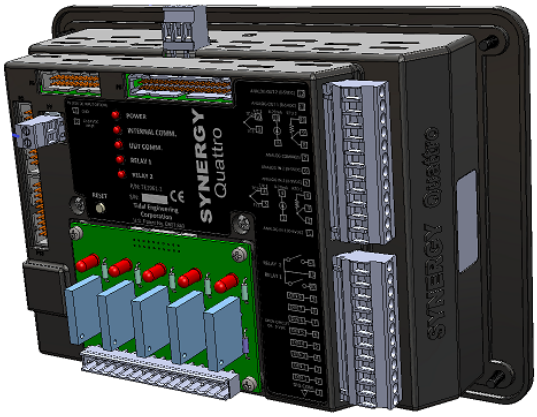
SYNERGY QUATTRO 2

Designed Specifically For Environmental Test Chambers

Installation Manual



Synergy Quattro 2

For One to Four Channel Systems

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Document Number TE2218 June 18, 2019

Revision History

Rev.	Date	Revision
-	August 28, 2013	Created this document, P/N TE2281 , "Synergy Quattro Installation Manual" from "Synergy Nano Installation Manual, Rev A"
-	January 5, 2015	Update this document, P/N TE2281 , "Synergy Quattro Installation Manual" to Rev B.
-	August 15, 2015	Update this document, P/N TE2281 , "Synergy Quattro Installation Manual" to Rev C. - Added Appendix D Application Notes
P1	June 16,2019	Preliminary Release for Synergy Quattro 2 -Added What's new -Moved shared Synergy Controller features to the Unified Technical Manual covering current generation Controller, Synergy Micro 2, Synergy Nano, Synergy Nano2 and Synergy Quattro

Table of Contents

Introduction

This Synergy Quattro 2 Installation Manual, written for OEMs, installers, and service personnel, is designed to provide a guide for Synergy Quattro 2 controller installations. The information and instructions are provided to help the reader select, configure, wire, and test a Synergy Quattro Controller.

The Synergy Controller Unified Technical Manual, Part Number TE1813, provides information for operators and programmers.

Tidal Engineering's family of Synergy Controllers provide state-of-the-art usability and connectivity for environmental test control and data acquisition and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards.

The new features and improvements in the Synergy Quattro 2 Controller highlights include:

- Faster Processor:
  - Dual Core, 1GHz NVIDIA Tegra 2 Processor (Original Quattro was Single Core 312MHz)
  - 512 MB Memory (Original Quattro was 64 MB)
- New Operating System
  - WEC 7 (Original Quattro was Windows CE 5)
- Brighter Screen:
  - 5.7" High Brightness TFT LCD
- More Connections:
  - HDMI Monitor Interface.
  - Second USB Port (on the back of the controller)
  - Low Cost WiFi Option
- Compatibility
  - 100% Compatible with all existing Synergy Controller Programs and configurations

Original Synergy Quattro Controller highlights include:

- 5.7" LED back Lit Color touch screen in a VersaTenn III compatible package.
- Up to four control channels.
- Ethernet and RS-232 communications standard. (GPIB /IEEE 488 Optional).
- Built in Data logger with USB Flash drive support
- Data Acquisition; Four process inputs. Up to (64) T-type thermocouples (Optional).
- Built-in Web Server for remote control; WebTouch Remote ™ (Free).
- Compatible with Synergy Manager for PC based control, monitoring, and programming.
- LabVIEW Driver
- Built-in FTP Server for factory automation and test and measurement applications.
- Two Analog Outputs
- 30 Digital Outputs, configurable for Time Proportioning and On-Off.
- 2 Electro Mechanical Relay Outputs, Time Proportioning and On-Off.
- Bar code reader feature with macro file for fast and error-proof setup

For more information regarding the controller including links for Synergy Manager and the Synergy Quattro Technical Manual downloads see our website at: www.tidaleng.com/synergy.htm

Download the Synergy Controller Unified Technical Manual Here:
https://tidaleng.com/techmans/Synergy_Controller_Unified_Technical_Manual.pdf

This Installation manual includes the following sections:

1. Controller Overview
2. Model Selection
3. Wiring
4. Setup
5. Tuning
6. Configuration Backup
7. Safety
8. Communications.

In addition, the following information is supplied in the Appendices as follows.

Appendix A: Accessories and Options
Appendix B: Output Primitive Descriptions
Appendix C: Frequently Asked Questions, FAQ
Appendix D: Application Notes
Appendix E: Example Wiring Diagram, VersaTenn III Temperature/Humidity retrofit
Appendix F: Example Wiring Diagram, VersaTenn III Temperature-Cascade retrofit
Appendix G: Example Wiring Diagram, VersaTenn III Temperature only retrofits

Safety

The Synergy Controller offers multiple built-in alarms to protect the chamber and the unit-under-test from conditions outside their ratings and capabilities. The alarms should be carefully set to appropriate limits based on the capabilities of the chamber and the safe limits of product exposure. In addition to these built-in alarms, a Secondary Limit Controlller (SLC), referred to here as a TempGard controller should always be employed to provide protection in the case of a controller failure.

1. Channel Alarm Limits

The Synergy Controller features high and low absolute limits and high and low deviations limits for each channel. Look for the alarms in the setup folder for each channel under SETUP/Calibration/Channel 1, 2, etc.

2. User Alarm Limits

In addition to the channel alarm limits, the Programmable User Alarm System can provide additional protection against open or failed sensors and process variables outside expected limits. User alarms can be created using redundant sensors for any channel and provide shut down protection to reduce the probability of damage or machinery failure.

3. Secondary Controller Alarms

Redundant protective mechanisms such as a TempGard SLC should be use to provide protection against controller and/or sensor failure. When used with a separate sensor, secondary alarm controllers reduce the probability that a single point failure will cause damage to the chamber or to the product under test. The secondary controller should be wired to remove power from all of the chamber's machinery in order to provide maximum protection.

3. Live Loads

When testing a product that dissipates heat (a "live" load) wire the TempGard SLC to some means to remove the power source fromo the product in the event of an alarm.

4. Alarm System Testing

It is important that users periodically verify all alarm systems by test. As a minimum, it is important to verify that a chamber shut- down occurs and power is removed from heaters, compressor, etc. when standard alarm limits, user programmable alarm limits, and secondary controller limits are reached.

No complex software or hardware system is perfect. Defects are always present in a software system of any size. In order to prevent danger to life or property, it is the responsibility of the system designer/owner to incorporate redundant protective mechanisms appropriate to the risk involved.

All Tidal Engineering products are 100 percent functionally tested. Additional testing may include visual inspections. Specifications are based on characterization of tested sample units; each production unit isn't tested over temperature and voltage. Additional testing or burn-in of a system is available by special order. Tidal Engineering reserves the right to make changes and improvements to its products without providing notice.

Make sure you completely understand the operation and function of the Synergy Controller before you begin using your test chamber.

Dangerous voltages are present both in the controller and in the test chamber. Disconnect electrical service from source and tag circuit out before servicing or replacing components.

Do not use the Synergy Controller in any manner not specified in this manual. Improper use may impair the safety features employed and may void your test chamber and controller warranty. Failure to follow the proper operating procedures listed throughout could cause damage to your equipment, personal injury, or death.

1. Controller Overview

The Synergy Quattro 2 Controller can operate a wide range of temperature chambers and process ovens. It supports simple time proportioning logic for heating and cooling, as well as complex output functions such as Boost Heat, Boost Cool, Vacuum and Vent, High and Low Stage Compressors, Artificial Load, Ambient Cooling, Vibration, etc.

Synergy Quattro 2 models support one 12-Output Triac board (1SM) and three 6-Output Triac boards (1SM and 2SM). Each output can be time proportioning or On/Off.

The Synergy Quattro 2 controller, like the Synergy Micro 2 and Synergy Nano work with a wide range of environmental test chamber configurations including; Temperature, Humidity, Altitude, Thermal Vacuum, Thermal Shock and HALT/HASS test chambers.

2. Model Selection

When selecting the best Synergy Controller model to use for a new or retrofit chamber application, engineers and installers should start by selecting the Chamber Definition from a list of standard definitions list.

The Chamber Definition File (CDF) defines the configuration of Channels, Outputs, Inputs, and Alarms. The Standard Chamber Definitions cover a wide range of applications. Custom Chamber Definitions can be provided by the factory and loaded onto the controller.

Channels Assignment

The Synergy Quattro 2 supports up to four channels. Each channel is assigned a process input and at least one control output and can be temperature, humidity, altitude (pressure) Torr or kft, Vibration (GRMS), Air Velocity, or light. Typically, temperature is assigned to channel 1. The Chamber Definition File defines the channels. The Synergy Quattro 2 accepts a variety of process inputs. See the block diagram below for an overview.

Output Assignments

Each CDF defines a set of outputs for each channel. For simple chambers, like Temperature only configurations, a compressor and a heater output is all that is required. For more sophisticated temperature applications and for cascade refrigeration systems, there may be eleven or more outputs. Fan, PID Heat, PID Cool, Hi and Low Stage compressors, Boost Heat, Boost Cool, Full Cool, Cascade Condenser, Hi Artificial Load (bypass), Low Artificial Load, etc.

Each primitive executes an algorithm that controls its function. The algorithms used to control these primitives are defined in the sections that follow. Primitive can be very simple. The Fan primitive for example comes on whenever Channel 1 is on. More complicated primitives such as

the dehumidify coil are controller by L-values L11 and L12, Digital Input 2 and LEV 1, and the dehumidifier PID.

Chamber Definition Selection

If none of the pre-configured chamber definitions fits the application, contact the factory or a Synergy Certified installer for a modified configuration.

The Chamber Definition File (CDF) can also be used to re-define standard alarms and define custom alarms.

The Chamber Definition also defines default sensors (sensor IDs) and default PID tuning. These settings can be modified after the configuration is loaded. The channel assignments and Output Primitive assignments cannot be changed from the controller.

Synergy Quattro 2 Sensors

Process Input 1 (one of the following inputs)

Signal	Signal Location	Sensor ID	Comments
RTD1	Hi Resolution RTD 1	**110**	
T/C1	Hi Resolution T/C 1	**170**	
4-20mA	Hi Resolution Analog 3	**150**	

And Voltage 1

Signal	Signal Location	Sensor ID	Comments
Voltage	Hi Resolution Analog 1	**130**	

Process Input 2 (one of the following inputs)

Signal	Signal Location	Sensor ID	Comments
RTD2	Hi Resolution RTD 2	**120**	
T/C2	Hi Resolution T/C 2	**180**	
4-20mA	Hi Resolution Analog 4	**160**	

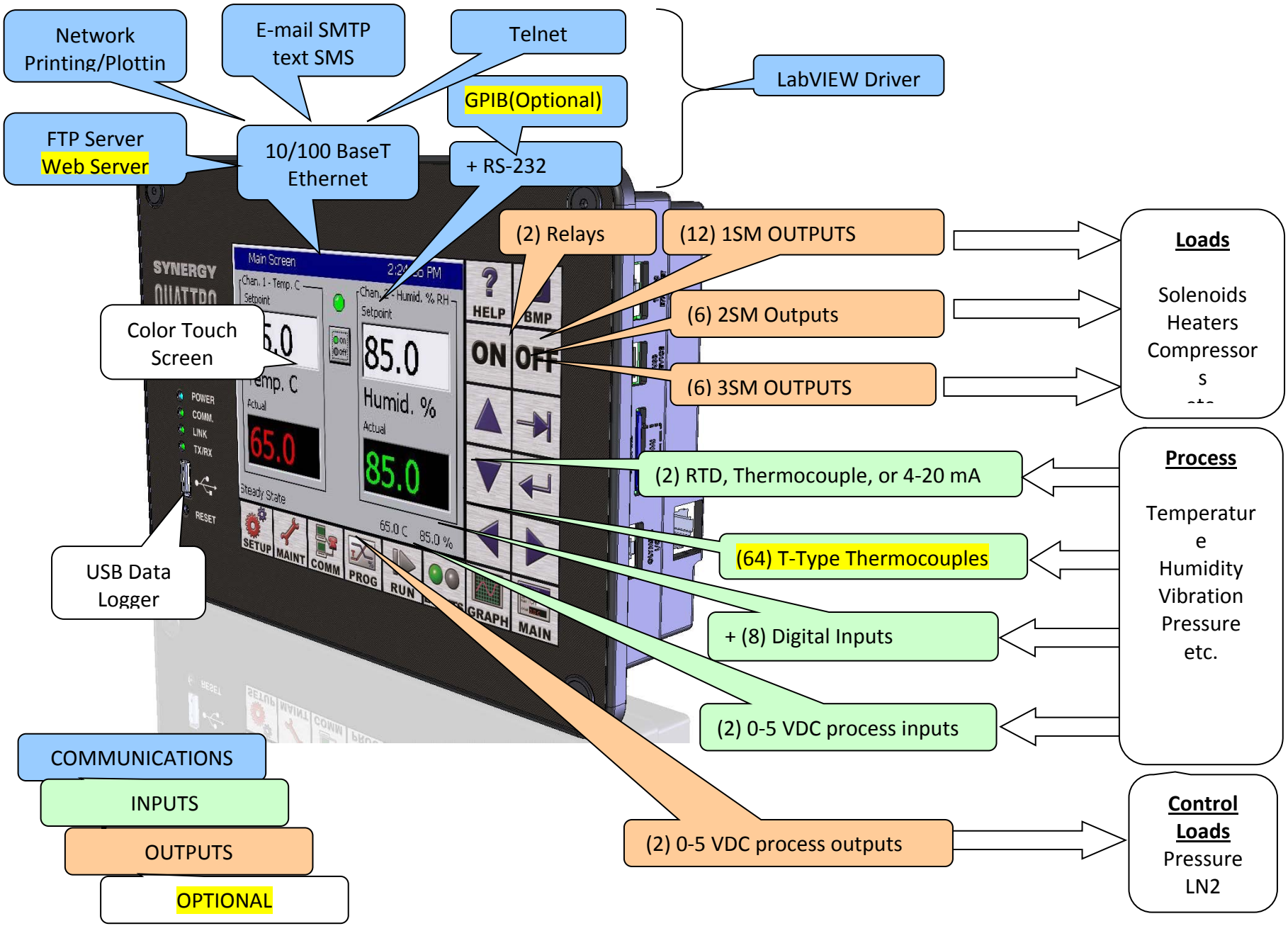
And Voltage 2

Signal	Signal Location	Sensor ID	Comments
Voltage	Hi Resolution Analog 2	**140**	

UUT Inputs

Up to 64 T-Type Thermocouples

Signal	Signal Location	Sensor ID	Comments
Temperature	UUT 1	**211-218**	**UUT Module 1, Sensor 1 to 8**
Temperature	UUT 2	**221-228**	**UUT Module 1, Sensor 9 to 16**
Temperature	UUT 3	**231-238**	**UUT Module 2, Sensor 1 to 8**
Temperature	UUT 4	**241-248**	**UUT Module 2, Sensor 9 to 16**
Temperature	UUT 5	**251-258**	**UUT Module 3, Sensor 1 to 8**
Temperature	UUT 6	**261-268**	**UUT Module 3, Sensor 9 to 16**
Temperature	UUT 7	**271-278**	**UUT Module 4, Sensor 1 to 8**
Temperature	UUT 8	**281-288**	**UUT Module 1, Sensor 9 to 16**


Network Printing/Plottin
E-mail SMTP text SMS
Telnet
GPIB(Optional)
+ RS-232
LabVIEW Driver
FTP Server
Web Server
10/100 BaseT Ethernet
(2) Relays
(12) 1SM OUTPUTS
(6) 2SM Outputs
(6) 3SM OUTPUTS
Loads
Solenoids
Heaters
Compressor
s
Color Touch Screen
USB Data Logger
(2) RTD, Thermocouple, or 4-20 mA
(64) T-Type Thermocouples
+ (8) Digital Inputs
(2) 0-5 VDC process inputs
Process
Temperatur
e
Humidity
Vibration
Pressure
etc.
(2) 0-5 VDC process outputs
Control Loads
Pressure
LN2
COMMUNICATIONS
INPUTS
OUTPUTS
OPTIONAL

3. Standard Chamber Definitions

The Chamber Setup Directory is used for factory setup. The chamber type specified in the Synergy Controller must match the chamber that it is controlling. The Chamber Type setting maps software outputs to chamber hardware. Each chamber type has as specific map that is unique to that type of chamber. The operator should NEVER change this setting. It should only be modified by a qualified technician.

3.1 Quattro Temperature Only	
3.2 Quattro Temperature/Temperature *	
3.3 Quattro Temperature/Humidity *	
3.4 Quattro Temperature/Humidity Single Stage	
3.5 Quattro Temperature/Pressure *	
3.6 Quattro Temperature/Humidity/Pressure	
3.7 Quattro Temperature/Vibration	
3.8 Quattro Retro Temperature Only	

The Chambers Types in the list above that are identified with * support VersaTenn retrofit fit applications.

WARNING: Incorrect Chamber Type settings may cause severe damage to your chamber.

Chamber Output Mapping

The Synergy Controller can be configured for many chamber types. Each chamber type has a unique device output mapping. For example, the fan is driven by Output 1 on Temp-Humidity and Temp-Only chambers, and by Output 10 for Temp-Temp chambers.

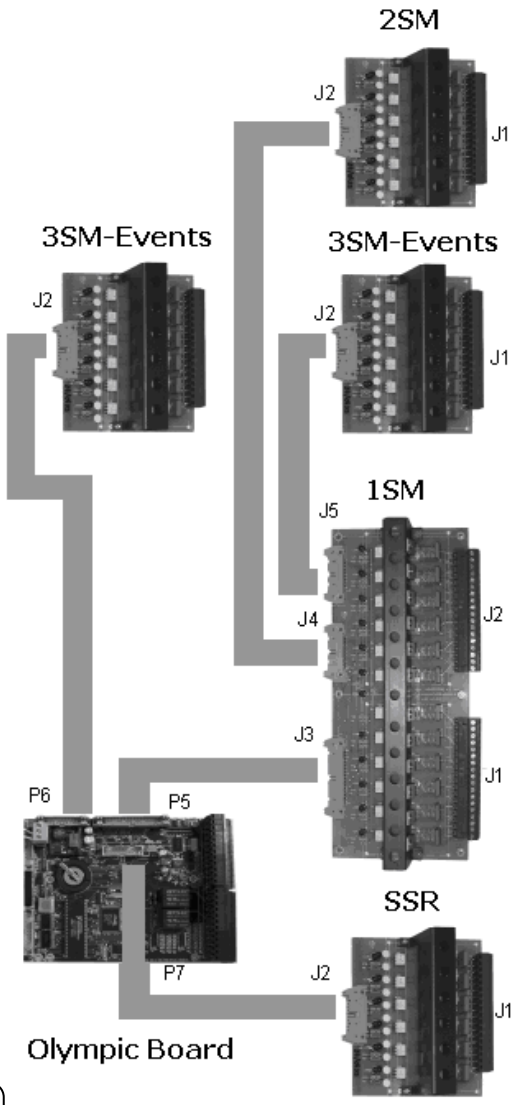
The following tables list the output mappings for the supported chamber types including retrofit configurations; i.e. when the Synergy Controller is installed on a chamber with a VersaTenn, VersaTenn II or VersaTenn III.

Output Map Abbreviations:

- SM – Switching Module
- SSR – Solid State Relay
- P# - Olympic Board Connector Labels
- J# - Output Board Connector Labels

Switching Module Configuration

The Olympic board drives all of the outputs for the chamber thru solid state switches called Switching Modules (SM). In some cases there is more than one way to connect a specific output. This provides flexibility when wiring the chamber to support new and retrofit installations. The figure at the right shows the different the ways Olympic board can be connected to the various SM boards.



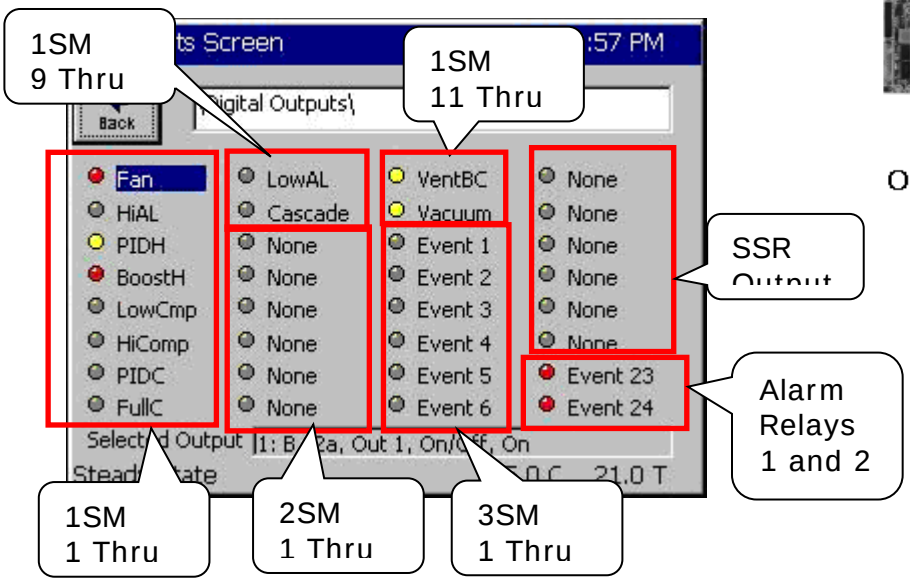
For example, note that the 3SM-Event outputs can be connected two ways; directly to the Olympic board P6 connector or thru the 1SM- J5 connector as shown at the right

In addition, some chamber definitions provide the same function to more than one output. This is referred to as mirroring.

For example, in the Generic Temperature Humidity configuration the “Humidify” output is available on 2SM-2 and SSR-2. The SSR outputs emulate the VersaTenn III SSR outputs which simplifies VersaTenn controller retrofits. To further support retrofits, the 5-Channel output board is wired to emulate the wiring of the VersaTenn III SSR outputs.

Installation section 17.0 describes the SSR outputs for retrofit configurations in greater detail.

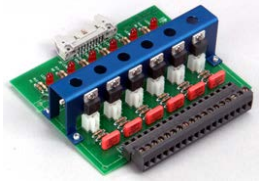
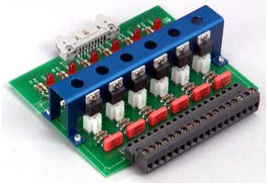
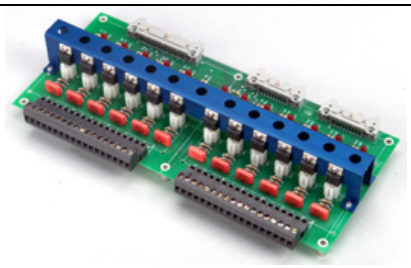
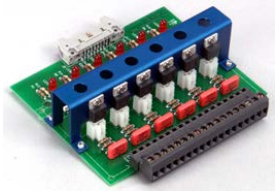
The Screenshot below shows the position of each switching module on the EVENTS/Digital Output Screen.



Output Mappings by Chamber Type

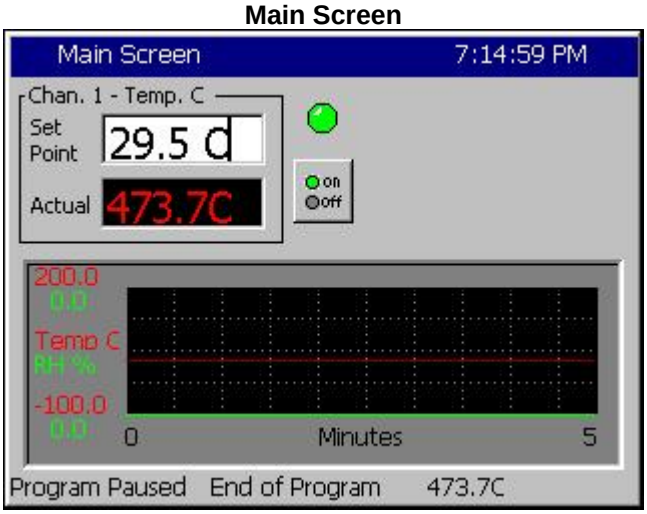
The following sections identify the output mappings for each chamber configuration.

3.1 Quattro Temperature Only

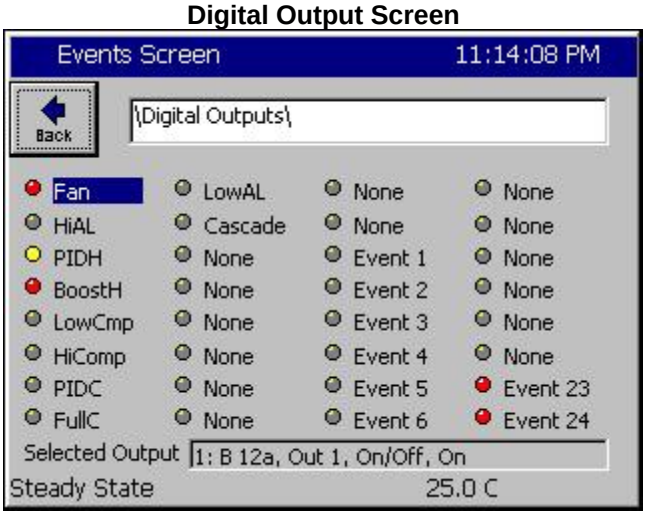
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	16	
	5	15	
	4	14	
	3	13	
	2	12	
	1	11	
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	
	5	23	
	4	22	
	3	21	
	2	20	
	1	19	
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	
	11	17	
	10	10	
	9	9	
	8	8	
	7	7	
	6	6	
	5	5	
	4	4	
	3	3	
	2	2	
	1	1	
SSR Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	30	
	5	29	
	4	28	
	3	27	
	2	26	
	1	25	

Quattro **Temp Only**

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type				
Sensor				
High Volt Scale				
Low Volt Scale				
High Eng Scale				
Low Eng. Scale				

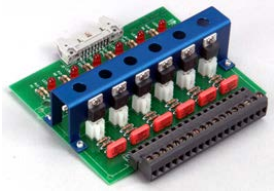
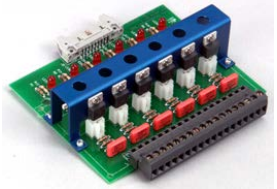
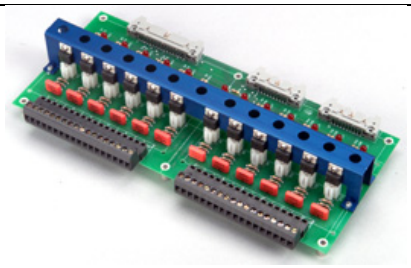
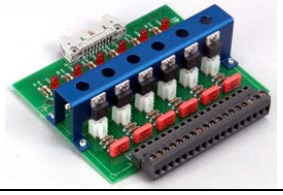
Digital Inputs

Name	Input	Function when Closed
Compressor Cut in Logic	Input 3	Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc)
Burn-in Logic	Input 4	Enables Low Stage Compressor and Full Cool with LEV1.
AGREE Chamber Logic	Input 5	Locks out Low Stage Compressor and enables High Stage Compressor and Full Cool with LEV1
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

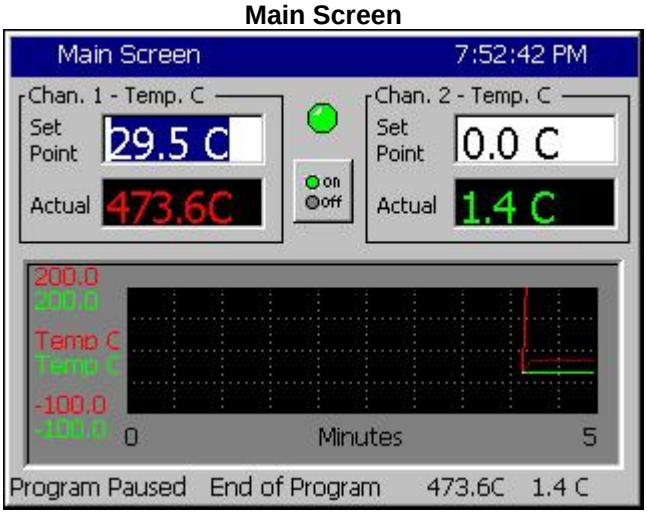
Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1							
Low Alarm Ch 1							
Bad Sensor Ch 1							
Bad Sensor Ch 1							
TempGard							

3.2 Quattro Temperature/Temperature, Dual Thermal Shock

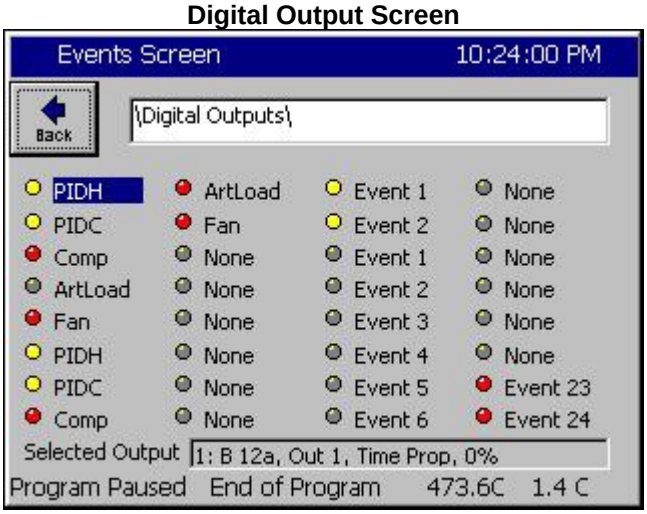
Generic Temp/Temp, Dual Thermal Shock			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	16	Not Used
	5	15	Not Used
	4	14	Not Used
	3	13	Not Used
	2	12	Not Used
	1	11	Not Used
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Event 2
	11	17	Event 1
	10	10	Fan
	9	9	Artificial Load
	8	8	Compressor
	7	7	PID Cool
	6	6	PID Heat
	5	5	Fan
	4	4	Artificial Load
	3	3	Compressor
	2	2	PID Cool
	1	1	PID Heat
SSR Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used

Quattro **Temp/Temp (Thermal Shock)**

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Temperature	N/A	N/A
Sensor	RTD1	RTD2	N/A	N/A
High Volt Scale	N/A	N/A	N/A	N/A
Low Volt Scale	N/A	N/A	N/A	N/A
High Eng Scale	N/A	N/A	N/A	N/A
Low Eng. Scale	N/A	N/A	N/A	N/A

Digital Inputs

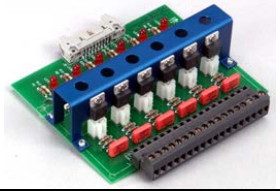
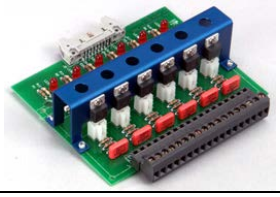
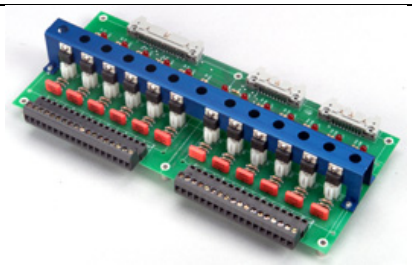
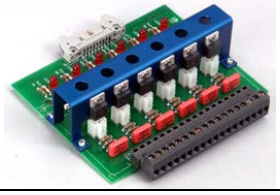
Name	Input	Function when Closed
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	RTD2	120	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 2	RTD2	120	< -200C	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	RTD2	120	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	RTD2	120	> 330 Ohm	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

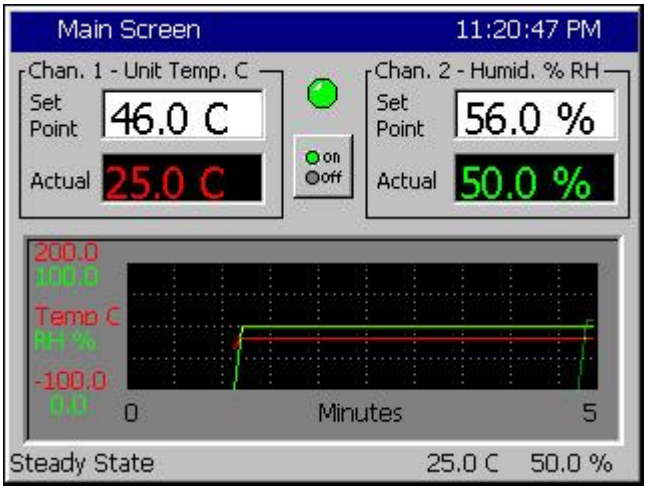
This Generic Temp/Temp configuration supports VersaTenn Thermal Shock retrofits.

3.3 Generic Temperature/Humidity

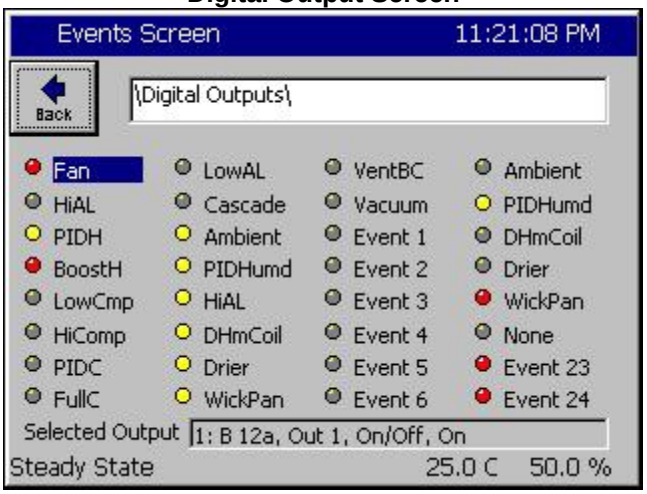
Quattro Temperature/Humidity			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	16	Wickpan
	5	15	Drier
	4	14	Dehumidify Coil
	3	13	Hi Al
	2	12	PID Humidify
	1	11	Ambient
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Vacuum
	11	17	Vent BC
	10	10	Cascade
	9	9	Low Artificial Load
	8	8	Full Cool
	7	7	PID Cool
	6	6	High Compressor
	5	5	Low Compressor
	4	4	Boost Heat
	3	3	PID Heat
	2	2	High Artificial Load
	1	1	Fan
SSR Outputs			
TE1151-5	SSR Channel	Digital Output	Device
			
	5	29	Wickpan
	4	28	Drier
	3	27	Dehumidify Coil
	2	26	PID Humidify
	1	25	Ambient

Quattro Temperature Humidity Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Humidity	N/A	N/A
Sensor	RTD1	Analog 1	N/A	N/A
High Volt Scale	N/A	5VDC	N/A	N/A
Low Volt Scale	N/A	0VDC	N/A	N/A
High Eng Scale	N/A	100%	N/A	N/A
Low Eng. Scale	N/A	0%	N/A	N/A

Digital Inputs

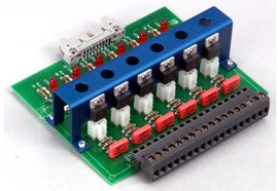
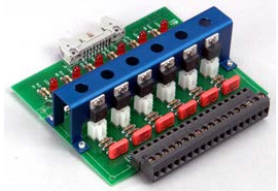
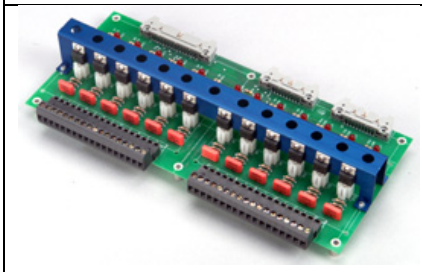
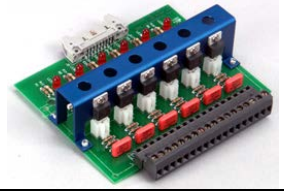
Name	Input	Function when Closed
Ambient Lock Out	Input 1	Disables Ambient Coil when Dehumidify Coil is on.
Drier Logic	Input 2	Enables Drier when LEV1 (Use Drier) is active.
Compressor Cut in Logic	Input 3	Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc)
Burn-in Logic	Input 4	Enables Low Stage Compressor and Full Cool with LEV1.
AGREE Chamber Logic	Input 5	Locks out Low Stage Compressor and enables High Stage Compressor and Full Cool with LEV1
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	Analog1	130	104%	Yes	Yes	Yes	No
Low Alarm Ch 2	Analog1	130	-10%	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	< -.1 Vdc	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	> 5.25 Vdc	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

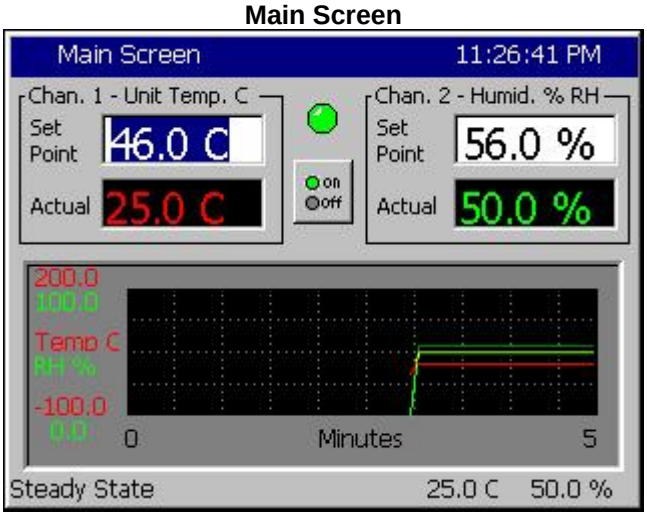
This Generic Temperature/Humidity configuration supports VersaTenn retrofits.

3.4 Quattro Temperature/Humidity Single Stage

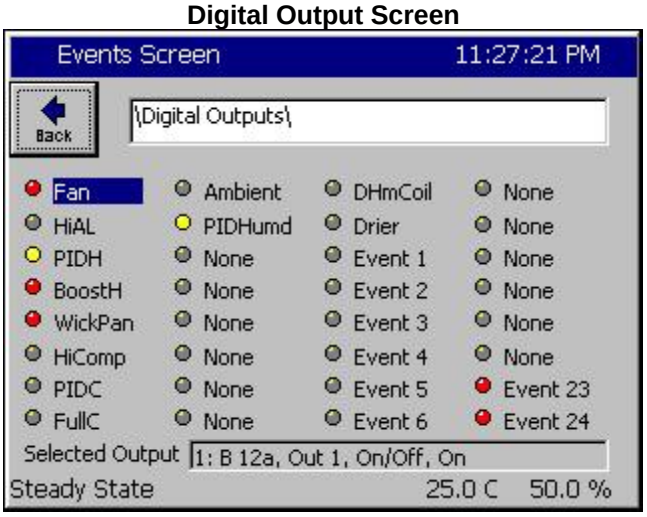
Quattro Temperature/Humidity Single Stage			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Drier
	11	17	Dehumidify Coil
	10	10	PID Humidity
	9	9	Ambient
	8	8	Full Cool
	7	7	PID Cool
	6	6	High Compressor
	5	5	Wickpan
	4	4	Boost Heat
	3	3	PID Heat
	2	2	High Artificial Load
	1	1	Fan
SSR Outputs			
TE1151-5	SSR Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used

Quattro Temperature/Humidity Single Stage Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Humidity	N/A	N/A
Sensor	RTD1	Analog 1	N/A	N/A
High Volt Scale	N/A	5VDC	N/A	N/A
Low Volt Scale	N/A	0VDC	N/A	N/A
High Eng Scale	N/A	100%	N/A	N/A
Low Eng. Scale	N/A	0%	N/A	N/A

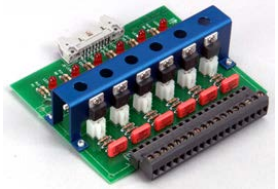
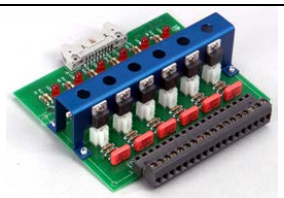
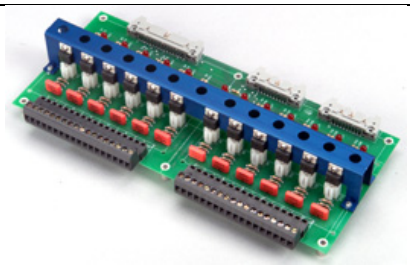
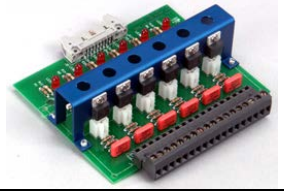
Digital Inputs

Name	Input	Function when Closed
Ambient Lock Out	Input 1	Disables Ambient Coil when Dehumidify Coil is on.
Drier Logic	Input 2	Enables Drier when LEV1 (Use Drier) is active.
Compressor Cut in Logic	Input 3	Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc)
Burn-in Logic	Input 4	Enables Low Stage Compressor and Full Cool with LEV1.
AGREE Chamber Logic	Input 5	Locks out Low Stage Compressor and enables High Stage Compressor and Full Cool with LEV1
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

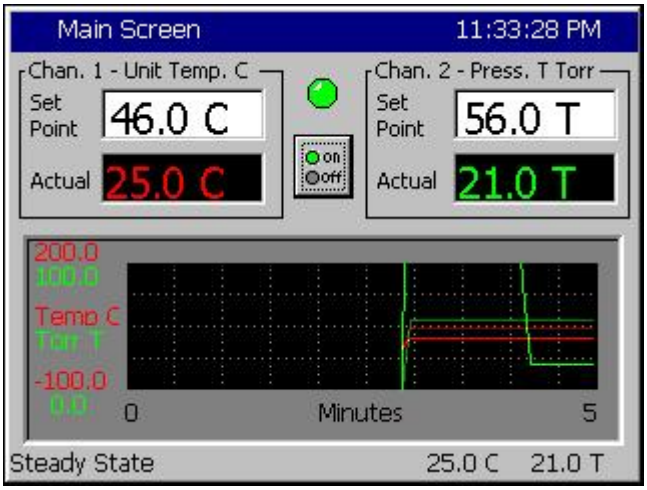
Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	Analog1	130	104%	Yes	Yes	Yes	No
Low Alarm Ch 2	Analog1	130	-10%	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	< -.1 Vdc	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	> 5.25 Vdc	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

3.5 Quattro Temperature/Pressure, Altitude and Space

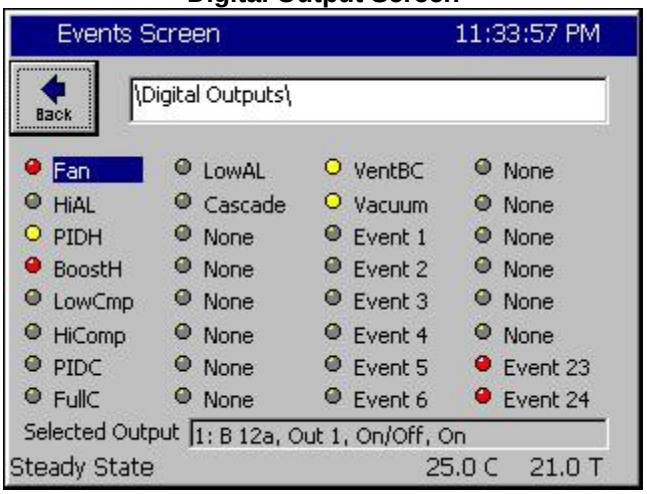
Quattro Temperature/Pressure, Altitude & Space			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Vacuum
	11	17	Vent BC
	10	10	Cascade
	9	9	Low Artificial Load
	8	8	Full Cool
	7	7	PID Cool
	6	6	High Compressor
	5	5	Low Compressor
	4	4	Boost Heat
	3	3	PID Heat
	2	2	High Artificial Load
	1	1	Fan
SSR Outputs			
TE1151-5	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used

Quattro Temperature/Pressure Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Pressure	N/A	N/A
Sensor	RTD1	Analog 1	N/A	N/A
High Volt Scale	N/A	5VDC	N/A	N/A
Low Volt Scale	N/A	0VDC	N/A	N/A
High Eng Scale	N/A	1000 Torr	N/A	N/A
Low Eng. Scale	N/A	0 Torr	N/A	N/A

Digital Inputs

Name	Input	Function when Closed
Ambient Lock Out	Input 1	Disables Ambient Coil when Dehumidify Coil is on.
Drier Logic	Input 2	Enables Drier when LEV1 (Use Drier) is active.
Compressor Cut in Logic	Input 3	Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc)
Burn-in Logic	Input 4	Enables Low Stage Compressor and Full Cool with LEV1.
AGREE Chamber Logic	Input 5	Locks out Low Stage Compressor and enables High Stage Compressor and Full Cool with LEV1
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

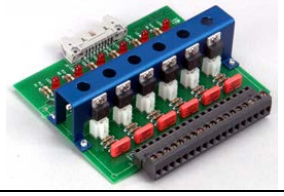
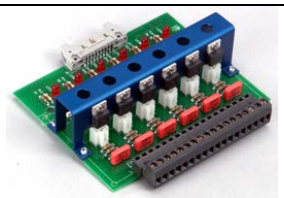
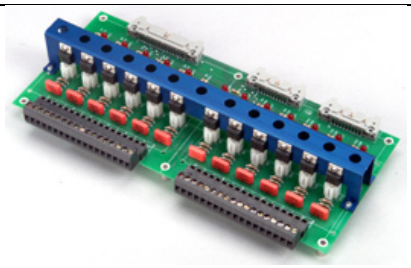
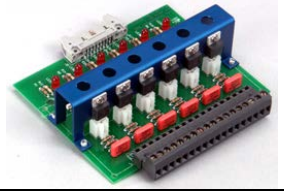
Alarms

Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	Analog1	130	1010T	Yes	Yes	Yes	No
Low Alarm Ch 2	Analog1	130	-10T	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	< -.1 Vdc	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	> 5.25 Vdc	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

See Section 15.0 Space and Altitude Chambers for additional setup information.

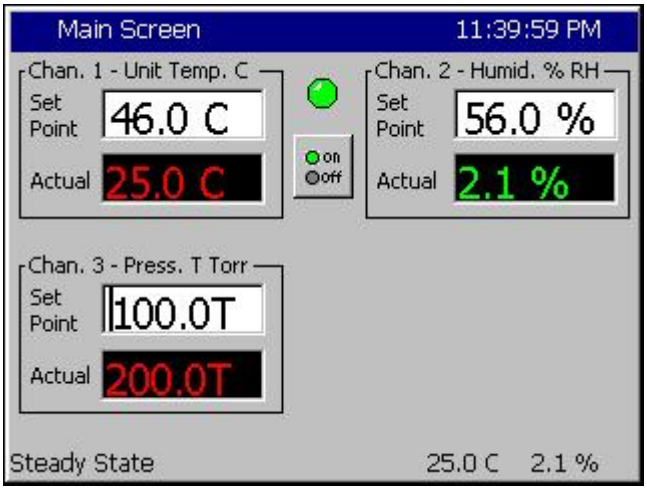
This Generic Temperature/Pressure configuration supports VersaTenn Altitude Chamber retrofits.

3.6 Quattro Temperature/Humidity/Pressure, Altitude

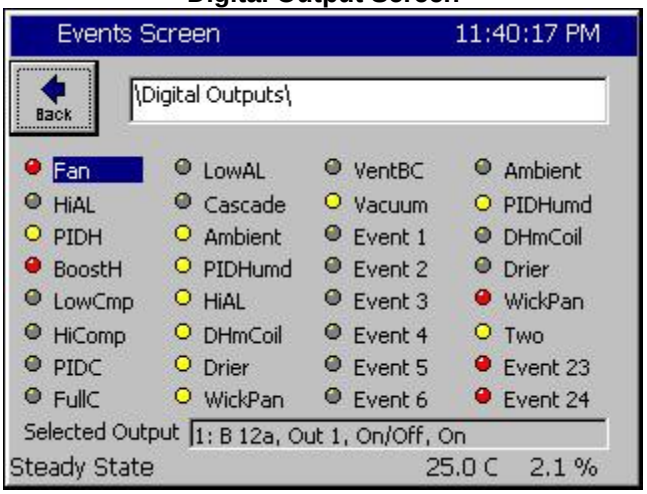
Quattro Temperature/Humidity/Pressure ,Altitude			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	16	Wickpan
	5	15	Drier
	4	14	Hi Al
	3	13	Dehumidify Coil
	2	12	PID Humidity
	1	11	Ambient
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Vacuum
	11	17	Vent BC
	10	10	Cascade
	9	9	Low Artificial Load
	8	8	Full Cool
	7	7	PID Cool
	6	6	High Compressor
	5	5	Low Compressor
	4	4	Boost Heat
	3	3	PID Heat
	2	2	High Artificial Load
	1	1	Fan
SSR Outputs			
TE1151-5	SM Channel	Digital Output	Device
	6	30	Two
	5	29	Wick Pan
	4	28	Drier
	3	27	Dehumidify Coil
	2	26	PID Humidity
	1	25	Ambient

Quattro Temperature/Humidity/Pressure Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Humidity	Pressure	N/A
Sensor	RTD1	Analog 1	Analog 2	N/A
High Volt Scale	N/A	5VDC	5VDC	N/A
Low Volt Scale	N/A	0VDC	0VDC	N/A
High Eng Scale	N/A	100%	1000 Torr	N/A
Low Eng. Scale	N/A	0%	0 Torr	N/A

Digital Inputs

Name	Input	Function when Closed
Ambient Lock Out	Input 1	Disables Ambient Coil when Dehumidify Coil is on.
Drier Logic	Input 2	Enables Drier when LEV1 (Use Drier) is active.
Compressor Cut in Logic	Input 3	Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc)
Burn-in Logic	Input 4	Enables Low Stage Compressor and Full Cool with LEV1.
AGREE Chamber Logic	Input 5	Locks out Low Stage Compressor and enables High Stage Compressor and Full Cool with LEV1
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

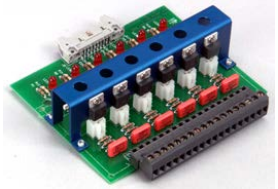
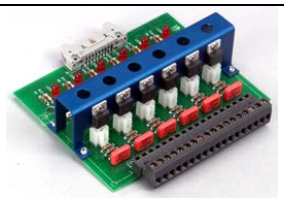
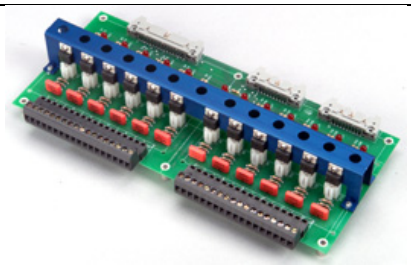
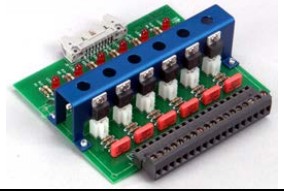
Alarms

Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	Analog1	130	104%	Yes	Yes	Yes	No
Low Alarm Ch 2	Analog1	130	-10%	Yes	Yes	Yes	No
Hi Alarm Ch 3	Analog2	140	1010 Torr	Yes	Yes	Yes	No
Low Alarm Ch 3	Analog2	140	-10 Torr	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	< -.1 Vdc	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	> 5.25 Vdc	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

See Section 15.0 Space and Altitude Chambers for additional setup information.

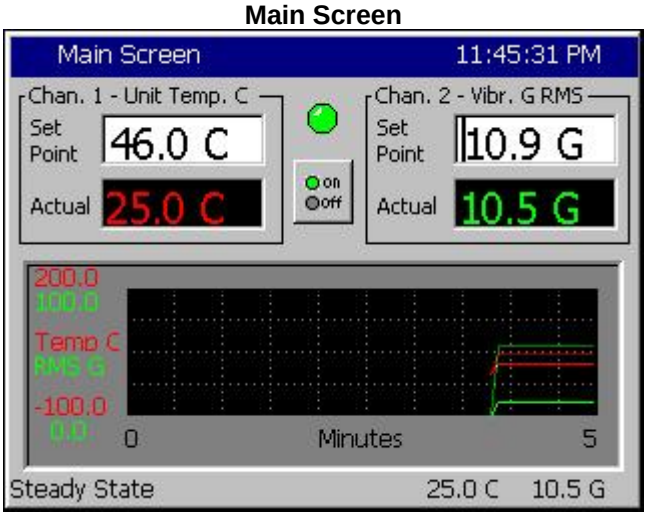
This Generic Temp/Humidity/Pressure configuration supports VersaTenn Altitude Chamber retrofits.

3.7 Quattro Temperature/Vibration

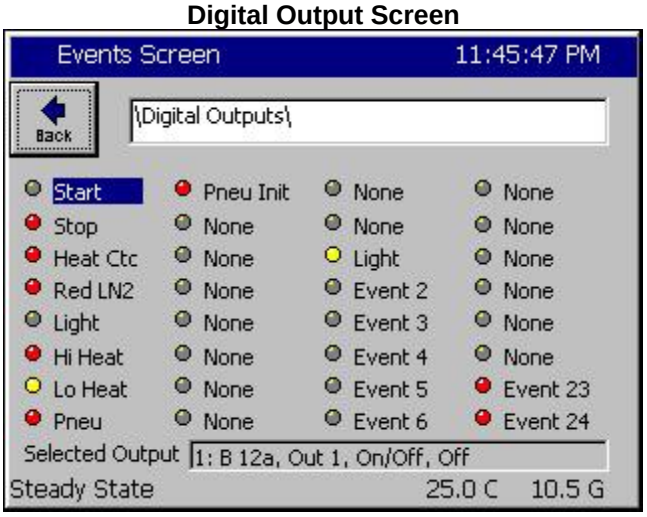
Quattro Temperature/Vibration (HALT/HASS)			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Not Used
	11	17	Not Used
	10	10	Not Used
	9	9	Pneumatic Initiate
	8	8	Pneumatic Enable
	7	7	Lo Heat
	6	6	High Heat
	5	5	Light
	4	4	Redundant LN2
	3	3	Heat Contactor
	2	2	Stop
	1	1	Start
SSR Outputs			
TE1151-5	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Not Used
	4	28	Not Used
	3	27	Not Used
	2	26	Not Used
	1	25	Not Used

Quattro Temperature/Vibration Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	Vibration	N/A	N/A
Sensor	RTD1	Analog 1	N/A	N/A
High Volt Scale	N/A	5VDC	N/A	N/A
Low Volt Scale	N/A	0VDC	N/A	N/A
High Eng Scale	N/A	100 Grms	N/A	N/A
Low Eng. Scale	N/A	0 Grms	N/A	N/A

Digital Inputs

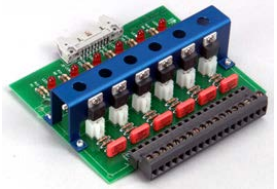
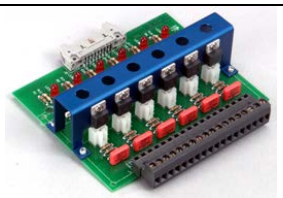
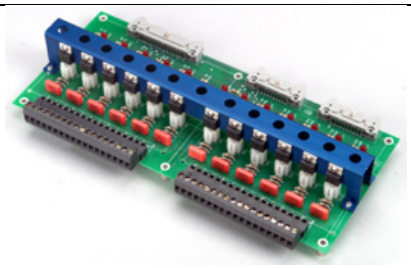
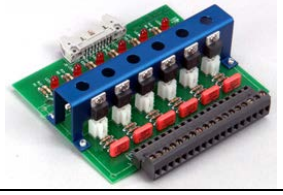
Name	Input	Function when Closed
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Hi Alarm Ch 2	Analog1	130	104 Grms	Yes	Yes	Yes	No
Low Alarm Ch 2	Analog1	130	0 Grms	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	< -.1 Vdc	Yes	Yes	Yes	No
Bad Sensor Ch 2	Analog1	130	> 5.25 Vdc	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

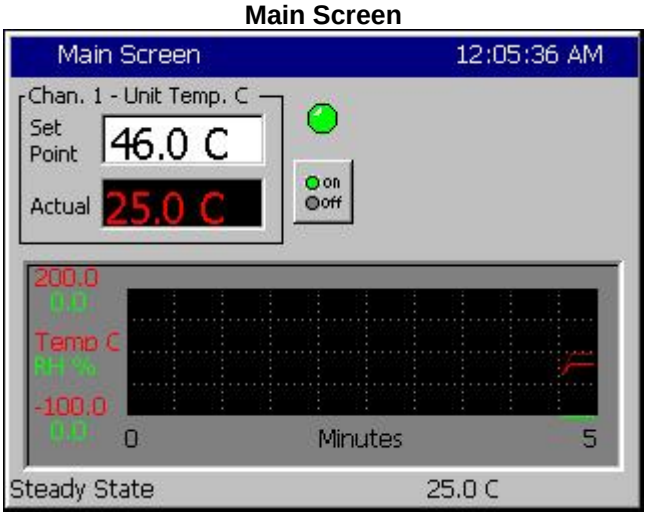
This Generic Temperature/Vibration configuration supports QualMark HALT/HASS Chamber retrofits.

3.8 Quattro Retro Temp Only

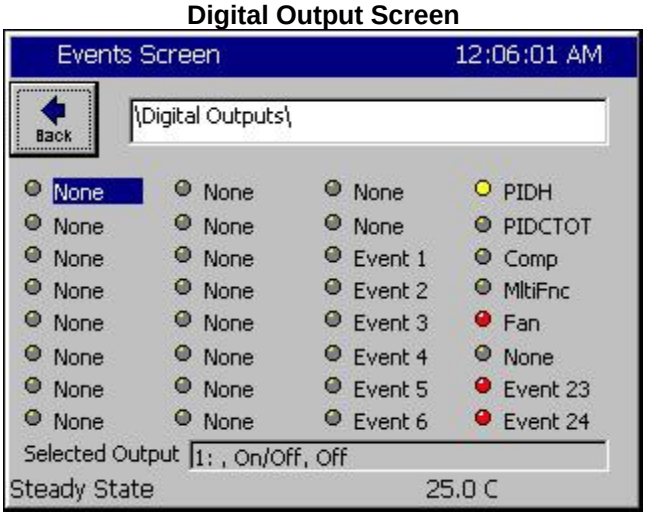
Quattro Retro Temp Only			
2SM Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	6	Not Used
	5	5	Not Used
	4	4	Not Used
	3	3	Not Used
	2	2	Not Used
	1	1	Not Used
3SM Event Outputs			
TE1151-6	SM Channel	Digital Output	Device
	6	24	Event 6
	5	23	Event 5
	4	22	Event 4
	3	21	Event 3
	2	20	Event 2
	1	19	Event 1
1SM Outputs			
TE1151-12	SM Channel	Digital Output	Device
	12	18	Not Used
	11	17	Not Used
	10	10	Not Used
	9	9	Not Used
	8	8	Not Used
	7	7	Not Used
	6	6	Not Used
	5	5	Not Used
	4	4	Not Used
	3	3	Not Used
	2	2	Not Used
	1	1	Not Used
SSR Outputs			
TE1151-5	SM Channel	Digital Output	Device
	6	30	Not Used
	5	29	Fan
	4	28	Multifunction
	3	27	Compressor
	2	26	PID Cool
	1	25	PID Heat

Quattro Retro Temp Only Main Screen

Main Screen



Digital Output Screen



Channels

Inputs	Channel 1	Channel 2	Channel 3	Channel 4
Type	Temperature	N/A	N/A	N/A
Sensor	RTD1	N/A	N/A	N/A
High Volt Scale	N/A	N/A	N/A	N/A
Low Volt Scale	N/A	N/A	N/A	N/A
High Eng Scale	N/A	N/A	N/A	N/A
Low Eng. Scale	N/A	N/A	N/A	N/A

Digital Inputs

Name	Input	Function when Closed
TempGard	Input 9	None, TempGard Alarm displays in Alarm Folder and Log File.

Alarms

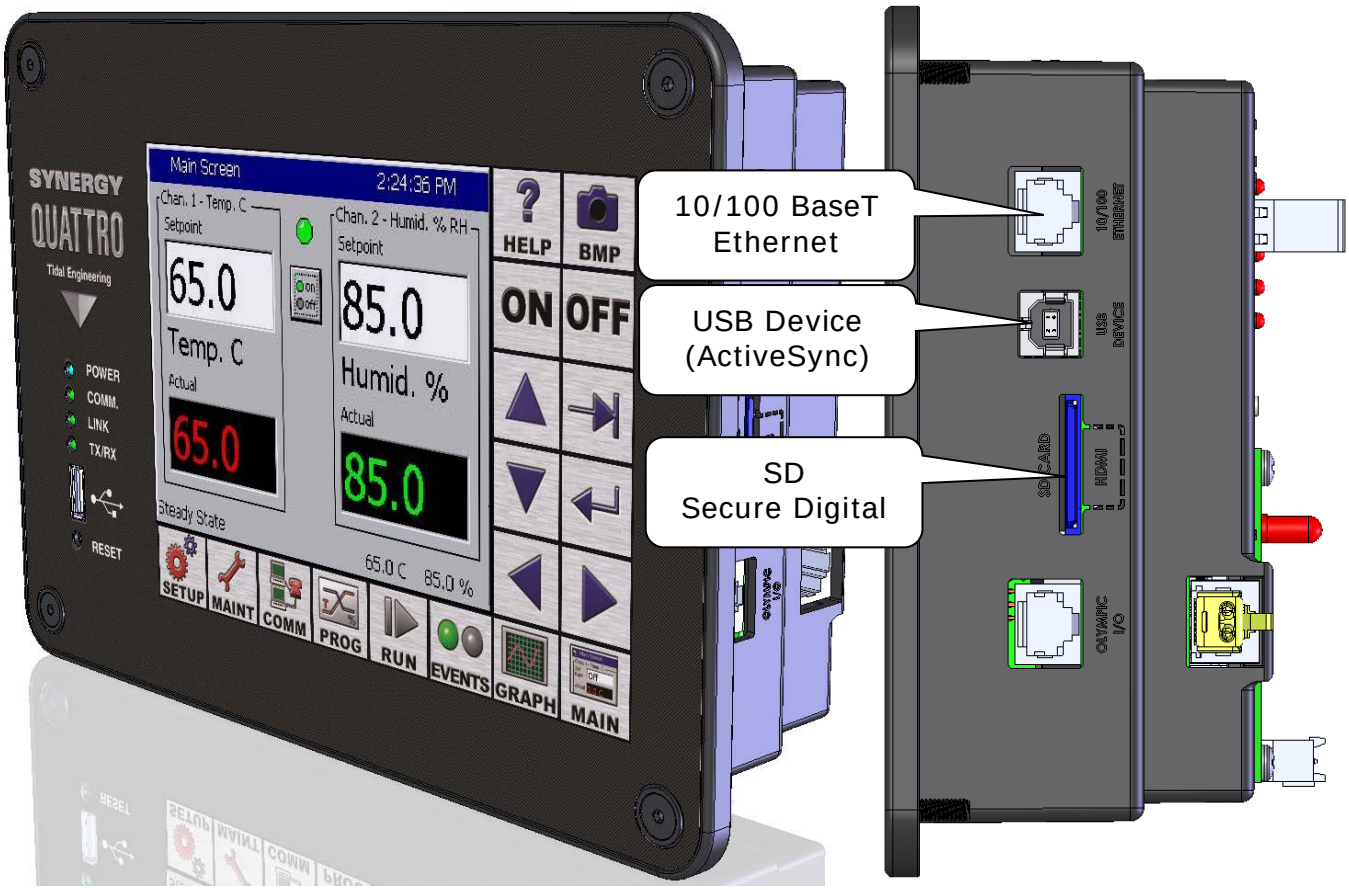
Name	Sensor	Sensor Code	Default Threshold	Report	Log	K1	K2
Hi Alarm Ch 1	RTD1	110	> 500 C	Yes	Yes	Yes	No
Low Alarm Ch 1	RTD1	110	< -200C	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	< 10 Ohm	Yes	Yes	Yes	No
Bad Sensor Ch 1	RTD1	110	> 330 Ohm	Yes	Yes	Yes	No
TempGard	Digital Input 9	409	Open	Yes	Yes	No	No

This Retro Temp Only configuration supports VersaTenn retrofits.

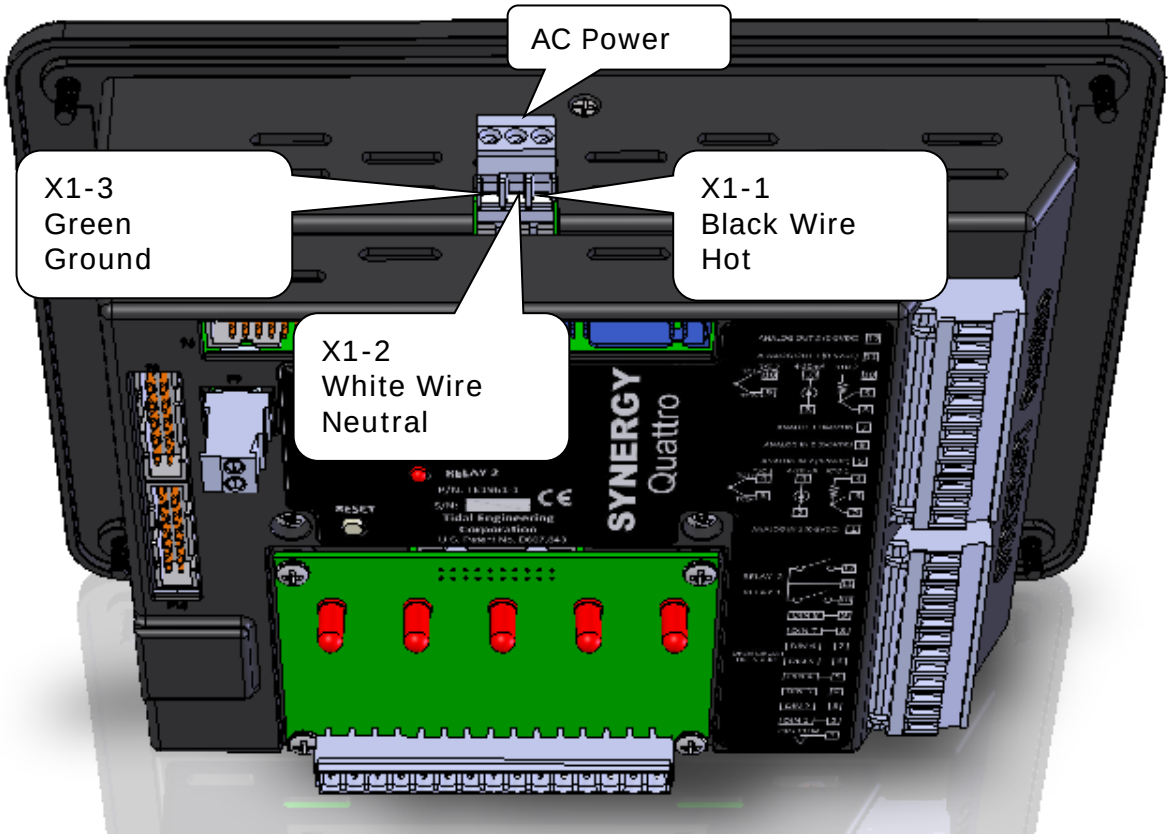
4. Wiring

An example Synergy Quattro 2 Controller mounting and wiring arrangement for a simple Temperature/Humidity chamber using an RTD temperature sensor and a loop-back humidity sensor is described in this section.

The figure below identifies the plug arrangement on the back of the controller.

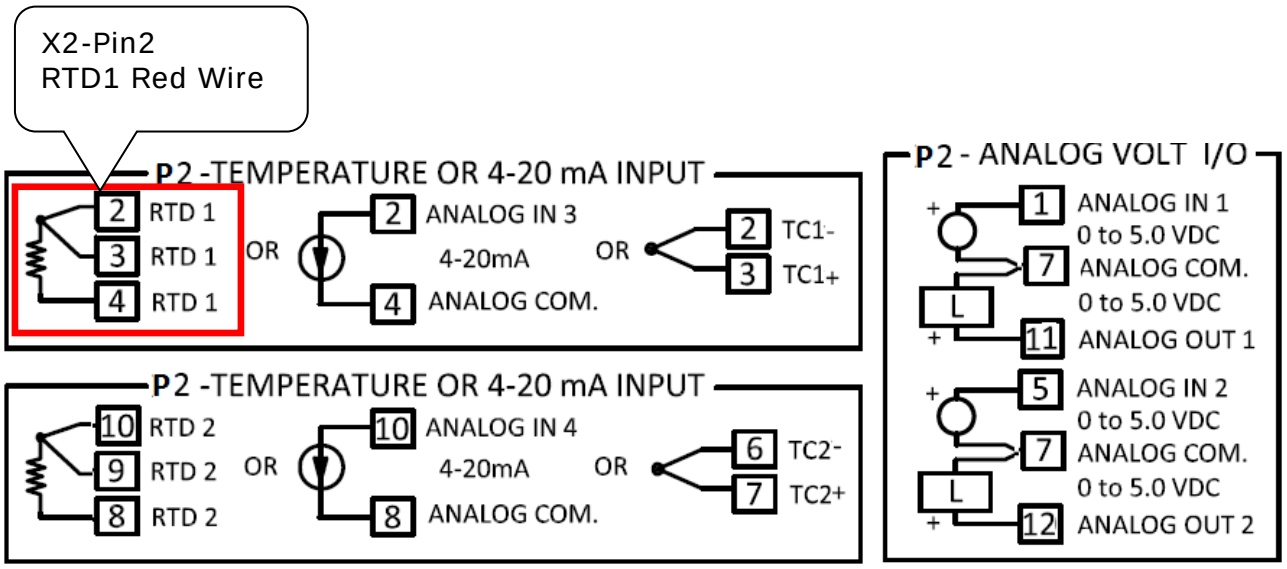


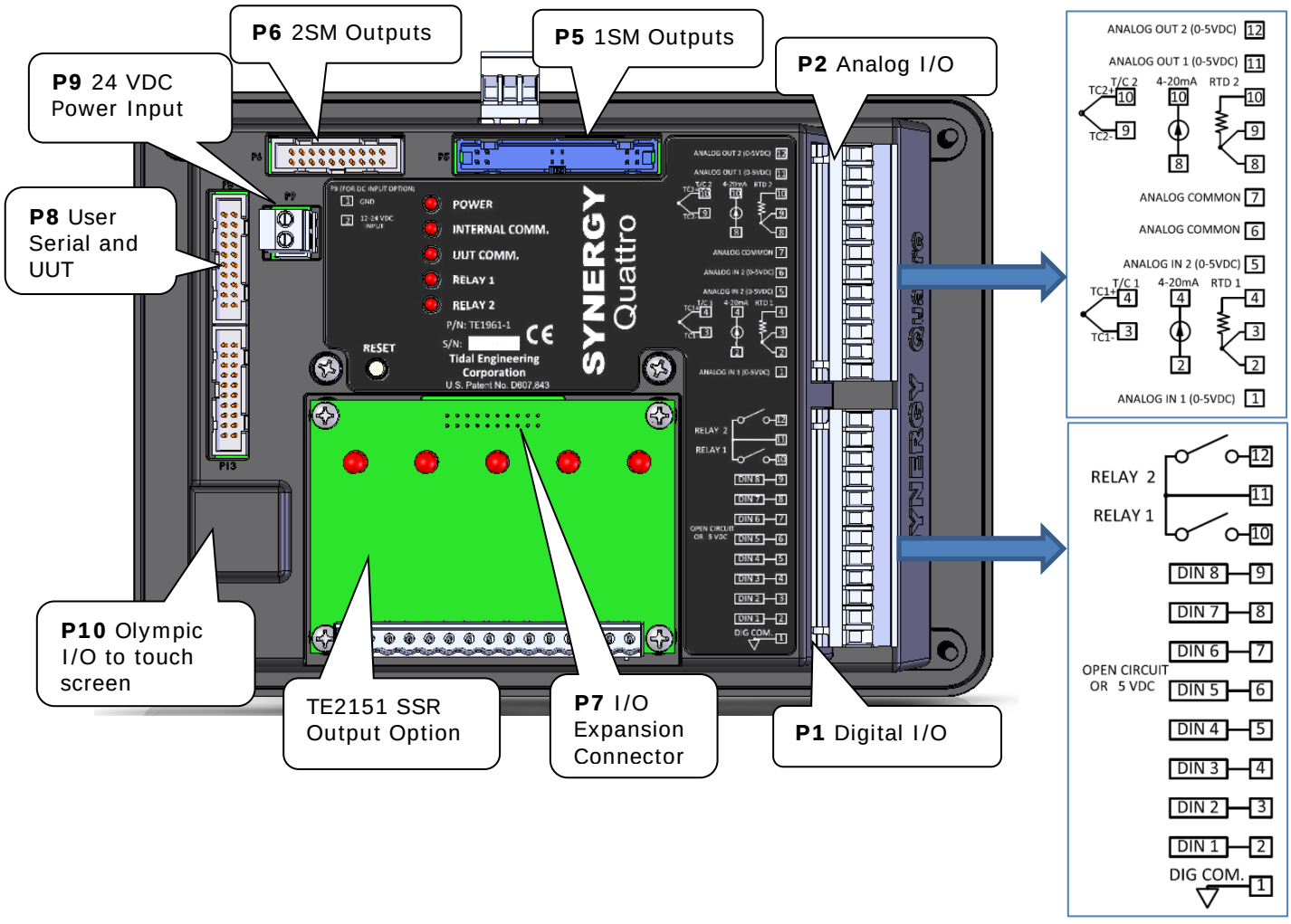
3.1. Connect an AC power source, to the X1 plug as follows:
White wire (AC Neutral) to X1 Pin 15
Black wire (AC Line) to X1 Pin 14.



WARNING: BE SURE THAT THE UNIT IS NOT CONNECTED TO THE AC SOURCE WHILE WIRING.

3.2. Wire the RTD Sensor to X3 plug, Pins 2, 3, and 4 as shown below. Alternatively use the TC1 or 4-20mA Inputs.





3.3 Wire the Channel 2 Sensor

For Humidity chambers, an electronic humidity sensor can be wired to Analog In 1 or Analog In 2 (for 0-5 VDC sensors) or to Analog In 3 or Analog In 4 (for 4-20 mA sensors)

For demonstration purposes you can loop-back Analog Out 2 to Analog Input 2 to simulate the humidity sensor and control channel.

With a 18-22 AWG wire, approximately 3 inches long, connect Analog Out 2 (X3 Pin 10) to Voltage input 2 (X3 Pin 5).

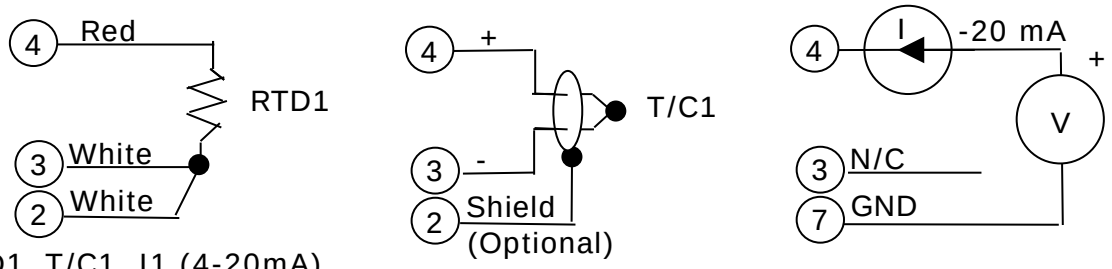
3.4 TempGard:

All standard Synergy Quattro 2 Chamber Definition Files expect a TempGard input on Digital Input 8. See Safety Section 8 regarding TempGard and other safety features of the controller.

With an 18-22 AWG wire, approximately 3 inches long, connect DIN8 (P1 Pin 9) to Ground (P1 Pin 1) to establish the TempGard safety. A Secondary Limit Controller (SLC) should be wired in place of this jumper in a complete implementation.

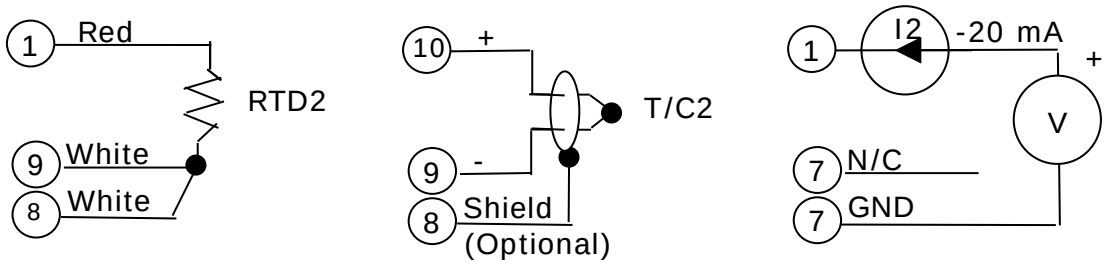
Input Sensor Wiring

The Synergy Controller supports four types of RTDs (100 Ohm pt. DIN or JIS, 500 Ohm pt. DIN or JIS), eight Thermocouple types, T,S, J,B,K,R and various 4-20 mA transducers. These sensors connect to the Synergy Quattro 2 P2 plug according to the tables shown below. These sensors are typically used for air temperature or product temperature.



RTD1, T/C1, I1 (4-20mA)

Pin	RTD	T/C	I1 (4-20mA)	Signal
4	RTD1-Red	T/C+	I+	+
3	RTD1-White	T/C-	N/C	-
2	RTD1-White	Shield (optional)	I-	Analog Common

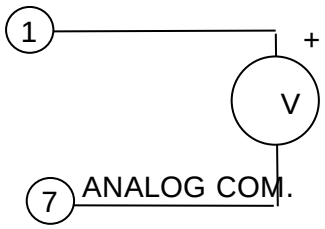


Process Input Wiring

The Synergy Controller supports two 0-5VDC Analog Inputs. These sensors connect to the Synergy Quattro 2 P2 connector according to the tables shown below.

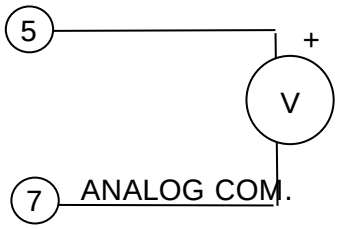
Analog In 1

Pin	Signal
1	V+ Analog In 1
7	V- Analog Com.



Analog In 2

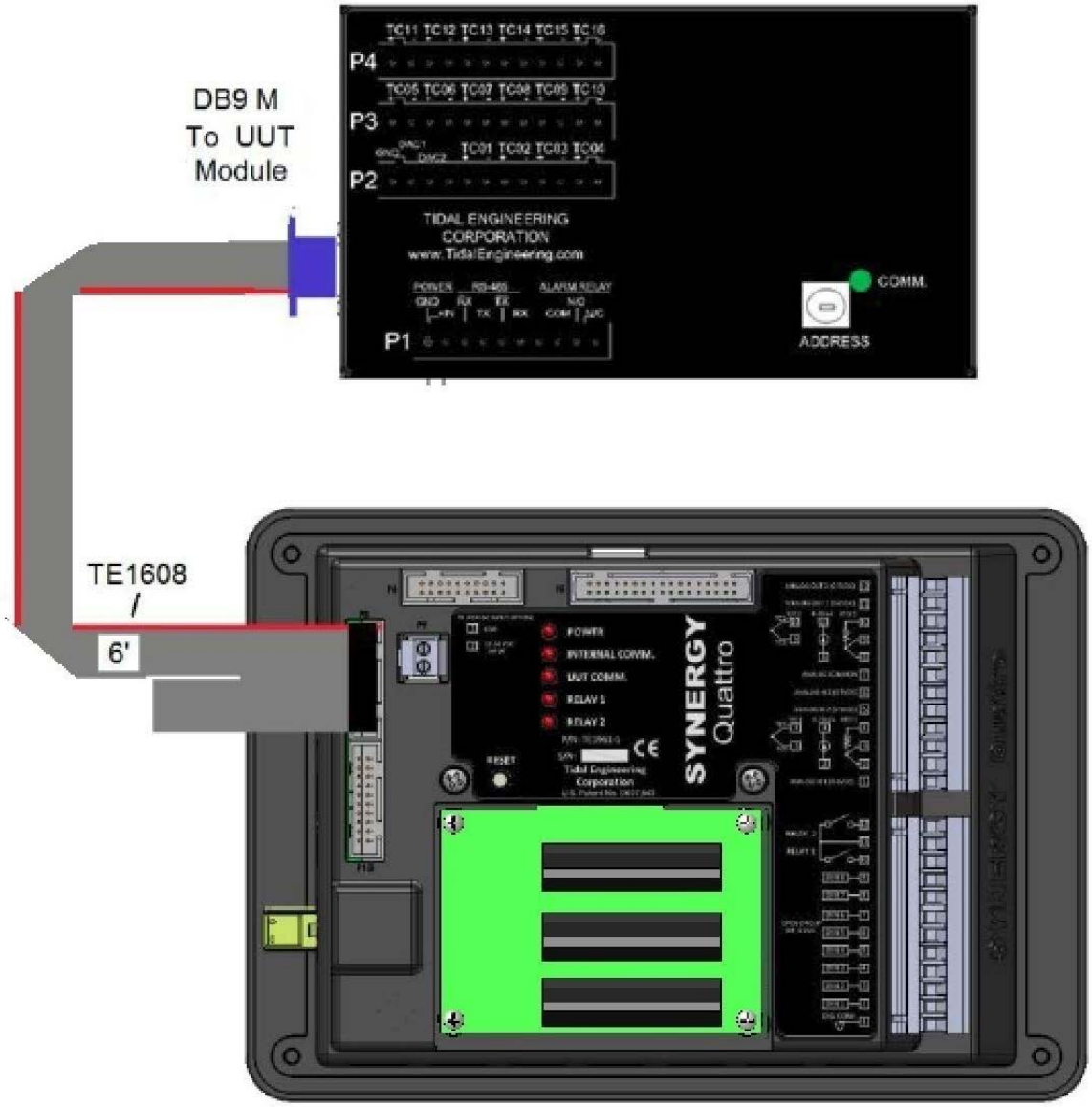
Pin	Signal
5	V+ Analog In 2
7	V- Analog Com.



Low Resolution Analog Inputs

J1 Terminal	Signal
J1-1	Low Res Analog 1
J1-2	Low Res Analog 2
J1-3	Low Res Analog 3
J1-4	Low Res Analog 4
J1-5	Low Res Analog 5
J1-1	Low Res Analog 6
J1-7	Low Res Analog 7
J1-8	Low Res Analog 8
J1-9	+5 VDC
J1-10	Common

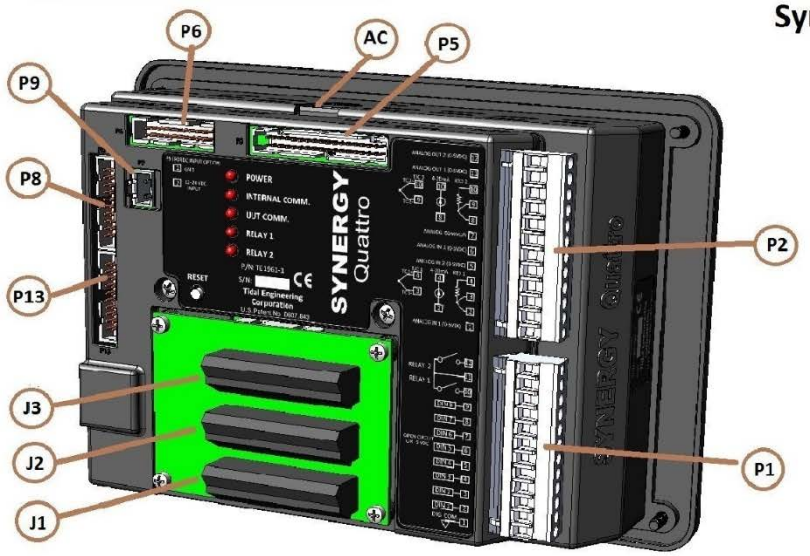
UUT Thermocouple Module Wiring



Digital Outputs.

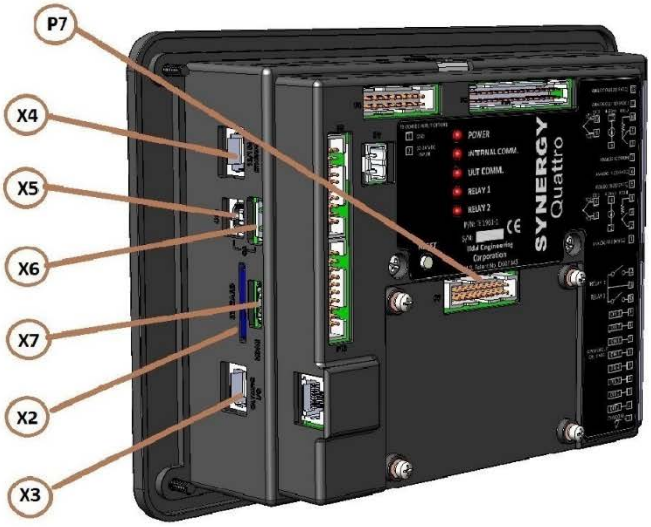
The Synergy Quattro 2 model features 30 (Open Collector) 5 VDC, 50 mA outputs. These outputs can drive Electro Mechanical Relays, Triacs, and SSRs. A wiring example of the SSR connection is shown below.

Synergy Quattro 2 TE1961-23



AC- 110-240 VAC Power Supply
P1- Digital Inputs and Alarm Relays
P2- Analog Inputs and Analog Outputs
P5- 1SM Ribbon Cable
P6- 3SM Ribbon Cable
P7- SSR Ribbon Cable or TE2251-4 Expander
P8- Serial Communications, User and UUT
P9- DC Voltage, Input and Output
P13- Touch Screen for Nano TE1858-4

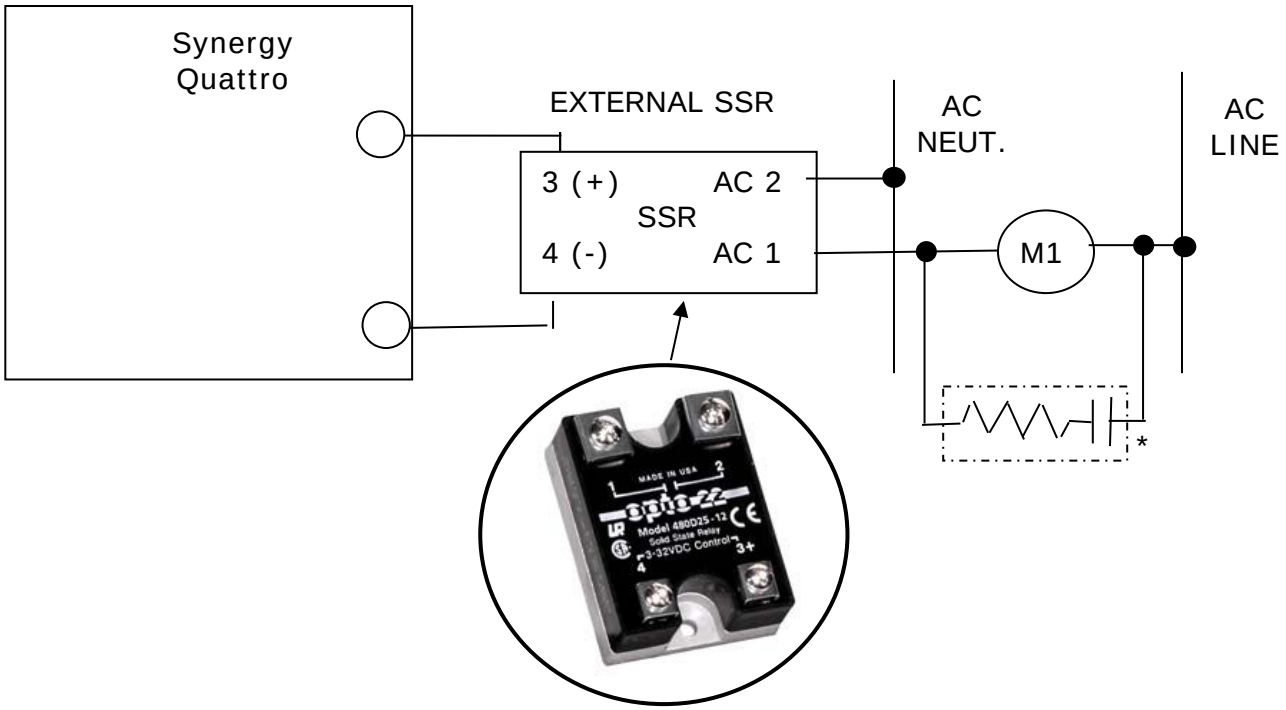
J1-Expander, Analog Inputs
J2-Expander, Digital Inputs
J3-Expander, SSR Outputs



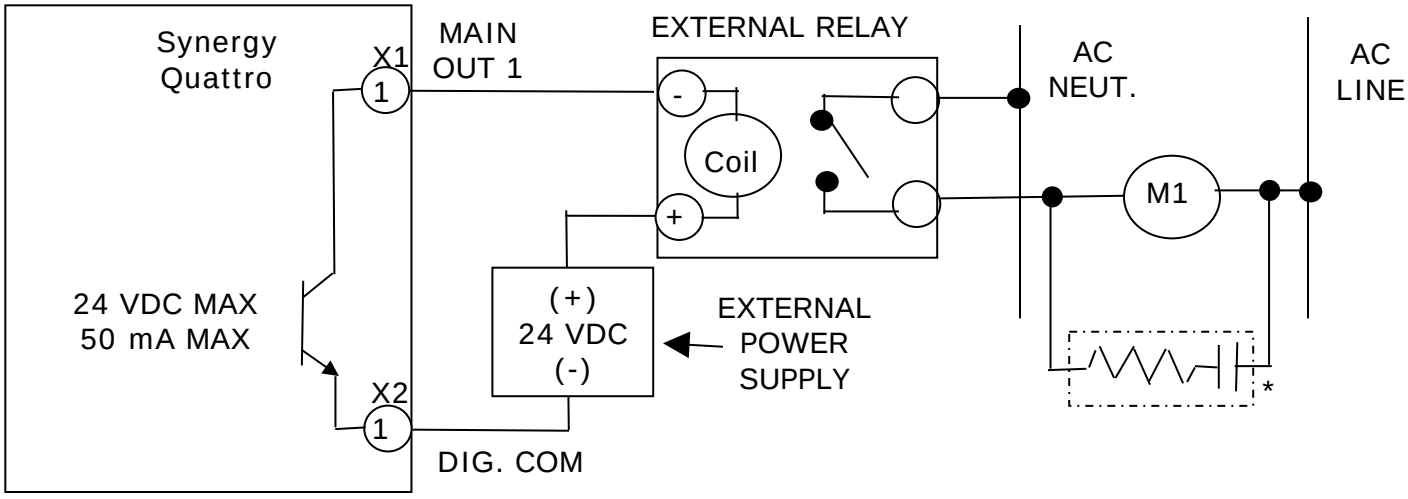
X1-USB Host-Front
X2-SD Card
X3-Olympic Board I/O Cable
X4-Ethernet
X5-USB Device
X6-USB Host-Rear
X7-HDMI-Monitor Output

Open Collector Wiring

The Synergy Quattro 2 features Open Collector (OC) transistor outputs; rated at 24 VDC and 50 mA. These outputs can drive external SSRs from Opto22, Grayhill, etc. There are six +5 VDC outputs on the X1 connector that source control power for these loads as shown in the figure below. An external source can also be used as shown in the figure at the bottom of the page.

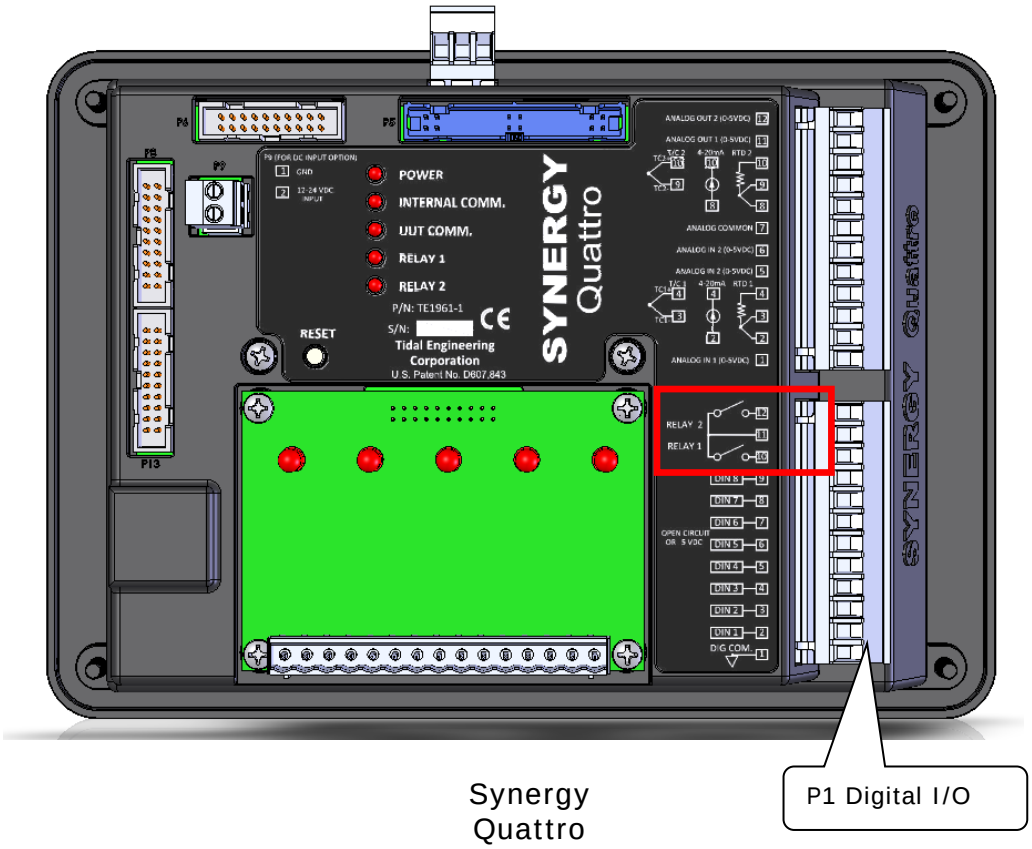


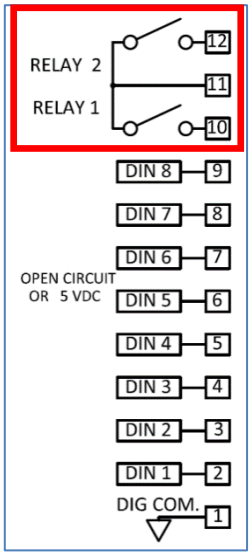
The figure below shows an example of a transistor output (OC) driving a load with an external power supply source. This configuration is applicable to the six Main outputs on TE1858-1 as well as the six AUX outputs on the TE1858-1,-2, and -3 models.

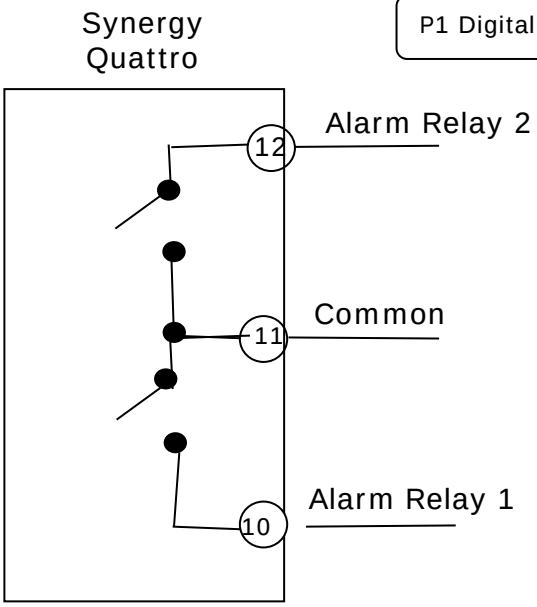


Note: * A transient suppressor (aka Quench Arc or equivalent) is recommended across all switched Inductive loads.

Synergy Quattro 2 Relay Outputs



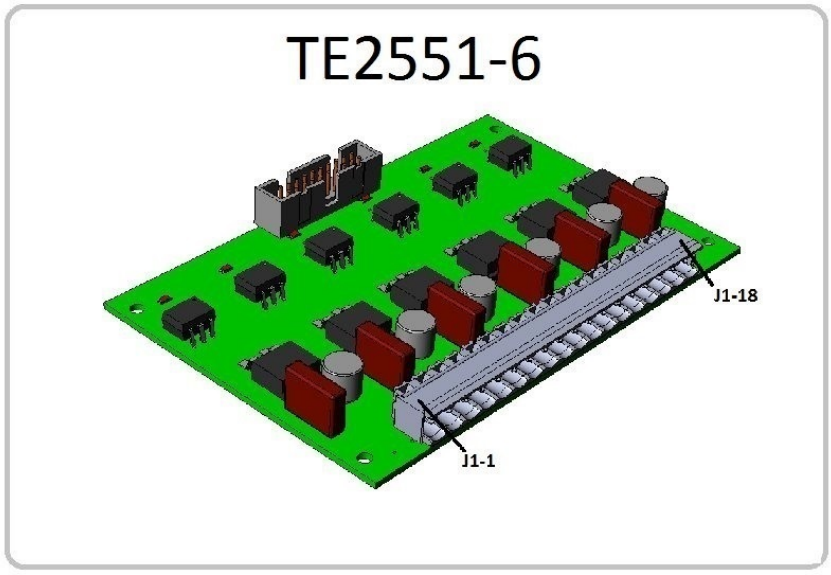




Notes:
* A transient suppressor (aka Quench Arc or equivalent) is required across any switched Inductive loads.
**Relay Rating: 5 AAC Continuous, 8 APK, 120/240 VAC

TE2551-6 Triac output board

The Triac output board can drive 6 small AC loads. It can also drive an AC controller Solid State Relay (SSR) module. When driving an SSR, an additional load resistor is required across the SSR input to prevent nuisance firing as a result of leakage current. The Triac output can also drive an external high current Triac as shown below.

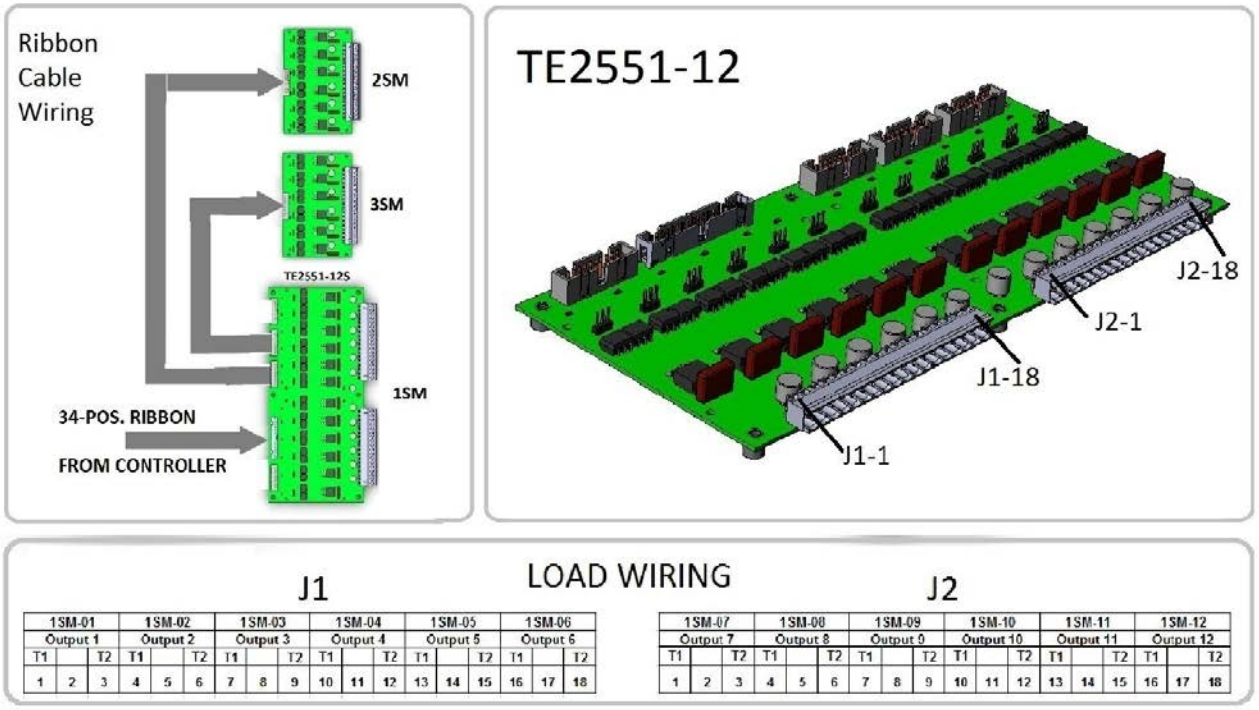


J1

1SM-01			1SM-02			1SM-03			1SM-04			1SM-05			1SM-06		
Output 1			Output 2			Output 3			Output 4			Output 5			Output 6		
T1	G	T2	T1	G	T2	T2	G	T0	T1	G	T3	T3	G	T2	T3	G	T4
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

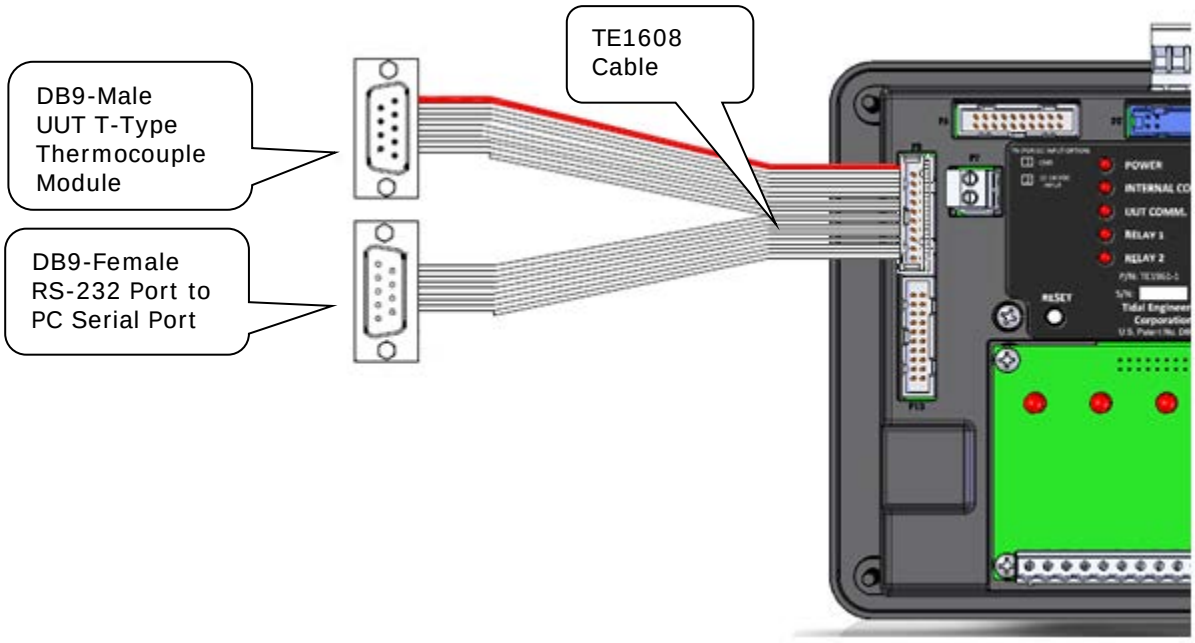
TE2551-12 Triac output board

The Triac output board can drive 12 small AC loads.



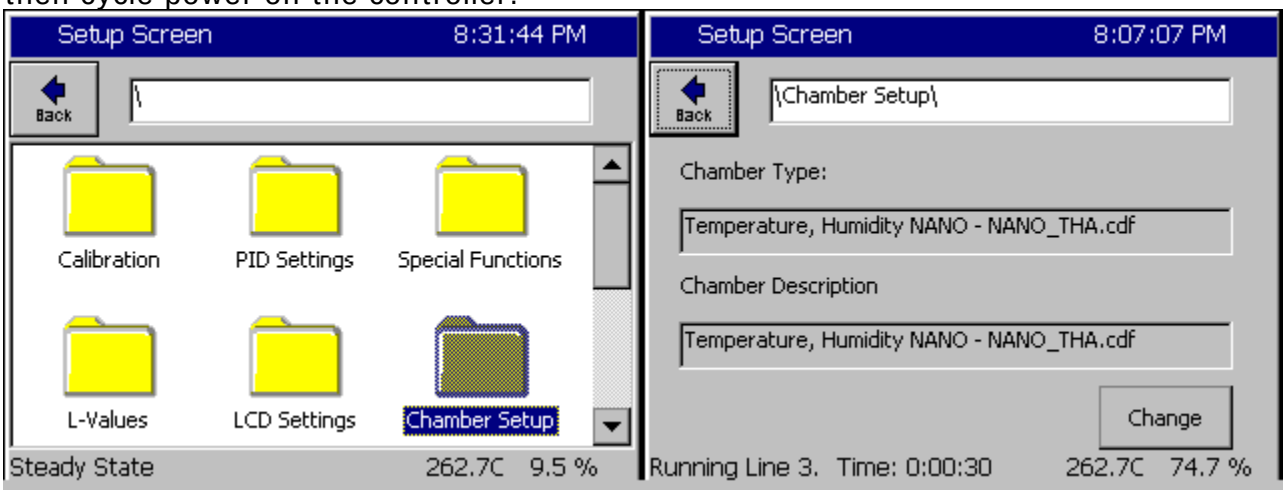
Wire Communications.

Wire the Ethernet and or Serial Communications as required. Note that the TE1608-1 cable is supplied with the Synergy Quattro 2 to connect the controller to your PC's serial port.

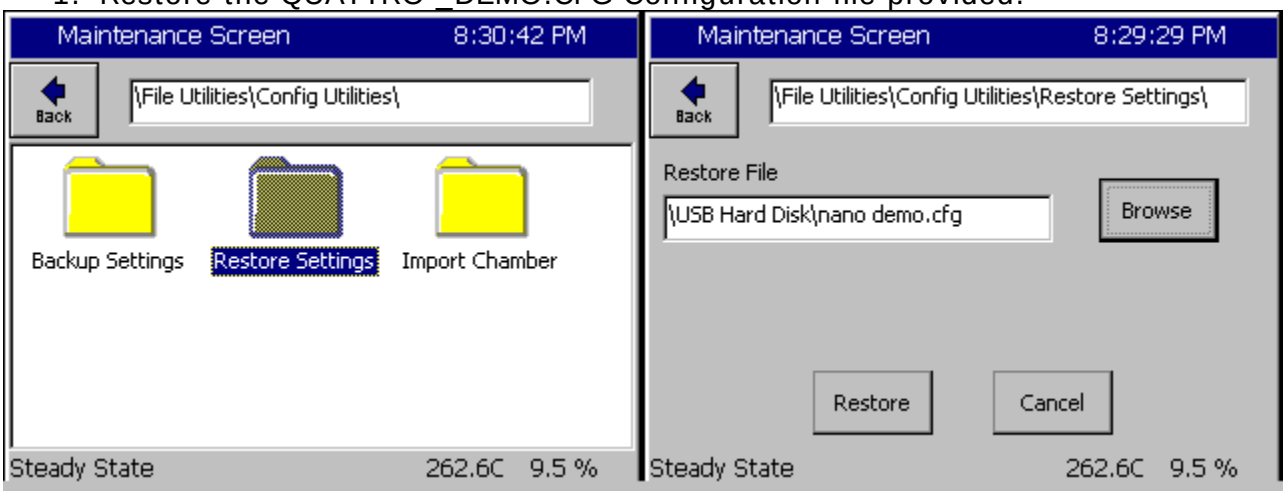


Setup

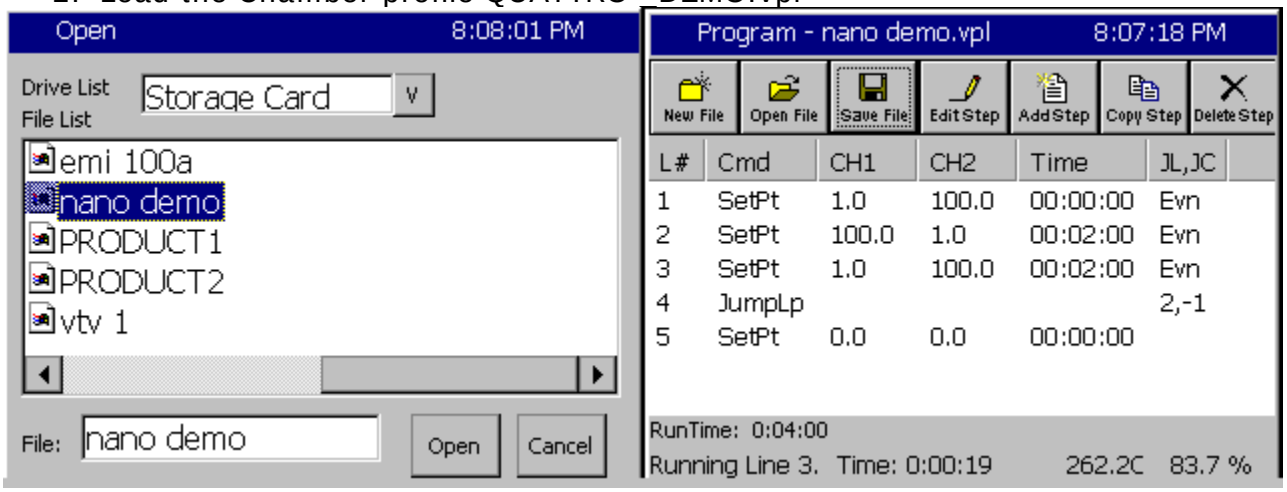
Load the QUATTRO_THA configuration from the SETUP Screen's Chamber Setup folder then cycle power on the controller.



1. Restore the QUATTRO _DEMO.CFG Configuration file provided.

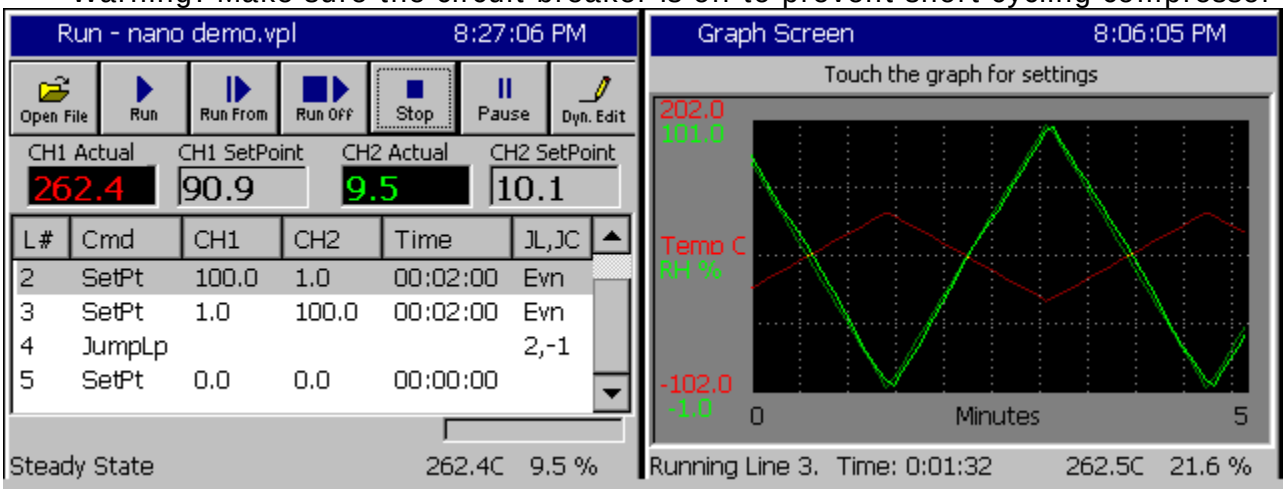


2. Load the Chamber profile QUATTRO _DEMO.vpl



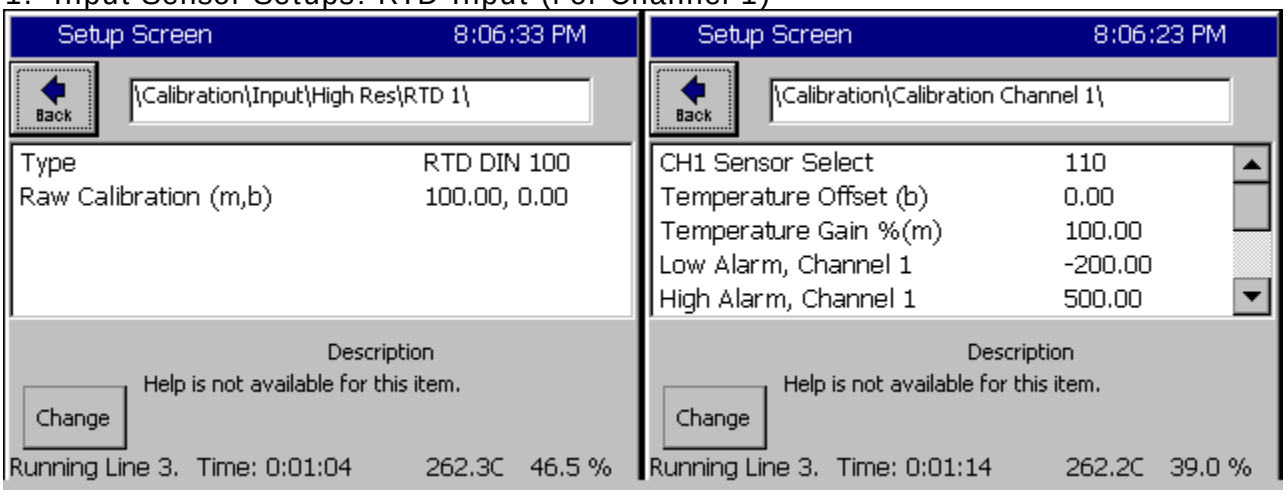
3. Run the profile from the Run Screen by pressing the Run button.*

*Warning: Make sure the circuit breaker is off to prevent short cycling compressor

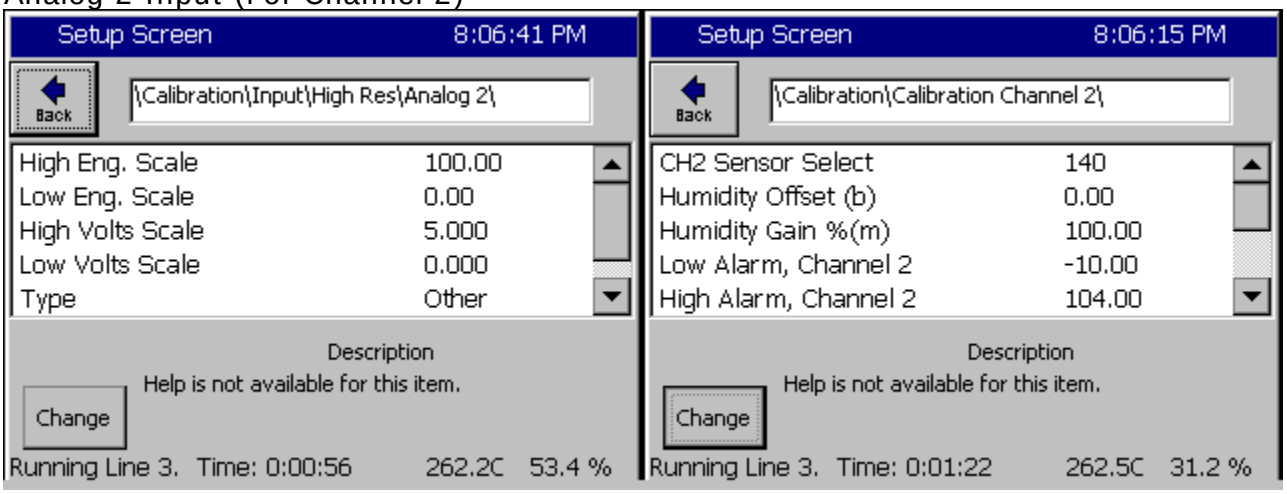


The following controller screens can be used to adjust the controller setup the to the QUATTRO _DEMO.cfg. This is for reference only.

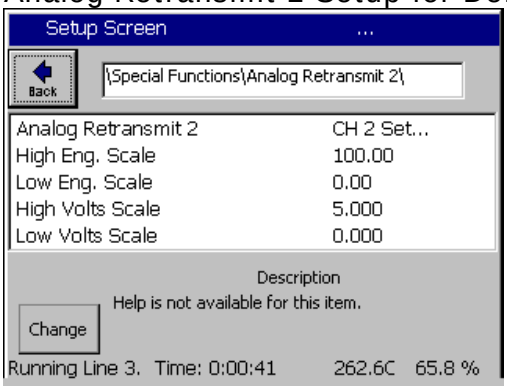
1. Input Sensor Setups: RTD Input (For Channel 1)

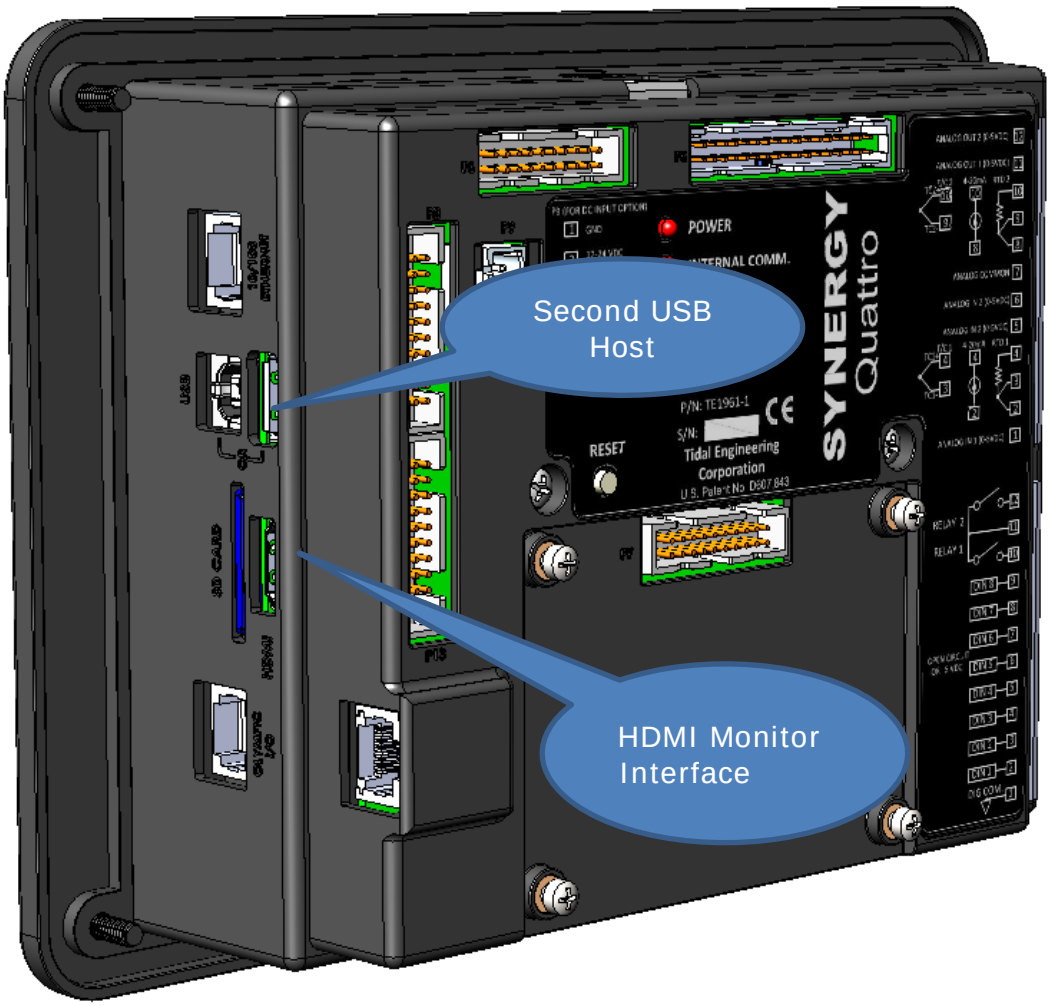


Analog 2 Input (For Channel 2)



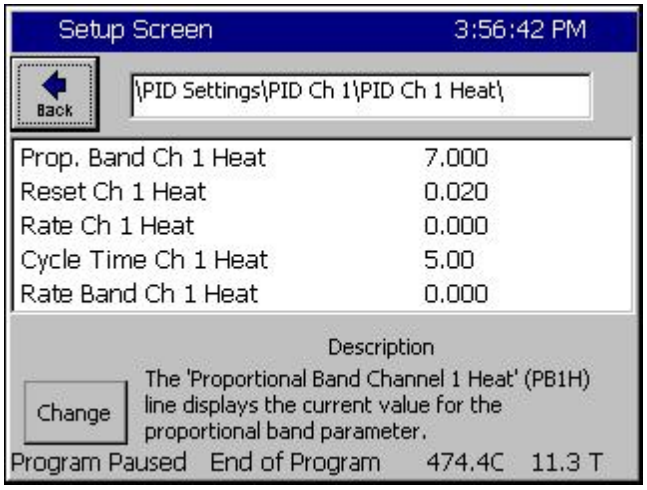
Analog Retransmit 2 Setup for Demonstration





5. Tuning

Synergy Quattro 2 PID algorithms provide high performance and flexible for up to 4 channels. The PID tuning parameter screen is shown in the following screenshot. Tuning parameters are available for each half of the split, Heat/Cool system for each channel.

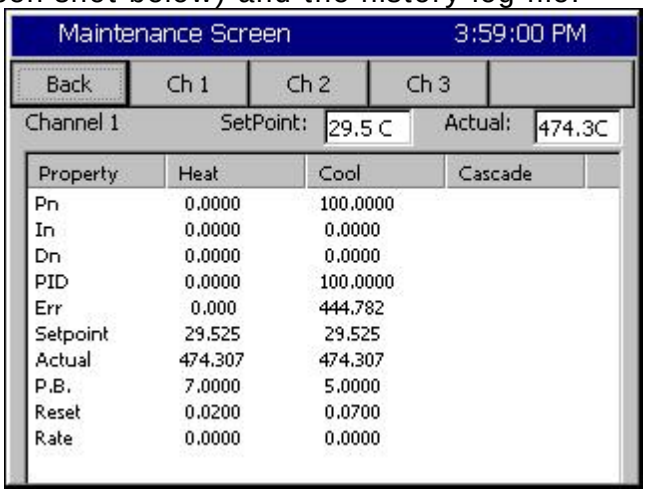


Optimum test chamber performance criteria depends on the application however typical criteria is summarized as follows:

1. Minimum over-shoot.
2. Minimum transition time.
3. Minimum energy.

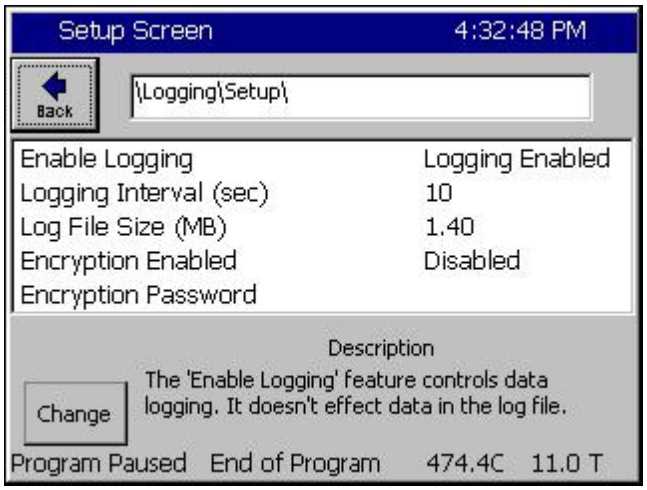
The later provides reduced LN2 and/or electricity consumption.

Synergy Controller provides built-in tools for PID tuning which include the on-screen PID monitor (See screen shot below) and the history log file.

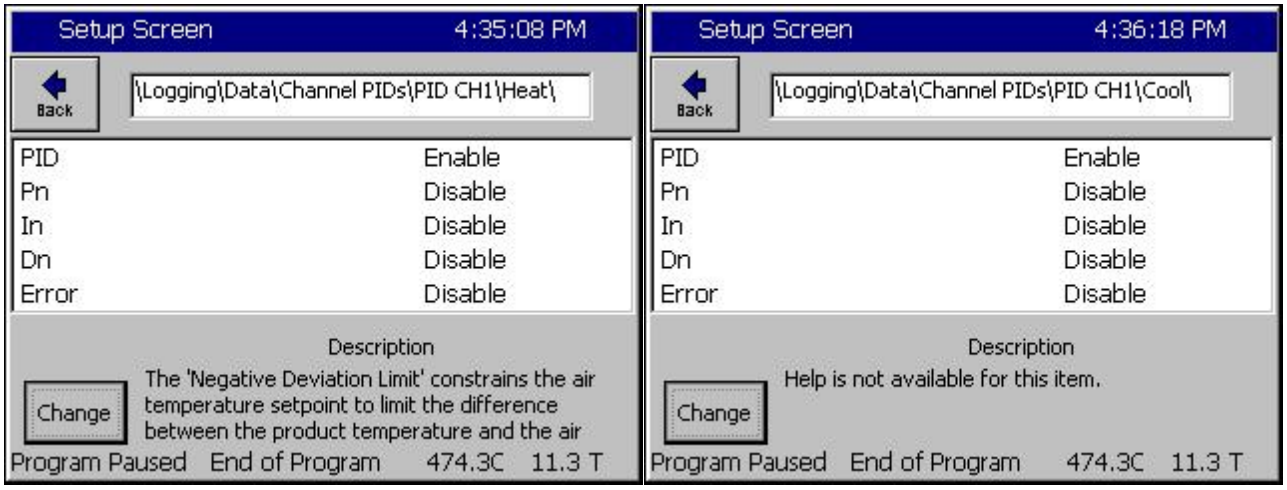


Logging Setup

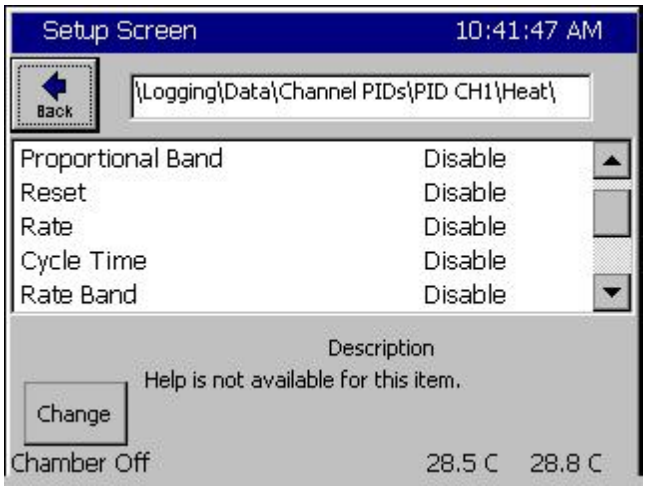
To gather data to help in the tuning process, a 10 second logging interval is recommended as shown below.



In addition, the Heat and Cool PID value logging can be enabled for all the channels of interest. These values are very helpful when evaluating the controller tuning.

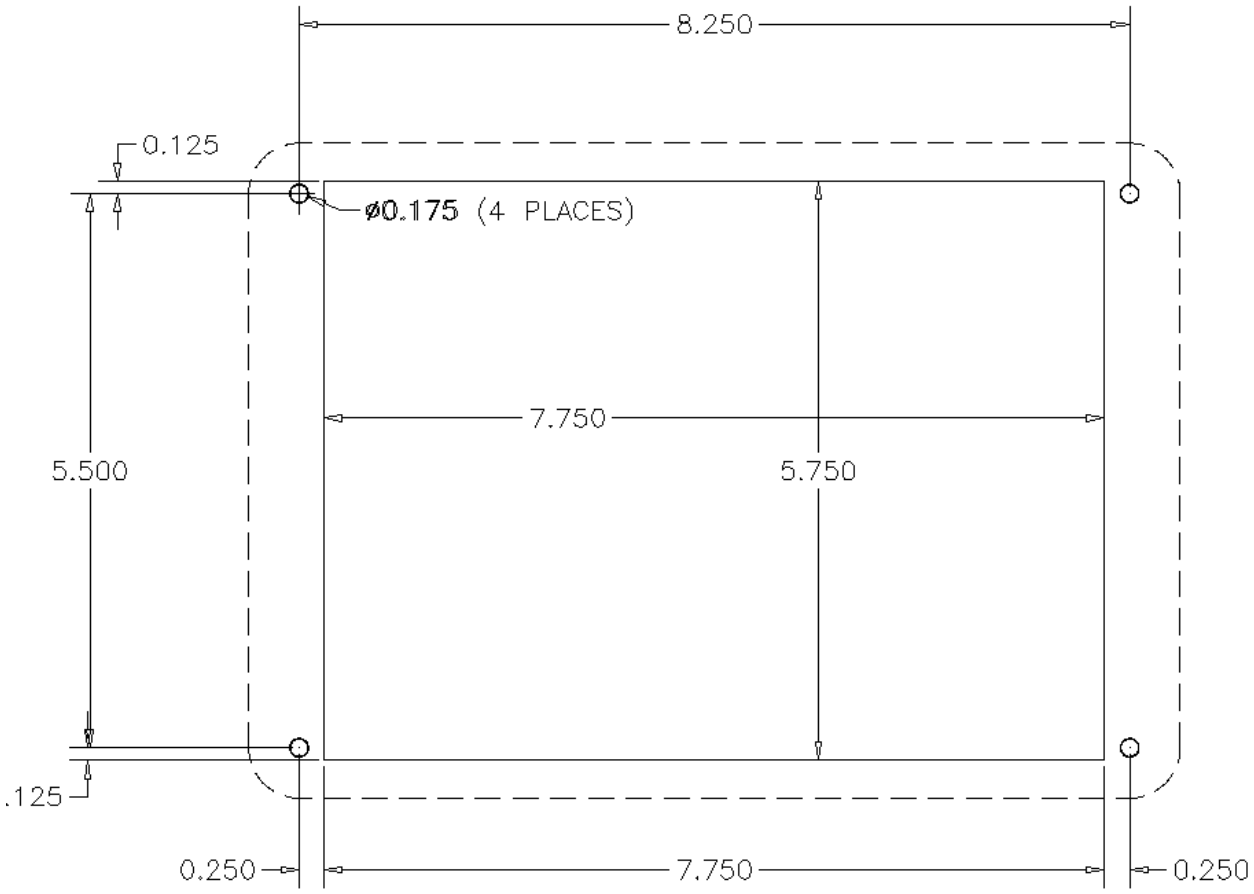


Logging the PID constants can also be helpful during tuning experiments since the tuning constants such as Proportional Band, Reset, and Cycle time are then recorded with the PID Outputs and process data. This makes it easy to see which tuning changes improved the performance and which tuning changes did not.



6. Mounting Options

The Synergy Quattro 2 is designed to drop in for VersaTenn III controllers.



In addition to panel mounting, a variety of outer mounting options are available.

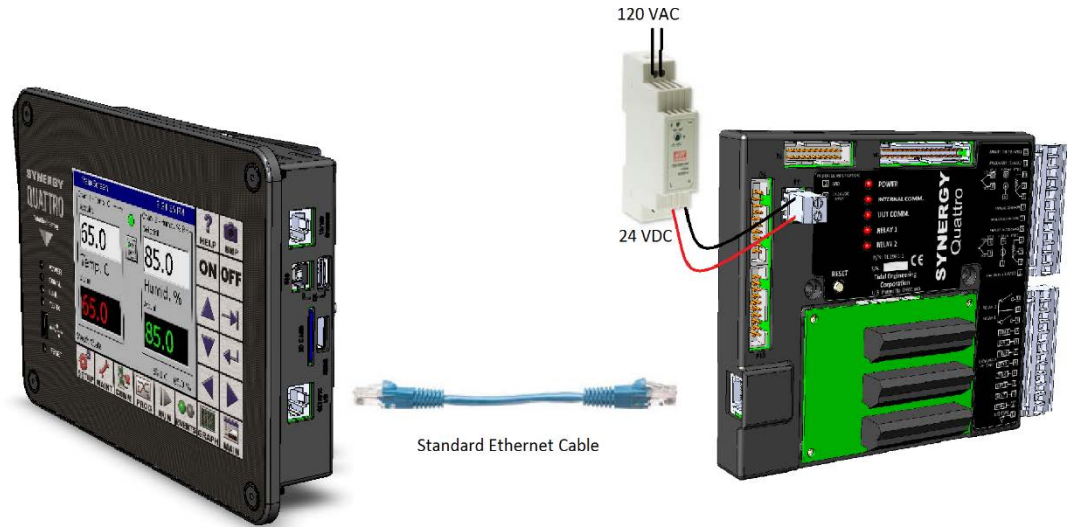
TE2012-5, Synergy Quattro Tilt Mounting Kit

TE2012-6, Synergy Quattro Articulation Mounting Arm, 1 Knuckle

TE2012-4, Synergy Quattro Articulation Mounting Arm, 2 Knuckle

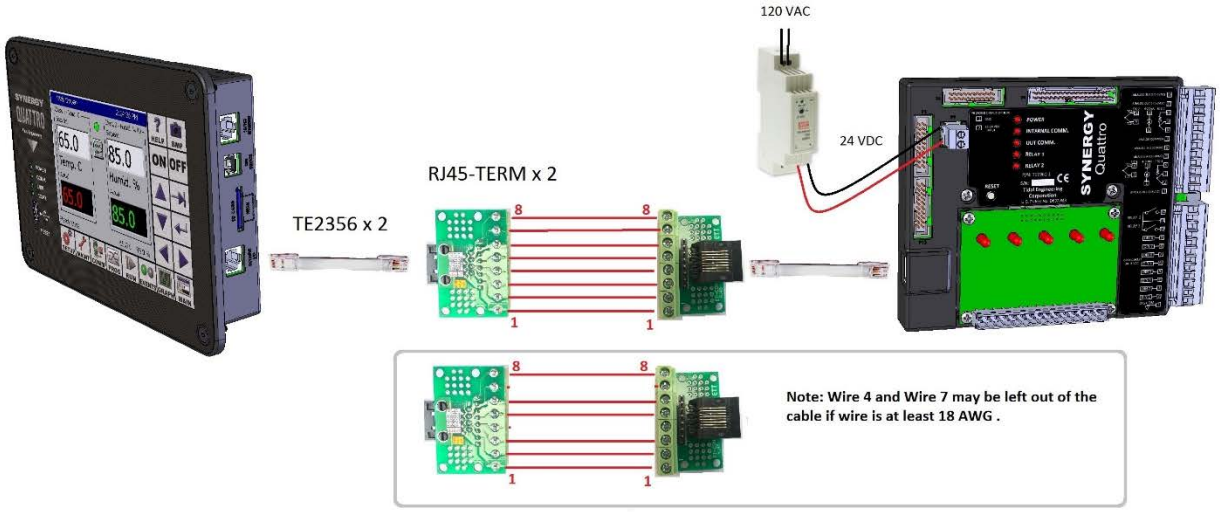
TE2012 Synergy Quattro Mounting Kit

The Synergy Quattro 2 is designed to accommodate systems where the refrigeration and mechanical components are a distance from the operator interface.



A standard CAT 5 cable can be used to connect the User Interface and the Olympic I/O Processor as shown above.

In addition, the, the TE2289 option allows an in place control harness to be used as shown below.

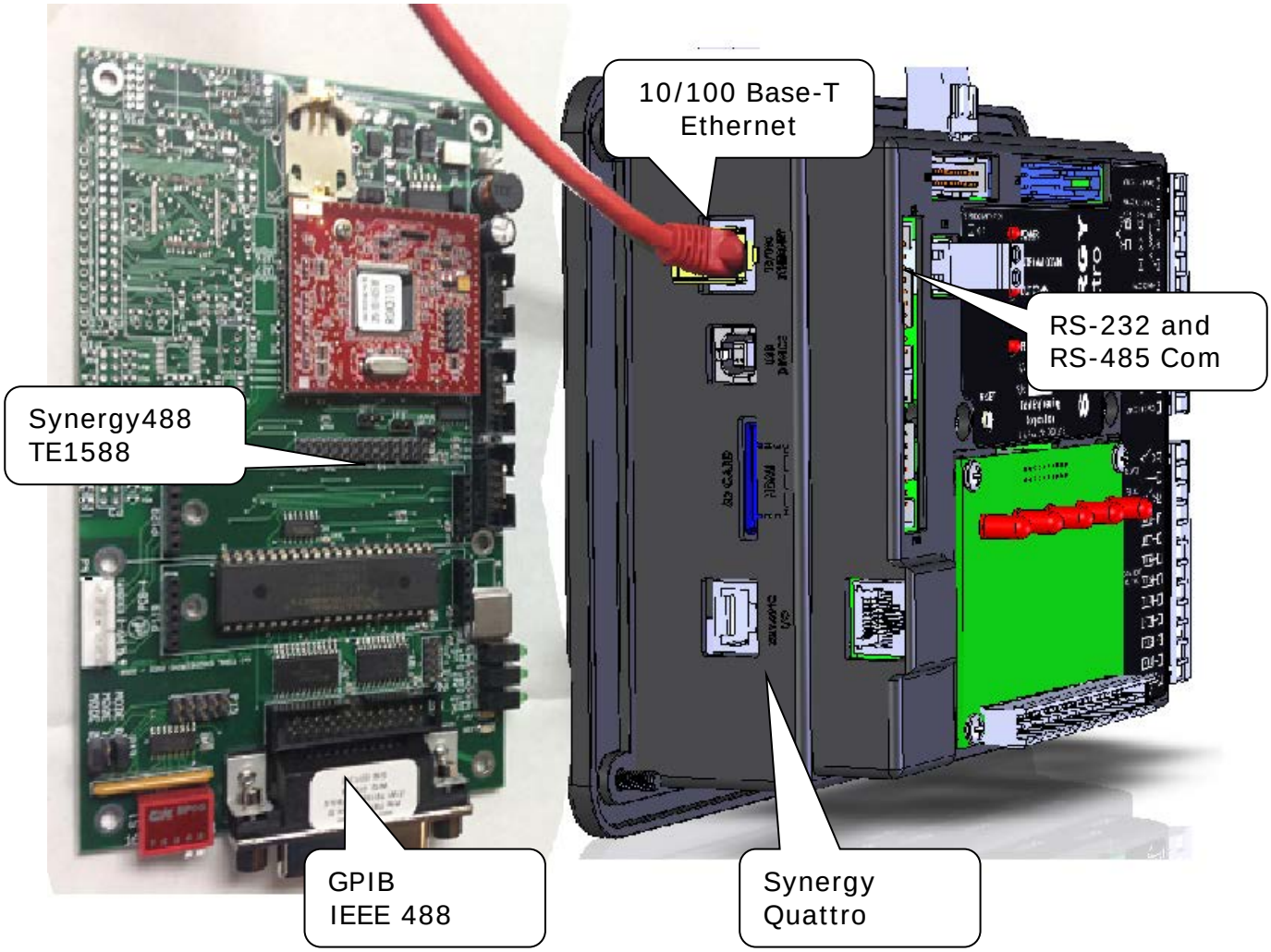


TE2289 Synergy Quattro Extention Cable Wiring Kit.png

A variety of other options are available.

7. Communications

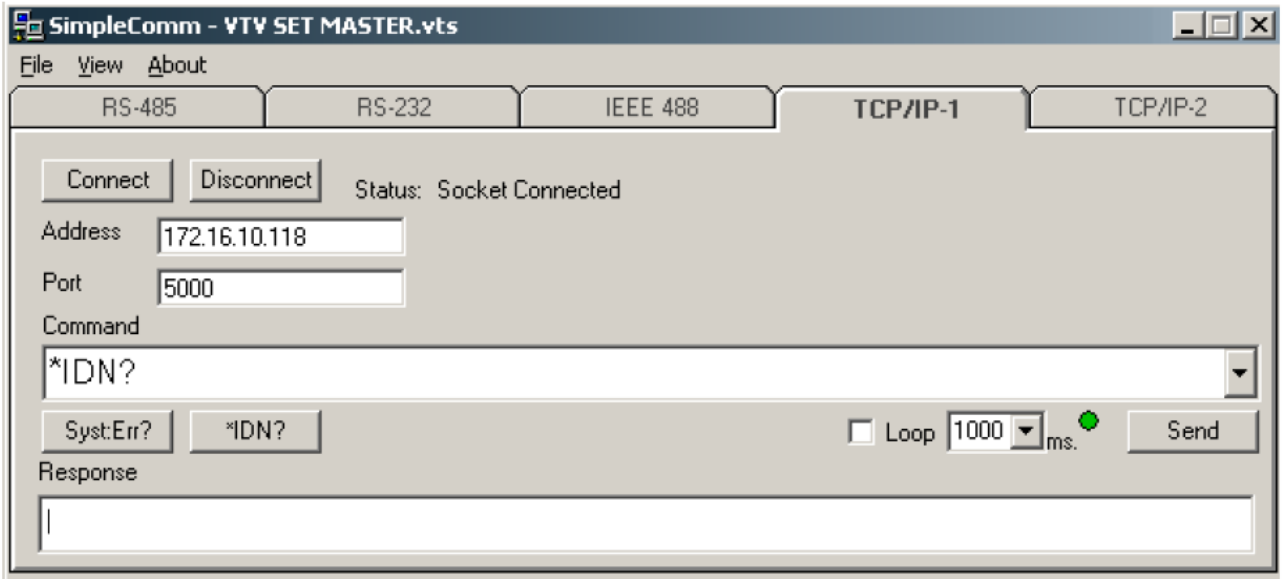
The Synergy Quattro 2 offers both Ethernet communications and RS-232 standard. An optional IEEE 488/GPIB board, P/N TE1588, provides GPIB communications for the Synergy Quattro 2.



Ethernet
The Synergy Quattro 2 features a 10/100 BaseT Ethernet port. See X6 in the figure above.

RS-232
The Synergy Quattro 2 features an RS-232 port, see X8 in the figure above. (Requires a Null Modem cable or adapter)

GPIB (Optional)
The optional GPIB feature requires the Synergy488, TE1588 option. See the unit in the figure below.



Synergy Remote Control and Application Programming

This Synergy Controller application note describes the various methods available to users for remote control and application programming on both the full sized Quattro and Micro and the ¼ DIN Synergy Nano controllers.

Tidal Engineering's Synergy Controllers provide state-of-the-art usability and connectivity for environmental test control and data acquisition and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards.

The following table includes the seven remote control and application programming methods available for use the Synergy Controllers and identifies the communication ports and capabilities of each.

Synergy Controller Remote Control and Programming Option Table

Application	Communication Port			Remote Control			
	Ethernet	RS-232	GPIB*	Web Browser	Other	Remote Monitor	File Transfer
WebTouch Remote™	✓			✓		✓	
Synergy Manager	✓	✓	✓			✓	
Synergy Manager (Full)	✓	✓	✓		✓	✓	✓
SimpleComm	✓	✓	✓		✓	✓	✓
LabVIEW	✓	✓	✓		✓	✓	✓
User Application	✓	✓	✓		✓	✓	✓
FTP Client	✓						✓

Note: GPIB communications are standard on Synergy Micro Controller and Synergy Plus (TE1858-4) and optional on other Synergy Nano Controllers.

As shown in the table above, the Synergy Controller supports many protocols and standards. These methods range from the simple and straightforward; WebTouch Remote - requires only a network connection and a web browser for remote control and monitoring through the Synergy Manager; a multi-chamber environmental lab control, monitoring and programming application. In addition to these turnkey pre-programmed applications, user application programs can be readily developed with the LabVIEW driver available from Tidal Engineering and downloadable from the website. In addition, custom Windows ™ applications can be developed using the SimpleComm source code as a starting point. And finally, the controller's built-in ftp server can be used to drag and drop chamber profiles, history and other files thru the local area network.

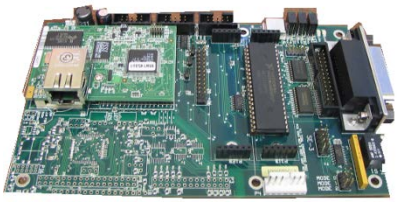
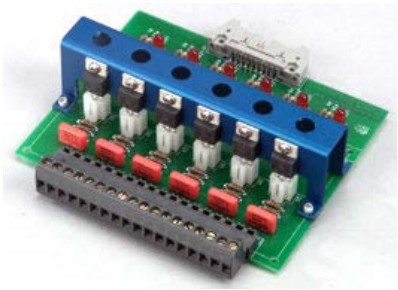
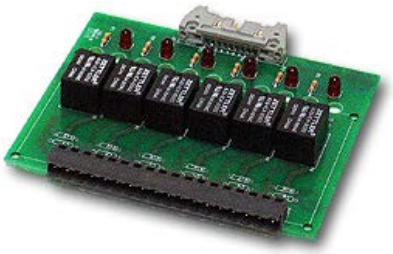
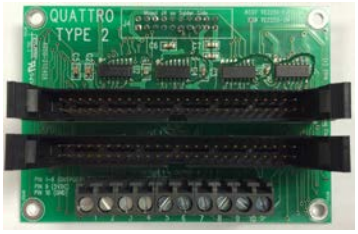
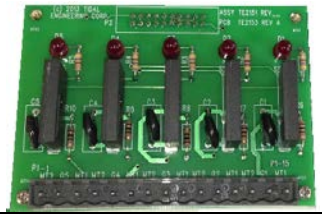
Appendix A: Accessories and Options

Synergy Quattro 2 Accessories Kit

Item	Quantity	Part	Description
1	2	120-D-121/12	Olympic Plugs
2	1	120-D-111/03	AC Power Connector (120 is 5mm)
3	1	311013-01	Cord 18AWG 3Cond 79" Black SJT
4	1	TE1608	RS-232/RS-485 Cable, 6 Feet
5	1	TE1722-34-6	Ribbon Cable Assembly, 34 position, 6 feet
6	2	TE1722-20-6	Ribbon Cable Assembly, 20 position, 6 feet
7	1	TE2013	Synergy USB Flash Drive, 8GB
8	1	TE2318-4	Synergy Controller Technical Manual
9	1	TE2281	Synergy Quattro 2 Controller Installation Manual (this document)
10	1	1770-06C	CAT6 Panel-Mount Extension 6FT.
11	1	TE2077-4	Synergy Bulkhead Connector Panel, SS
12	1	TE1566-0	Synergy Manager (Monitor Only Version)
13	1	15206	Hex Key driver, 3/32"
14	3	TE2183	Triac Leakage Suppression Resistor, 4K, 6.5W
15	4	91253A196	Black-Oxide Alloy Steel, Flat Socket Head Cap Screw, 8-32 x 5/8
16	4	8CNHMS	8-32 HEX NUT M/S 18-8 S/S
17	4	8NLMSS	#8 MED. SPLIT LOCKWASHER S/S
18	4	8NMFWS	#8 FLAT M/S WASHER 18-8 S/S

Synergy Quattro Options

Part Number	Model	Description
TE1566-1	Synergy Manager Software	Windows Based, Multi-Chamber Monitor Program
TE1567	Synergy Web Touch Remote™	Operate your Synergy Controller over a network or the Internet using a standard web browser. For all Synergy Controller models
TE2013	Synergy Pressure Feature Registration	Pressure channel for altitude and thermal vacuum (Space) chamber applications. For all Synergy controller models.
TE2042	Synergy Cascade Feature Registration	Synergy Controller Cascade Feature Registration. For all Synergy Controller models.
TE1299-16	UUT Thermocouple Monitor - 16 Channel T-Thermocouple Monitor - Daisy chain up to four of these 16-Channel monitors together and acquire 64 temperatures. - Displays and log readings to the Synergy internal log file for analysis, graphing and reporting	

TE1588	IEEE 488/ GPIB Communications Adapter	
TE1151-6	6-Channel Triac Event Board	
TE1708-6	6-Channel Relay Event Board	
TYPE 1	P/N TE2251-1 8-Channel Expansion 4 x Ribbon Cable connections	
TYPE 2	P/N TE2251-2 OPTO-22 I/O Board	
TYPE 3	P/N TE2251-3 LED Outputs	

Appendix A Options-Continued

TYPE 4	P/N TE2251-4 I/O Expander 8-Digital Inputs 8-Analog Inputs 8-Digital Outputs	
TYPE 5	P/N TE2251-5 5-SSR Board 2 Amp SSRs	

Appendix B: Output Primitive List

See Unified Technical Manual (UTM) for Details

Cascade Temperature Control Outputs

- PID Heat
- Boost Heat
- Hi Stage Compressor
- Lo Stage Compressor
- PID Cool
- Boost Cool
- Full Cool
- Cascade Condenser
- High Artificial Load
- Low Artificial Load

Humidity Outputs

- Wick Pan (AKA Humidity Enable)
- Drier
- PID Dehumidify (AKA Dehumidify Coil)
- PID Humidify
- Ambient Coil

Single Stage Temperature Control Outputs

- Compressor
- Artificial Load
- PID Cool, Temperature Only or Thermal Shock

Altitude Outputs

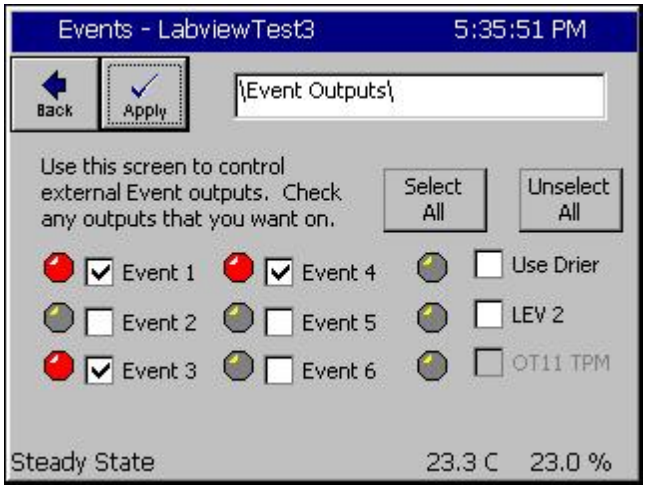
- Vacuum
- Vent (Vent/BC)

Other Outputs

- Fan Output
- Event Outputs (1 thru 6)
- Alarm Relays
- Copy Output
- Inverse Output
- Timed Output
- Input Controlled Output
- PWM Output

Event Outputs

Up to 6 Event Outputs are available for user functions. These Events are controlled from the Events\Event Outputs screen. All of the events are disabled when the Chamber is turned Off.



Alarm Relays

There are two Alarm Relay Primitives designed to operate when there is a standard channel alarm. In addition, the Alarm Relay Primitives can be programmed to operate with any number of User Defined Alarms. The Alarm Relay primitives are the only primitives that are enabled when the chamber is turned Off (The chamber Off button is pressed).

Copy Outputs

Copy Outputs follow another output on an instantaneous basis. For example, some application might require two Humidity enable outputs.

Inverse Outputs

Inverse Outputs follow the inverse of another output on an instantaneous basis. For example, a Hot Gas Bypass output is the instantaneous inverse of the PID Cooling output.

Timed Outputs

Timed Outputs are used to control defrost or other periodic features.

Digitally Controlled Output

Digitally Controlled Outputs follow the state of one of the Digital Inputs.

PWM Outputs

PWM Outputs are Time Proportioning (AKA Pulse Width Modulated) outputs. These outputs are controlled by setpoints, process variables, or PID values.

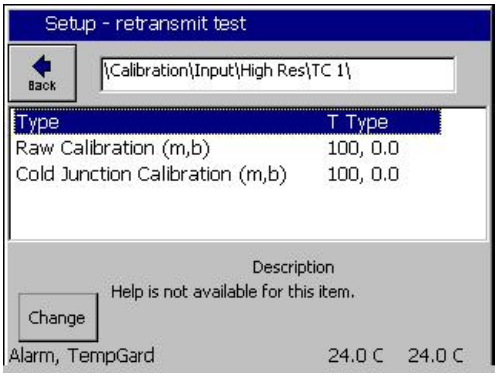
PWM outputs setup screen is identical to the Analog Retransmit Output screen.

Appendix C: Frequently Asked Questions, FAQ

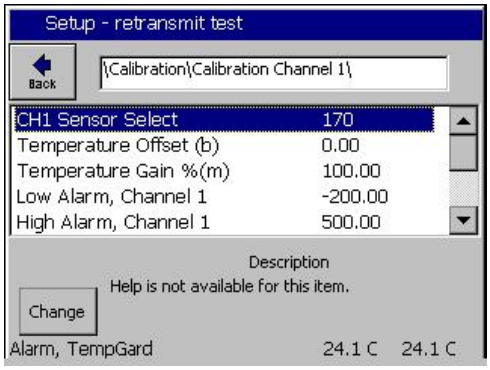
Q1: We would like to use a type T Thermocouple for our air temperature sensor, but the Quattro reads "Open Sensor" when wired according to the manual. Do we need to order the Quattro specifically for T/C inputs?

A1: The Synergy Quattro, Synergy Nano TE1858-1, -2, and -3 models support RTD's, T/C's, Process voltage and Process current inputs. A default Sensor ID for each channel is loaded when you select a chamber definition file (CDF). The default Sensor ID defines the input assigned to each channel control loop. The default Sensor ID for the chamber definition file you loaded is RTD but that can be easily changed.

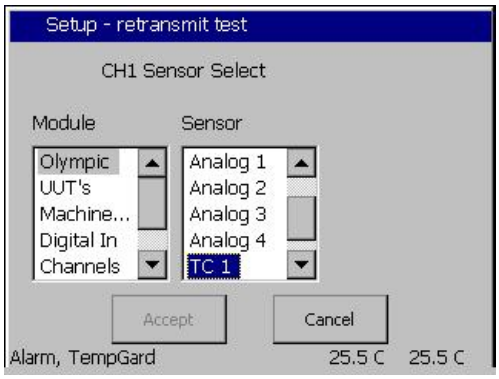
Follow these two steps:
1. Setup either T/C Input for the appropriate T/C Type.
2. Assign the Sensor ID for the sensor in step 1 to the channel on the SETUP/Calibration/Channel 1 Calibration screen,



1. To setup TC1, browse to the SETUP[\Calibration\Input\Hi Res\TC 1\] folder as shown at left and select the **Type** parameter. Then press **Change** and make your selection. (Note that this screen is also used to calibrate the sensors if required with the raw and cold junction calibration parameters).



2. Browse to the SETUP[\ Calibration \Calibration Channel 1\] folder as shown at left and select the CH1 Sensor Select parameter, then press **Change**. Select TC 1 as shown below and press **Accept**.


Setup - retransmit test
CH1 Sensor Select
Module
Sensor
Olympic
UUT's
Machine...
Digital In
Channels
Analog 1
Analog 2
Analog 3
Analog 4
TC 1
Accept
Cancel
Alarm, TempGard
25.5 C
25.5 C

Q2: The TempGard Alarm is always on. What is it and how do I get rid of it?

A2: The Synergy Micro, Synergy Quattro and Synergy Nano controllers can optionally display the state of a secondary limit controller (SLC). An SLC provides extra protection for the chamber and the unit(s) under test in case of a controller or chamber failure and is recommended for all systems. The Chamber Definition File (CDF File) determines if the controller is configured to display this alarm and if so, the digital input used. "TempGard Alarm" is the message displayed in the Alarm folder [MAINT\Alarms\] and in the Log file when the secondary limit controller is in the Alarm state. An auxiliary contact can be wired from the SLC to the Synergy Controller digital input to trigger this alarm. The default digital input for the Synergy Micro Controller is Input 9 (P1-1 to P1-11) and the default for the Synergy Quattro is Input 8 (P1-1 to P1-9).

Browse to the [EVENTS\Digital Inputs\] folder to monitor the state of the Digital Inputs on your Synergy touch screen. Wire a jumper in place of the auxiliary contact if your system doesn't include an SLC. Alternatively, contact the factory for a modified Chamber Definition File that doesn't include the TempGard alarm feature.

Q3: We have an issue with our vacuum oven when we pull vacuum of 3 Torr or less and then go back to atmosphere. The controller vacuum/pressure reading climbs to 10 Torr but does not go any higher even when the chamber reached pressure ambient unless we manually reset the controller.

A3: Your vacuum oven is equipped with two vacuum sensors, 10 Torr and 1000 Torr to enhance the accuracy of pressure measurements at low pressures. The Synergy Controller Virtual Pressure Sensor algorithm handles the automatic switchover from one sensor to the other.

The Virtual Pressure sensor is controlled by two L-Values named Transfer Pressure Threshold and Transfer Pressure Hysteresis.

Since the Low Pressure (High Altitude sensor) is only reading 10 Torr when the system returns to ambient pressure, the pressure does not reach the switch over point (Transfer Pressure Threshold plus Transfer Pressure Hysteresis) and therefore the transfer to the 1000 Torr sensor isn't occurring. The controller assumes that the 10 Torr sensor is still in range since it's reading hasn't exceeded 10 Torr. This may be occurring because of a calibration issue with the sensor or because the output clamp designed to protect the input from damage during over range is clamping at or below 5.0 Volts.

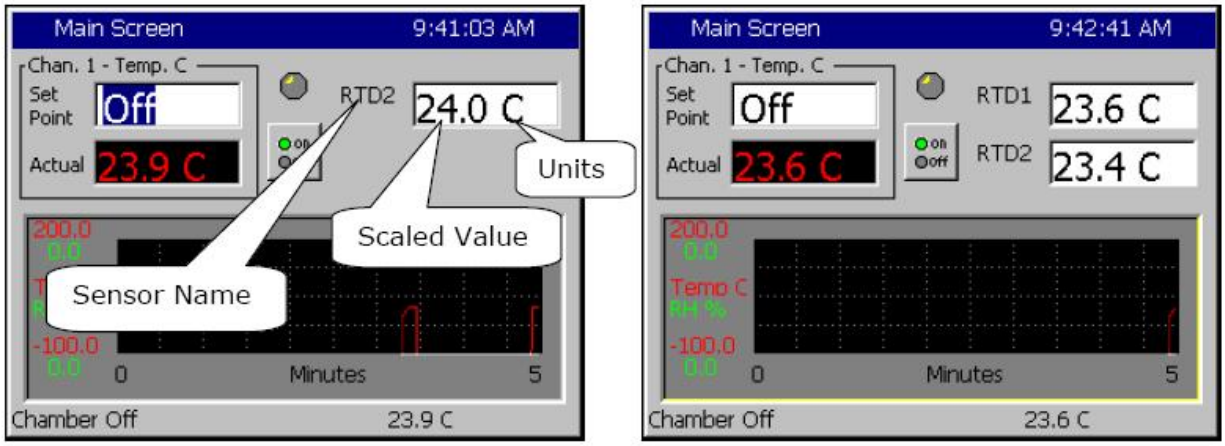
To correct this, you can make the transfer to the 1000 Torr sensor occur at 9.5 or 9.0 Torr by adjusting the Transfer Pressure Threshold (default 9 Torr) or the Transfer Pressure Hysteresis (Default 1 Torr). If you lower the Transfer Pressure Threshold by 0.5 Torr to 8.5 Torr it will lower the switch over point (Transfer Pressure Threshold plus Transfer Pressure Hysteresis) to 9.5 Torr.

Note that with the default virtual pressure sensor settings, the reading will transfer to the 10 Torr sensor when the 10 Torr sensor reads below 8 Torr and transfer back to the 1000 Torr Sensor when the 10 Torr sensor reads above 10 Torr.

Q4: I want to place a second temperature sensor in my temperature chamber and display it on the second channel of the controller. Can the Synergy Controller display a second temperature reading on a single channel application?

A4: Yes, the Synergy Micro 2, Synergy Quattro, and the Synergy Nano can do this with "Sensor Display Channels". This feature is explained in " Synergy_Controller_App_Note_48_Synergy_Display_Channels.pdf " attached. Here are two example screenshots of this feature.

Synergy Display Channels



Q5: Does the WebTouch Remote (tm) feature have any hardware requirements for the PC ?

A5: There are no specific hardware requirements except that you'll need a computer with a network connection and a web browser such as Internet Explorer, Firefox or Safari.

Even an Apple iPad will work.

All Synergy test chamber controllers are equipped with a WebTouch Remote ™ web server. Any computer with a web browser can remotely monitor and control the test chamber by connecting to it.

You can watch a video that explains the controller's WebTouch Remote feature by following the link below.

http://www.tidaleng.com/swf/Synergy_Controller_WebTouch_Remote_Demonstration.htm

The Synergy Controller Technical Manual also covers the WebTouch Remote feature.

Q6: How do I change the temperature range limits allowed on the Setpoint number pad?

A6: The Setpoint Limits for Channel 1 are controlled from the folder:
SETUP[\Calibration\Channel 1\Low Limit, Channel 1]
SETUP[\Calibration\Channel 1\High Limit, Channel 1]

Similarly named folders are used for the other channels enabled on your controller.

Q7: The first step of my program is a setpoint of 100 C but the controller does not go to 100 C when it starts.

A7: The Synergy Controller's Ramp step begins at that the controller temperature setpoint when the profile starts (for the first step of the profile) or the ending setpoint of the previous step otherwise.

If you want the chamber setpoint to go immediately to a temperature, set the ramp time for the first step to 00:00:00 (Hrs:Mins:Secs).

Q8: Can you explain the purpose of the deviation alarm limits and the deviation alarm delay?

A8: The Synergy Controllers Deviation alarms monitor the deviation between the controller's setpoints (SP) and the Process Variables (PV). The Deviation Alarm limits are calculated from the setpoint; i.e. relative to the setpoints. This is in contrast with the standard alarms which are absolute limits.

To allow short excursions outside the deviation alarm limits, the Deviation Alarm Delay feature can help avoid nuisance alarms when the setpoint is ramping and the chamber machinery can't keep up with the setpoint.

To adjust the Deviation Low Alarm limit, select Deviation Low Alarm in the SETUP[\Calibration\Calibration Channel X\]" folder and press Change. Then enter the new value in the number pad.

To adjust the Deviation High Alarm limit, select Deviation High Alarm, press Change and enter the new value on the number pad.

The Deviation Alarm limits can be disabled or delayed using the Deviation Alarms Enabled and Deviation Alarm Delay parameters.

Q9: What are the responses from the “DIGITAL OUTPUT QUERY” command?

A9: The “? DO n” query reports the current state of the nth digital output from the controller (n out of 32 digital controller outputs). The controller’s digital outputs control fans, compressors, heaters, etc. The response is:

n:m=x, o = y where: n is the channel, x is the mode and y is the output value.

For example, the query “? DO 1” reports the status of the Fan output for standard chambers.

“1:M=0, O=1”
"1:" for Output 1, "M=0" for Mode On/Off (not time proportioning), "O=1" for Output is On.

Can I use this command to determine that status of event outputs?

If you are interested in determining if one of the nine User Events are on, you can use the "? EVENTS n" query. The response is 1 for On, 0 for Off. You can also use the “? DO n” command. Output 11 is Event 1 on standard generic chambers. You can use the “= EVENTS n,x” commands to set the state of Event Outputs. N is the event number and x is the value.

Q10: The OT11 TPM event is grayed out and not selectable?

A10: When you are running a profile, the OT11 control type is configured for each step from the Events screen in the profile wizard. When running a steady state condition, the OT11 output type is controlled from the Setup\Special Functions Screen. See the Output 11 Control Type folder.

Q11: Channel 2 humidity calibration is wrong. I'm feeding the Synergy input with a 0-5 Volt source and the humidity reading is not following the voltage linearly.

A11: When the SETUP[\Calibration\Input\High Res\Analog 1\] input is set to HMM30C-RTD1 (or other Vaisala setting), the Synergy Controller displays a temperature compensated humidity reading using the Vaisala compensation algorithm. In this case, the reading in %RH will not be linearly proportional to the input voltage. Set the Type parameter to “Other” or “Linear”and the reading will be proportional.

Q12: My controller is setup for WB/DB and the Humidity readings are going below 0% and driving the controller into an alarm when the chamber temperature goes below 0C.

A12: Synergy Controller Virtual Wetbulb/Drybulb Humidity Sensor will give erroneous humidity values below 0C (32F). To prevent an alarm from occurring in this situation and shutting down the chamber, turn off the Humidity channel and set the disable the humidity alarm when the channel is off.
Set "SETUP\Calibration\Calibration Channel 2\Ignore Alarm When Off" to ENABLED.

Q14: In Graph screen, I can change the temp range but can not change the time range. Is this correct?

A14: Both the y axis and time axes are adjustable. Browse to the Setup\Graph Settings folder.

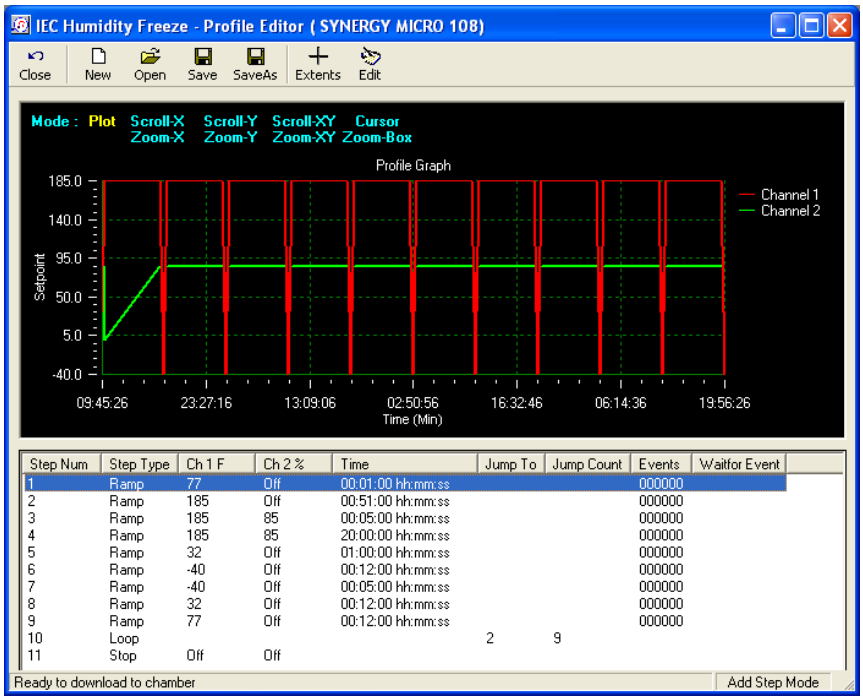
Q15: What parts come with a 16-Channel thermocouple UUT module, P/N TE1299-16?

A15: In addition to the UUT Module itself, the following items are included with the TE1299-16.

QTY	REF DES	P/N	Description
1	XTR1	TE1435 (100853)	WALL TRASFORMER WITH 120-D-111/10 CONNECTOR
3	XP2-XP4	120-D-121/12	HEADER PLUG, 12 POS, 5 MM
1	Daisy Chain Cable	TE1467	UUT and TCweb Slave cable

Q16: Can the operator view the profile on the controller screen after he writes a profile?

A16: The operator can view the list of steps in the profile on the controller from the RUN and PROGRAM screens. In addition, the Synergy Manager's profile editor can be used to create profiles for the controller. The Profile Editor can display the profile graphically as well. Profiles created on the PC can be copied to a flash drive in "VPL" format and installed on the controller. Users that purchase the full version of Synergy Manager can use the software to send profiles to the controller thru the network or Serial/GPIB ports.



Q17: When the pressure gets close to ambient pressure on our Temperature/Pressure chamber, the electric solenoid valve that vents off chamber pressure is clacking on and off about every second. It is very loud and I am afraid it is going to shorten the life of the solenoid. Any idea how we can slow this cycling on and off down a little?

A17: The Cycle Time parameter (in seconds) for the Vent valve can be set from the following folder: SETUP[\PID Settings\PID Ch 2\PID Ch 2 Vent]. Increasing the cycle time will slow down the clacking.

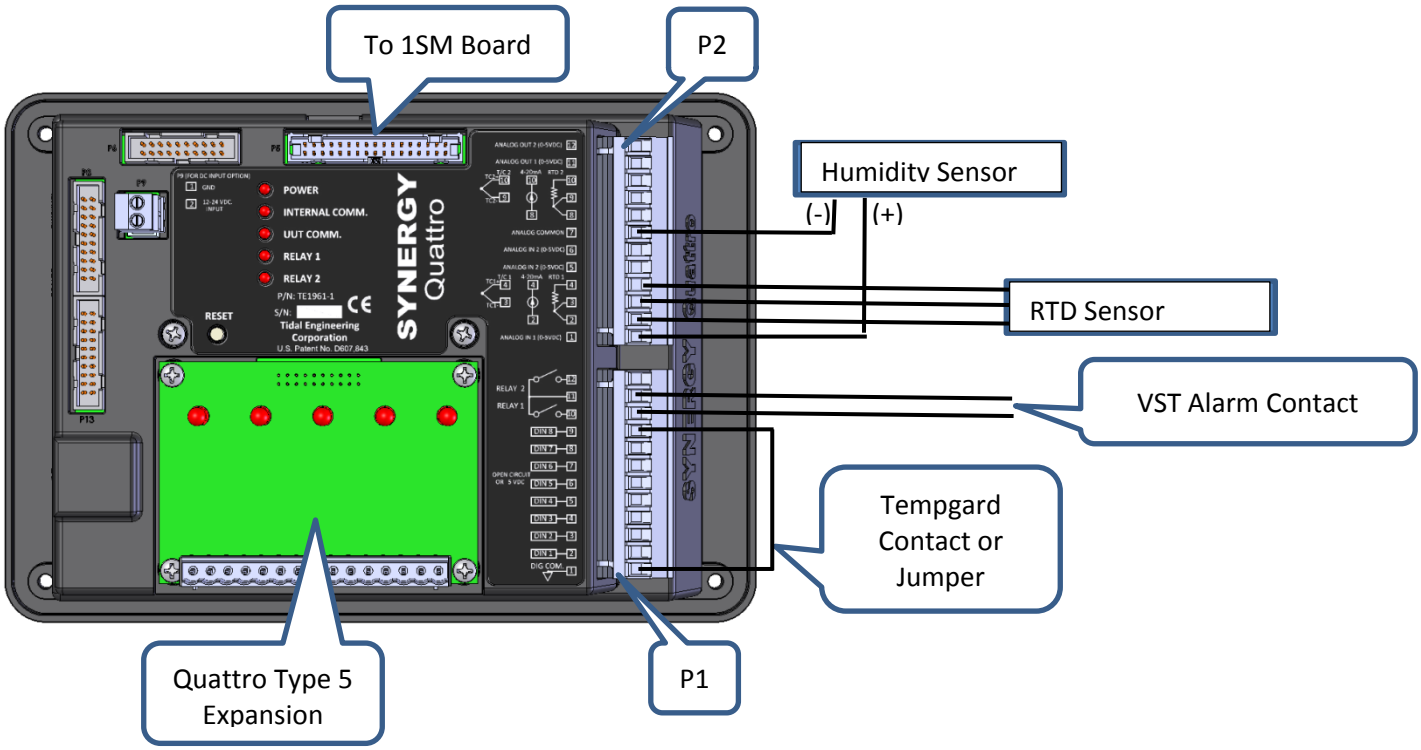
Appendix D: Synergy Controller Application Notes

AppNote 1 - Replacing a VersaTenn III Controller
AppNote 2 - Synergy Controller Data Logging Capacity Calculations
AppNote 3 - Retrofitting a Qualmark HALT/HASS Chamber
AppNote 4 - Configuring the Synergy Controller to Read from a Bar Code scanner
AppNote 5 - Synergy Controller vs. VersaTenn III
AppNote 7 - Synergy Controller WebTouch Remote Feature
AppNote 8 - Using SimpleComm application to communicate with the Synergy Controller
AppNote 10 - Synergy Controller Retransmit Signal Conditioner :
AppNote 20 - Using the TE1908 Single Channel Thermocouple Signal Conditioner
AppNote 25 - Using the Synergy Controller with Space Chamber applications.
AppNote 26 - Using the programmable User Alarms with the Synergy Controller
AppNote 40 - Two Point Calibration.
AppNote 45 - Using the Synergy Controller's ftp server.
AppNote 49 - Synergy Controller Security Enhancements
AppNote 56 - Using the Synergy Controller Watchdog Timers
AppNote 58 - Synergy Controller Wet-Bulb/Dry-Bulb Humidity Measurements.
AppNote 59 - Synergy Controller Wireless Network Setup.
AppNote 60 - Graphing Synergy Log Files in Microsoft Excel.
AppNote 67 - Synergy Controller Mounting Options.
AppNote 71 - Synergy Controller PWM Retransmit Feature
AppNote 72 - Synergy Controller Thermocouple Data Acquisition with Synergy UUT Modules
AppNote 74 - Synergy Controller LED Backlight Retrofit Kit
AppNote 77 - Synergy Controller Remote Start/Stop Feature
AppNote 84 - Synergy Controller E-Mail Feature
AppNote 85 - Synergy Controller Logging Features and Applications
AppNote 89 - Synergy Controller Loop-Back Setup
AppNote 90 - Synergy Controller Network Printing Feature
AppNote 91 - Synergy Controller Built-In Alarms
AppNote 95 - Synergy Controller Kft and other Pressure Display
AppNote 96 - Synergy Controller Analog Retransmit Applications
AppNote 99 - Synergy Server Feature
AppNote 102 - Synergy Certified OEM and Installer Training
AppNote 106 - Synergy Controller Cascade Loop (Part Temperature) Control Feature
AppNote 107 - Synergy Controller Programming with Python
AppNote 109 - Synergy488 Kit Setup for Synergy Nano and Synergy Quattro GPIB
AppNote 112 - General Purpose Logic Programming for OEMS and Integrators
AppNote 113 - Main Screen Display Setup Options
AppNote 116 - Synergy Controller Pressure Applications
AppNote 117 - Synergy Controller Help System Video QR Codes.
AppNote 121 - Synergy Controller Ramp Rate Control.

Appendix E: Temperature - Humidity Application Wiring

1. Connect the 34 position ribbon cable from the 1SM board to P5 on the Synergy Quattro.
2. Wire the RTD to Synergy Quattro P2 as shown below. (P2-2, P2-3, P2-4)
3. Wire the Humidity Sensor to Synergy Quattro P2 Analog Input 1. (P2-1 to P2-7)
4. Connect the Temp Guard input to the Synergy Quattro Digital Input 8 (P1-1 to P1-9) as shown below.
5. Wire the VersaTenn Alarm (VST ALARM) to the Synergy Quattro Alarm Relay 1 (P1-10 to P1-11).
6. Plug the orange SSR plug into the Synergy Quattro Type 5 Expansion module.

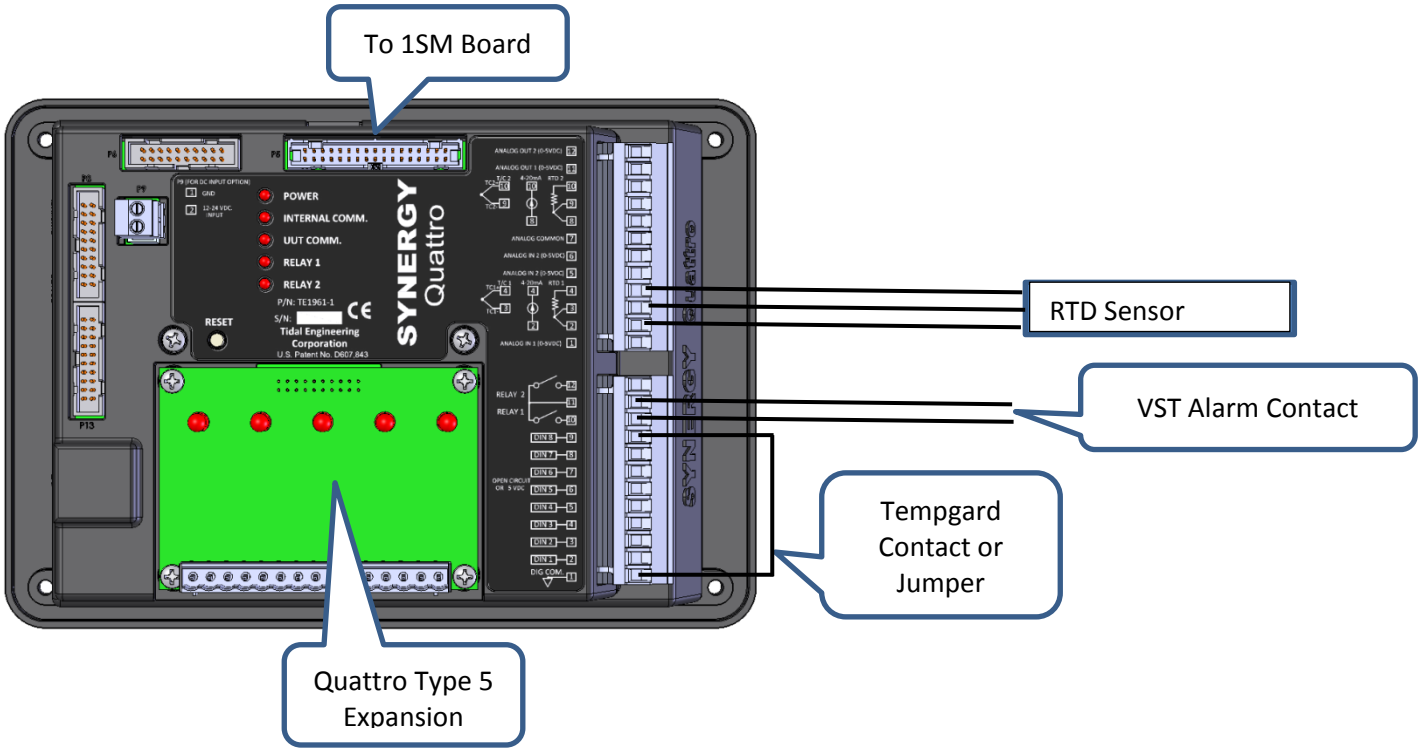
Temperature Humidity (QUATTRO_TH_VERSATENN.CDF)



Appendix F: Temperature Only (Cascade) Application Wiring.

1. Connect the 34 position ribbon cable from the 1SM board to the P5 plug.
2. Wire the RTD to Synergy Quattro P2 as shown below. (P2-2, P2-3, P2-4).
3. Connect the Temp Guard input to the Synergy Quattro Digital Input 8 (P1-1 to P1-9) as shown below.
4. Wire the VersaTenn Alarm (VST ALARM) output to the Synergy Quattro Alarm Relay 1 (P1-10 to P1-11).
5. Plug the orange SSR plug into the Synergy Quattro Type 5 Expansion module.

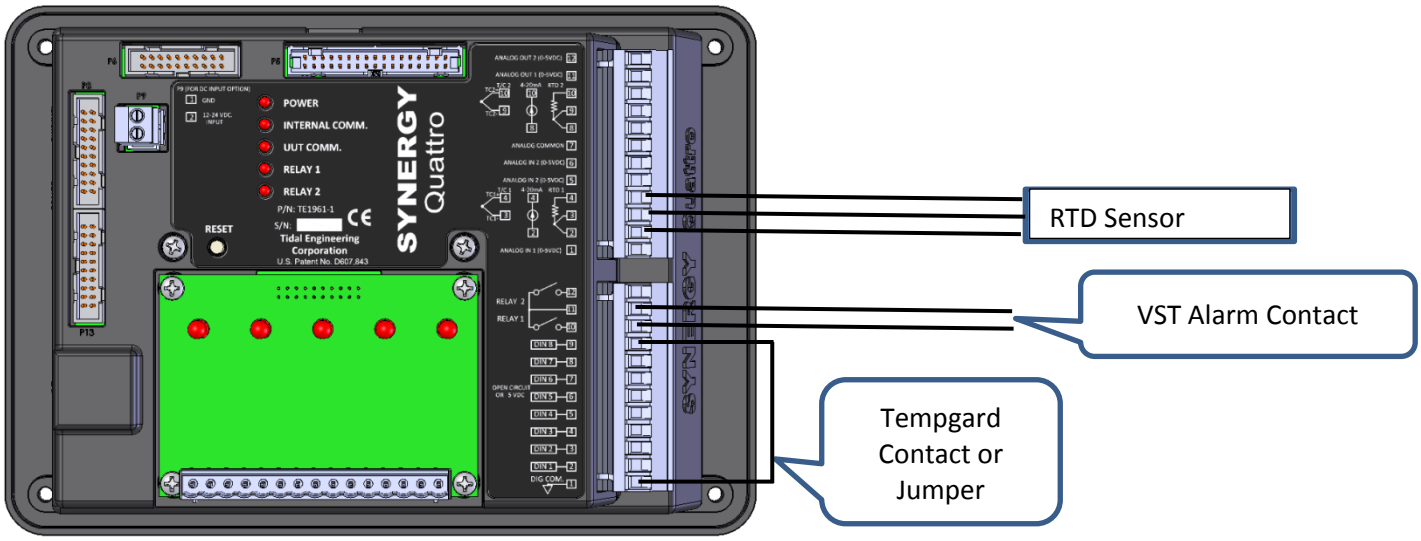
Temperature Only for Cascade Chambers (QUATTRO_TO_VERSATENN_CASCADE.CDF)



Appendix G: Temperature Only (Cascade) Application Wiring.

1. Wire the RTD to Synergy Quattro P2 as shown below. (P2-2, P2-3, P2-4)
2. Connect the Temp Guard input to the Synergy Quattro Digital Input 8 (P1-1 to P1-9) as shown below.
3. Wire the VersaTenn Alarm (VST ALARM) to the Synergy Quattro Alarm Relay 1 (P1-10 to P1-11).
4. Plug the orange SSR plug into the Synergy Quattro Type 5 Expansion module.

Temperature Only for Single Stage Chambers (QUATTRO_TO_VERSATENN.CDF)



About the Synergy Controller Family

Tidal Engineering's Synergy Controllers, the Synergy Micro 2, Synergy Quattro, and the ¼ DIN Synergy Nano provide state-of-the-art usability and connectivity for environmental test control and data acquisition. They combine the functions of a chamber controller and a data logger and are designed to improve test efficiency by supporting both factory automation and test and measurement protocols and standards.

Synergy Controller feature highlights includes:

- ➔ Color touch screen
- ➔ Ethernet, RS-232 and GPIB communications
- ➔ Built in 100 MB Data logger with USB drive support
- ➔ Data Acquisition, up to 64 T-type thermocouples (Optional)
- ➔ Built-in Web Server for remote control; WebTouch Remote ™
- ➔ Compatible with Synergy Manager for PC based control, monitoring and programming.
- ➔ Built-in FTP Server for factory automation and test and measurement applications

For more information regarding these controllers please see the full Synergy Controller Technical Manual on our website at http://www.tidaleng.com/synergy.htm

About Tidal Engineering

Headquartered in Randolph, NJ, Tidal Engineering Corporation has been designing and building award-winning embedded hardware and software for test and measurement and data acquisition applications since 1992. The company is recognized for technical expertise in such areas as Embedded IEEE 488, and turnkey SCADA (Supervisory Control and Data Acquisition) systems.

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