GE PTCC YTCC Thermocouple Input Modules

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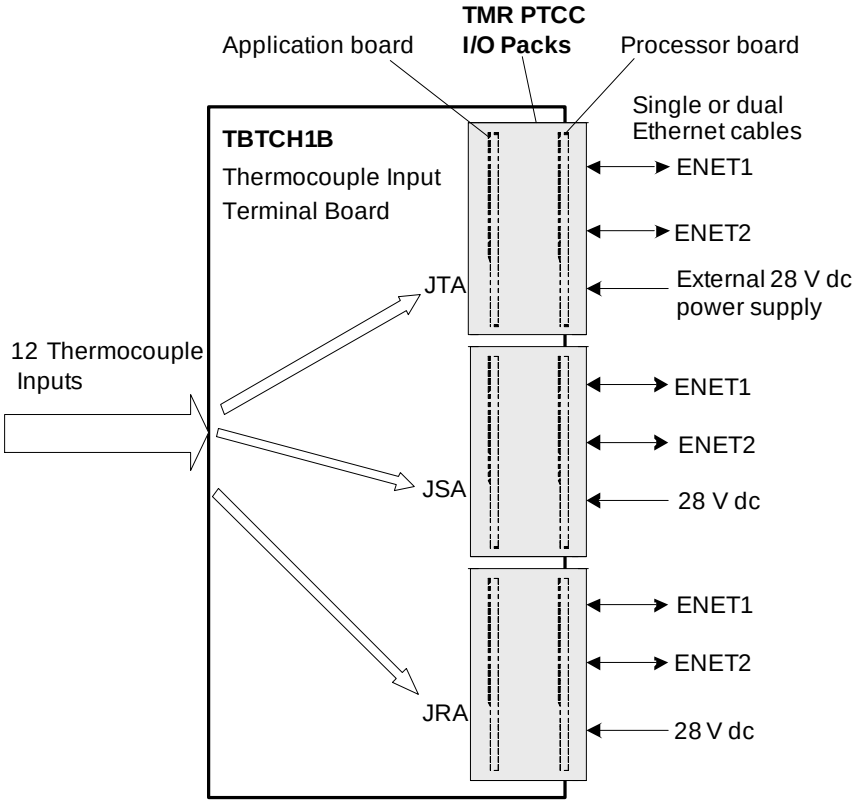
16.1 Mark VIe PTCC Thermocouple Input Pack

The Thermocouple Input PTCC provides the electrical interface between one or two I/O Ethernet networks (IONet) and a thermocouple input terminal board. The I/O pack contains a BPPx processor board and an acquisition board specific to the thermocouple input function. Input to the PTCC is through dual RJ-45 Ethernet connectors and a three-pin power input. Output is through a DC-37 pin connector that mates directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.

In a simplex configuration using the TBTCH1C terminal board, each PTCC is capable of handling up to 12 thermocouple inputs, for a total of 24 inputs (with two of them). In simplex configuration using the TBTCH1B terminal board, each PTCC is capable of handling up to 12 thermocouple inputs (for a total of 24 inputs), provided the two PTCCs are installed at the JRA and JTB connectors. In TMR configuration with the TBTCH1B, three PTCCs are used with three cold junctions, but only 12 thermocouples are available.



16.1.1 Compatibility

The PTCC includes one of the following compatible processor boards:

- PTCCH1A and H2A contain a BPPB processor board
- PTCCH1B and H2B contains a functionally compatible BPPC processor board that is supported in the ControlST***** software suite V04.06 and later

The PTCC is available in the following two versions:

- PTCCH1A and PTCCH1B support E, J, K, S, and T types of standard thermocouples and mV inputs. The mV span is –8 to 45 mV.
- PTCCH2A and H2B support E, J, K, S, T, B, N, and R types of standard thermocouples and mV inputs. The mV span for PTCCH2 is –20 to 95 mV.

Attention

B, N and R types of thermocouples should only be selected if PTCCH2A or PTCCH2B is used. These types of thermocouples must not be used or selected with PTCCH1A or PTCCH1B I/O packs.

The PTCC is compatible with the thermocouple input terminal board TBTC, and the simplex STTC terminal board, but not the DIN-rail mounted DTTC board. The following table provides the details of the terminal board compatibility.

Terminal Board	Configuration	# Packs	Thermocouple Inputs	Connectors
TBTCH1B, S1B	Simplex	1	12	Any
		2	24†	JRA and JTB
	TMR	3	12	JRA, JSA, JTA
TBTCH1C, S1C	Simplex	1 or 2	12 or 24	JA1, JB1
STTCH1A, S1A, H2A, S2A	Simplex	1	12	JA1
† Support of 24 thermocouple inputs on the TBTC_1B in simplex configuration requires the use of two PTCC I/O packs, which must be connected to JRA and JTB.				

16.1.2 Installation

➢ **To install the PTCC**

1. Securely mount the desired terminal board.
2. Directly plug the PTCC into the terminal board connectors.
3. Mechanically secure the PTTC(s) 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 connector between the PTCC and the terminal board. The adjustment should only be required once in the service life of the product.

Note The PTCC mounts directly to a Mark* VIe terminal board. Simplex terminal boards (TBTCH1C) have two DC-37 pin connectors that receive the PTCC, one for each set of 12 TC inputs. TMR capable terminal boards (TBTCH1B) have six DC-37 pin connectors. The PTCC directly supports all of these connections.

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4. Plug in one or two Ethernet cables depending on the system configuration. The PTCC 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. Apply power by plugging in the connector on the side of the PTCC. It is not necessary to remove power from the cable before plugging it in because the PTCC has inherent soft-start capability that controls current inrush on power application.
6. Use the ToolboxST* application to configure the PTCC as necessary.

16.1.3 Operation

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

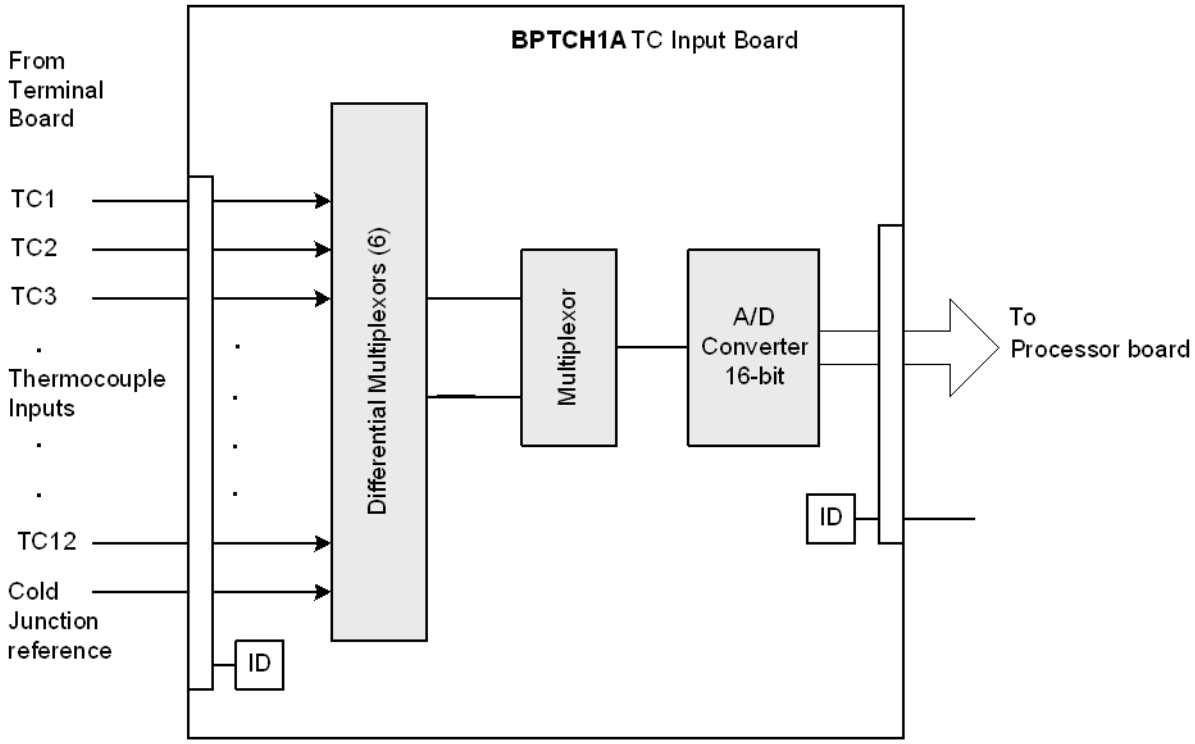
- *BPPx Processor*
- *Processor LEDs*
- *Power Management*
- *ID Line*
- *I/O Module Common Diagnostic Alarms*

16.1.3.1 Analog Input Hardware

The PTCC internal input board (BPTC) accepts 12 signals at mV levels from the thermocouples wired to the terminal board. The analog input section consists of six differential multiplexers, a main multiplexer, and a 16-bit analog to digital converter that sends the digital data to the adjacent processor board. Each input has hardware and firmware filters, and the converter samples at up to 120 Hz.

Type E, J, K, S, and T thermocouples can be used with PTCCH1A, and they can be grounded or ungrounded. Type E, J, K, S, T, B, N and R thermocouples can be used with PTCCH2A, and they can be grounded or ungrounded. Thermocouples can be located up to 300 meters (984 feet) from the turbine I/O panel with a maximum two-way cable resistance of 450 Ω.

Linearization for individual thermocouple types is performed in software by the I/O pack board. A thermocouple, which is determined to be out of the hardware limits, is removed from the scanned inputs to prevent adverse effects on other input channels. If two I/O packs are used, and both Cold Junction (CJ) devices are within the configurable limits, then the average of the two is used for CJ compensation.



16.1.3.2 Thermocouple Limits

TBTC with PTCCH1

Thermocouple inputs support a full-scale input range of –8.0 mV to 45.0 mV. The following table displays typical input voltages for different thermocouple types versus the minimum and maximum temperature range. The CJ temperature is assumed to range from –30 to 65°C (–22 to 149 °F). The units (°C or °F) are based on the *ThermCplUnit* parameter.

TC Limits for I/O Pack Type PTCCH1

Item	Thermocouple Type				
	E	J	K	S	T
Low range, °F	-60	-60	-60	0	-60
Low range, °C	-51	-51	-51	-17.78	-51
mV at low range with reference at 70°C (158 °F)	-7.174	-6.132	-4.779	-0.524	-4.764
High range, °F	1100	1400	2000	3200	750
High range, °C	593	760	1093	1760	399
mV at high range with reference at 0°C (32 °F)	44.547	42.922	44.856	18.612	20.801

TBTC with PTCCH2

Thermocouple inputs support a full-scale input range of -20.0 mV to 95.0 mV. The following table displays typical input voltages for different thermocouple types versus the minimum and maximum temperature range. The CJ temperature is assumed to range from -30 to 65°C (-22 to 149 °F).

TC Limits for I/O Pack Type PTCCH2

Item	Thermocouple Type				
	E	J	K	S	T
Low range, °F	-60	-60	-60	0	-60
Low range, °C	-51	-51	-51	-17.78	-51
mV at low range with reference at 70°C (158 °F)	-7.174	-6.132	-4.779	-0.524	-4.764
High range, °F	1832	2192	2372	3200	752
High range, °C	1000	1200	1300	1760	400
mV at high range with reference at 0°C (32 °F)	76.373	69.553	52.41	18.612	20.869

TC Limits for I/O Pack Type PTCCH2

Item	Thermocouple Type		
	B	N	R
Low range, °F	32	-60	0
Low range, °C	0	-51	-17.78
mV at low range with reference at 70°C (158 °F)	-0.0114	-3.195	-0.512
High range, °F	3272	2282	3092
High range, °C	1800	1250	1700
mV at high range with reference at 0°C (32 °F)	13.593	45.694	20.220

16.1.3.3 Cold Junctions

The CJ signal goes into signal space and is available for monitoring. Acceptable limits are configured, and if a CJ goes outside the limit, a logic signal is set. A 1 °F error in the CJ compensation will cause a 1 °F error in the thermocouple reading.

Hard-coded limits are set at -50 to 85°C (-58 to 185 ºF), and if a CJ goes outside this, it is regarded as unhealthy. Most CJ failures are open or short circuit. If the CJ is declared bad, the backup value (CJBackup, an output variable sent from the controller) is used. This backup value can be derived from CJ readings on other terminal boards, or can be the configured default value. The units (°C or °F) are based on the *ColdJuncUnit* parameter.

16.1.4 PTCC Specifications

Item	PTCC Specification
Number of Channels	12 channels per I/O pack
Thermocouple Types	E, J, K, S, T thermocouples, and mV inputs for PTCCH1. E, J, K, S, T, B, N, R thermocouples, and mV inputs for PTCCH2. ***B, N and R types of thermocouples should only be selected with PTCCH2A or PTCCH2B.***
Span	-8 mV to 45 mV for PTCCH1 -20 mV to 95 mV for PTCCH2
A/D Converter	Sampling type 16-bit A/D converter
Cold Junction Compensation	Reference junction temperature measured in each module TMR board has three cold junction references
Cold Junction Temperature Accuracy	Over the Celsius operating range: 1.1°C Over the Fahrenheit operating range: 2 °F
Conformity Error	Maximum software error 0.14ºC (0.25 ºF)
Measurement Accuracy	PTCCH1 = 53 µV (excluding cold junction reading). Example: For type K, at 1000 °F, including cold junction contribution, RSS error= 3 °F PTCCH2 = 115 µV (excluding cold junction reading). Example: For type K, at 1000 °F, including cold junction contribution, RSS error= 6 °F
Common Mode Rejection	AC common mode rejection 110 dB at 50/60 Hz, for balanced impedance input. Both hardware and firmware filtering.
Common Mode Voltage	±5 Volts
Normal Mode Rejection	Rejection of 250 mV rms at 50/60 Hz, ±5%, Both hardware and firmware filtering provides a total of 80 dB NMRR
Scan Time	All inputs are sampled at up to 120 times per second per input
Fault Detection	High/low (hardware) limit check High/low system (software) limit check Monitor readings from all TCs, CJs, calibration voltages, and calibration zero readings
Ambient Rating for Enclosure Design†	PTCCH1B is rated from -40 to 70°C (-40 to 158 °F) PTCCH1A 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*.

16.1.5 Diagnostics

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 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

Details of the individual diagnostics are available in the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RESET_DIA signal if they go healthy.

16.1.6 Configuration

16.1.6.1 Parameters

Parameter	Description	Choices
SysFreq	System Frequency (used for noise rejection)	60 Hz, 50 Hz
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
AutoReset	Automatic restoring of thermocouples removed from scan	Disable, Enable

16.1.6.2 Thermocouples

Thermocouple Name	Thermocouple Description	Choices
Thermocouple01	First of 24 thermocouples, point signal	Point Edit (Input FLOAT)
Thermocouple12		
ThermCplType	Select thermocouples type or mV input. Unused inputs are removed from scanning. The mV inputs are primarily for maintenance, but can also be used for custom remote CJ compensation. Standard remote CJ compensation is also available.	PTCCH1– Unused, mV, T, K, J, E, or S PTCCH2 – Unused, mV, T, K, J, E, S, B, N, or R B, N and R types of thermocouples should only be selected if PTCCH2A or PTCCH2B is used.

Thermocouple Name	Thermocouple Description	Choices
ThermCplUnit	Select thermocouples display unit in °C or °F. This value needs to match units of attached variable. The ThermCplUnit parameter affects the native units of the controller application variable. It is only indirectly related to the tray icon and associated unit switching capability of the HMI. This parameter should not be used to switch the display units of the HMI.	deg_F, deg_C
	 ***Caution*** **Do not change the ThermCplUnit parameter because these changes will require corresponding changes to application code and to the Format Specifications or units of the connected variable. This parameter modifies the actual value sent to the controller as seen by application code. Application code that is written to expect degrees Fahrenheit will not work correctly if this setting is changed. External devices, such as HMIs and Historians, may also be affected by changes to this parameter.**	
ReportOpenTC	For PTCCH2 version only; this parameter sets the failed state of an open thermocouple to either hot (high) or cold (low). This parameter is not applicable to the PTCCH1 version.	Fail_Cold, Fail_Hot
LowPassFiltr	Enable 2 Hz low pass filter	Enable, Disable
SysLimit1	System Limit 1 in °C, °F, or mV	-450 to 3500 (FLOAT)
SysLim1Enabl	Enable system limit 1 fault check, a temperature limit which can be used to create an alarm.	Enable, Disable
SysLim1Latch	Latch system limit 1 fault Determines whether the limit condition will latch or unlatch; reset used to unlatch	NotLatch, Latch
SysLim1Type	System limit 1 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤) a preset value	≥ or ≤
SysLimit2	System Limit 2 in °C, °F, or mV	-450 to 3500 (FLOAT)
SysLim2Enabl	Enable system limit 2 fault check, a temperature limit which can be used to create an alarm.	Enable, Disable
SysLim2Latch	Latch system limit 2 fault Determines whether the limit condition will latch or unlatch; reset used to unlatch System limit 2 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤) a preset value	NotLatch, Latch

Thermocouple Name	Thermocouple Description	Choices
SysLim2Type	System limit 2 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤), a preset value.	≥ or ≤
TMR_DiffLimt	Diagnostic limit, TMR input vote difference in engineering units Limit condition occurs if three temperatures in R, S, T differ by more than a preset value (engineering units); this creates a voting alarm condition.	-450 to 3500 (FLOAT)

16.1.6.3 Cold Junctions

Cold junctions are similar to thermocouples but without low pass filters.

Cold Junction Name	Cold Junction Description	Choices
ColdJuncType	Select CJ Type	Remote, Local
ColdJuncUnit	Select TC Display Unit Deg °C or °F. Value needs to match units of attached variable	Deg_F, Deg_C
SysLimit1	System Limit 1 - Deg °F or Deg °C	-40 to 185 (FLOAT)
SysLim1Enabl	Enable System Limit 1 Fault Check	Disable, Enable
SysLim1Latch	Latch System Limit 1 Fault	NotLatch, Latch
SysLim1Type	System Limit 1 Check Type (≥ or ≤)	≥ or ≤
SysLimit2	System Limit 2 - Deg °F or Deg °C	-40 to 185 (FLOAT)
SysLim2Enabl	Enable System Limit 2 Fault Check	Disable, Enable
SysLim2Latch	Latch System Limit 2 Fault	NotLatch, Latch
SysLim2Type	System Limit 2 Check Type (≥ or ≤)	≥ or ≤
TMR_DiffLimt	Diag Limit, TMR Input Vote Difference, in Eng Units	-450 to 3500 (FLOAT)

16.1.6.4 Variables

Variable	Description	Direction	Type
L3DIAG_PTCC	I/O Diagnostic Indication	Input	BIT
LINK_OK_PTCC	I/O Link Okay Indication	Input	BIT
ATTN_PTCC	I/O Attention Indication	Input	BIT
PS18V_PTCC	I/O 18 V Power Supply Indication	Input	BIT
PS28V_PTCC	I/O 28 V Power Supply Indication	Input	BIT
IOPackTmpr	I/O Pack Temperature (deg °F)	AnalogInput	FLOAT
SysLim1TC1	System limit 1 for thermocouple 1	Input	BIT
↓	↓	↓	
SysLim1TC12	System limit 1 for thermocouple 12	Input	BIT
SysLim1CJ1	System limit 1 for cold junction 1	Input	BIT
SysLim2TC1	System limit 2 for thermocouple 1	Input	BIT
↓	↓	↓	
SysLim2TC12	System limit 2 for thermocouple 12	Input	BIT
SysLim2CJ1	System limit 2 for cold junction 1	Input	BIT
CJBackup	Backup Cold Junction Temperature (°F or °C based on Cold Junction configuration)	AnalogOutput	FLOAT
CJRemote1	Remote Cold Junction Temperature. Used when Cold Junction set to Remote (°F or °C based on Cold Junction configuration)	AnalogOutput	FLOAT

16.2 PTCC Specific Alarms

The following alarms are specific to the PTCC I/O pack.

32-43

Description Thermocouple [ ] input voltage exceeds HW limit ([ ])

Possible Cause

- Thermocouple millivolt input to the analog-to-digital converter exceeded the converter limits and will be removed from the scan.

Solution

- Check field wiring, including shields.
- Check installation of the I/O pack on the terminal board. Problem is usually not a I/O pack or terminal board failure if other thermocouples are working correctly.

80

Description Cold Junction [ ] input voltage exceeds HW limit ([ ])

Possible Cause Cold junction input to the analog-to-digital converter exceeded the limits of the converter. If a cold junctions fails, the **CJ_Backup** value is used.

Solution

- Check the mounting of the I/O pack on the terminal board.
- Replace the terminal board.
- Replace the I/O pack.

92-103

Description Thermocouple [ ] value beyond range of configured TC type ([ ] deg)

Possible Cause

- Thermocouple mV input exceeded range of linearization (lookup) table for this TC type. Refer to documentation for specified thermocouple ranges.
- Thermocouple configured as wrong type.
- Board detected a thermocouple open, applied bias to circuit, driving it to a large negative number.
- Stray voltage or noise caused the input to exceed its range.

Solution

- Check field wiring, including shields.
- Check thermocouple for open circuit.
- Verify that the thermocouple type matches the configuration.
- Measure incoming mV signal and verify that it is within the specified thermocouple range.

128

Description Logic Signal [ ] Voting Mismatch

Possible Cause N/A

Solution N/A

160

Description Internal pack power supply not OK.

Possible Cause A power supply internal to the pack is not working properly. All thermocouple readings are suspect.

Solution Replace the I/O pack.

161

Description Reference Voltage out of limits

Possible Cause The reference voltage for the inputs is more than +/-5% beyond the expected value, indicating hardware failure.

Solution Replace the I/O pack.

163

Description Null Voltage out of limits

Possible Cause The Null voltage for the inputs is more than +/-5% beyond the expected value, indicating hardware failure.

Solution Replace the I/O pack.

224-236

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

Possible Cause

- The specified input signal varies from the voted value of the signal by more than the **TMR_DiffLimt**.
- A problem exists with the input, either from the device, the wire to the terminal board, or the terminal board.

Solution

- Verify that **TMR_DiffLimt** is set to the proper value.
- Check the grounding of the connected inputs and terminal board.
- Reboot the I/O pack.
- Replace the I/O pack.
- Replace the terminal board.