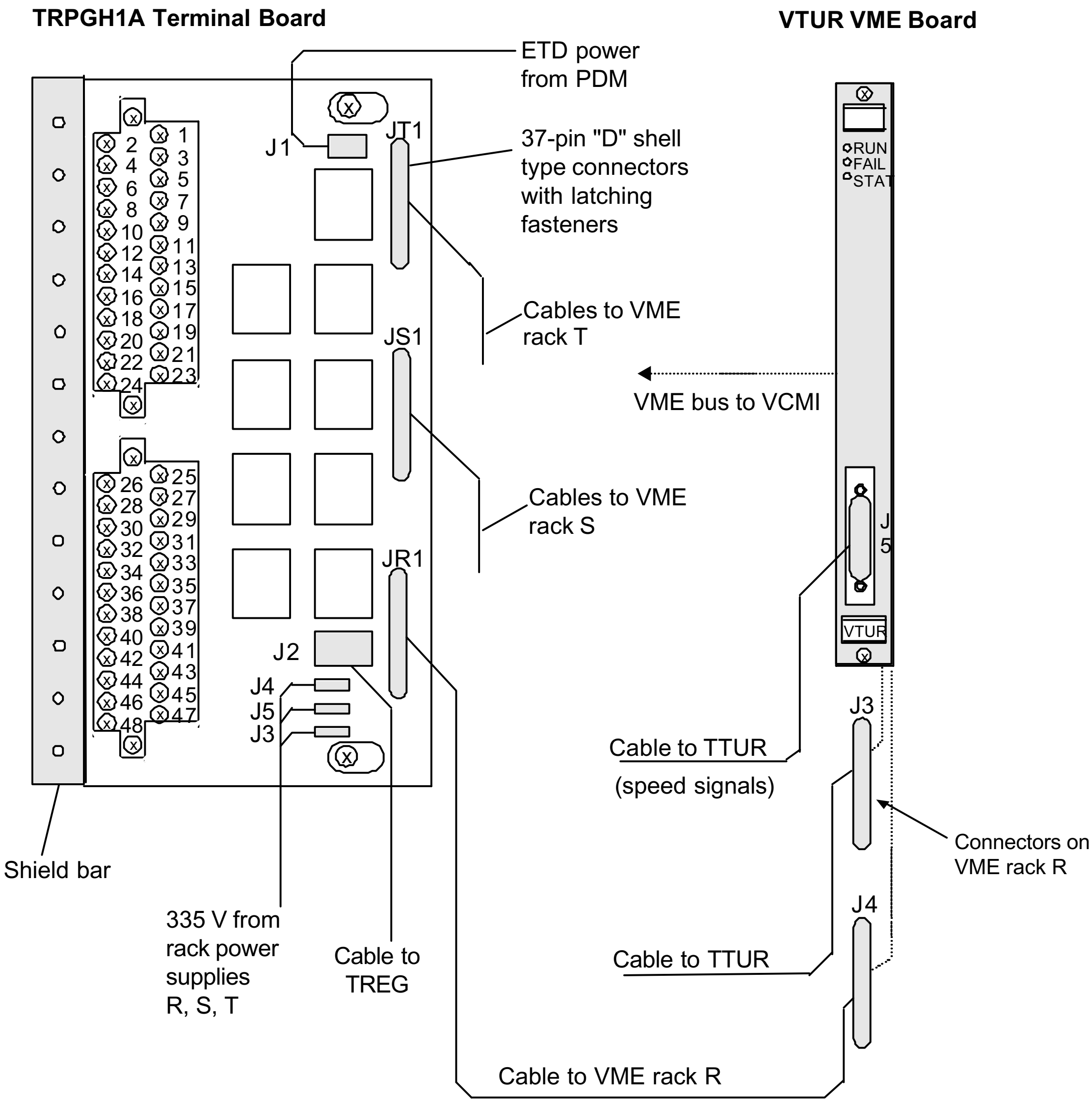
Board Points Signals	Description – Point Edit (Enter Signal Connection)	Direction	Type
L3DIAG_VTUR1	Board diagnostic	Input	BIT
L3DIAG_VTUR2	Board diagnostic	Input	BIT
L3DIAG_VTUR3	Board diagnostic	Input	BIT
ShShntTst_OK	Shaft voltage monitor shunt test OK	Input	BIT
ShBrshTst_OK	Shaft voltage brush test OK	Input	BIT
CB_Volts_OK	L3BKR_VLT circuit breaker coil voltage available	Input	BIT
CB_K25P_PU	L3BKR_PERM sync permissive relay picked up	Input	BIT
CB_K25_PU	L3KBR_GES auto sync relay picked up	Input	BIT
CB_K25A_PU	L3KBR_GEX sync check relay picked up	Input	BIT
Gen_Sync_LO	Generator sync trouble (lockout)	Input	BIT
L25_Command	--------	Input	BIT
Kq1_Status	--------	Input	BIT
:	:	Input	BIT
Kq6_Status	--------	Input	BIT
FD1_Flame	--------	Input	BIT
:	:	Input	BIT
FD16_Flame	--------	Input	BIT
SysLim1PR1	--------	Input	BIT
:	:	Input	BIT
SysLim1PR4	--------	Input	BIT

SysLim1SHV	Ac shaft voltage frequency high L30TSVH	Input	BIT
SysLim1SHC	Ac shaft current high L30TSCH	Input	BIT
SysLim1GEN	--------	Input	BIT
SysLim1BUS	--------	Input	BIT
SysLim2PR1	(same set as for Limit1 above)	Input	BIT
GenFreq	Hz frequency	Input	FLOAT
BusFreq	Hz frequency	Input	FLOAT
GenVoltsDiff	KiloVolts rms-Gen Low is negative	Input	FLOAT
Gen Freq Diff	Slip Hz-Gen Slow is negative	Input	FLOAT
Gen Phase Diff	Phase Degrees-Gen Lag is negative	Input	FLOAT
CB1CloseTime	Breaker #1 close time in milliseconds	Input	FLOAT
CB2CloseTime	Breaker #2 close time in milliseconds	Input	FLOAT
Accel1	RPM/SEC	Input	FLOAT
:	:	Input	FLOAT
Accel4	RPM/SEC	Input	FLOAT
FlmDetPwr1	335 V dc	Input	FLOAT
ShTestAC	L97SHAFT_AC SVM_AC_TEST	Output	BIT
ShTestDC	L97SHAFT_DC SVM_DC_TEST	Output	BIT
FD1_Level	1 = high detection counts level	Output	BIT
:	:	Output	BIT
FD16_Level	1 = high detection counts level	Output	BIT
Sync_Perm_AS	L83AS - auto sync permissive	Output	BIT
Sync_Perm	L25P - sequencing sync permissive	Output	BIT
Sync_Monitor	L83S_MTR - monitor mode	Output	BIT
Sync_Bypass1	L25_BYP-1 = auto aync bypass	Output	BIT
Sync_Bypass0	L25_BYPZ-0 = auto sync permissive	Output	BIT
CB2_Selected	L43SAUT2 - 2nd breaker selected	Output	BIT
AS_Win_Sel	L43AS_WIN - special window selected	Output	BIT
Sync_Reset	L86MR_SYNC - sync trouble reset	Output	BIT
Kq1	L20PTR1 - primary trip relay	Output	BIT
:	:	Output	BIT
Kq6	L20PTR6 - primary trip relay	Output	BIT

TRPG Primary Trip Terminal Board

The TRPG terminal board contains nine magnetic relays to interface with three trip solenoids, known as the Electrical Trip Devices (ETD). The TRPG works in conjunction with the TREG to form the *Primary* and *Emergency* sides of the interface to the ETDs. The H1A version for TMR applications has three voting relays per trip solenoid. The H2A version for simplex applications has one relay per trip solenoid. TRPG also accommodates eight Geiger Mueller flame detectors.

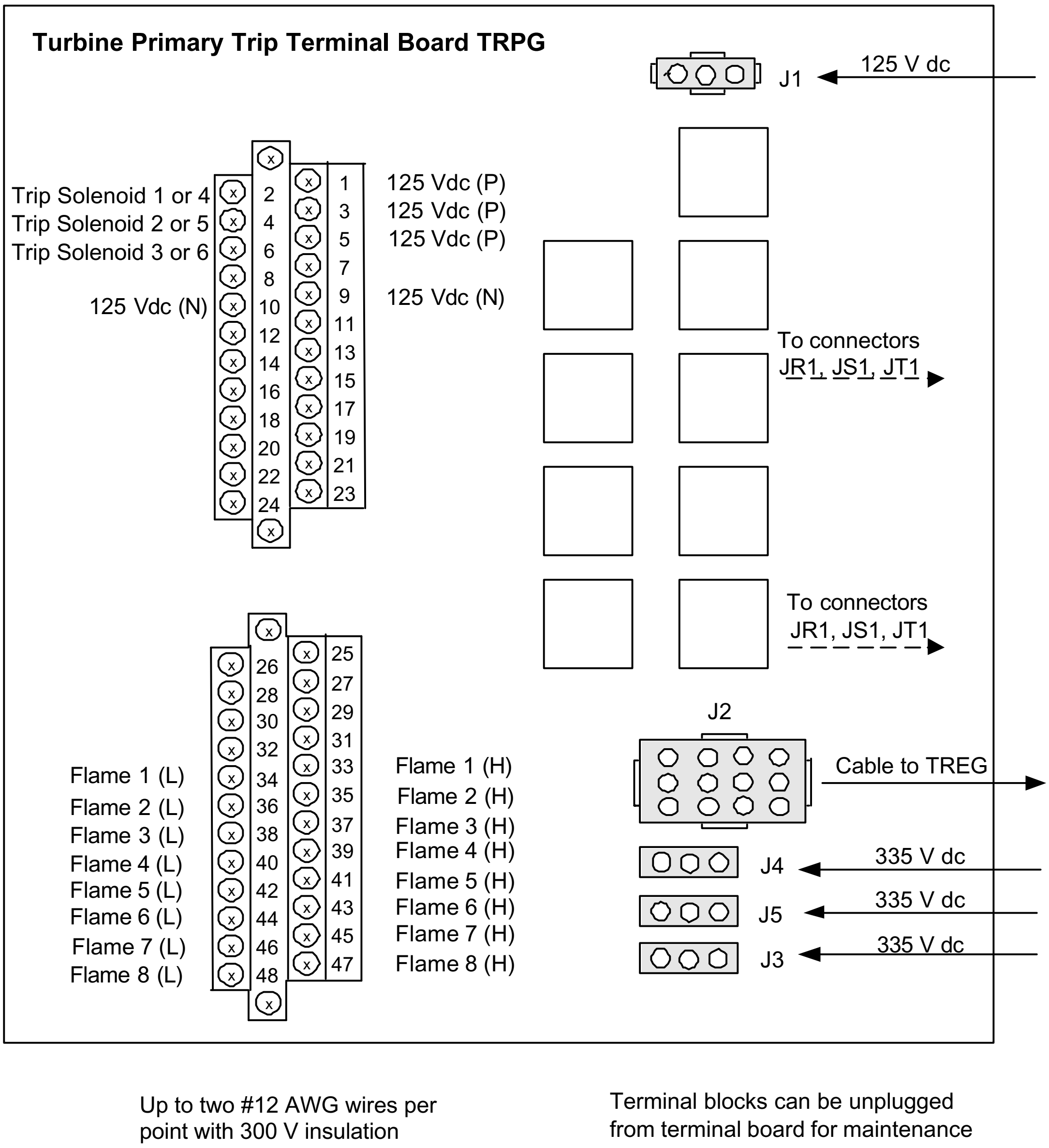
An optional double-width VTURH2A board can be cabled to a second TRPG board for interface to three additional ETDs, but **no** additional flame detectors.



TRPG Terminal Board, I/O Board and Cabling

Installation

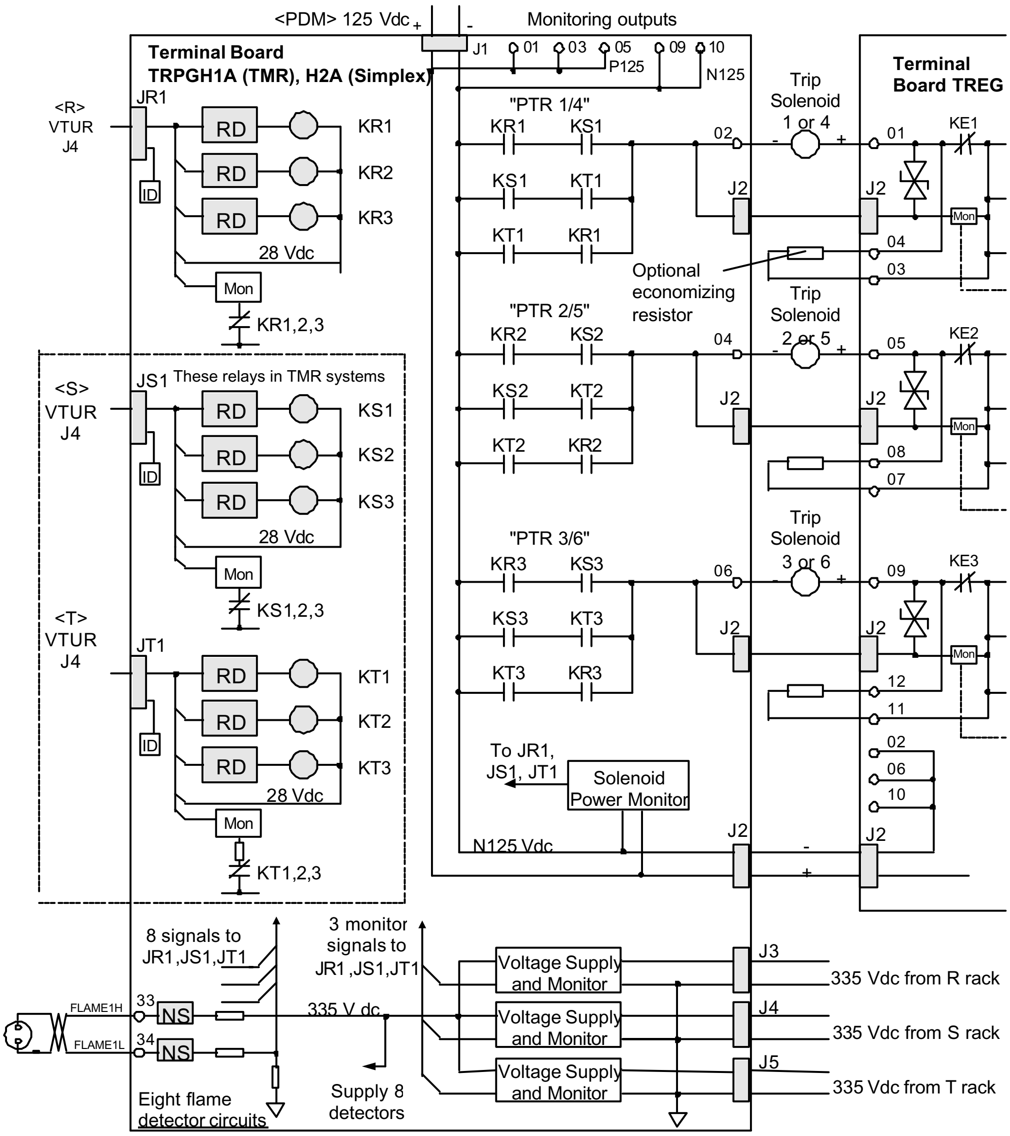
The three trip solenoids are wired directly to the first I/O terminal block and the flame detectors (if used) to the second terminal block. Power to the flame detectors is wired to J3, J4, and J5.



TRPG Terminal Board Wiring

Operation

VTUR provides the primary trip function by controlling the relays on TRPG, which trip the main protection solenoids. In TMR applications, the three inputs are voted in hardware using a relay ladder logic two-out-of-three voting circuit. Relay coil currents, contact status, and supply voltages are monitored for diagnostic purposes.



TRPG and Trip Solenoids

Features

VTUR controls the main breaker through TTUR and three trip solenoids through TRPG. With a second TRPG, six trip solenoids can be controlled. In addition, VTUR handles shaft speed, generator voltage, and bus voltage inputs from TTUR, plus up to eight flame detector inputs from one TRPG board.

Control Of Trip Solenoids

In Simplex systems, TRPGH2 is used. This board has one relay per ETD circuit instead of three and is controlled by only one VTUR board.

Both TRPG and TREG control the trip solenoids so that either one can remove power and close the steam or fuel valves. TRPG holds nine relays in three voting groups of three, one group for each trip solenoid. Voltage for the relay coils is supplied from the R, S, and T rack backplane. The trip solenoids are supplied with power through plug J1. A metal oxide varistor (MOV) for current suppression is on TREG, and an optional economizing current limiting resistor can be wired to the TREG terminals.

Flame Detectors

Up to eight flame detectors can be used for gas turbine applications. The detectors are supplied with 335 V dc, 0.5 mA through plugs J3, J4, and J5.

Voltage pulses above 2.5 volts generate a logic high, and the pulse rate over a 40 ms time period is measured in a counter.

With no flame present, the detector charges up to the supply voltage, but presence of the flame causes the detector to charge to a level and then discharge through the TRPG board. As the flame intensity increases the discharge frequency increases. When the detector discharges, VTUR and TRPG convert the discharged energy into a voltage pulse. The pulse rate varies from 0 to 1,000 pulses/sec. These voltage pulses are fanned out to all three modules.

TRPG Specification

Item	Specification
Trip solenoids	3 solenoids per TRPG (total of 6 per VTUR)
Solenoid rated voltage/current	125 V dc standard with up to 1 A draw 24 V dc is alternate with up to 1 A draw
Solenoid response time	L/R time constant is 0.1 sec
Current suppression	Metal oxide varister (MOV) on TREG
Current economizer	Terminals for optional 10 ohm, 70 watt economizing resistor
Control relay coil voltage supply	Relays supplied with 28 V dc from R, S, and T racks
Flame detectors	8 detectors per TRPG (total of 8 per VTUR)
Detector supply voltage/current	335 V dc with 0.5 mA per detector

Diagnostics

The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the plug location

Descriptions of the TRPG diagnostics are listed under VTUR. The diagnostics include feedback from the trip solenoid relay driver and contact, solenoid power bus, and the flame detector excitation voltage too low or too high.

Connectors JR1, JS1, and JT1 on the terminal board have their own ID device, which is interrogated by the I/O board.

Configuration

Like all I/O boards, the TRPG board is configured using the toolbox. This software usually runs on a data-highway connected CIMPLICITY station or workstation. The following table defines the configuration choices. For details refer to GEH-6403, *Control System Toolbox for Configuring the Mark VI Turbine Controller.*

Typical TRPG Configuration

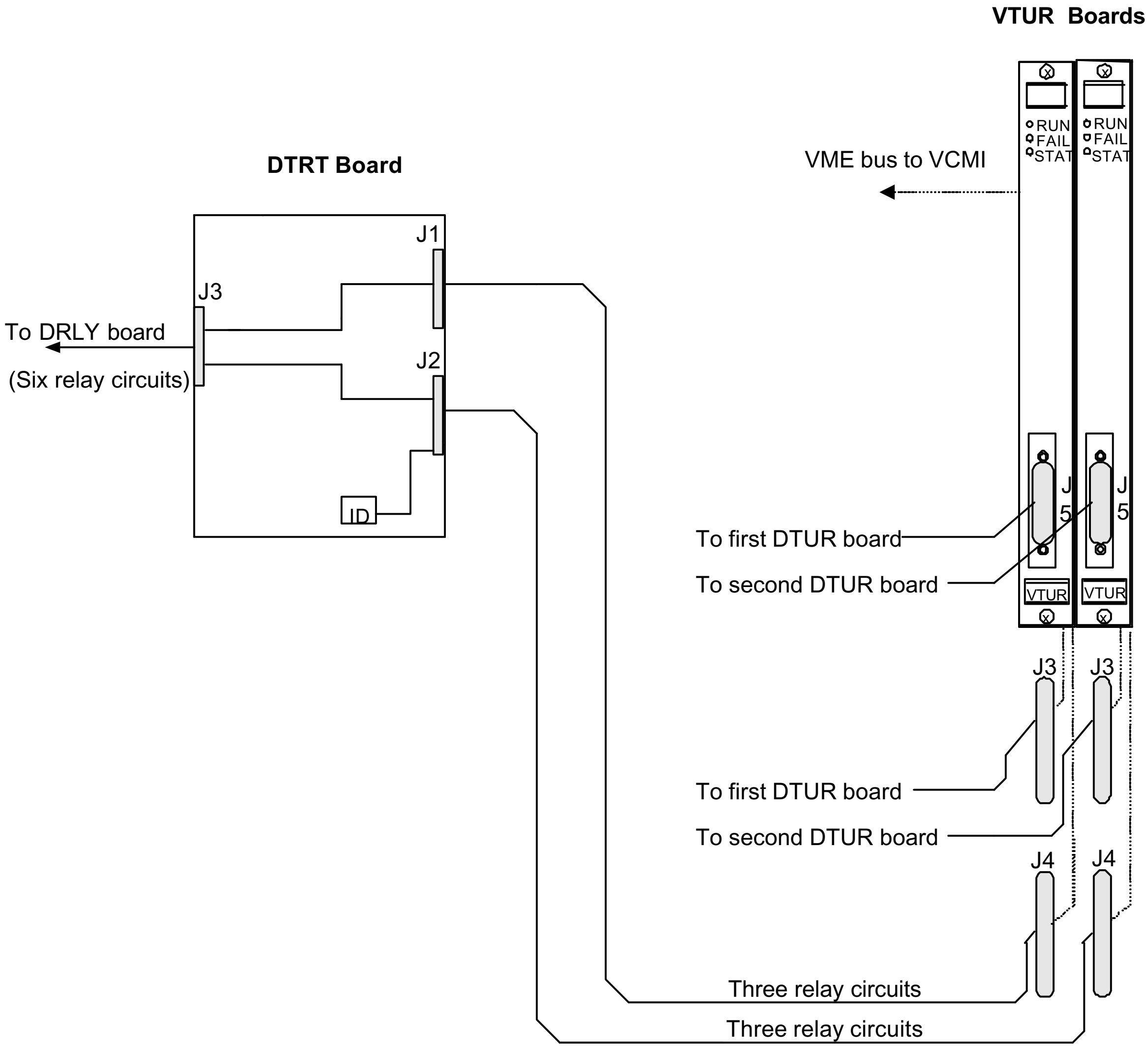
Parameter	Description	Choices	
Configuration			
J4:IS200TRPGH1A	First TRPG terminal board	Connected, not connected	
FlameInd1	Intensity (Hz), flame detector number 1 - board point	Point edit (input FLOAT)	
FlmDetTime	Flame detector time interval	0.04, 0.08, 0.16 sec	
FlameLimitHI	Flame threshold limit HI (HI detection cnts means LOW sensitivity)	0 to 160	
FlameLimitLOW	Flame threshold limit LO (LOW detection cnts means HI sensitivity)	0 to 160	
Flame_Det	Flame detector selected	Used, unused	
FlameIndN	Flame detectors 2 through 8 as above - board point	Point edit (input FLOAT)	
Kq1_Status	Primary trip relay status, first of 3 PTRs - board point	Point edit (input BIT)	
Kq1	Primary trip relay, first of three PTR - board point	Point edit (output BIT)	
PTR_Output	Primary trip relay - used/unused	Used, unused	
J4A:IS200TRPGH1A	Second TRPG board for expanded VTUR, with three more trip solenoid outputs, and flame detectors 9 through 16 (not used)	Connected, not connected	
Board Points Signals	**Description – Point Edit (Enter Signal Connection)**	**Direction**	**Type**
FlameInd1	Intensity (Hz)	Input	FLOAT
:	Intensity (Hz)	Input	FLOAT
FlameInd8	Intensity (Hz)	Input	FLOAT

DTRT Trip Transition Board

Only the simplex version of this board is available.

The DTRT board is a DIN-rail mounted trip transition board that interfaces the VTUR board with the DRLY board. DTRT allows up to six trip functions on the VTUR to interface with DRLY, instead of the normal TRPG board. Two VTUR boards can be connected to the DTRT to control a total of six relays on DRLY. DTRT transfers board identification from the ID chip on DRLY to VTUR for diagnostic purposes. DTRT has its own ID chip connnected to J2.

DTRT must be used in all applications where trips from VTUR to DRLY are required. DTRT cannot be eliminated if the application requires only one VTUR. Three 37-pin D connectors for the three cables are provided. A high density Euro-Block type terminal block is permanently mounted to the board with three screw connections for the ground connection (SCOM).



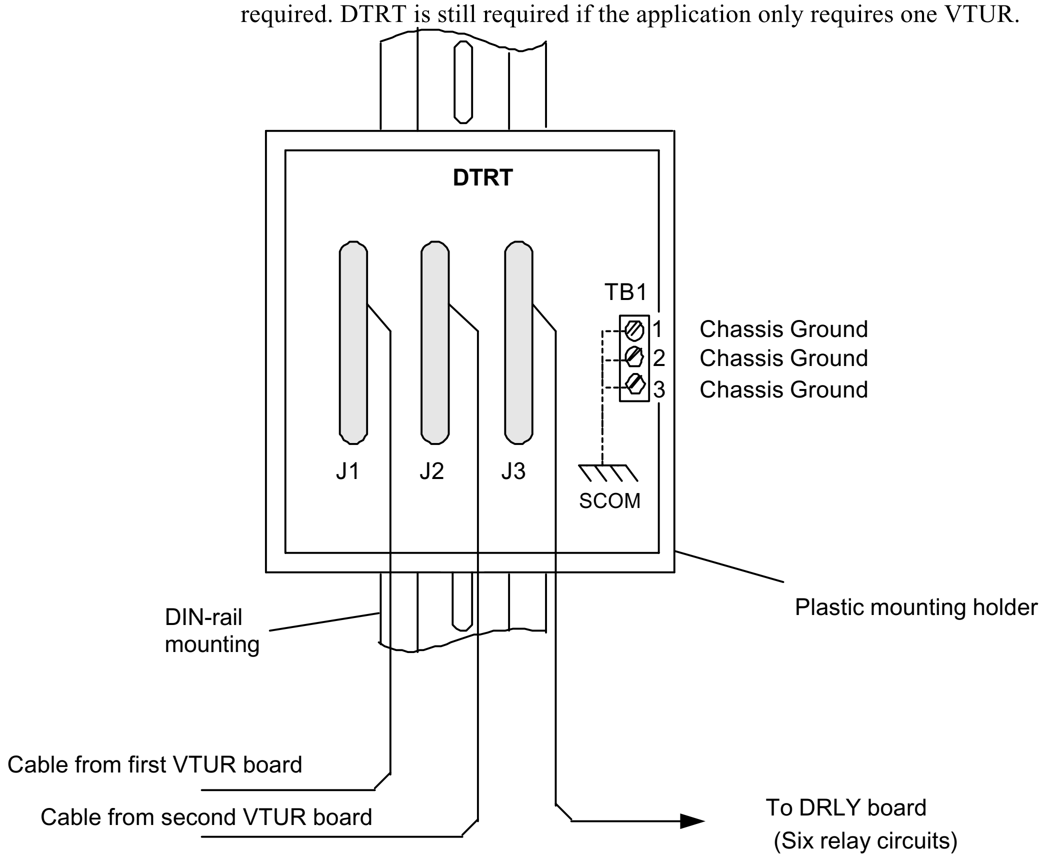
DTRT Board

Installation

There is no shield termination strip with this design.

The DTRT board slides into a plastic holder, which mounts on the DIN-rail. The three cables connecting VTUR and DRLY plug into the 37-pin D type connector. The first three DRLY circuits are driven by the VTUR connected to J1, and the second three DRLY circuits are driven by the VTUR connected to J2. Three screws are provided on terminal block TB1 for the SCOM (ground) connection, which should be as short a distance as possible.

DTRT must be used in all applications where trips from VTUR to DRLYs are required. DTRT is still required if the application only requires one VTUR.



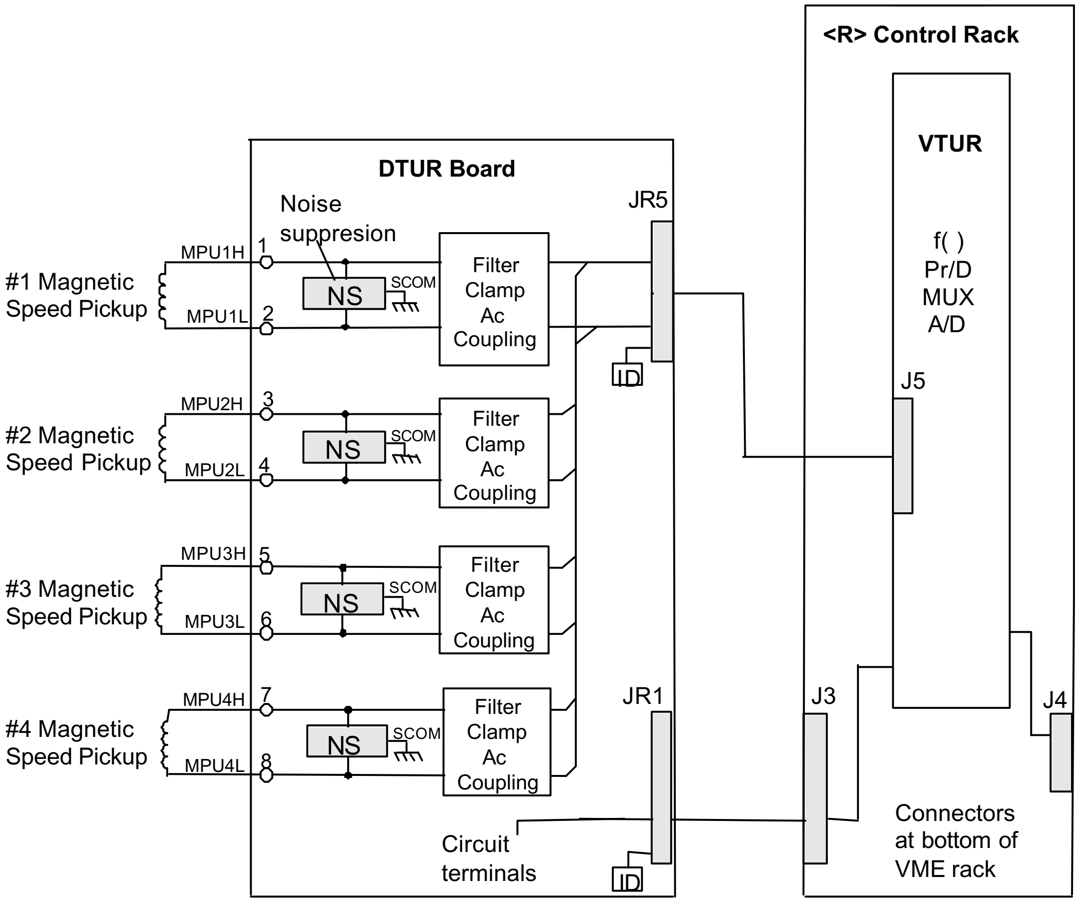
DTRT Wiring and Cabling

DTUR Pulse Rate Terminal Board

Only the simplex version is available.

The DTUR board is a compact pulse-rate terminal board, designed for DIN-rail mounting. The board accepts four passive pulse-rate transducers (magnetic pickups) for speed and flow measurement. It connects to the VTUR processor board with a 37-pin cable and a 15-pin cable. These cables are identical to those used on the larger TTUR terminal board. DTUR boards can be stacked vertically on the DIN-rail to conserve cabinet space. VTUR only accommodates one DTUR board.

DTUR has onboard pulse rate signal conditioning identical to that on the TTUR. High density Euro-Block type terminal blocks are permanently mounted to the board with two screws for the ground connection (SCOM). Two on-board ID chips identify the connectors and board to VTUR for system diagnostic purposes.

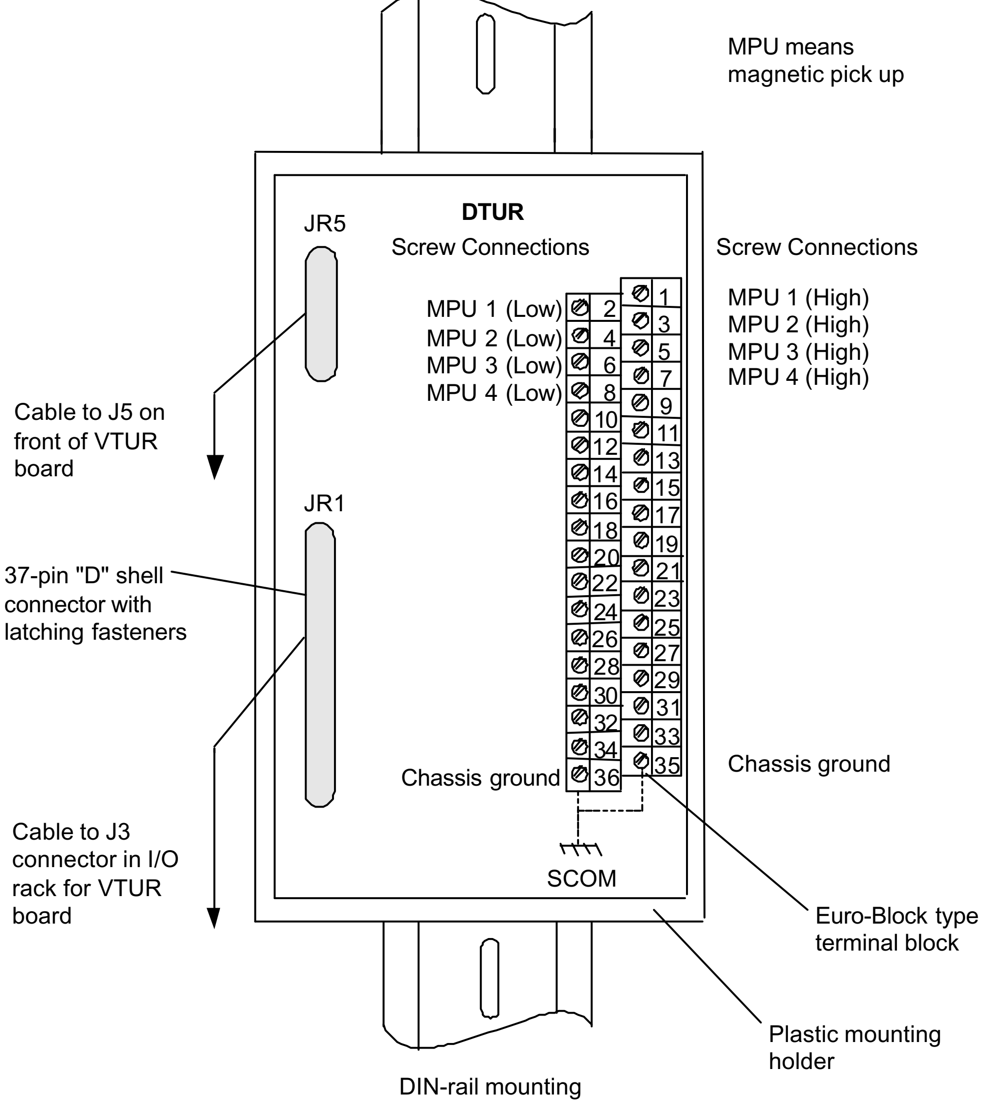


DTUR Board

Installation

There is no shield termination strip with this design.

The DTUR board slides into a plastic holder, which mounts on the DIN-rail. The magnetic pickups are wired directly to the terminal block which has 36 terminals. Typically #18 AWG shielded twisted pair wiring is used. There are two screws for the SCOM (ground) connection, which should be as short a distance as possible.



DTUR Wiring and Cabling

I/O Board Alarms

Diagnostic alarms for any I/O board can be displayed and reset from the toolbox. For troubleshooting and general diagnostic alarm information refer to GEH-6421 Volume I, Chapter 8.

I/O Board Diagnostic Alarms

Board	Fault	Fault Description	Possible Cause
VTUR	**2**	Flash Memory CRC Failure	Board firmware programming error (board will not go online)
	3	CRC failure override is Active	Board firmware programming error (board is allowed to go online)
	16	System Limit Checking is Disabled	System checking was disabled by configuration
	17	Board ID Failure	Failed ID chip on the VME I/O board
	18	J3 ID Failure	Failed ID chip on connector J3, or cable problem
	19	J4 ID Failure	Failed ID chip on connector J4, or cable problem
	20	J5 ID Failure	Failed ID chip on connector J5, or cable problem
	21	J6 ID Failure	Failed ID chip on connector J6, or cable problem
	22	J3A ID Failure	Failed ID chip on connector J3A, or cable problem
	23	J4A ID Failure	Failed ID chip on connector J4A, or cable problem
	24	Firmware/Hardware Incompatibility	Invalid terminal board connected to VME I/O board
	30	ConfigCompatCode mismatch; Firmware: #; Tre: # The configuration compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	31	IOCompatCode mismatch; Firmware: #; Tre: # The I/O compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	32-37	Solenoid # Relay Driver Feedback Incorrect. Solenoid (1-6) relay driver feedback is incorrect as compared to the command; VTUR cannot drive the relay correctly until the hardware failure is corrected	The solenoid relay driver on the TRPG/L/S board has failed, or the cabling between VTUR and TRPG/L/S is incorrect.
	38-43	Solenoid # Contact Feedback Incorrect. Solenoid (1-6) relay contact feedback is incorrect as compared to the command; VTUR cannot drive the relay correctly until the hardware failure is corrected	The solenoid relay driver or the solenoid relay on the TRPG/L/S board has failed, or the cabling between VTUR and TRPG/L/S is incorrect.

44-45	TRPG # Solenoid Power Absent. P125/24 V dc power is not present on TRPG terminal board; VTUR cannot energize trip solenoids 1 through 3, or 4 through 6 until power is present	Power may not be coming into TRPG/L/S on the J1 connector, or the monitoring circuit on TRPG/L/S is bad, or the cabling between TRPG/L/S and VTUR is at fault.
46,48	TRPG # Flame Detector Volts Low at Y Volts. TRPG 1 or 2 flame detect voltage is low; the ability to detect flame by detectors 1 through 8, or 9 through 16 is questionable	Power comes into TRPG via J3, J4, and J5. If the voltage is less than 314.9 V dc, this should be investigated. If the voltage is above this value, the monitoring circuitry on TRPG or the cabling between TRPG and VTUR is suspect.
47,49	TRPG # Flame Detector Volts High at Y Volts. TRPG 1 or 2 flame detect voltage is high; the ability to detect flame by detectors 1 through 8, or 9 through 16 is questionable because the excitation voltage is too high and the devices may be damaged	This power comes into TRPG via J3, J4, and J5. If the voltage is greater than 355.1 V dc, this should be investigated. If the voltage is below this value, the monitoring circuitry on TRPG or the cabling between TRPG and VTUR is suspect.
50	L3BKRGXS – Synch Check Relay is Slow. The auto synchronization algorithm has detected that during synchronization with no dead bus closure (synch bypass was false) the auto synch relay I3BKRGES closed before synch relay I3BKRGEX closed	The synch check relay I3BKRGXS, known as K25A, on TTUR is suspect; also the cabling between VTUR and TTUR may be at fault.
51	L3BKRGES – Auto Synch Relay is Slow. The auto synchronization algorithm has detected that the auto synch relay I3BKRGES had not closed by two cycle times after the command I25 was given	The Auto synch relay I3BKRGES also known as K25, on TTUR is suspect; also the cabling between VTUR and TTUR may be at fault.
52-53	Breaker # Slower than Adjustment Limit Allows. Breaker 1 or 2 close time was measured to be slower than the auto synch algorithms adaptive close time adjustment limit allows	The breaker is experiencing a problem, or the operator should consider changing the configuration (both nominal close time and self-adaptive limit in ms can be configured).
54	Synchronization Trouble - K25 Relay Locked Up. The auto synchronization algorithm has determined that the auto synch relay I3BKRGES, also known as K25, is locked up. Auto synch will not be possible until the relay is replaced	K25 on TTUR is most likely stuck closed, or the contacts are welded.
55	Card and Configuration File Incompatibility. You are attempting to install a VTUR board that is not compatible with the VTUR TRE file you have installed	Install the correct TRE file from the factory
56	Term Board on J5X and Config File Incompatibility. VTUR detects that the terminal board that is connected to it through J5 is different than the board that is configured	Check your configuration.
57	Term Board on J3 and Config File Incompatibility. VTUR detects that the terminal board that is connected to it through J3 is different than the board that is configured	Check your configuration.
58	Term Board on J4 and Config File Incompatibility. VTUR detects that the terminal board that is connected to it through J4 is different than the board that is configured	Check your configuration.
59	Term Board on J4A and Config File Incompatibility. VTUR detects that the terminal board that is connected to it through J4A is different than the board that is configured	Check your configuration.

60	Term. Board TTUR and card VTUR Incompatibility. VTUR detects that the TTUR connected to it is an incompatible hardware revision	The TTUR or VTUR must be changed to a compatible combination.
61	TRPL or TRPS Solenoid Power Bus "A" Absent	Cabling problem or solenoid power source
62	TRPL or TRPS Solenoid Power Bus "B" Absent	Cabling problem or solenoid power source
63	TRPL or TRPS Solenoid Power Bus "C" Absent	Cabling problem or solenoid power source
64-66	TRPL/S J4 Solenoid # Voltage mismatch. The voltage feedback disagrees with the PTR or ETR feedback	PTR or ETR relays, or defective feedback circuitry
128-223	Logic Signal # Voting mismatch. The identified signal from this board disagrees with the voted value	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.
224-251	Input Signal # Voting mismatch, Local #, Voted #. The specified input signal varies from the voted value of the signal by more than the TMR Diff Limit	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.

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Board Specification

VVIB Vibration/Position Board

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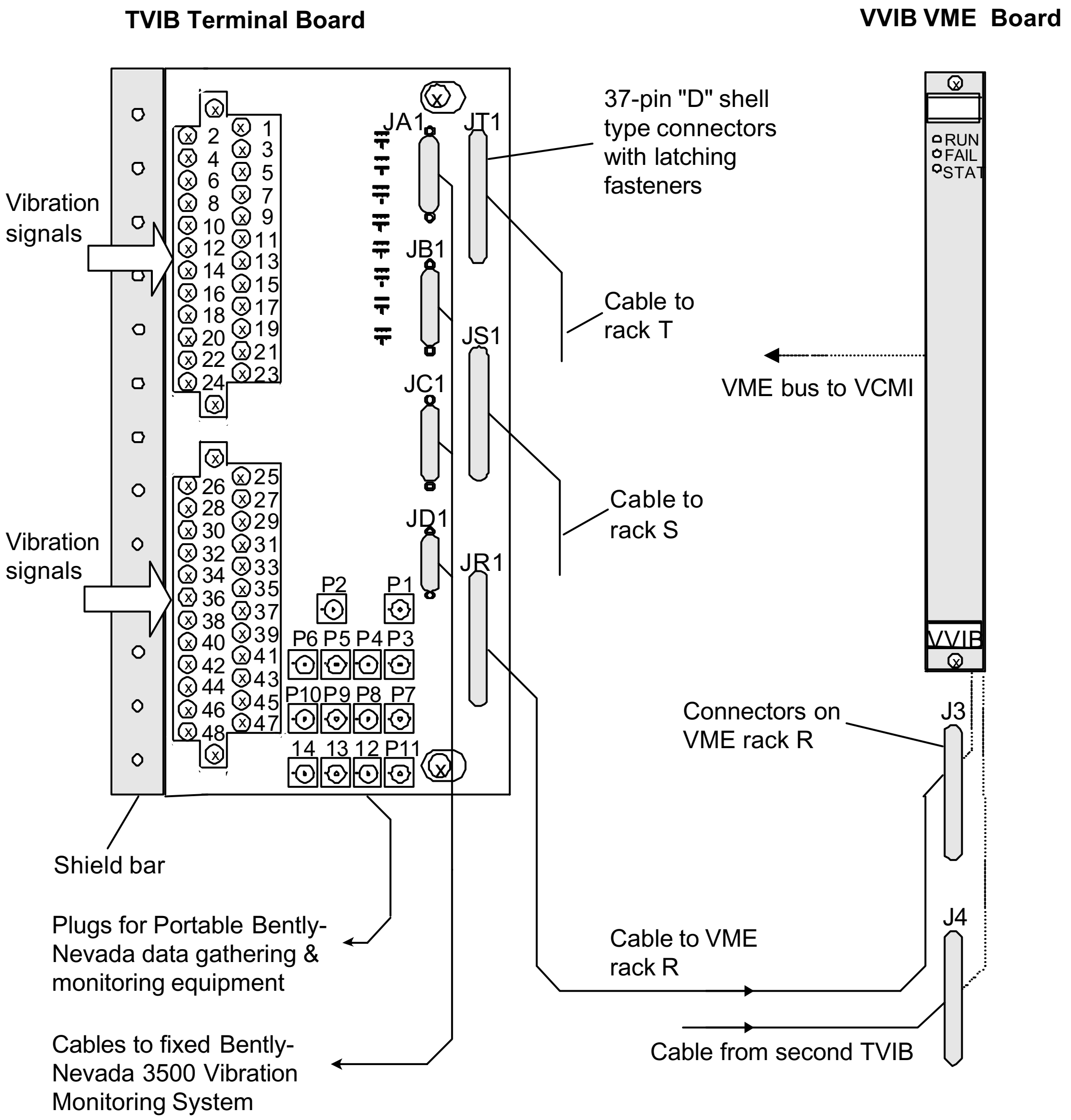
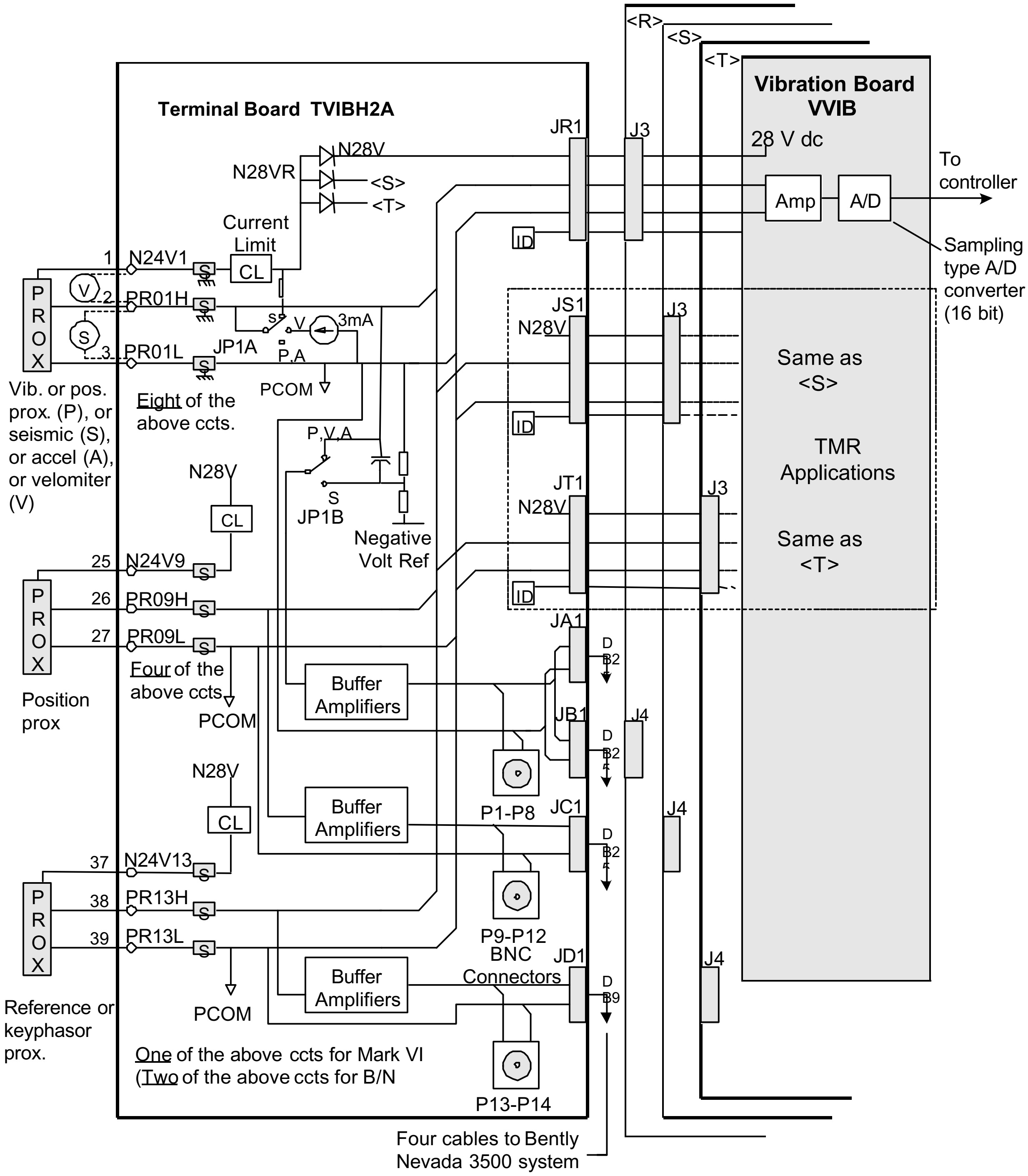
Functional Description

If desired a Bently Nevada 3500 monitoring system can be cabled into the terminal board to permanently monitor turbine vibration.

The Mark VI system uses Bently Nevada probes for shaft vibration monitoring. Up to 14 probes connect directly to the TVIB terminal board, two of which can be cabled to the VVIB board. The signals are processed by the VVIB board, and the digitized displacement and velocity signals are sent over the VME bus to the controller. Also the type 2 terminal board (H2A) has BNC connectors allowing portable vibration data gathering equipment to be plugged in for predictive maintenance purposes.



Vibration Terminal Board, Processor Board, and Cabling

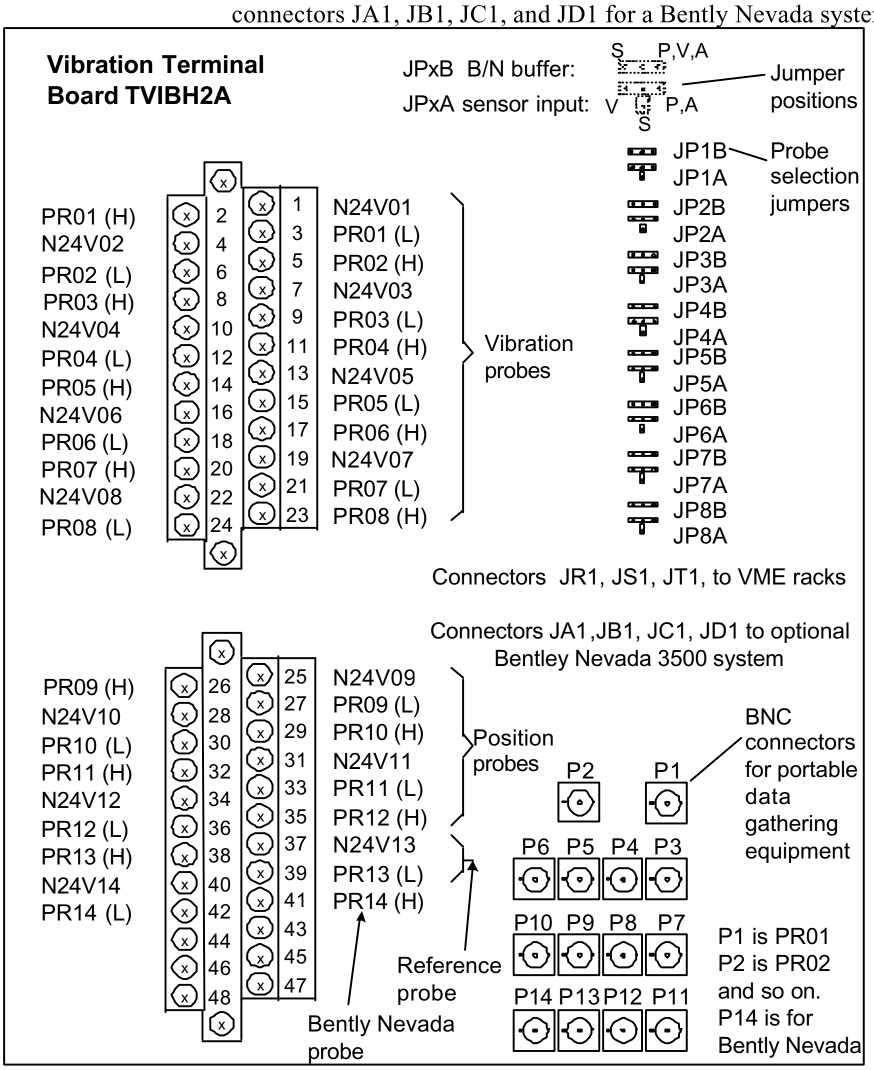


TVIB Board, Vibration Probes, and Bently Nevada Interface

Installation

There are no permanent cable connections to BNCs P1 through P14.

Fourteen vibration probes are wired to the two terminal blocks, three wires per probe. Jumpers JP1 through JP8 select the type of the first eight probes. Use of connectors JA1, JB1, JC1, and JD1 for a Bently Nevada system is optional.



Ckt	Sensor	Conn	Comm	Sign	Shld	Px, BNC Connector
		Connector Pin Assignments				
01	Vib 1	JA1	2	3	4	P1
02	Vib 2	JA1	6	7	8	P2
03	Vib 3	JA1	10	11	12	P3
04	Vib 4	JA1	24	23	22	P4
05	Vib 5	JB1	2	3	4	P5
06	Vib 6	JB1	6	7	8	P6
07	Vib 7	JB1	10	11	12	P7
08	Vib 8	JB1	24	23	22	P8
09	Pos 1	JC1	2	3	4	P9
10	Pos 2	JC1	6	7	8	P10
11	Pos 3	JC1	10	11	12	P11
12	Pos 4	JC1	24	23	22	P12
13	Ref probe	JD1	3	1	2	P13
14	B/N only	JD1	9	5	4	P14

Jumper JPXA:
S = Seismic
V = Velomitor
P = Proximitor
A = Accelerometer

Jumper JPXB:
S = Seismic
V = Velomitor
P = Proximitor
A = Accelerometer

Terminal Board TVIB Wiring

Operation

TVIB supports Proximitor, Seismic, Accelerometer, and Velomitor probes of the type supplied by Bently Nevada. Power for the vibration probes comes from the VVIB boards, in either Simplex or TMR mode. The probe signals return to VVIB where they are A/D converted and sent over the VME bus to the controller. Vibration, eccentricity, and axial position alarms and trip logic are generated in the controller.

A –28 V dc source is supplied to the terminal board from the VME board for Proximitor power. In TMR systems, a diode high-select circuit selects the highest –28 V dc bus for redundancy. Regulators provide individual excitation sources, –23 to –26 V dc, short circuit protected. Probe inputs are sampled at high speed over discrete time periods. The maximum and minimum values are accumulated, the difference is taken (max-min) for vibration, and the results are filtered. The resulting peak to peak voltage is scaled to yield mils (peak to peak) displacement, or velocity.

Features

Vibration Functions

Vibration probe inputs are normally used for four protective functions in turbine applications as follows:

Vibration: Proximity probes monitor the peak-to-peak radial displacement of the shaft (the shaft motion in the journal bearing) in two radial directions. This system uses non-contacting probes and proximitors, and results in alarm, trip, and fault detection.

Rotor Axial Position: A probe is mounted in a bracket assembly off the thrust bearing casing to observe the motion of the thrust collar on the turbine rotor. This system uses non-contacting probes and Proximitors, and results in thrust bearing wear alarm, trip, and fault detection.

Differential Expansion: This application uses non-contacting probe(s) and proximitor(s) and results in alarm, trip, and fault detection for excessive expansion differential between the rotor and the turbine casing.

Rotor Eccentricity: A probe is mounted adjacent to the shaft to continuously sense the surface and update the turbine control. The calculation of eccentricity is made once per revolution while the turbine is on turning gear. Alarm and fault indications are provided.

Probes

The eight vibration inputs on each terminal board can be applied as either proximitor, accelerometer, seismic (velocity), or velomitor inputs. Jumpers on the terminal board are used to assign a specific vibration sensor type to each input point with the seismic type assigned to point (S), the velomitor type assigned to point (V), and the proximitor and accelerometer types sharing point (P/A). A proximitor reads a shaft keyway to generate a once per revolution keyPhasor input for phase angle reference.

Specifications

VIB Specifications

Item	Specification			
Number of Channels	TVIB: 13 probes: 8 vibration, 4 position, 1 keyPhasor VVIB: 26 probes with two TVIB boards			
Vibration	**Measurement**	**Range**	**Accuracy**	**Frequency**
Proximity	Displacement 5 to 200 Hz	0 to 4.5 V pp	±0 .030 V pp	
	Displacement 200 to 500 Hz	0 to 4.5 V pp	±0 .150 V pp	
Seismic	Velocity	0 to 2.25 V p 5 to 200 Hz	Max [2% reading, ±0.008 Vp]	
	Velocity	0 to 2.25 V p 200 to 500 Hz	Max [5% reading, ±0.008 Vp]	
Velomitor	Velocity	0 to 2.25 V p 5 to 200 Hz	Max [2% reading, ±0.008 Vp]	
	Velocity	0 to 2.25 V p 200 to 500 Hz	Max [5% reading, ±0.008 Vp]	
Accelerometer	Velocity (track filter) 10 to 233 Hz	0 to 2.25 V p	±0 .015 Vp	
Position	Position	–.5 to –20 V dc Air gap (average)	±0.2 V dc	
Phase	Degrees (1X vibration component with respect to key slot)	0 to 360 degrees Up to 14,000 rpm	±2 degrees	
Probe power	–24 V dc from the –28 V dc bus; each probe supply is current limited 12 mA load per transducer			
Probe signal sampling	16-bit A/D converter with 14-bit resolution on the VVIB Sampling rate is 4,600 samples per second in fast scan mode (4,000 to 17,500 rpm) Sampling rate is 2,586 samples per second for nine or more probes (less than 4,000 rpm) All inputs are simultaneously sampled in time windows of 160 ms			
Rated RPM	If greater than 4,000 rpm, can use eight vibration channels, (others can be prox/position) If less than 4,000 rpm, can use 16 vibration channels, and other probes			
Buffered outputs	Amplitude accuracy is 0.1% for signal to Bently Nevada 3500 vibration analysis system			

Diagnostics

Diagnostics perform a high/low (hardware) limit check on the input signal and a high/low system (software) limit check. The software limit check is adjustable in the field.

A probe fault, alarm, or trip condition will occur if either of an X or Y probe pair exceeds its limits. In addition, the application software will inhibit a vibration trip (the ac component) if a probe fault is detected based on the dc component.

Position inputs for thrust wear protection, differential expansion, and eccentricity are monitored similar to the vibration inputs except only the dc component is used for a position indication. A 16-bit sampling type A/D converter is used with 14-bit resolution and overall circuit accuracy of 1% of full scale.

Vibration Monitoring and Analysis

Mark VI provides vibration protection and displays the basic vibration parameters.

Each input is actively isolated and the signals made available through four plugs for direct cabling to a Bently Nevada 3500 monitor. This configuration provides the maximum reliability by having a direct interface from the proximitors to the turbine control for trip protection and still retain the real-time data access to the Bently Nevada system for static and dynamic vibration monitoring. Note that the Mark VI displays the total vibration, the 1X vibration component and the 1X vibration phase angle, but it is not intended as a vibration analysis system.

Fourteen BNC connectors on TVIB provide buffered signals available to portable data gathering equipment for predictive maintenance purposes. Buffered outputs have unity gain, 10 K ohm internal impedance, and can drive loads up to 1500 oh Configuration.

VVIB Configuration

Parameter	Description	Choices
Configuration		
System limits	Enable system limits	Enable, disable
Vib_PP_Fltr	First order filter time constant (sec)	0.01 to 2
LMVib1A	Vib, 1X component, for LM_RPM_A, input #1 - board point	Point edit (input FLOAT)
SysLim1Enable	Enable system limit 1 fault check	Enable, disable
SysLim1Latch	Latch system limit 1 fault	Latch, not latch
SysLim1Type	system limit 1 check type	>= or <=
SysLimit1	System Limit 1 - Vibration in mils (Prox) or Inch/sec (seismic, accel)	–100 to +100
SysLim2Enable	Enable system limit 2 (same configuration as above)	Enable, disable
TMR_DiffLimt	Difference limit for voted TMR inputs in volts or mils	–100 to +100
LMVib1B	Vib, 1X component, for LM_RPM_B, #1 - board point	Point edit (input FLOAT)
LMVib1C	Vib, 1X component, for LM_RPM_C, #1 - board point	Point edit (input FLOAT)
LMVib2A	Vib, 1X component, for LM_RPM_A, #2 - board point	Point edit (input FLOAT)
LMVib2B	Vib, 1X component, for LM_RPM_B, #2 - board point	Point edit (input FLOAT)
LMVib2C	Vib, 1X component, for LM_RPM_C, #2 - board point	Point edit (input FLOAT)
LMVib3A	Vib, 1X component, for LM_RPM_A, #3 - board point	Point edit (input FLOAT)
LMVib3B	Vib, 1X component, for LM_RPM_B, #3 - board point	Point edit (input FLOAT)
LMVib3C	Vib, 1X component, for LM_RPM_C, #3 - board point	Point edit (input FLOAT)
J3:IS200TVIBH1A	Vibration terminal board, first of two	Connected, not connected
GAP1_VIB1	Average air gap (for Prox) or dc volts (for others) - board point	Point edit (input FLOAT)
VIB_Type	Type of vibration probe	Unused, PosProx, VibProx, VibProx-KPH1, VibProx-KPH2, VibLMAccel, VibVelomitor, KeyPhasor
VIB_Scale	Volts/mil or volts/ips	0 to 2
ScaleOff	Scale offset for prox position only, in mils	0 to 90
SysLim1Enable	Enable system limit 1	Enable, disable
SysLim1Latch	Latch the alarm	Latch, not latch
SysLim1Type	System limit 1 check type	>= or <=
SysLimit1	System limit 1 – GAP in negative volts (for vel) or positive mils (prox)	–100 to +100

SysLim2Enabl	Enable system limit 2 (same configuration as above)	Enable, disable
TMR_DiffLimt	Difference limit for voted TMR inputs in volts or mils	−100 to +100
Vib1	Vibration, displacement (pk-pk) or velocity (pk) - board point	Point edit (input FLOAT)
SysLim1Enable	System limits configured as above	Enable, disable
GAP2_VIB2	Second vibration probe of 8 - board point	Point edit (input FLOAT)
Vib2	Vibration, displacement (pk-pk) or velocity (pk) - board point	Point edit (input FLOAT)
GAP9_POS1	First position probe of 4 - board point	Point edit (input FLOAT)
GAP13_KPH1	KeyPhasor probe air gap - board point	Point edit (input FLOAT)
J4:IS200TVIBH1A	Second vibration terminal board	Connected, not connected
GAP14_VIB9	First Vibration Probe of 8 - board point	Point edit (input FLOAT)
Vib9	Vibration, displacement (pk-pk) or velocity (pk) - board point	Point edit (input FLOAT)
GAP22_POS5	First position probe of 4 - board point	Point edit (input FLOAT)
GAP26_KPH2	KeyPhasor probe air gap - board point	Point edit (input FLOAT)

Board Points Signals	**Description - Point Edit (Enter Signal Connection)**	**Direction**	**Type**
L3DIAG_VVIB1	Board diagnostic	Input	BIT
L3DIAG_VVIB2	Board diagnostic	Input	BIT
L3DIAG_VVIB3	Board diagnostic	Input	BIT
SysLim1GAP1	Gap signal limit	Input	BIT
:	:	Input	BIT
SysLim1GAP26	Gap signal limit	Input	BIT
SysLim2GAP1	Gap signal limit	Input	BIT
:	:	Input	BIT
SysLim2GAP26	Gap signal limit	Input	BIT
SysLim1VIB1	Vibration signal limit	Input	BIT
:	:	Input	BIT
SysLim1VIB16	Vibration signal limit	Input	BIT
SysLim1ACC1	Acceleration signal limit	Input	BIT
:	:	Input	BIT
SysLim1ACC9	Acceleration signal limit	Input	BIT
SysLim2VIB1	Vibration signal limit	Input	BIT
:	:	Input	BIT
SysLim2VIB16	Vibration signal limit	Input	BIT
SysLim2ACC1	Acceleration signal limit	Input	BIT
:	:	Input	BIT
SysLim2ACC9	Acceleration signal limit	Input	BIT
RPM_KPH1	Speed RPM, of KP #1	Input	FLOAT

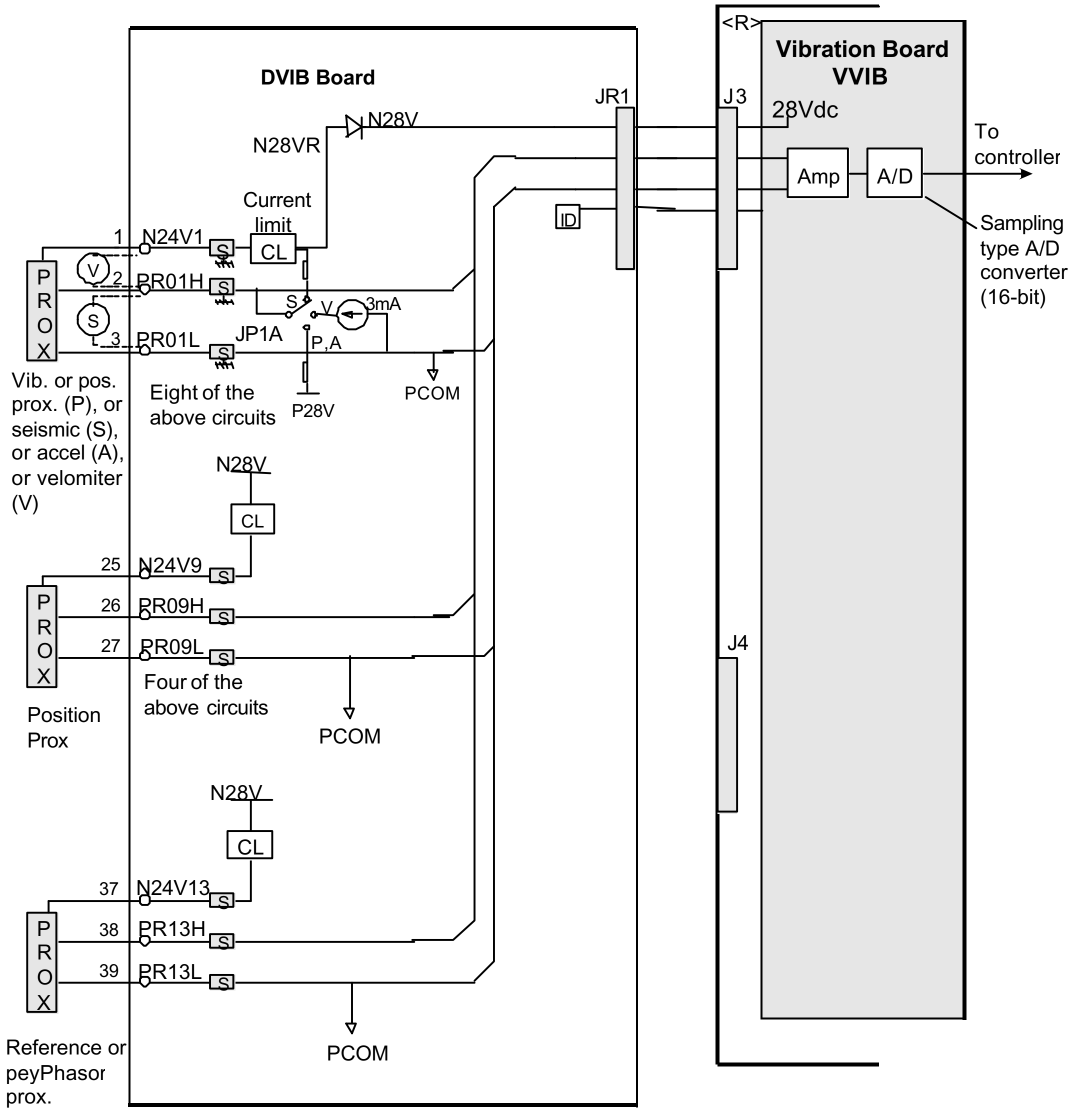
RPM_KPH2	Speed RPM, of KP #2	Input	FLOAT
Vib1X1	Vibration, 1X component only, displacement	Input	FLOAT
:	:	Input	FLOAT
Vib1X16	Vibration, 1X component only, displacement	Input	FLOAT
Vib1XPH1	Angle of 1X component to KP	Input	FLOAT
:	:	Input	FLOAT
Vib1XPH16	Angle of 1X component to KP	Input	FLOAT
LM_RPM_A	--------	Output	FLOAT
LM_RPM_B	--------	Output	FLOAT
LM_RPM_C	--------	Output	FLOAT

DVIB Vibration Terminal Board

Only the simplex version is available.

The DVIB board is a compact vibration terminal board, designed for DIN-rail mounting. (Designed to meet UL 1604 specification for operation in a 65 °C class 1, division 2 environment.) The board accepts eight vibration, four position, and one keyphasor input. It connects to the VVIB processor board with a 37-pin cable. These cables are identical to those used on the larger TVIB terminal board. VVIB accommodates two DVIB boards.

High-frequency decoupling to ground on all signals is the same as on TVIB. High density Euro-Block type terminal blocks are permanently mounted to the board with two screws for the ground connection (SCOM). An on-board ID chip identifies the board to VVIB for system diagnostic purposes.

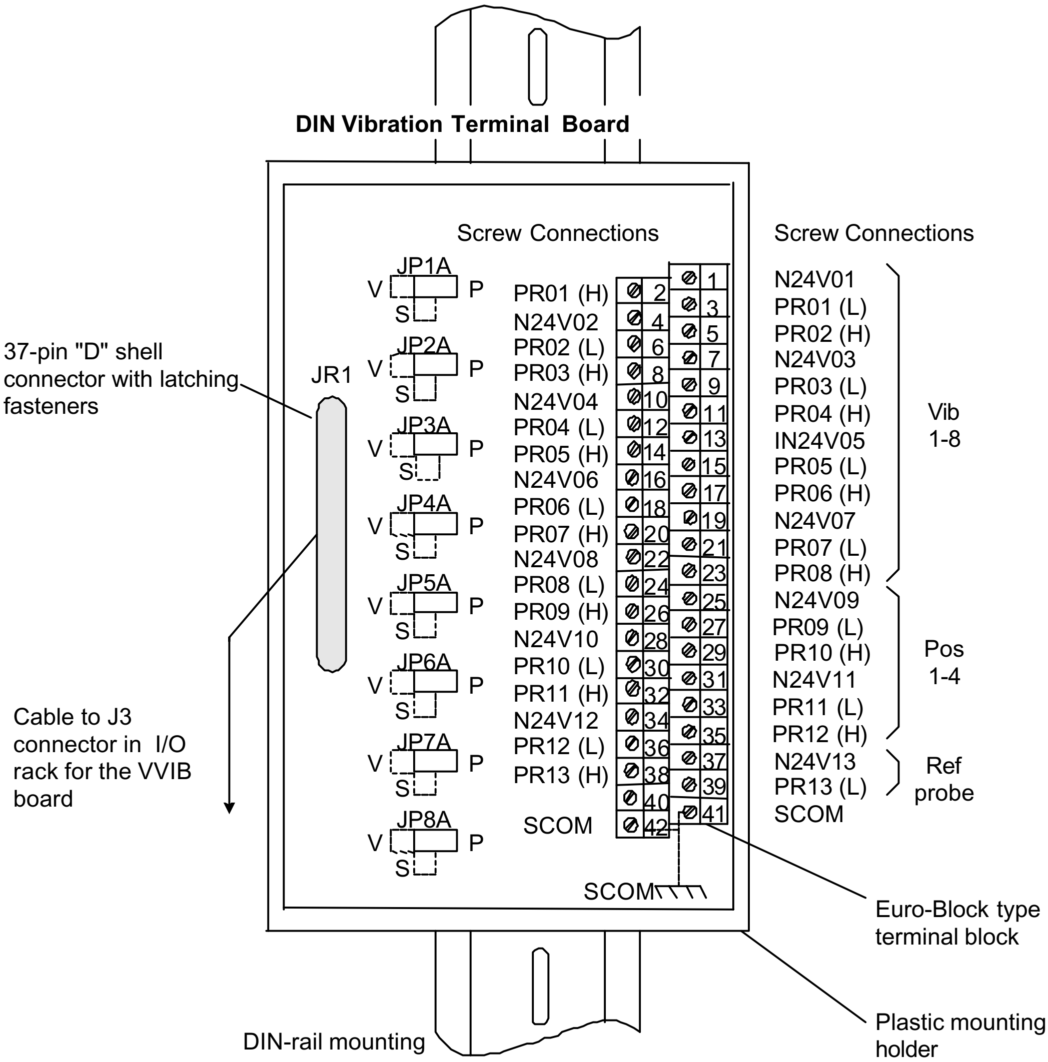

DVIB Board
<R>
Vibration Board
VVIB
JR1
J3
28Vdc
N28V
N28VR
To
controller
Amp
A/D
Current
limit
ID
Sampling
type A/D
converter
(16-bit)
1
N24V1
S
CL
PROX
V
2
PR01H
S
S
V
3mA
3
PR01L
JP1A
P,A
Vib. or pos.
prox. (P), or
seismic (S),
or accel (A),
or velomiter
(V)
Eight of the
above circuits
P28V
PCOM
N28V
CL
25
N24V9
26
PR09H
27
PR09L
J4
Four of the
above circuits
PCOM
Position
Prox
N28V
CL
37
N24V13
38
PR13H
39
PR13L
PCOM
Reference or
peyPhasor
prox.

DVIB Board

Installation

There is no shield terminal strip with this design.

The DVIB board slides into a plastic holder, which mounts on the DIN-rail. The vibration probes are wired directly to the terminal block which has 42 terminals. Typically #18 AWG shielded twisted triplet wiring is used. There are two screws for the SCOM (ground) connection, which should be as short a distance as possible.



DVIB Wiring and Cabling

I/O Board Alarms

Diagnostic alarms for any I/O board can be displayed and reset from the toolbox. For troubleshooting and general diagnostic alarm information refer to GEH-6421 Volume I, Chapter 8.

I/O Board Diagnostic Alarms

Board	Fault	Fault Description	Possible Cause
VVIB	**2**	Flash Memory CRC Failure	Board firmware programming error (board will not go online)
	3	CRC failure override is Active	Board firmware programming error (board is allowed to go online)
	16	System Limit Checking is Disabled	System checking was disabled by configuration.
	17	Board ID Failure	Failed ID chip on the VME I/O board
	18	J3 ID Failure	Failed ID chip on connector J3, or cable problem
	19	J4 ID Failure	Failed ID chip on connector J4, or cable problem
	20	J5 ID Failure	Failed ID chip on connector J5, or cable problem
	21	J6 ID Failure	Failed ID chip on connector J6, or cable problem
	22	J3A ID Failure	Failed ID chip on connector J3A, or cable problem
	23	J4A ID Failure	Failed ID chip on connector J4A, or cable problem
	24	Firmware/Hardware Incompatibility	Invalid terminal board connected to VME I/O board.
	30	ConfigCompatCode mismatch; Firmware: #; Tre: # The configuration compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	31	IOCompatCode mismatch; Firmware: #; Tre: # The I/O compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	32	VVIB A/D Converter 1 Calibration Outside of Spec. VVIB monitors the Calibration Levels on the 2 A/D. If any one of the calibration voltages is not within 1% of its expected value, this alarm is set	The hardware failed (if so replace the board) or there is a voltage supply problem
	33	VVIB A/D Converter 2 Calibration Outside of Spec. VVIB monitors the Calibration Levels on the 2 A/D. If any one of the calibration voltages is not within 1% of its expected value, this alarm is set	The hardware failed (if so replace the board) or there is a voltage supply problem

65-77/ 81-93	TVIB J3/J4 Analog Input # out of limits. VVIB monitors the Signal Levels from the 2 A/D. If any one of the voltages is above the max value, this diagnostic is set	The TVIB board(s) may not exist but the sensor is specified as used, or the sensor may be bad, or the wire fell off, or the device is miswired.
128-287	Logic Signal # Voting mismatch. The identified signal from this board disagrees with the voted value	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.
288-404	Input Signal # Voting mismatch, Local #, Voted #. The specified input signal varies from the voted value of the signal by more than the TMR Diff Limit	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.

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Board Specification

VGEN Generator Board

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("+" indicates the international access code required when calling from outside the USA)

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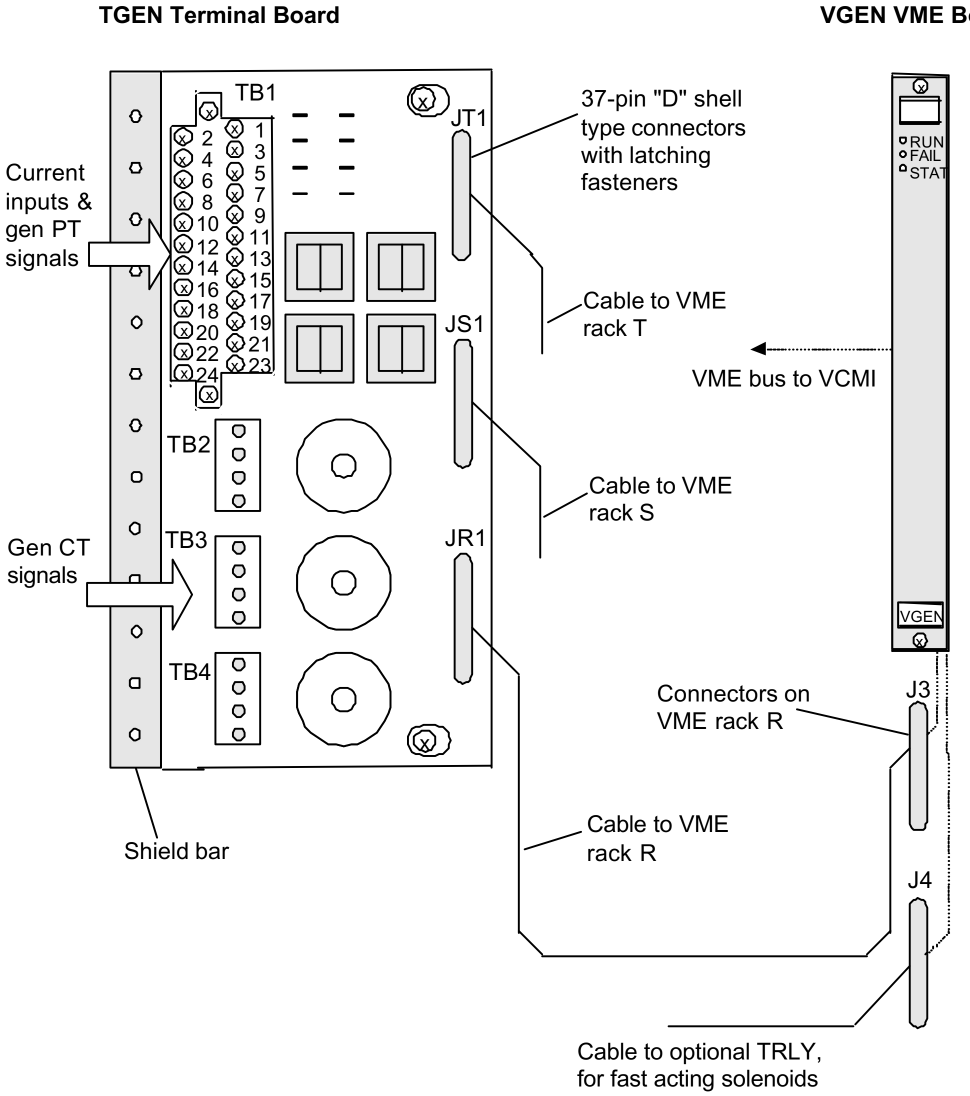
Section	Page

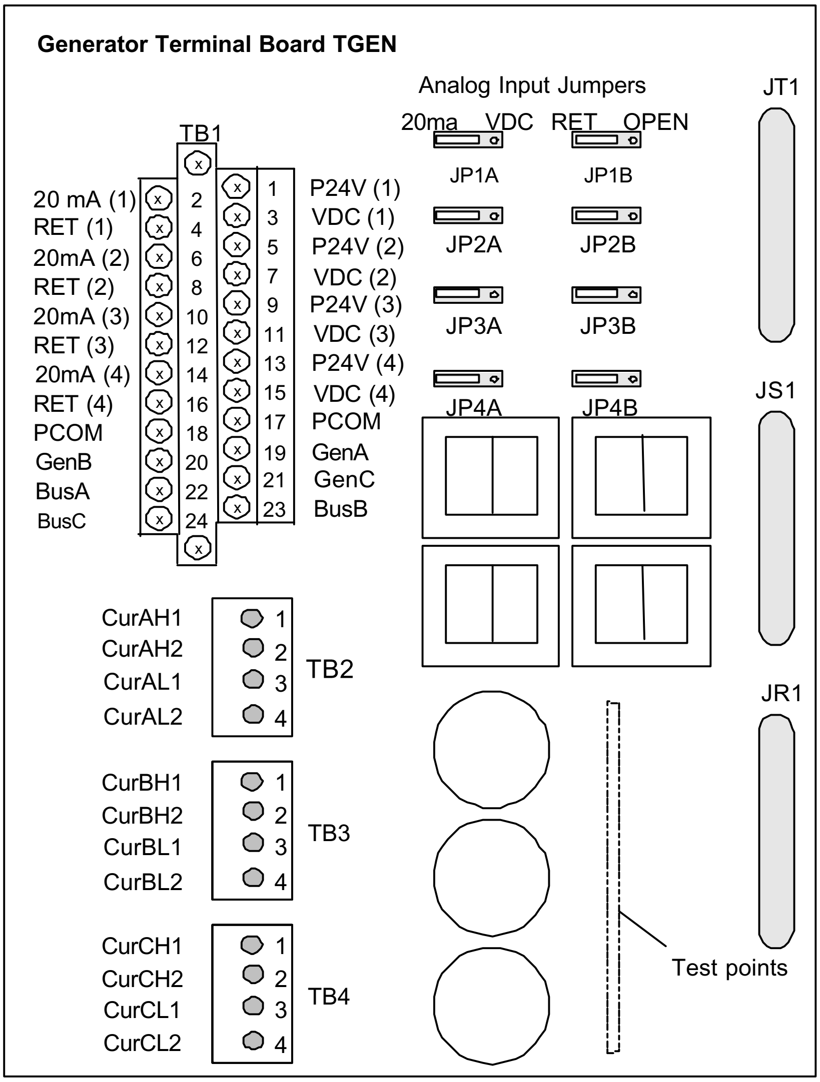
Functional Description

The generator board VGEN and its terminal board TGEN monitor the generator three-phase voltage and currents, and calculate three-phase power and power factor. For large steam turbine applications, VGEN provides the power load unbalance (PLU) and early valve actuation (EVA) functions, using fast acting solenoids located on the TRLY terminal board.



Installation

The analog current and PT inputs are wired to terminal block 1. The CTs are wired to special terminal blocks TB2 , 3, and 4, which cannot be unplugged. This protects against an open CT circuit. Jumpers J1A, B set the desired input current or voltage on analog inputs 1 through 4.



Terminal block 1 can be unplugged from terminal board for maintenance. TB2, TB3, TB4 are not pluggable.

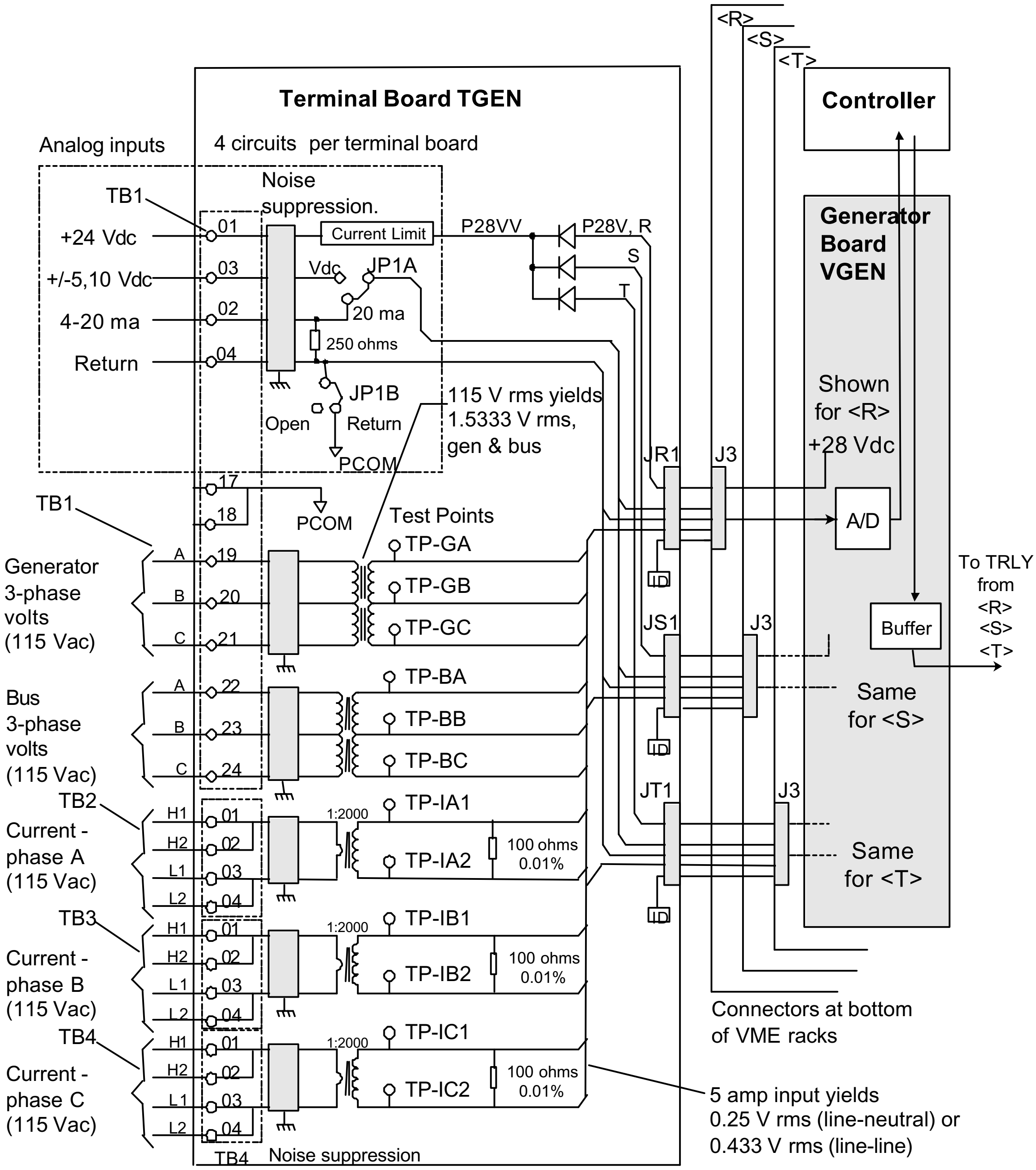
Terminal Board TGEN and Wiring

Operation

VGEN monitors two, 3-phase potential transformer (PT) inputs, and three, one-phase current transformer (CT) inputs. On TGEN there are four analog inputs which can be configured for 4-20 mA or ±5, ±10 V dc.

Test Points on the generator and bus voltages and currents are for checking the phase of the input signals. Signal conversion and calculations of power, power factor and frequency take place on the VGEN board.

Note TGEN may be used with on VGEN board (simplex) or three VGEN boards (TMR).



TGEN Board Showing Potential and Current Transformer Inputs

VGEN monitors generator 3-phase power, and supplies the power load unbalance (PLU) and early valve actuation (EVA) functions for large steam turbines.

The generator and bus PT inputs are three-wire, open delta, voltage measurements that are used to calculate all three line-to-line voltages. They are not used for automatic synchronizing which requires two separate single-phase PT inputs. Each PT input is nominally 115 V rms, and the PTs are magnetically isolated.

Test points are provided for all PT and CT inputs to verify the phase in the field.

Three single-phase CT inputs are provided with a normal current range of 0 to 5 A continous. The Cts are magnetically isolated on TGEN. Terminations for the CTs are non-pluggable terminal blocks with captive lugs accepting are up to #10 AWG wires. The following parameters are calculated from these inputs:

- Total Mwatts
- Total Mvars
- Total MVA
- Power factor
- Bus frequency (5 to 66 Hz)

High frequency and 50/60 Hz noise is reduced with an analog hardware filter.

The four analog inputs can accept 4-20 mA inputs or ± 5, ± 10 V dc inputs. A +24 V dc source is available for all four circuits with individual current limits for each circuit. The 4-20 mA transducer can be connected to use the +24 V dc source from the turbine control or as a self-powered source. A jumper is located on the terminal board to select between current and voltage inputs for each circuit.

Specifications

VGEN Specifications

Item	Specification
Inputs to TGEN and VGEN	2 three-phase generator and bus PTs 3 one-phase generator CTs 4 analog inputs (4–20 mA, ± 5, ± 10 V dc)
Outputs from VGEN via TRLY	12 relay outputs (for large steam turbines)
Generator and bus voltages	Nominal 115 V rms with range of interest of 10 to 120% Nominal frequency 50/60 Hz with range of interest 25 to 66 Hz Magnetic isolation to 1,500 V rms and loading less than 3 VA Input measurement resolution is 0.1% Input accuracy is 0.5% of rated V rms from 45 to 66 Hz Input accuracy is 1.0% of rated V rms from 25 to 45 Hz Input loading less than 3 VA per circuit
Generator current inputs	Normal current range is 0 to 5 A with overange to 10 A Nominal frequency 50/60 Hz with range of interest 45 to 66 Hz Magnetic isolation to 1,500 V rms Input accuracy 0.5% of full scale (5A) with resolution of 0.1% FS Input burden less than 0.5 ohms per circuit
Analog inputs	Current inputs: 4–20 mA Voltage inputs: ± 5 V dc or ± 10 V dc Transducers can be up to 300 m (984 ft) from the control cabinet with a two-way cable resistance of 15 ohms. Input burden resistor on TGEN is 250 ohms. Jumper selection of single ended or self powered inputs Jumper selection of voltage or current inputs Analog Input Filter: Breaks at 72 and 500 radians/sec Ac common mode rejection (CMR) 60 dB Dc common mode rejection (CMR) 80 dB
Conversion accuracy	Sampling type 16-bit A/D converter, 14 bit resolution Accuracy 0.1% overall
Frame rate	100 Hz
Calculated values	Total MWatts and MVars have an accuracy of 1% FS, and 0.5% for totalizing. Total MVA and power factor have an accuracy of 1% full scale. Bus frequency (5 to 66 Hz) has an accuracy of ± 0.1%.

Diagnostics

Diagnostics perform a high/low (hardware) limit check on the input signal and a high/low system (software) limit check. The software limit check is adjustable in the field. Open wire detection is provided for voltage inputs, and relay drivers and coil currents are monitored.

Connectors JR1, JS1, and JT1, on the terminal board have their own ID device which is interrogated by the I/O board. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and plug location.

Configuration

Typical VGEN Configuration

Parameter	Description	Choices
Configuration		
PLU_Enab	Enable PLU function	Enable, disable
PLU_Del_Enab	Enable PLU delay	Enable, disable
MechPwrInput	Mech. power through TMR (first 3 MA ccts), dual xducer (Max), single xducer, or signal space	TMR_1 thru 3, dual 1 and 2, SMX_1, SMX_2, signal space
PLU_Rate	Select PLU threshold rate	ME, LO, HI
PLU_Unbal	PLU Unbalance threshold %	20 to 80
PLU_Delay	PLU delay, secs	0 to 10
Press Ratg	Reheat press equiv. to 100% mechanical power	50 to 600
Current Ratg	Generator current equivalent to 100% electrical power	1,000 to 60,000
EVA_Enab	Enable EVA function	Enable, disable
EVA_ExtEnab	Enable external EVA function	Enable, disable
EVA_Rate	Select EVA threshold rate	LO, ME, HI
EVA_Unbal	EVA unbalance threshold %	20 to 80
EVA_Delay	EVA drop out time, seconds	0 to 10
MW_Ratg	Generator MW equivalent to 100 % electrical power	10 to 1,500
IVT_Enab	Enable IVT function	Enable, disable
Min_MA_Input	Minimum MA for healthy 4-20 mA input	0 to 21
MAx_MA_Input	Maximum MA for healthy 4-20 mA input	0 to 21
SystemFreq	System frequency in Hz	50 or 60
J3:IS200TGENH1A		Connected, Not Connected
AnalogIn1	First analog input (of four) - board point	Point edit (input FLOAT)
Input type	Type of analog input	Unused, 4−20 ma, ± 5 V, ± 10 V
Low input	Input MA at low value	−10 to 20
Low value	Input value in engineering units at low MA (configuration inputs the same as for TBAI)	−3.4028e+038 to 3.4028e+038
System limits	Standard System Limits (see TBAI configuration)	
GenPT_Vab_KV	Generator potential transformer input "ab", (first of 3) - board point	Point edit (input FLOAT)
PT_Input	PT input in KV rms for PT_output	1 to 1,000

PT_Output	PT output in V rms for PT_Input-typically 115	60 to 150
Phase Shift	Compensating phase shift, applied to PT signals	Zero, plus 30, plus 60, minus 30, minus 60
System limits	Standard system limits (similar to analog Inputs)	
BusPT_Vab_KV	Bus potential transformer input "ab", (first of three) configuration similar to GenPT - board point	Point edit (input FLOAT)
GenCT_A	Generator current transformer A (first of three) - board point	Point edit (input FLOAT)
CT_Input	CT input in amperes rms for rated CT_Output	100 to 50,000
CT_Output	Rated CT output in amperes rms, typically 5	1 to 5
System Limits	Standard system limits (similar to genPT)	
J4:IS200TRLYH1A		Connected, not connected
Relay01_Tst	Fast acting solenoid #1 test, first of 12 relays - board point	Point edit (output BIT)
Relay Output	FAS valve type	Unused, CV, tst only, CV EVA
RelayDropTime	Relay dropout time	0 to 5

Board Points Signals	Description – Point Edit (Enter Signal Name)	Direction	Type
L3DIAG_VGEN1	Board diagnostic	Input	BIT
L3DIAG_VGEN2	Board diagnostic	Input	BIT
L3DIAG_VGEN3	Board diagnostic	Input	BIT
SysLim1Anal1	System limit 1 exceeded on analog cct #1	Input	BIT
:	:	Input	BIT
SysLim1Anal4	System limit 1 exceeded on Analog cct #4	Input	BIT
SysLim2Anal1	System limit 2 exceeded on Analog cct #1	Input	BIT
:	:	Input	BIT
SysLim2Anal4	System limit 2 exceeded on analog cct #4	Input	BIT
SysL1GenPTab	System limit 1 exceeded on gen PT, Vab	Input	BIT
SysL1GenPTbc	System limit 1 exceeded on gen PT, Vbc	Input	BIT
SysL1GenPTca	System limit 1 exceeded on gen PT, Vca	Input	BIT
SysL1BusPTab	System limit 1 exceeded on bus PT, Vab	Input	BIT
SysL1BusPTbc	System limit 1 exceeded on bus PT, Vbc	Input	BIT
SysL1BusPTca	System limit 1 exceeded on bus PT, Vca	Input	BIT
SysL2GenPTab	System limit 2 exceeded on gen PT, Vab	Input	BIT
SysL2GenPTbc	System limit 2 exceeded on gen PT, Vbc	Input	BIT
SysL2GenPTca	System limit 2 exceeded on gen PT, Vca	Input	BIT
SysL2BusPTab	System limit 2 exceeded on bus PT, Vab	Input	BIT
SysL2BusPTbc	System limit 2 exceeded on bus PT, Vbc	Input	BIT
SysL2BusPTca	System limit 2 exceeded on bus PT, Vca	Input	BIT
SysL1GenCTa	System limit 1 exceeded on gen CT, phase A	Input	BIT
SysL1GenCTb	System limit 1 exceeded on gen CT, phase B	Input	BIT

SysL1GenCTc	System limit 1 exceeded on gen CT, phase C	Input	BIT
SysL2GenCTa	System limit 2 exceeded on gen CT, phase A	Input	BIT
SysL2GenCTb	System limit 2 exceeded on gen CT, phase B	Input	BIT
SysL2GenCTc	System limit 2 exceeded on gen CT, phase C	Input	BIT
Relay01_Fdbk	Status of relay 01	Input	BIT
:	:	Input	BIT
Relay12_Fdbk	Status of relay 12	Input	BIT
L10PLU_EVT	Power load unbalance event	Input	BIT
L10EVA_EVA	Early valve actuation event	Input	BIT
GenMW	Generator MWatts	Input	FLOAT
GenMVAR	Generator MVars	Input	FLOAT
GenMVA	Generator MVA	Input	FLOAT
GenPF	Generator power factor, 0/1/0	Input	FLOAT
BusFreq	Bus frequency, Hz	Input	FLOAT
PLU_Tst	Power load unbalance test	Output	BIT
EVA_Tst	Early valve actuation test	Output	BIT
IV_Trgr	Intercept valve trigger command	Output	BIT
EVA_ExtCmd	Early valve actuation external command	Output	BIT
EVA_ExtPrm	Early valve actuation external permissive	Output	BIT
TN_Hz	PLL center frequency, Hz	Output	FLOAT
MechPower	Mechanical power, percent, when configured through signal space	Output	FLOAT
AnalogIn1	Analog input 1	Input	FLOAT
:	:	Input	FLOAT
AnalogIn4	Analog input 4	Input	FLOAT
GenPT_Vab_KV	Kilovolts rms	Input	FLOAT
GenPT_Vbc_KV	Kilovolts rms	Input	FLOAT
GenPT_Vca_KV	Kilovolts rms	Input	FLOAT
BusPT_Vab_KV	Kilovolts rms	Input	FLOAT
BusPT_Vbc_KV	Kilovolts rms	Input	FLOAT
BusPT_Vca_KV	Kilovolts rms	Input	FLOAT
GenCT_A	Generator Amperes RMS, phase A	Input	FLOAT
GenCT_B	Generator amperes rms, phase B, same configuration as phase A	Input	FLOAT
GenCT_C	Generator amperes rms, phase C, same configuration as phase A	Input	FLOAT
Relay01_Tst	Fast acting solenoid #1 test	Output	BIT
:	:	Output	BIT
Relay12_Tst	Fast acting solenoid #12 test	Output	BIT

I/O Board Alarms

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I/O Board Diagnostic Alarms

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	3	CRC failure override is Active	Board firmware programming error (board is allowed to go online)
	16	System Limit Checking is Disabled	System checking was disabled by configuration
	17	Board ID Failure	Failed ID chip on the VME I/O board
	18	J3 ID Failure	Failed ID chip on connector J3, or cable problem
	19	J4 ID Failure	Failed ID chip on connector J4, or cable problem
	20	J5 ID Failure	Failed ID chip on connector J5, or cable problem
	21	J6 ID Failure	Failed ID chip on connector J6, or cable problem
	22	J3A ID Failure	Failed ID chip on connector J3A, or cable problem
	23	J4A ID Failure	Failed ID chip on connector J4A, or cable problem
	24	Firmware/Hardware Incompatibility	Invalid terminal board connected to VME I/O board
	30	ConfigCompatCode mismatch; Firmware: #; Tre: # The configuration compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	31	IOCompatCode mismatch; Firmware: #; Tre: # The I/O compatibility code that the firmware is expecting is different than what is in the tre file for this board	A tre file has been installed that is incompatible with the firmware on the I/O board. Either the tre file or firmware must change. Contact the factory.
	32-43	Relay Driver # does not Match Requested State. There is a mismatch between the relay driver command and the state of the output to the relay as sensed by VGEN	The relay terminal board may not exist and the relay is configured a used, or there may be a faulty relay driver circuit or drive sensors on VGEN.
	44-55	Relay Output Coil # does not Match Requested State. There is a mismatch between the relay driver command and the state of the current sensed on the relay coil on the relay terminal board	Relay is defective, or the connector cable J4 to the relay terminal board J1 is disconnected, or the relay terminal board does not exist.

56-59	Analog Input # Unhealthy. Analog Input 4–20 mA ## has exceeded the A/D converter's limits	Analog input is too large, TGEN jumper (JP1, JP3, JP5, JP7) is in the wrong position, signal conditioning circuit on TGEN is defective, multiplexer or A/D converter circuit on VGEN is defective.
60-65	Fuse # and/or # Blown. The fuse monitor requires the jumpers to be set and to drive a load, or it will not respond correctly	One or both of the listed fuses is blown, or there is a loss of power on TB3, or the terminal board does not exist, or the jumpers are not set.
66-69	Analog 4–20 mA Auto Calibration Faulty. One of the analog 4–20 mA auto calibration signals has failed. Auto calibration or 4-20 mA inputs are invalid	3 Volt or 9 Volt precision reference or null reference on VGEN is defective, or multiplexer or A/D converter circuit on VGEN is defective.
70-73	PT Auto Calibration Faulty. One of the PT auto calibration signals has gone bad. Auto calibration of PT input signals is invalid, PT inputs are invalid	Precision reference voltage or null reference is defective on VGEN, or multiplexer or A/D converter circuit on VGEN is defective.
74-79	CT Auto Calibration Faulty. One of the CT auto calibration signals has gone bad. Auto calibration of CT input signals is invalid, CT inputs are invalid	Precision reference voltage or null reference is defective on VGEN, or multiplexer or A/D converter circuit on VGEN is defective.
96-223	Logic Signal # Voting mismatch. The identified signal from this board disagrees with the voted value	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.
224-241	Input Signal # Voting mismatch, Local #, Voted #. The specified input signal varies from the voted value of the signal by more than the TMR Diff Limit	A problem with the input. This could be the device, the wire to the terminal board, the terminal board, or the cable.

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