GE YTUR Primary Turbine Protection

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3.8.10 YTUR Primary Turbine Protection

The Primary Turbine Protection (YTURS1A) pack provides the electrical interface between one or two IONets and a primary protection terminal board. YTUR plugs into the TTUR terminal board and handles four speed sensor inputs, bus and generator voltage inputs, shaft voltage and current signals, eight flame sensors, and outputs to the main breaker. Safety certified protection includes:

Speed An interface is provided for up to four passive, magnetic speed inputs with a frequency range of 2 to 20,000 Hz.

Flame Detection Voltage pulses above 2.5 V generate a logic high; the pulse rate is measured in a counter over a configurable time (multiple of 40 ms).

ETD TRPx contains relays for interface with the electrical trip devices (ETD).

Note For the Mark VIeS control, the flame sensing circuitry analysis was performed with the presence of flame considered as the safe state. YTUR flame sensing is not intended for applications where detected flame is the unsafe condition.

Attention

Only speed, flame detectors, ETD, and E-Stop circuits are certified for safety applications. All other functionality is non-safety rated.

YTURS1A is compatible with the TTUR and TRPA terminal boards. As an alternative to TTUR, three YTUR packs can be plugged directly into a TRPA terminal board. In this arrangement, TRPA holds four speed inputs per YTUR, or alternately fans the first four inputs to all three YTURs. TRPA provides two solid-state primary trip relays. This arrangement does not support bus and generator voltage inputs, shaft voltage or current signals, flame sensors, or main breaker output.

Note YTUR modules are complex in their configuration and operation, and should only be installed and configured by qualified personnel familiar with turbine protection systems.

SIL capability is as follows:

- SIL 2 in HFT = 0 architectures (1 out of 1, 2 out of 2)
- SIL 3 in HFT = 1 architectures (1 out of 2, 2 out of 3)

3.8.10.1 TTUR Primary Turbine Protection Input

The Primary Turbine Protection Input (TTUR) terminal board works with the YTUR turbine I/O packs as part of the Mark VIeS control. Two barrier style terminal blocks accept the following inputs and outputs:

- Safety rated inputs and outputs:
  - Twelve pulse rate devices that sense a toothed wheel to measure turbine speed
  - Three overspeed trip signals to the trip board
- Non-safety rated inputs and outputs:
  - Generator voltage and bus voltage signals taken from PTs
  - 125 V dc output to the main breaker coil for automatic generator synchronizing
  - Shaft voltage and current inputs to measure induced shaft voltage and current

In simplex systems, YTUR mounts on connector JR4 and cable connects to TRPG through connector PR3. For TMR systems, signals fan out to the PR3, PS3, and PT3. TTUR supports connection of TRPG and TRPA boards through the JR4, JS4, and JT4 connectors.

Note TTUR configuration information refers to non-safety-related functions.

3.8.10.2 TRPG Turbine Primary Trip

The Gas Turbine Primary Trip (TRPG) terminal board is controlled by the YTUR. On two barrier style terminal blocks, TRPG holds nine magnetic relays in three voting circuits to interface with three trip solenoids (ETDs). The TRPG works with TREG to form the primary and emergency interface to the ETDs. TRPG holds inputs from eight Geiger-Mueller® flame detectors for gas turbine applications. There are two board types:

- The S1A and S1B version for TMR applications with three voting relays per solenoid
- The S2A and S2B version for simplex applications with one relay per solenoid

In Mark VIeS systems, the TRPG is controlled by YTUR packs mounted on a TTUR terminal board. The I/O packs plug into the D-type connectors on TTUR, which is connected by cable to TRPG.

Note In a dual-control mode topology where (1 out of 2) or (2 out of 2) tripping is desired, use YTUR with an externally wired TRPGS2 terminal board for the desired configuration.

3.8.10.3 TRPA Turbine Primary Trip

The Aeroderivative Turbine Primary Trip (TRPA) terminal board works with the YTUR turbine I/O packs or with the TTUR terminal board as part of the Mark VIeS system. Both TRPAS1A and TRPAS2A are compatible with YTUR. TRPA holds the following inputs and outputs on two barrier style terminal blocks:

- Twelve passive pulse rate devices (four per R/S/T section) that sense a toothed wheel to measure the turbine speed. Or, six active pulse rate inputs (two per TMR section)
- One 24 to 125 V dc fail-safe E-Stop input to remove power from trip relays
- Two 24 V dc (S1) or 125 V dc (S2) TMR voted output contacts to the main breaker coil for trip coil
- Four 24 to 125 V dc voltage detection circuits for monitoring trip string

For TMR systems, signals fan out to the PR3, PS3, PT3, JR4, JS4, and JT4 connectors. TRPA can be configured to provide 12 independent pulse rate speed inputs with 4 per YTUR or fan a single set of 4 inputs to all 3 YTUR packs. Jumpers JP1 and JP2 select the fanning of the four R section passive speed pickups to the S and T section YTURs. Unused jumpers are stored on passive headers located on the corner of the board.

5.9 YTUR

YTUR Module

Configuration	Description	Select Option ✓ or Enter Value
I/O pack redundancy		Simplex, TMR
Hardware group		Distributed I/O, Group
Main terminal board	Terminal board type/ HW form/ Barcode/ Group/ TB Location	TTUR, TRPA
Auxiliary terminal board	Terminal board Phy Pos/ Type/ HW form/ Group/ TB Location	TRPG, TRPA
I/O pack configurations	Pack form/ TB Connector/ IONet	

Parameters Tab

YTUR Parameter	Description	Select Option ✓ or Enter Value
SystemLimits	Enable or disable all system limit checking	Enable, Disable
SMredundancy	Used to determine how shaft monitor testing is controlled if a TMR application	Simplex, TMR
AccelCalType	Select acceleration calculation type	10 to 100
TripType	Select fast trip algorithm	Unused, PR_Single, PR_Max
Trip Type (PR_Single)		
AccASetpoint	Acceleration Trip Setpoint, Chan A, RPM/Sec	0 to 1500
AccAEnable	Acceleration Trip Enable, Chan A	Enable, Disable
AccBSetpoint	Acceleration Trip Setpoint, Chan B, RPM/sec	0 to 1500
AccBEnable	Acceleration Trip Enable, Chan B	Enable, Disable
PR1Setpoint	Fast overspeed trip #1, set point, PR1, RPM	0 to 20000
PR1TrEnable	Fast overspeed trip #1, enable	Disable, Enable
PR2Setpoint	Fast overspeed trip #2, set point, PR1, RPM	0 to 20000
PR2TrEnable	Fast overspeed trip #2, enable	Disable, Enable
PR3Setpoint	Fast overspeed trip #3, set point, PR1, RPM	0 to 20000
PR3TrEnable	Fast overspeed trip #3, enable	Disable, Enable
PR4Setpoint	Fast overspeed trip #4, set point, PR1, RPM	0 to 20000
PR4TrEnable	Fast overspeed trip #4, enable	Disable, Enable
InForChanA	Input change selection for Accel/Decel trip	Accel1, Accel2, Accel3, Accel4
InForChanB	Input change selection for Accel/Decel trip	Accel1, Accel2, Accel3, Accel4
Trip Type (PR_Max)		
InForChanA	Input change selection for Accel/Decel trip	Accel1, Accel2, Accel3, Accel4
InForChanB	Input change selection for Accel/Decel trip	Accel1, Accel2, Accel3, Accel4
AccelCalType	Select acceleration calculation type	10 to 100
DecelStpt	Deceleration set point, RPM/sec	0 to 1500 (FLOAT)
DecelEnab	Deceleration enable	Disable, Enable
FastOS1Stpt	Fast overspeed trip #1 set point, max (PR1,PR2), RPM	0 to 20000 (FLOAT)
FastOS1Enabl	Fast overspeed trip #1, enable	Disable, Enable
FastOS2Stpt	Fast overspeed trip #2 set point, max (PR3,PR4), RPM	0 to 20000 (FLOAT)
FastOS2Enabl	Fast overspeed trip #2, enable	Disable, Enable
DiffSetpoint	Diff Setpoint	0 to 20000 (FLOAT)
DiffEnable	Difference speed trip, enable	Disable, Enable

Flame Tab

YTUR Flame Detector	Description	Select Option ✓ or Enter Value
FlmDetTime	Flame detector time interval (seconds)	0.040 sec, 0.080 sec, 0.160 sec
FlameLimitHI	Flame threshold LimitHI (HI detection cnts means Low sensitivity)	0 to 160
FlameLimitLow	Flame threshold LimitHI (LOW detection cnts means high sensitivity)	0 to 160
Flame_Det	Flame detector used/unused	Used, Unused
TMR_DiffLimit	Diag Limit, TMR input difference limit, in Hz	0 to 160

Pulse Rate Tab (4 each)

YTUR Pulse Rate	Description	Choices
PRType	Selects the type of pulse rate input, n (for proper resolution)	Unused, Flow, Speed, Speed_High, Speed_LM
PRScale	Pulses per revolution (outputs RPM)	0 to 1,000
SysLim1Enabl	Enable system limit 1 fault check	Enable, Disable
SysLim1Latch	Latch system limit 1 fault	Latch, Not Latch
SysLim1Type	System limit 1 check type (= or <=)	= or <=
SysLimit1	System limit 1 – RPM	0 to 20,000
SysLim2Enabl	Enable system limit 2 fault check (as above)	Enable, Disable
SysLim2Latch	Latch system limit 2 fault	Latch, Not Latch
SysLim2Type	System limit 2 check type (= or <=)	= or <=
SysLimit2	System limit 2 – RPM	0 to 20,000
TMR_DiffLimit	Diag Limit, TMR input vote difference, in engineering units	0 to 20,000

Shunt V Tab

YTUR Shaft Voltage Monitor	Description	Select Option ✓ or Enter Value
SysLim1Enabl	Enable system limit 1	Enable, Disable
SysLim1Latch	Latch system limit 1 fault	Latch, Not Latch
SysLim1Type	System limit 1 check type (= or <=)	= or <=
SysLimit1	Select alarm level in frequency Hz	0 to 100
SysLim2Enabl	Select system limit 2 (as above)	Enable, Disable
SysLim2Latch	Latch system limit 1 fault	Latch, Not Latch
SysLim2Type	System limit 1 check type (= or <=)	= or <=
SysLimit2	Select alarm level in frequency Hz	0 to 100
TMR_DiffLimit	Diag Limit, TMR input vote difference, in engineering units	0 to 100

Shunt C Tab

YTUR Shaft Current Monitor	Description	Select Option ✓ or Enter Value
ShuntOhms	Shunt ohms	0 to 100
ShuntLimit	Shunt maximum test ohms	0 to 100
BrushLimit	Shaft (Brush) maximum ohms	0 to 100
SysLim1Enabl	Select system limit 1	Enable, Disable
SysLim1Latch	Select whether alarm will latch	Latch, Not Latch
SysLim1Type	Select type of alarm initiation	= or <=
SysLimit1	Current Amps, select alarm level in Amps	0 to 100

Shunt C Tab (continued)

YTUR Shaft Current Monitor	Description	Select Option ✓ or Enter Value
SysLim2Enabl	Select system limit 2	Enable, Disable
SysLim2Latch	Select whether alarm will latch	Latch, Not Latch
SysLim2Type	Select type of alarm initiation	= or <=
SysLimit2	Current Amps, select alarm level in Amps	0 to 100
TMR_DiffLimit	Diag Limit, TMR input vote difference, in engineering units	0 to 100

PT Tab (Gen and Bus)

YTUR Potential Transformer	Description	Select Option ✓ or Enter Value
PT_Input	PT primary in engineering units (kv or percent) for PT_Output	0 to 1,000
PT_Output	PT output in volts rms, for PT_Input – typically 115	0 to 150
SysLim1Enabl	Select system limit 1	Enable, Disable
SysLim1Latch	Select whether alarm will latch	Latch, Not Latch
SysLim1Type	Select type of alarm initiation	= or <=
SysLimit1	Current Amps, select alarm level in Amps	0 to 1,000
SysLim2Enabl	Select system limit 2	Enable, Disable
SysLim2Latch	Select whether alarm will latch	Latch, Not Latch
SysLim2Type	Select type of alarm initiation	= or <=
SysLimit2	Current Amps, select alarm level in Amps	0 to 1,000
TMR_DiffLimit	Diag Limit, TMR input vote difference, in engineering units	0 to 1,000

Circuit Breaker Tab

YTUR Circuit Breaker	Description	Select Option ✓ or Enter Value
SystemFreq	Select frequency in Hz	60 Hz, 50 Hz
CB1CloseTime	Breaker 1 closing time, ms	0 to 500
CB1AdaptLimt	Breaker 1 self adaptive limit, ms	0 to 500
CB1AdaptEnab	Enable breaker 1 self adaptive adjustment	Enable, Disable
CB1FreqDiff	Breaker 1 special window frequency difference, Hz	0.15 to 0.66
CB1PhaseDiff	Breaker 1 special window phase Diff, degrees	0 to 20
CB1DiagVoteEnab	Enable voting disagreement diagnostic	Enable, Disable
CB2CloseTime	Breaker 2 closing time, ms (as above)	0 to 500
CB2 AdaptLimit	Breaker 2 self adaptive limit, ms	0 to 500
CB2 AdaptEnabl	Enable breaker 2 self adaptive adjustment	Enable, Disable
CB2FreqDiff	Breaker 2 special window frequency difference, Hz	0.15 to 0.66
CB2PhaseDiff	Breaker 2 special window phase diff, degrees	0 to 20
CB2DiagVoteEnab	Enable voting disagreement diagnostic	Enable, Disable

Relays Tab

YTUR Relays	Description	Select Option ✓ or Enter Value
PTR_Output	Primary protection relay used/unused	Unused, Used
DiagVoteEnab	Enable voting disagreement diagnostic	Enable, Disable

E-Stop Tab

YTUR E-Stop	Description	Select Option ✓ or Enter Value
DiagVoteEnab	Enable voting disagreement diagnostic	Enable, Disable

TTUR Jumper

Jumper	Select ✓
JP1	TMR, SMX
JP2	TMR, SMX

TRPA (P1 and P2 jumpers)

Speed Input Connections	Function	Jumper
Wire to all 12 pulse inputs:	Each set of four pulse inputs goes to its own dedicated YTUR I/O pack.	Cannot use jumper
PR1_R – PR4_T		Place in STORE position
Wire to TTL pulse inputs:	Each set of two pulse inputs goes to its own dedicated YTUR I/O pack.	Cannot use jumper
TTL1_R – TTL2_T		Place in STORE position
Wire to bottom 4 pulse inputs only: PR1_R – PR4_R	The same set of signals is fanned to all the YTUR I/O packs.	Use jumper
NO wiring to TTL1_R-TTL2_T or PR1_S-PR4_T		Place over pin pairs
Wire to bottom 2 pulse inputs:	Cannot fan the TTL signals. Only the R YTUR will receive data.	Cannot use jumper
TTL1_R – TTL2-R		Place in STORE position

TRPA Jumper

Jumper	Select ✓
P1	FAN, STORE
P2	FAN, STORE

6.8 YTUR Test Procedures

Configurable items in the YTUR pack are identified in this test plan by including (CFG) at the end of the name of the item. Any configurable items that must be set for a particular test are defined in the detailed test instructions below. If a setting is not given for a configurable item, it is not relevant to that test.

- Unless otherwise noted, verify that there are no diagnostics faults on the YTUR pack under test prior to performing each test case.
- Any diagnostic fault(s) that are expected to occur as a result of performing a test case are detailed in the acceptance criteria for the test case.
- If additional diagnostics faults are generated that are not detailed in the acceptance criteria, they must be fully explained prior to acceptance of the test.

Note The following tests can be performed in any order. Individual steps within a test should be performed in the order presented.

6.8.1 Speed Inputs Accuracy

Test Overview:

This test checks the characteristics of speed inputs (range and accuracy). It verifies that the YTUR supports applications by allowing speed inputs to be sent to the controllers without cross-interference.

Alternative Accuracy Test:

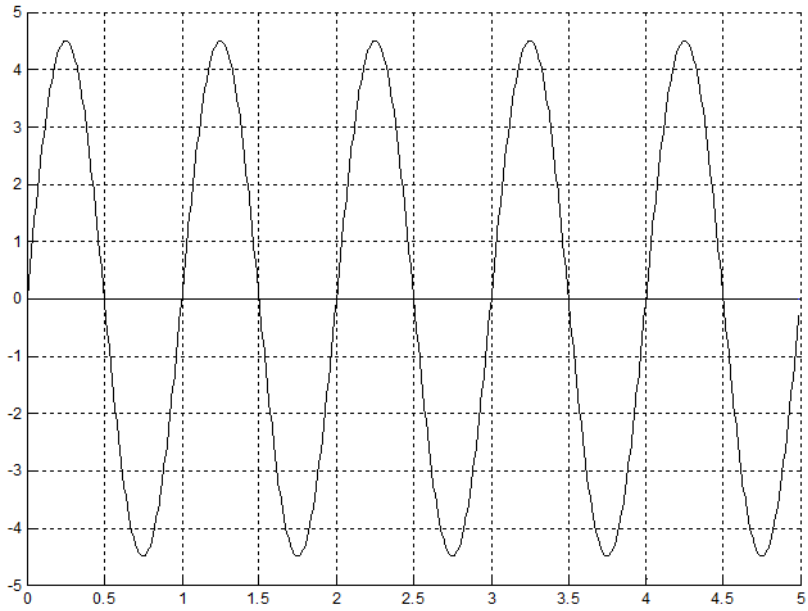
Compare YTUR speed signal at several different operating points with BPCS speed signals.

Test Steps:

1. **a.** Connect an oscilloscope to the speed sensor terminal board inputs to measure the pulse rates from the speed pickups

   Or

   b. Disconnect the speed sensor inputs and configure a function generator for a 9 Vpp sine wave output with zero offset to provide a reference speed signal to the pulse rate inputs.



Speed Input Accuracy

2. For at least two speeds in the range of 2 to 20,000 Hz, apply a speed signal and record the value of speed reported by the controller.

Note It is best to select a maximum applied test frequency that represents the overspeed signal for the unit under test.

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3. Verify that the channel being stimulated reads the correct value of speed and that all inputs that are not being stimulated read zero.
4. Repeat steps 2 and 3 on all configured pulse rate inputs.

Acceptance Criteria:

- The speed input function has less than a 1% deviation between the actual steady state field signal and the reported value.
- Each channel reads the correct value of speed when stimulated.
- All inputs that are not being stimulated read zero.
- There are no diagnostics.

6.8.2 TRPA E-Stop Input

Test Overview:

This test verifies that the E-Stop input on the TRPA:

- Can drive the trip relay outputs
- Can cross-trip the YPRO trip logic

Test Setup:

Note This test assumes that the trip solenoids are isolated from the circuit.

For each trip relay output, connect dummy loads to simulate trip solenoids as follows:

1. Connect one side of an appropriately sized resistor (10 kΩ 2 W) to the positive side of the trip relay output.
2. Connect the other side of the resistor to the positive side of a power supply (output voltage of power supply should be set to the nominal trip circuit voltage).
3. Connect the negative side of the power supply to the negative side of the trip relay output.

Test Steps:

1. Energize the E-Stop input and reset the trip relays (clear all trip sources and reset the YTUR such that the trip relays (PTR1-2) are picked up).
2. Verify that each controller (R, S, and T) correctly reads the status of the E-Stop input (KESTOP1_Fdbk).
3. Initiate an E-Stop Trip.
4. Verify the PTR's are de-energized (dropped out and that each controller (R, S, and T) correctly reads the status of the E-Stop input (KESTOP1_Fdbk).

Acceptance Criteria:

- E-Stop is energized (closed), the Primary Trip Relays (PTR) are energized (picked up)
- E-Stop is open, the PTRs are de-energized (dropped out)

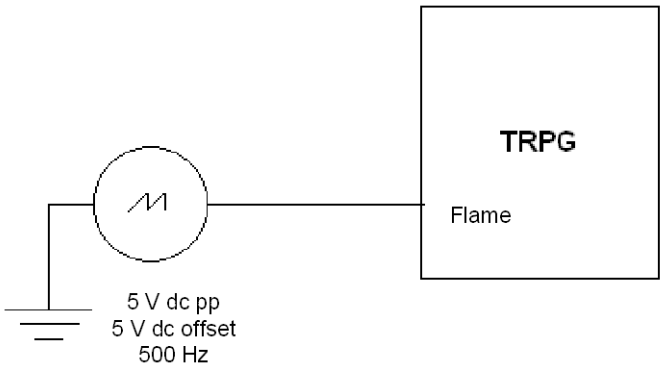
6.8.3 Flame Detection Inputs – Loss of Flame Detection

Test Overview:

This test checks for the YTUR to detect loss of flame and also verifies that no flame is the fail-safe state.

Test Setup:

For each configured (Geiger-Muller) flame detector input, connect a function generator as indicated in the following figure:



Flame Detector Simulation

Test Steps:

Perform the following steps five times on each of the flame detector inputs:

1. Set the function generator to 500 Hz, 5 V dc pp saw tooth with a 5 V dc offset.
2. Verify that FDn_Flame = *True*.
3. Remove the function generator signal from the flame detector input.
4. Verify that FDn_Flame transitions to *False*.

Acceptance Criteria:

- The function generator signal is disconnected and FDn_Flame transitions to *False*.
- There are no diagnostics generated during this test.

6.8.4 Low Source Voltage

Test Overview:

This test verifies that the I/O pack:

- Monitors its 28 V dc supply
- Generates diagnostics, if the supply is out of limits
- Performs an orderly shutdown, if the power supply voltage is too low for safe operation

Test Setup:

Prepare system for a fail-safe response from the I/O pack.

Test Steps:

1. Disconnect the 28 V dc power supply connection from the I/O pack. For TMR, disconnect two 28 V power supply connections.
2. Confirm that all the outputs are in their safe state and display as *Unhealthy*, and a diagnostic is generated.

Acceptance Criteria:

The supply voltage is less than 16 ± 1 V dc and:

- All outputs go their fail-safe state and displays as *Unhealthy.*
- A diagnostic is generated.
- Variables **PS18V_YTUR** and **PS28V_YTUR** display *False* and *Unhealthy.*