

SYNERGY QUATTRO

Designed Specifically For Environmental Test Chambers

A FOUR CHANNEL PROCESS CONTROLLER AND DATA LOGGER



Installation Manual

Tidal Engineering Corporation

2 Emery Ave.
Randolph, NJ 07869
www.TidalEng.com

Document Number: TE2281 Revision: B Date January 05, 2015

Revision History

| Rev. | Date | Revision |
|------|-----------------|--|
| A | August 28, 2013 | Created this document, P/N TE2281 , "Synergy Quattro Installation Manual" from "Synergy Nano Installation Manual, Rev A" |
| B | January 5, 2014 | Update this document, P/N TE2281 , "Synergy Quattro Installation Manual" to Rev B. |
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| Appendix F: Example Wiring Diagram, NANO_TH_F4_02 | Error! Bookmark not defined. |

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Introduction

This Synergy Quattro Installation Manual, written for OEMs, installers, and service personnel, is designed to provide a guide for Synergy Quattro controller installations.

The information and instructions are provided to help the reader select, configure, wire, and test a Synergy Quattro Controller.

The Synergy Controller Technical Manual, Part Number TE2242, 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 Synergy Quattro controller provides most of the high-end environmental test chamber control features of the Synergy Micro 2 but in more economical package.

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 Software 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

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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: Standard Chamber Definitions

Appendix E: Example Wiring Diagram, VersaTenn III Temperature only retrofit

Appendix F: Example Wiring Diagram, VersaTenn III Temperature/Humidity retrofit

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 Controller (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 used 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 from 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.

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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.

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1. Controller Overview

The Synergy Quattro 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 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 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 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 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

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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 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

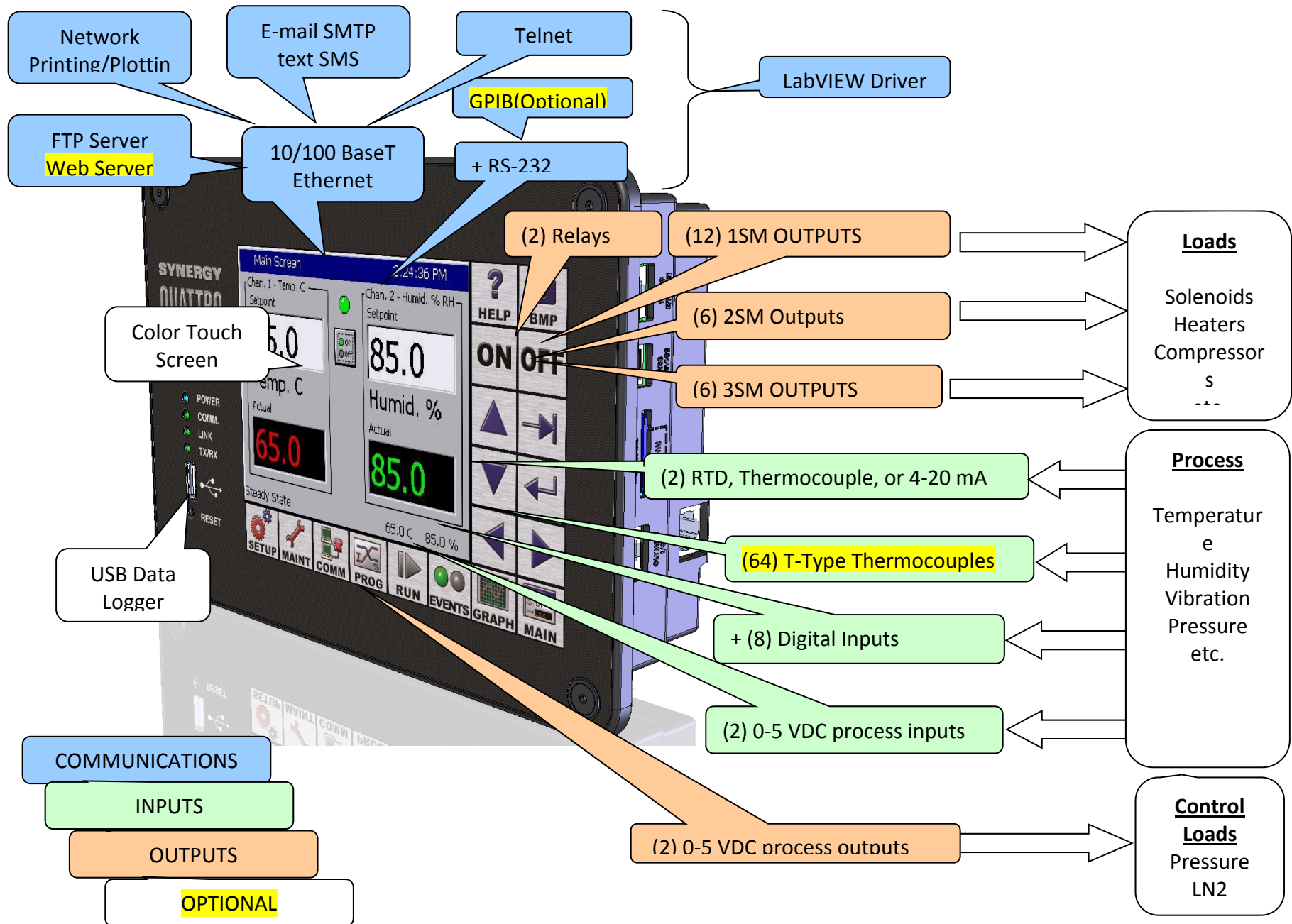
| Signal | Signal Location | Sensor ID | Comments |
|---------|------------------------|-----------|----------|
| Voltage | Hi Resolution Analog 2 | 140 | |

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 |

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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

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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.

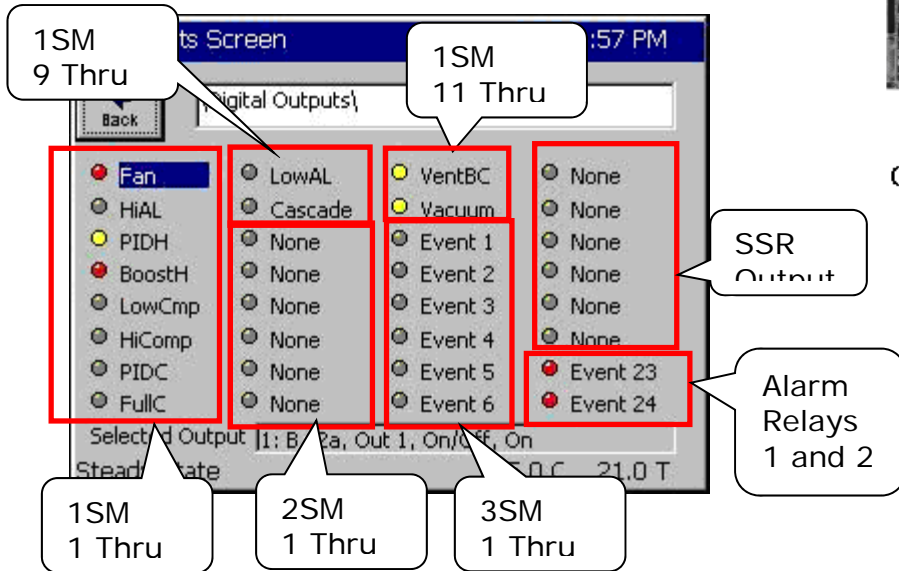
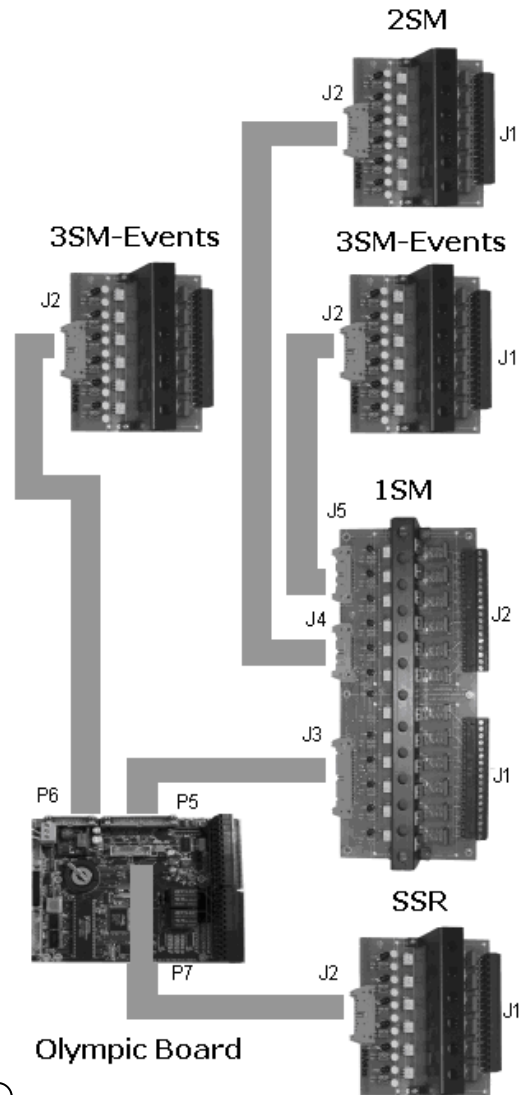
For example, note that the 3SM-Event outputs can be connected two ways; directly to the Olympic board P6 connector or thru the 1SM- J5 connector as shown at the right

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.

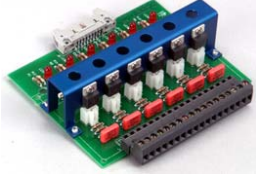
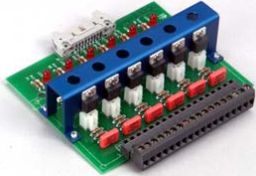
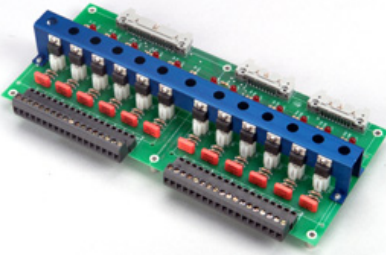
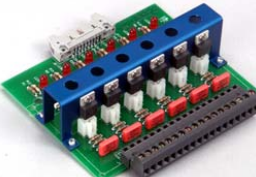


Output Mappings by Chamber Type

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

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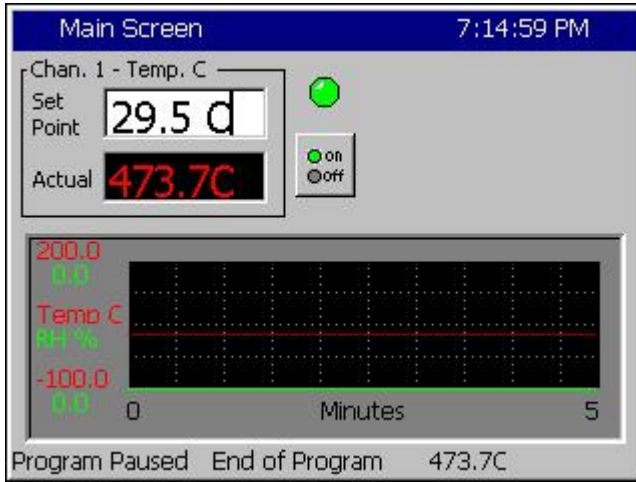
3.1 Quattro Temperature Only

| 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 | |

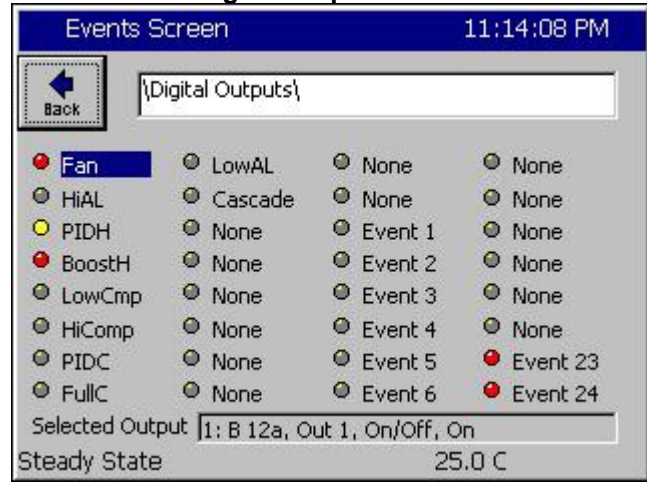
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Quattro Temp Only

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

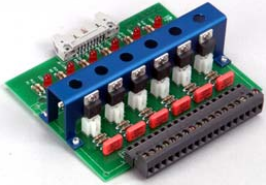
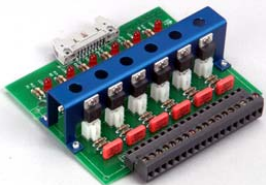
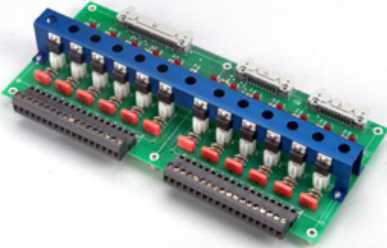
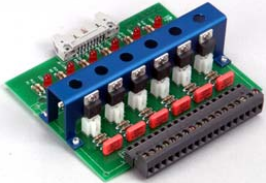
| Name | Input | Function when Closed |
|-------------------------|---------|--|
| Compressor Cut in Logic | Input 3 | Boost Heat, High Artificial Load, High Stage Compressor, Cascade Condenser (See Section 6.7 Device Primitives etc) |
| Burn-in Logic | Input 4 | Enables Low Stage Compressor and Full 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 | | | | | | | |

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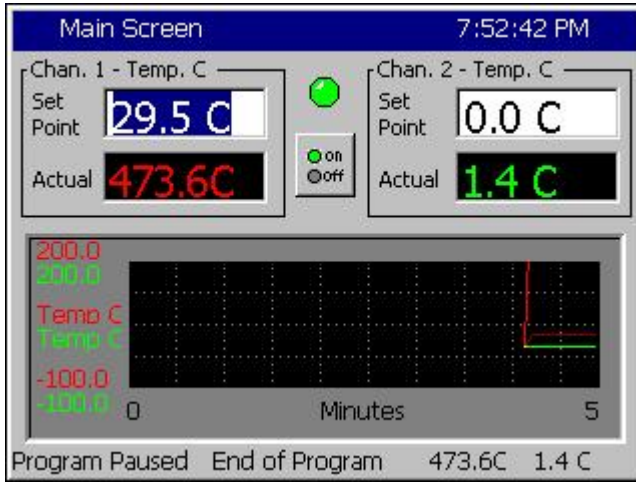
3.2 Quattro Temperature/Temperature, Dual Thermal Shock

| 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 |

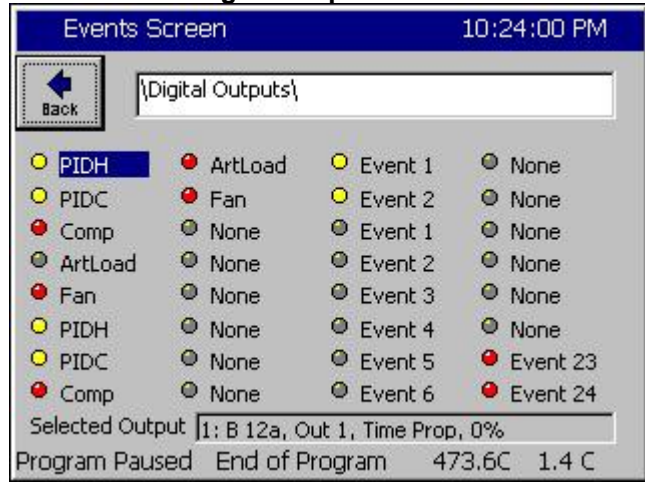
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Quattro Temp/Temp (Thermal Shock)

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. |

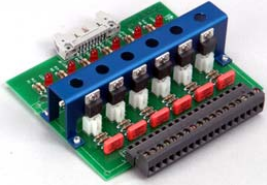
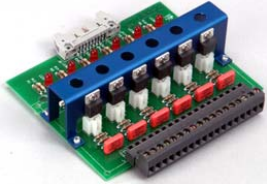
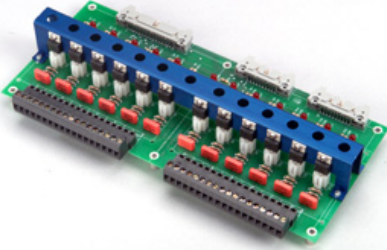
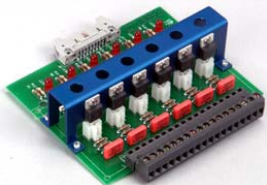
Alarms

| 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.

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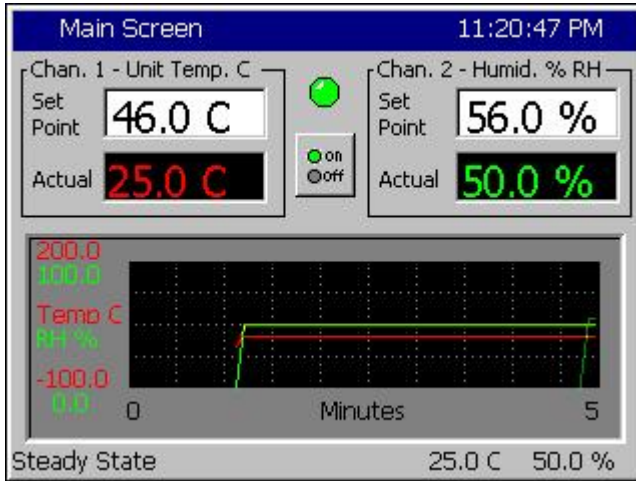
3.3 Generic Temperature/Humidity

| 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 AI |
| | 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 |

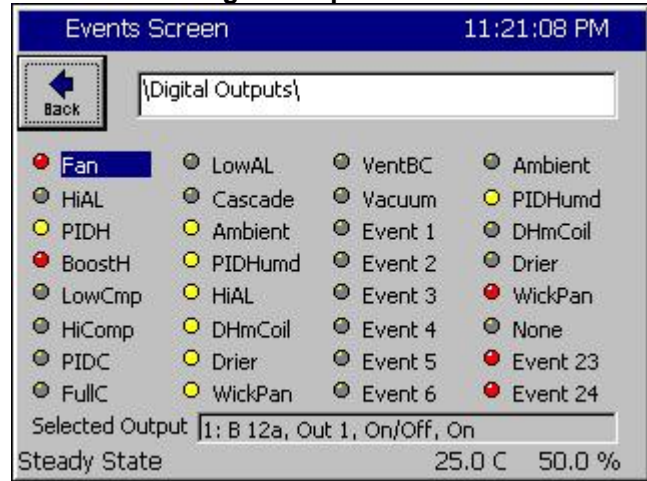
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Quattro Temperature Humidity Main Screen

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. |

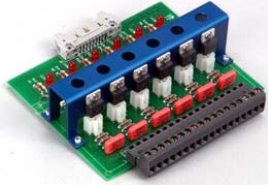
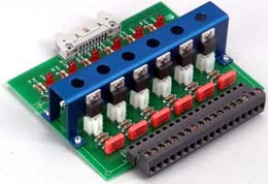
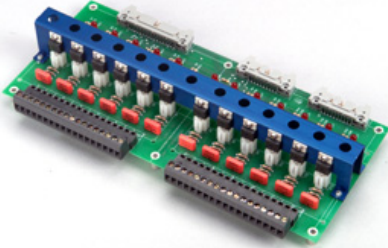
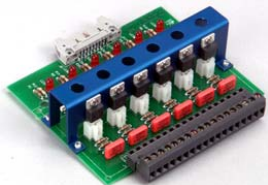
Alarms

| 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.

SYNERGY QUATTRO

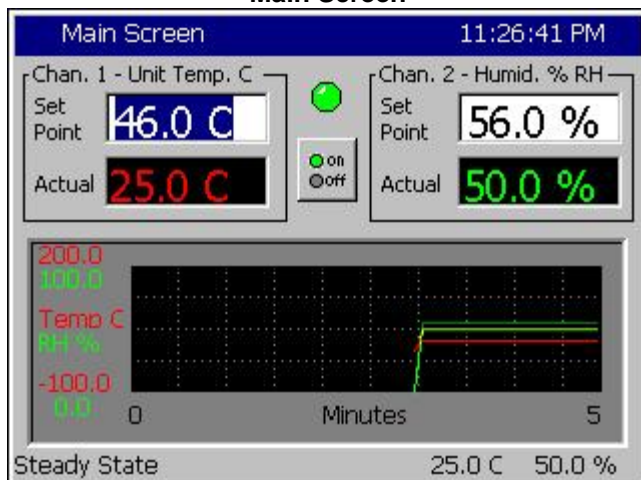
3.4 Quattro Temperature/Humidity Single Stage

| 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 |

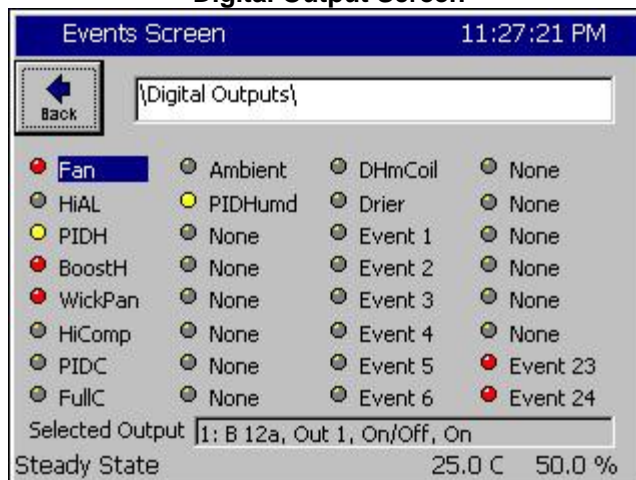
SYNERGY QUATTRO

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

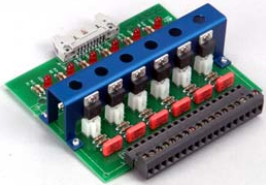
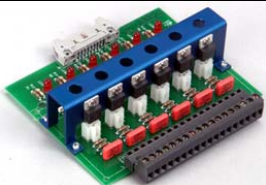
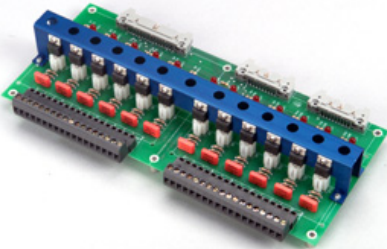
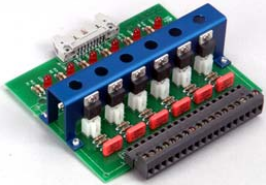
| Name | Input | Function when Closed |
|-------------------------|---------|---|
| Ambient Lock Out | Input 1 | Disables Ambient Coil when Dehumidify Coil is on. |
| Drier Logic | Input 2 | Enables Drier when LEV1 (Use Drier) is active. |
| Compressor Cut in Logic | Input 3 | Boost Heat, High Artificial 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 |

SYNERGY QUATTRO

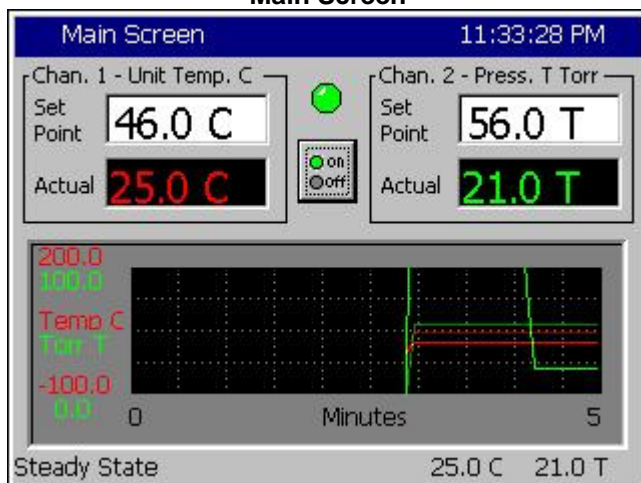
3.5 Quattro Temperature/Pressure, Altitude and Space

| 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 |

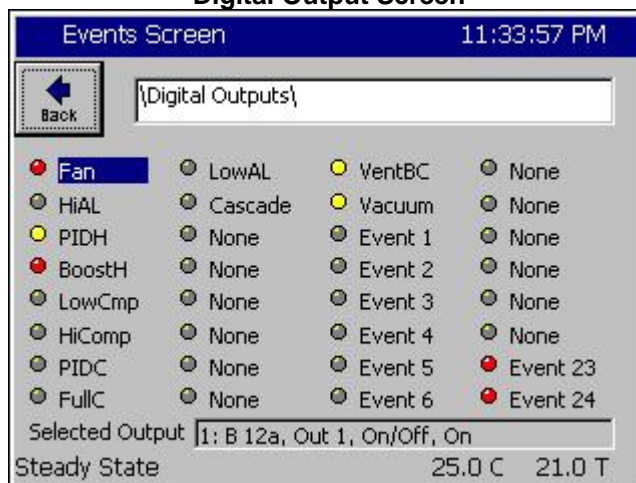
SYNERGY QUATTRO

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

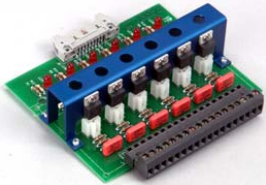
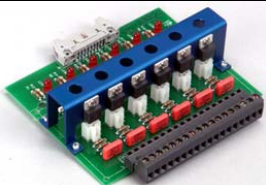
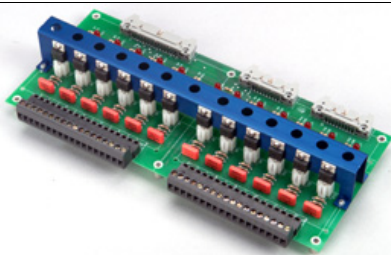
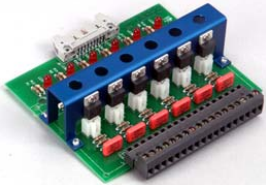
| Name | Sensor | Sensor Code | Default Threshold | Report | Log | K1 | K2 |
|-----------------|-----------------|-------------|-------------------|--------|-----|-----|----|
| Hi Alarm Ch 1 | RTD1 | 110 | > 500 C | Yes | Yes | Yes | No |
| Low Alarm Ch 1 | RTD1 | 110 | < -200C | Yes | Yes | Yes | No |
| 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.

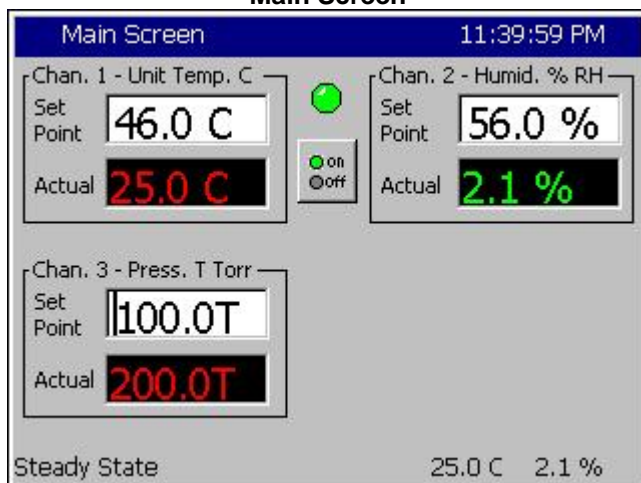
SYNERGY QUATTRO

3.6 Quattro Temperature/Humidity/Pressure, Altitude

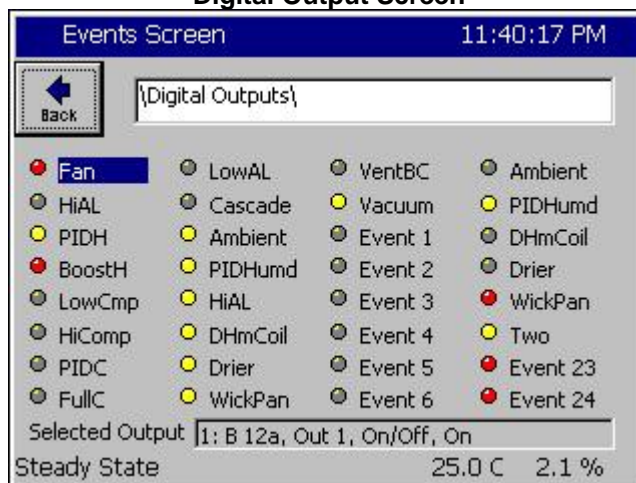
| Quattro Temperature/Humidity/Pressure ,Altitude | | | |
|---|------------|----------------|----------------------|
| 2SM Outputs | | | |
| TE1151-6 | SM Channel | Digital Output | Device |
|  | 6 | 16 | Wickpan |
| | 5 | 15 | Drier |
| | 4 | 14 | Hi Al |
| | 3 | 13 | Dehumidify Coil |
| | 2 | 12 | 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 |

SYNERGY QUATTRO

Quattro Temperature/Humidity/Pressure 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

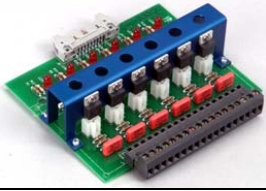
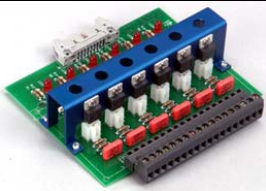
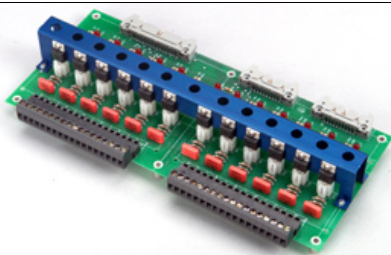
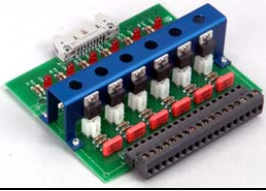
| Name | Sensor | Sensor Code | Default Threshold | Report | Log | K1 | K2 |
|-----------------|-----------------|-------------|-------------------|--------|-----|-----|----|
| Hi Alarm Ch 1 | RTD1 | 110 | > 500 C | Yes | Yes | Yes | No |
| Low Alarm Ch 1 | RTD1 | 110 | < -200C | Yes | Yes | Yes | No |
| 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.

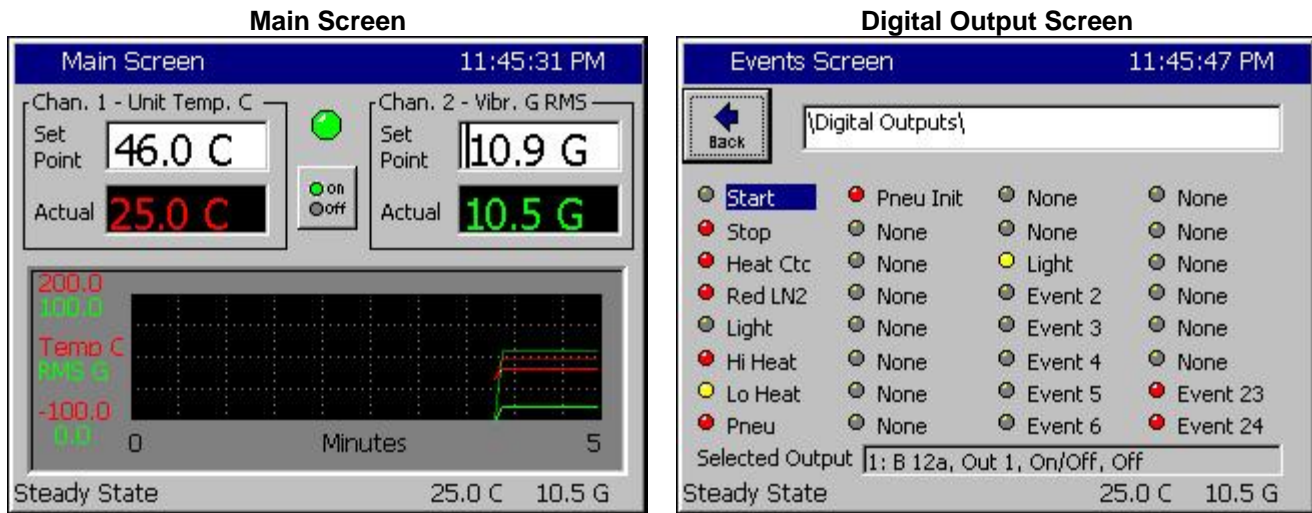
SYNERGY QUATTRO

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 |

SYNERGY QUATTRO

Quattro Temperature/Vibration Main 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. |

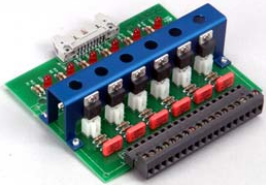
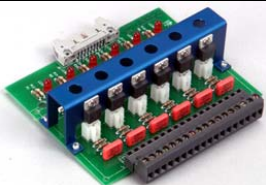
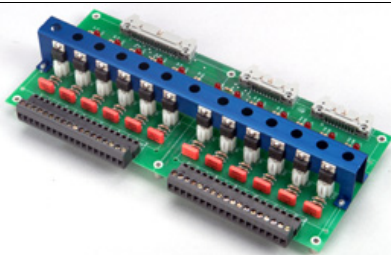
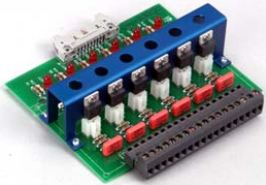
Alarms

| 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.

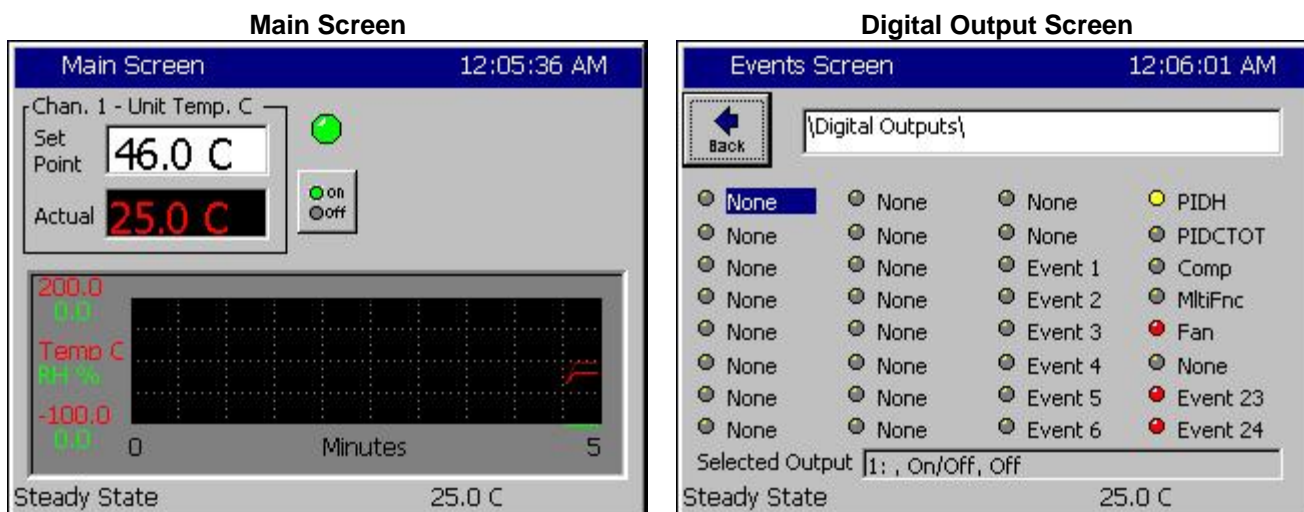
SYNERGY QUATTRO

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 |

SYNERGY QUATTRO

Quattro Retro Temp Only Main 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.

SYNERGY QUATTRO

4. Wiring

An example Synergy Quattro 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.

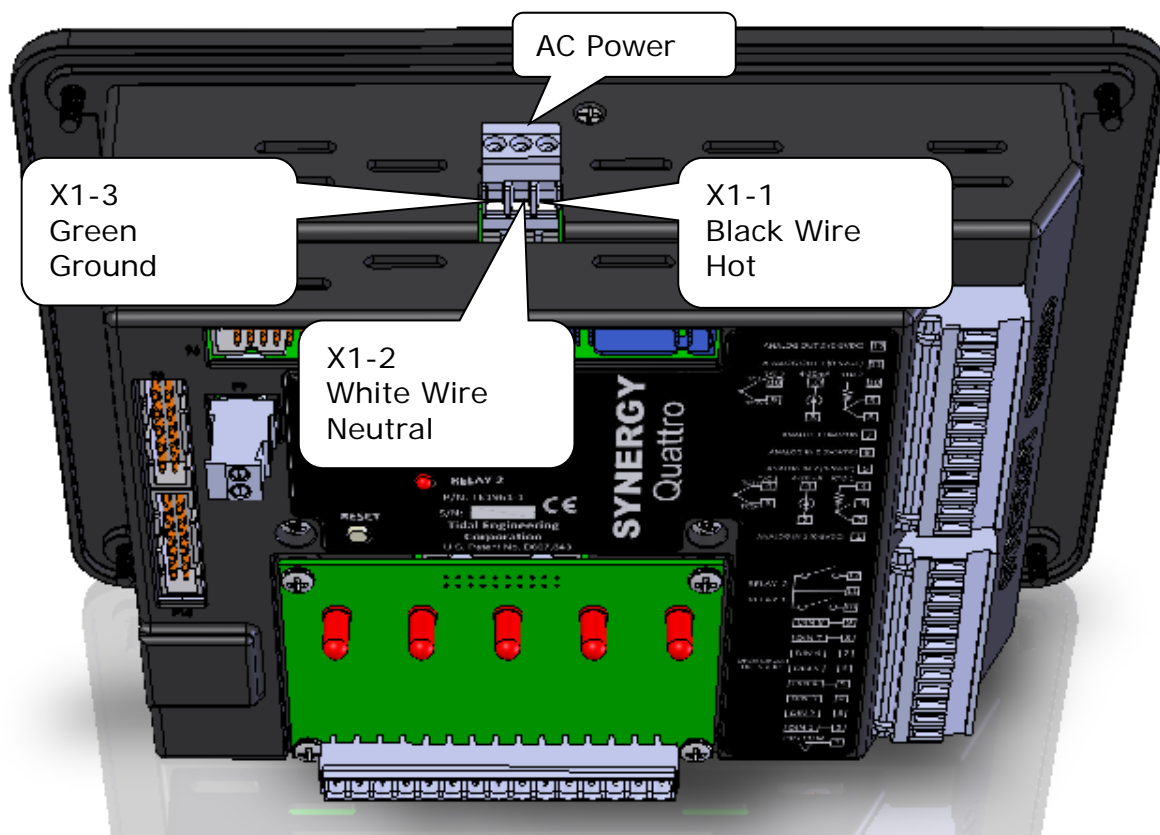
The figure below identifies the plug arrangement on the back of the controller.

TBD



SYNERGY QUATTRO

- 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.

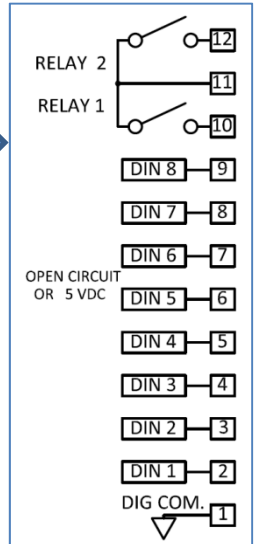
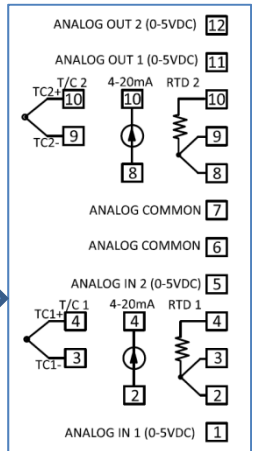
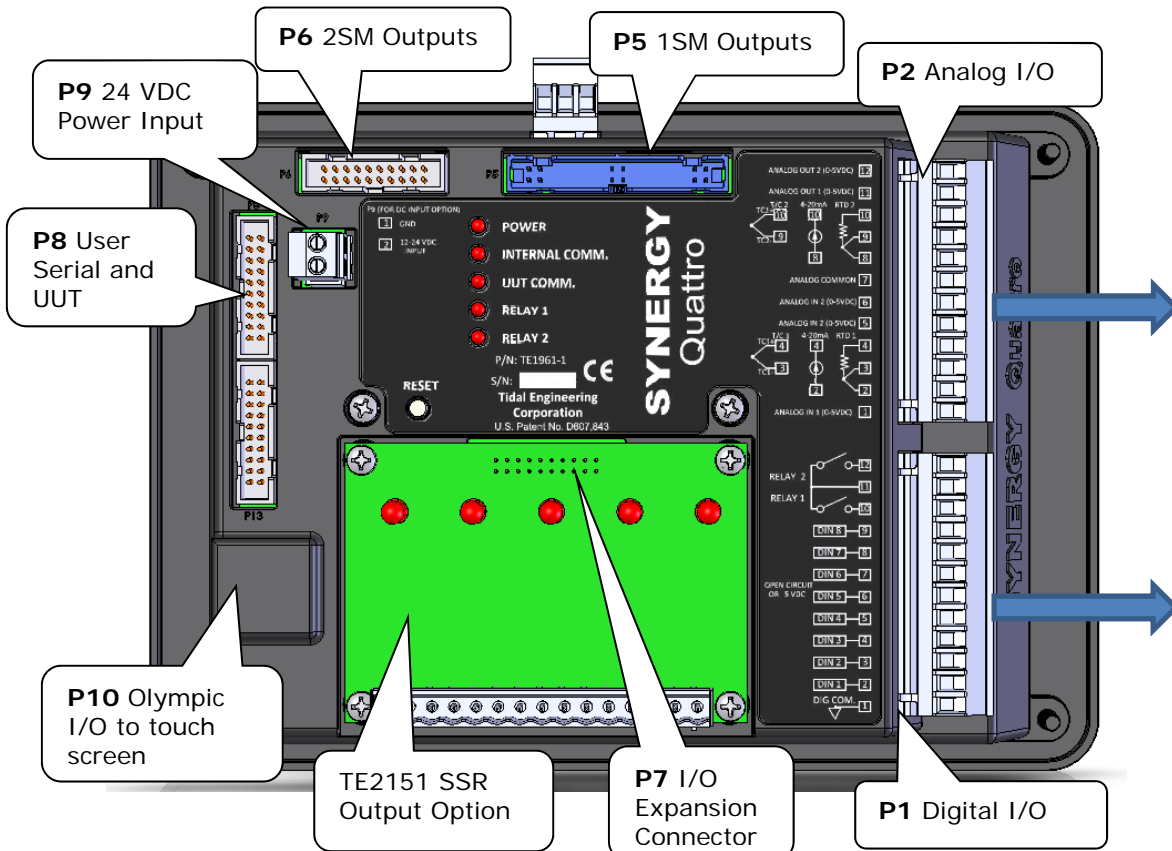
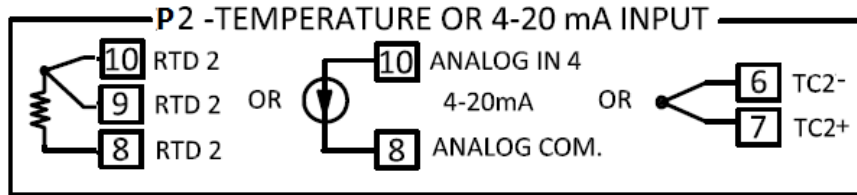
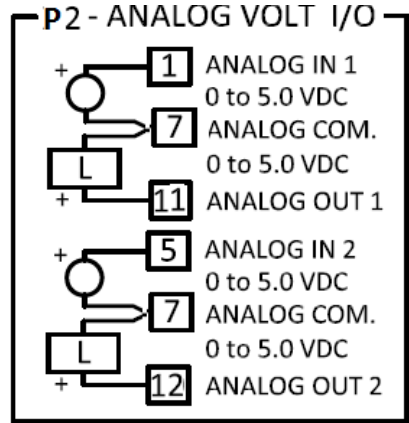
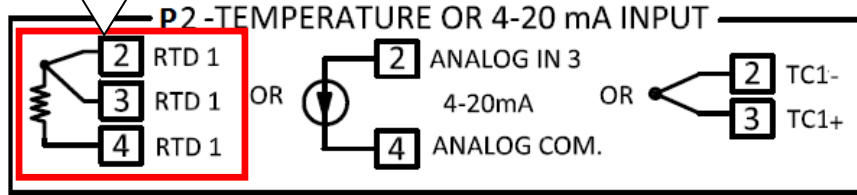


WARNING: BE SURE THAT THE UNIT IS NOT CONNECTED TO THE AC SOURCE WHILE WIRING.

SYNERGY QUATTRO

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.

X2-Pin2
RTD1 Red Wire



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:

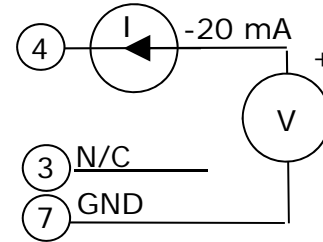
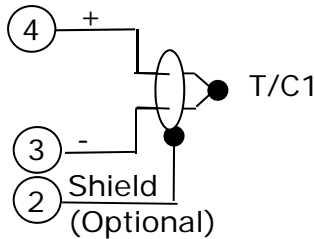
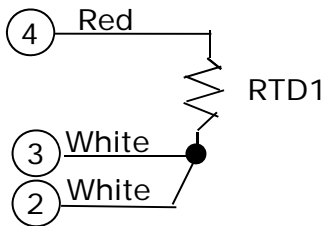
All standard Synergy Quattro Chamber Definition Files expect a TempGard input on Digital Input 8. See Safety Section 8 regarding TempGard and other safety features of the controller.

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.

SYNERGY QUATTRO

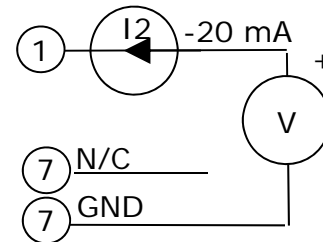
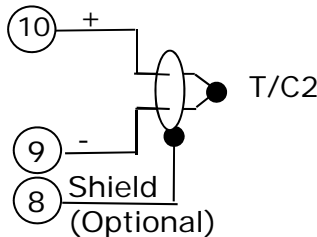
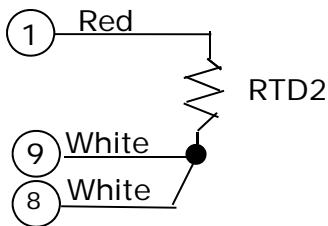
Input Sensor Wiring

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 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 |

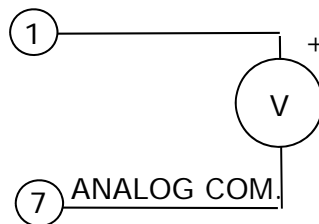


Process Input Wiring

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

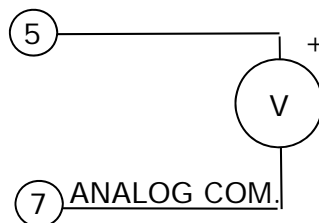
Analog In 1

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



Analog In 2

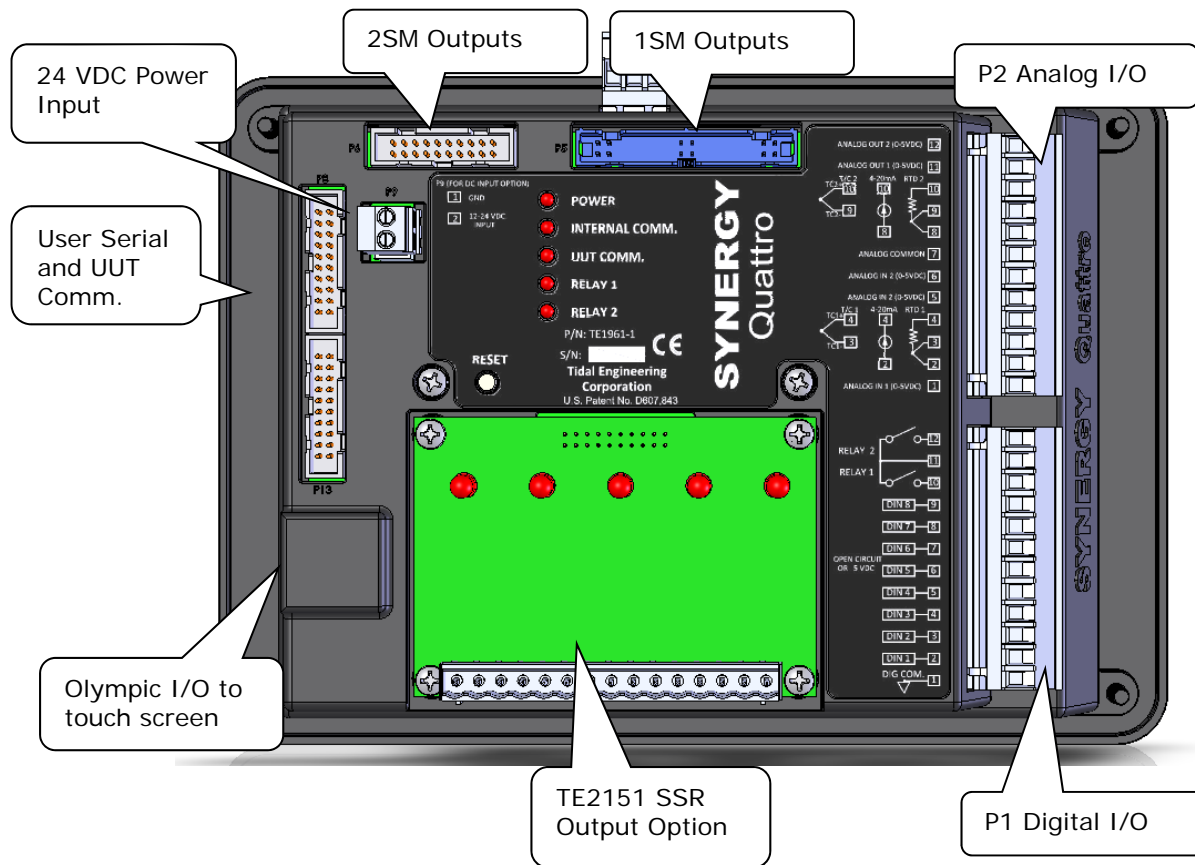
| Pin | Signal |
|-----|----------------|
| 5 | V+ Analog In 2 |
| 7 | V- Analog Com. |



SYNERGY QUATTRO

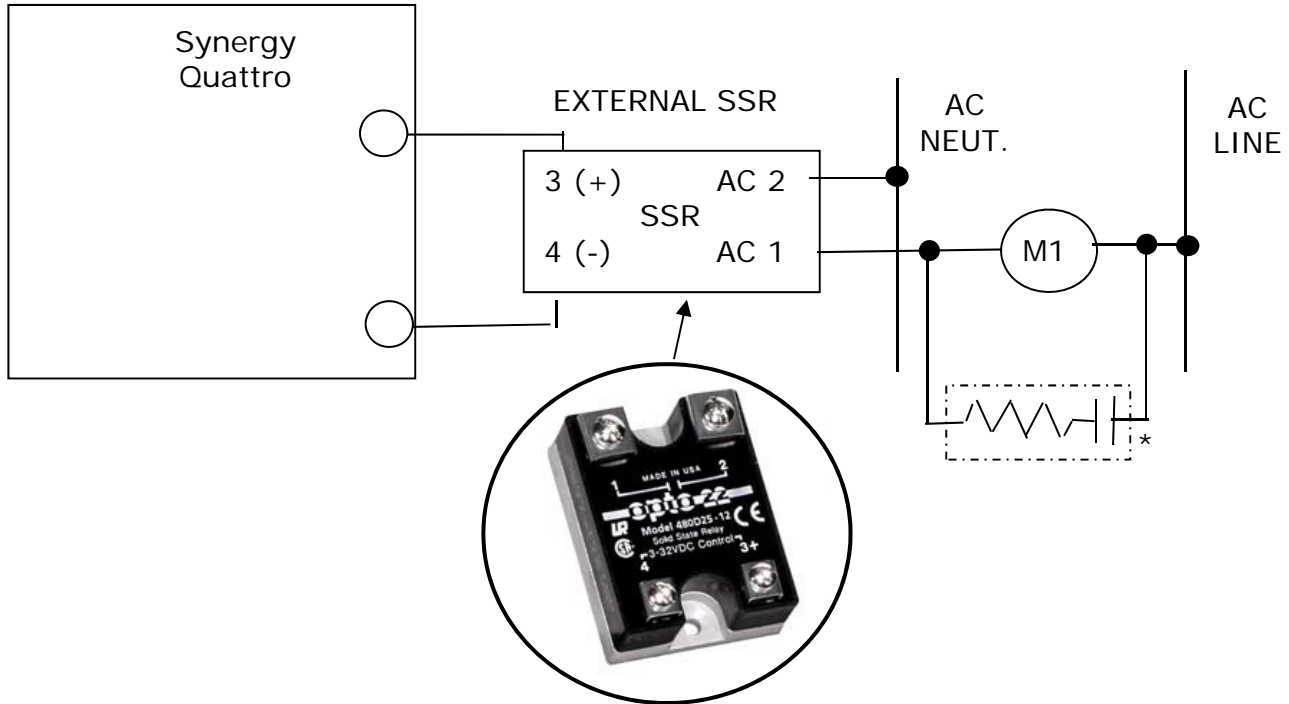
Digital Outputs.

The Synergy Quattro 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.

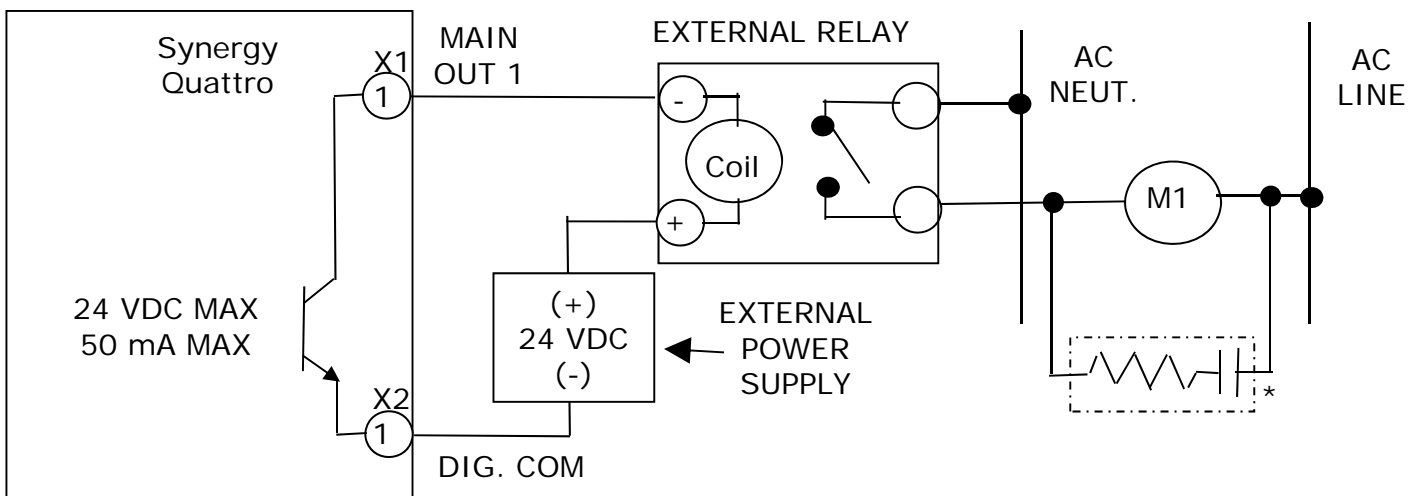


SYNERGY QUATTRO

The Synergy Quattro 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.



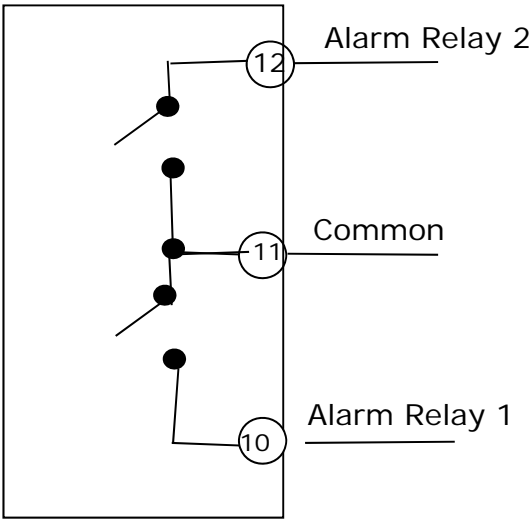
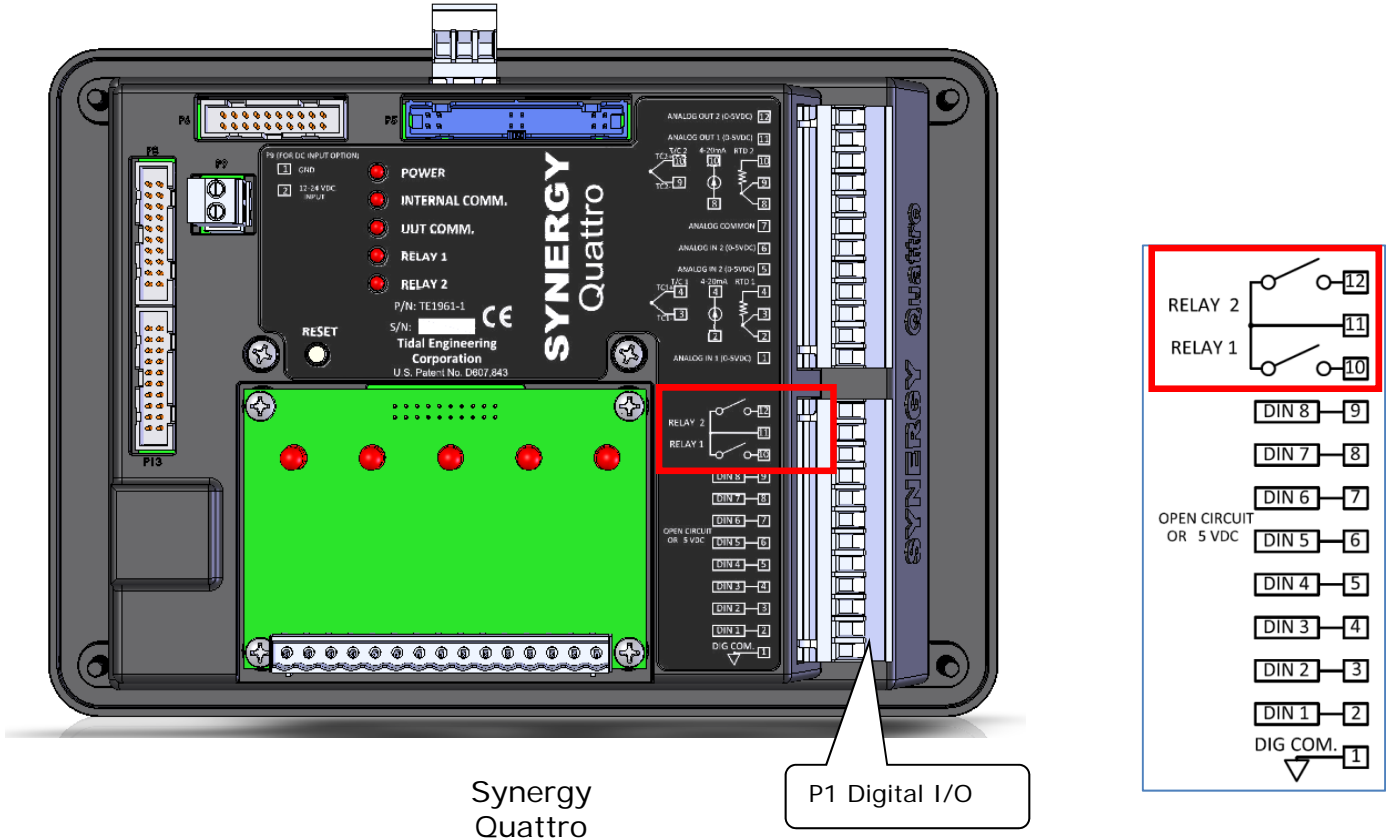
The figure below shows an example of a transistor output (OC) driving a load with an external power supply source. This configuration is applicable to the six Main outputs on TE1858-1 as well as the six AUX outputs on the TE1858-1, -2, and -3 models.



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

SYNERGY QUATTRO

Synergy Quattro Relay Outputs



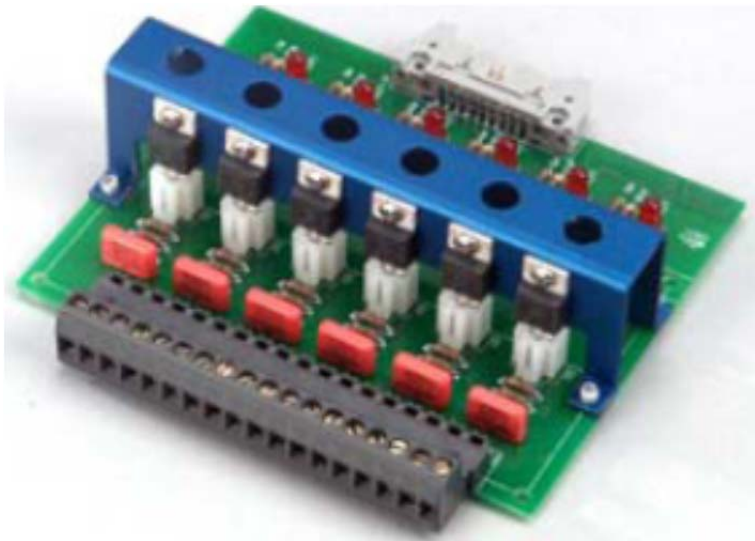
*

- 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

SYNERGY QUATTRO

TE1151-6 Triac output board

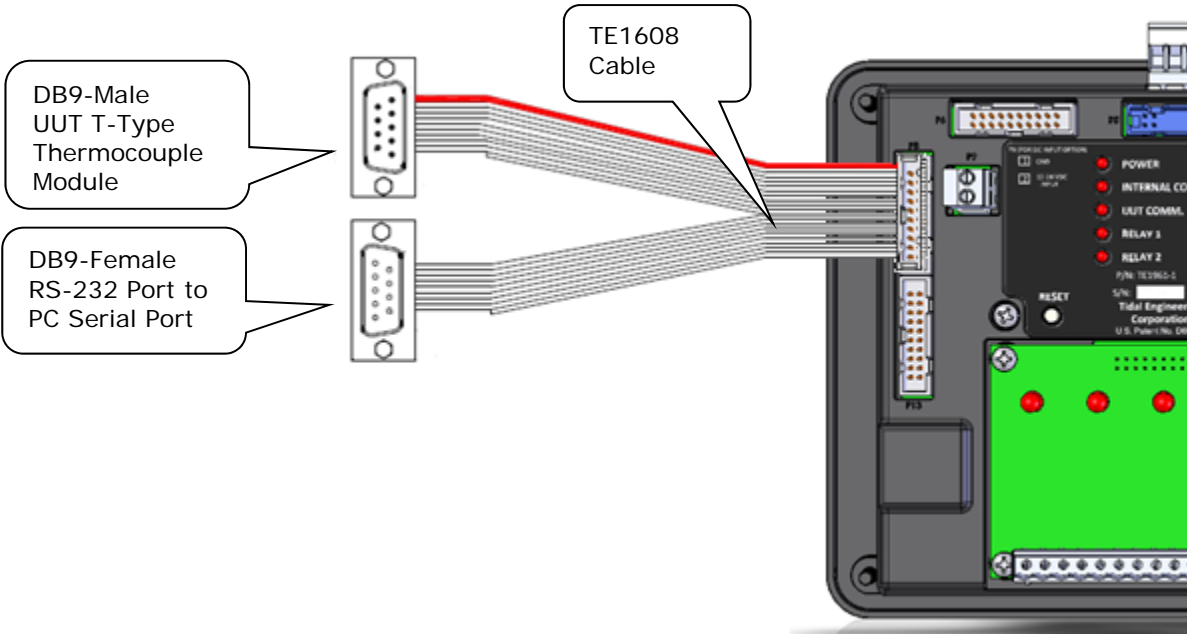
The Triac output board can drive 6 small AC loads. It can also drive an AC controller Solid State Relay (SSR) module. When driving an SSR, an additional load resistor is required across the SSR input to prevent nuisance firing as a result of leakage current. The Triac output can also drive an external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



SYNERGY QUATTRO

Wire Communications.

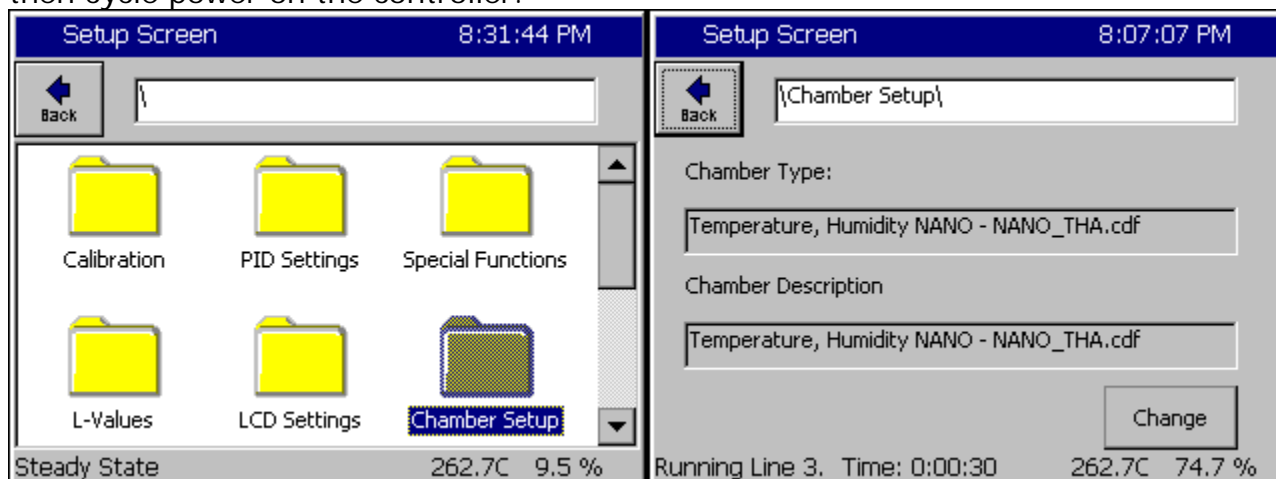
Wire the Ethernet and or Serial Communications as required. Note that the TE1608-1 cable is supplied with the Synergy Quattro to connect the controller to your PC's serial port.



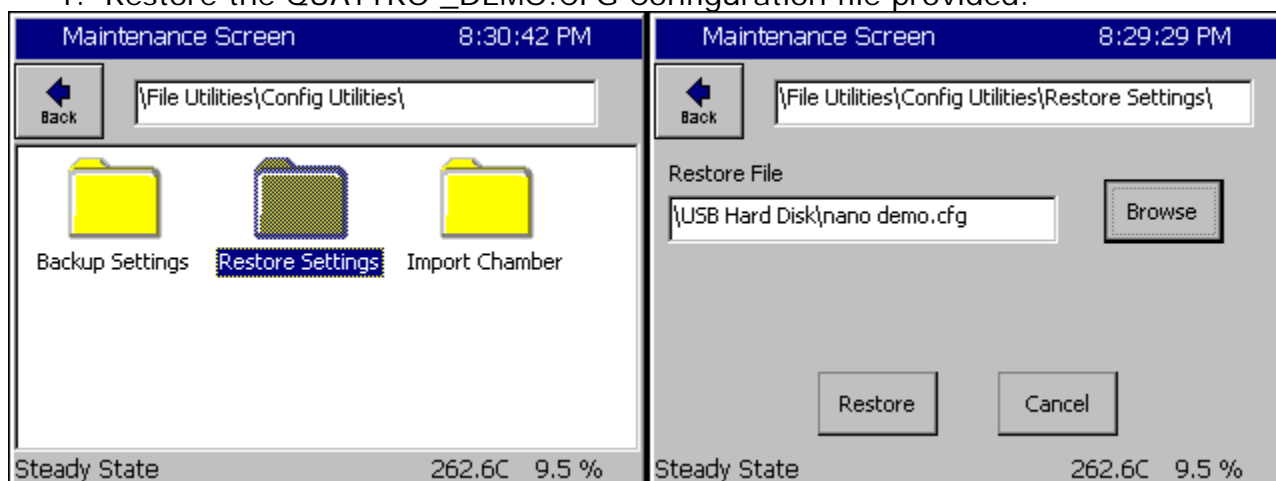
SYNERGY QUATTRO

Setup

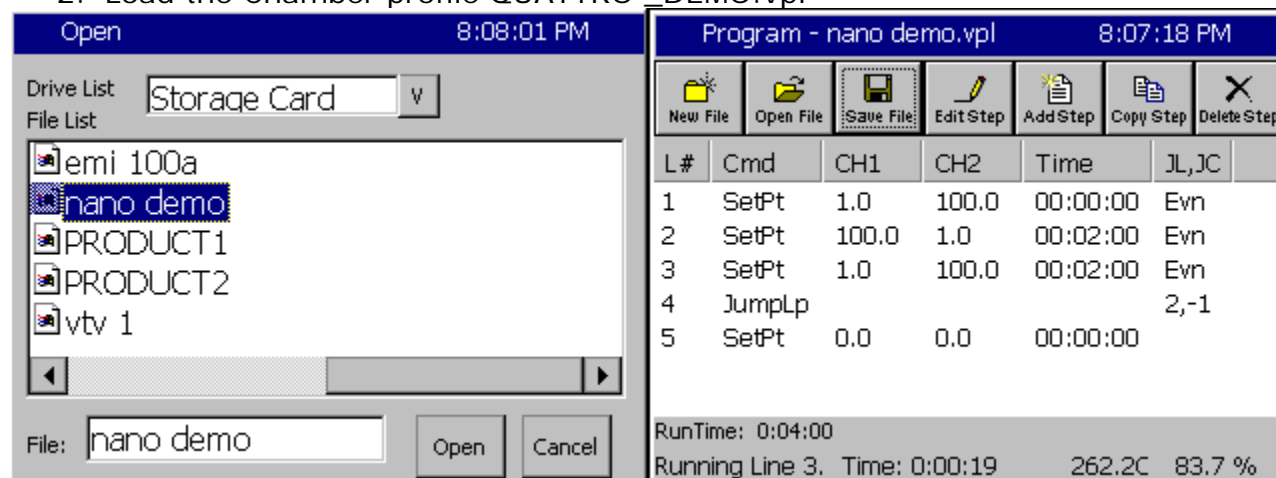
Load the QUATTRO_THA configuration from the SETUP Screen's Chamber Setup folder then cycle power on the controller.



1. Restore the QUATTRO_DEMO.CFG Configuration file provided.



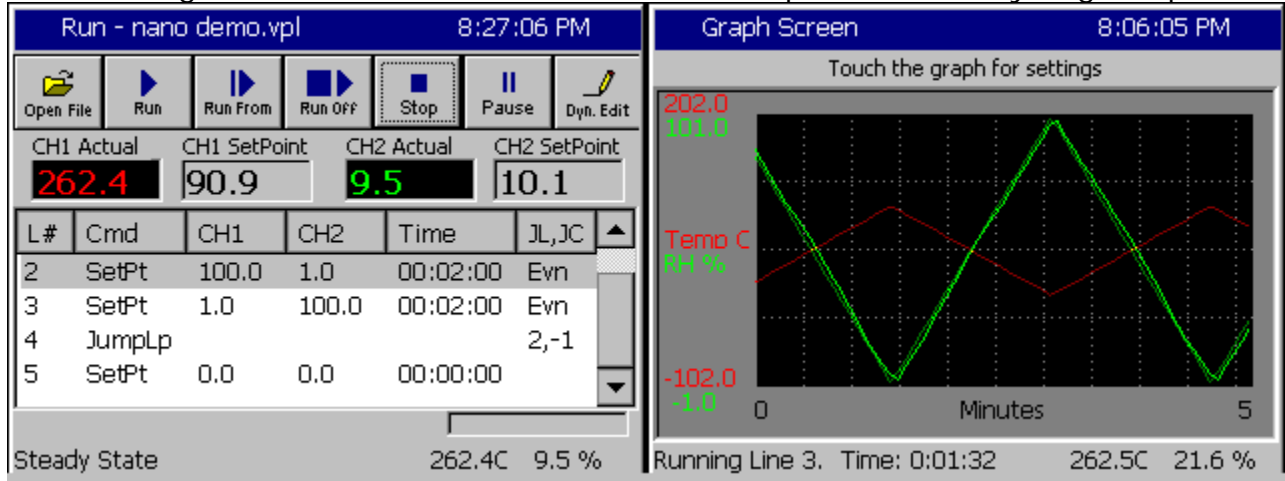
2. Load the Chamber profile QUATTRO_DEMO.vpl



SYNERGY QUATTRO

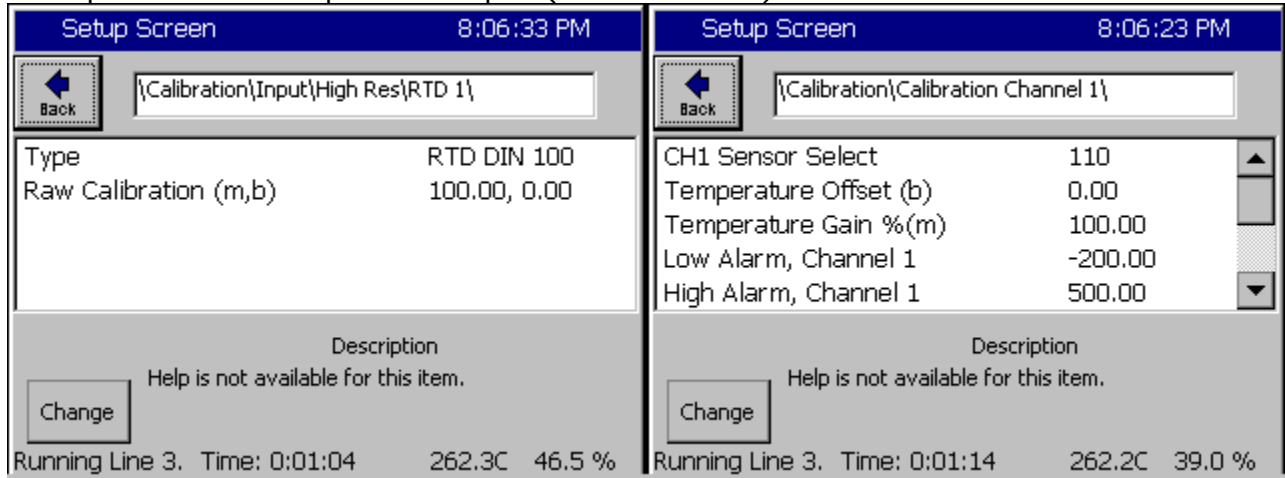
3. Run the profile from the Run Screen by pressing the Run button.*

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

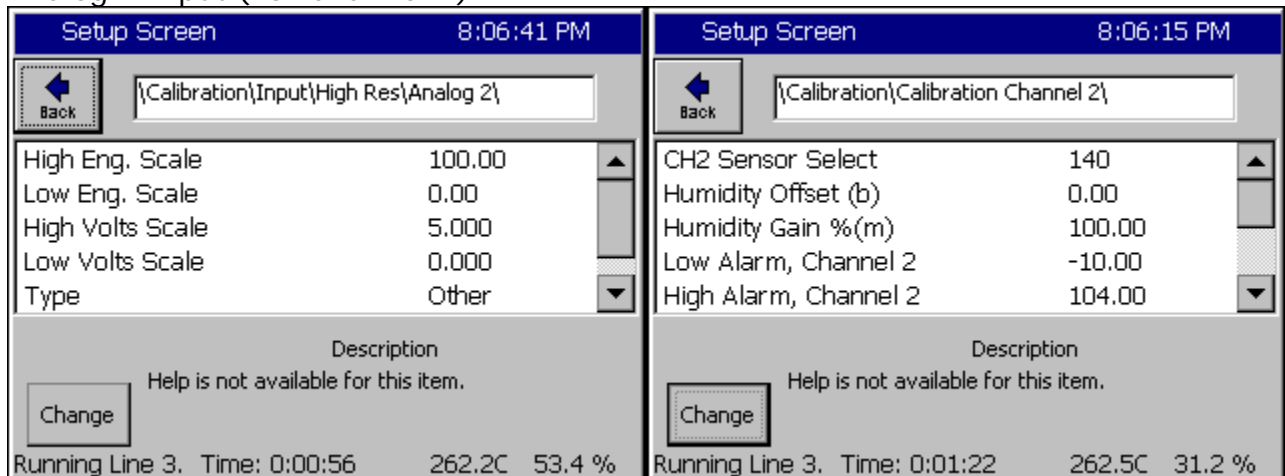


The following controller screens can be used to adjust the controller setup the to the QUATTRO_DEMO.cfg. This is for reference only.

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



Analog 2 Input (For Channel 2)



Analog Retransmit 2 Setup for Demonstration

The screenshot shows a software interface titled "Setup Screen" with a blue header bar. Below the header is a navigation bar with a "Back" button and a text field containing "{Special Functions}\Analog Retransmit 2\".

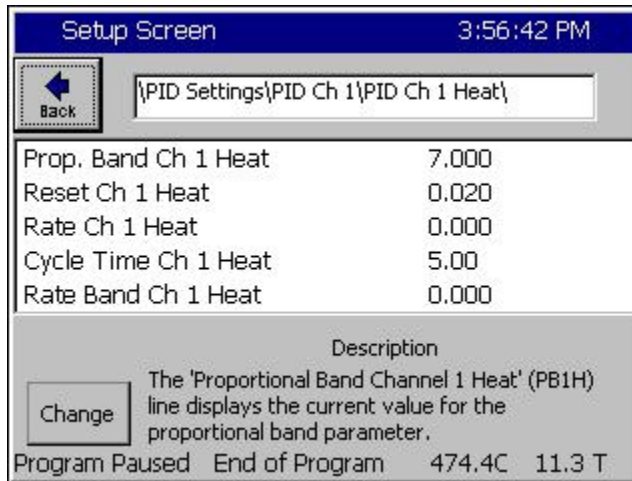
| | |
|---------------------|-------------|
| Analog Retransmit 2 | CH 2 Set... |
| High Eng. Scale | 100.00 |
| Low Eng. Scale | 0.00 |
| High Volts Scale | 5.000 |
| Low Volts Scale | 0.000 |

Below the table is a "Description" section with a "Change" button and the text "Help is not available for this item."

At the bottom of the screen, a status bar displays: "Running Line 3. Time: 0:00:41 262.6C 65.8 %"

5. Tuning

Synergy Quattro 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.

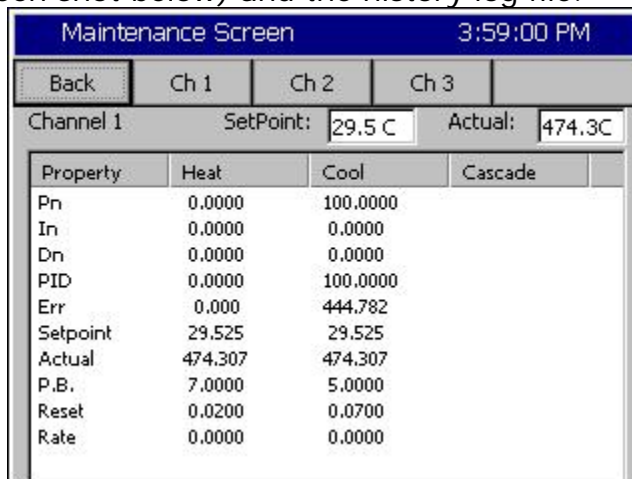


Optimum test chamber performance criteria depends on the application however typical criteria is summarized as follows:

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

The later provides reduced LN2 and/or electricity consumption.

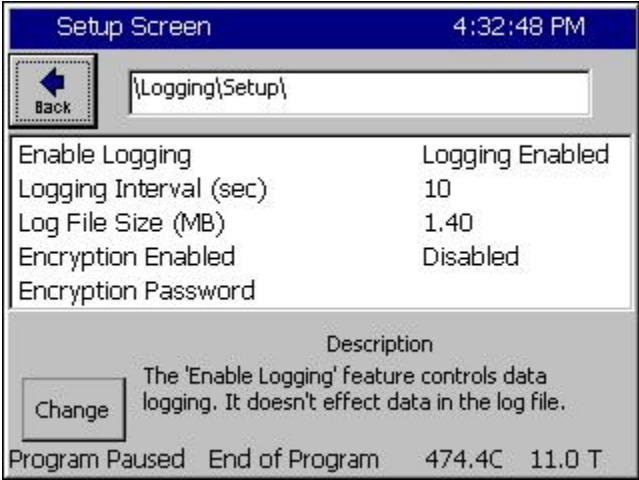
Synergy Controller provides built-in tools for PID tuning which include the on-screen PID monitor (See screen shot below) and the history log file.



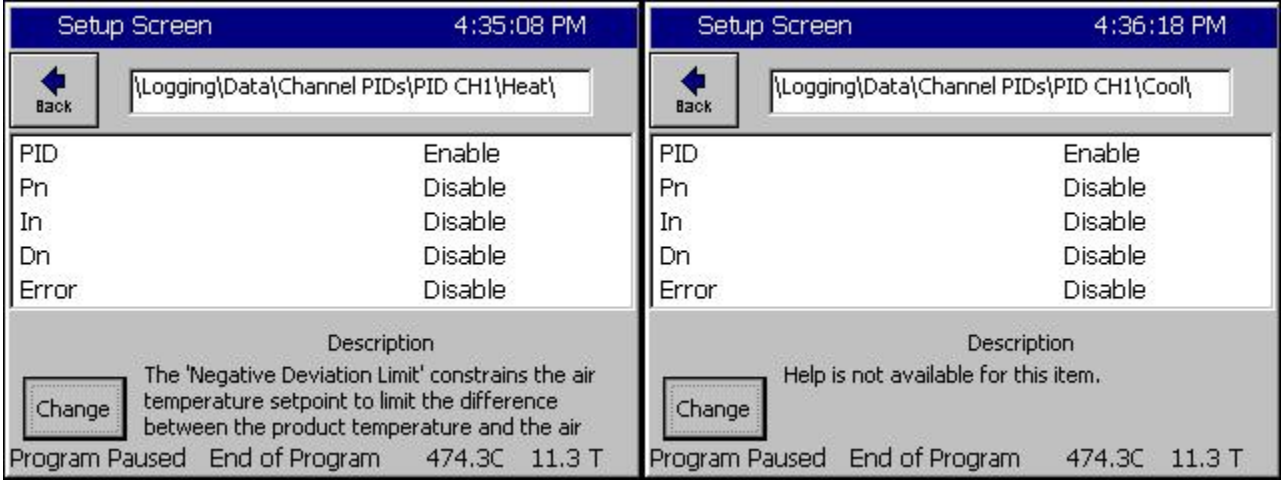
SYNERGY QUATTRO

Logging Setup

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

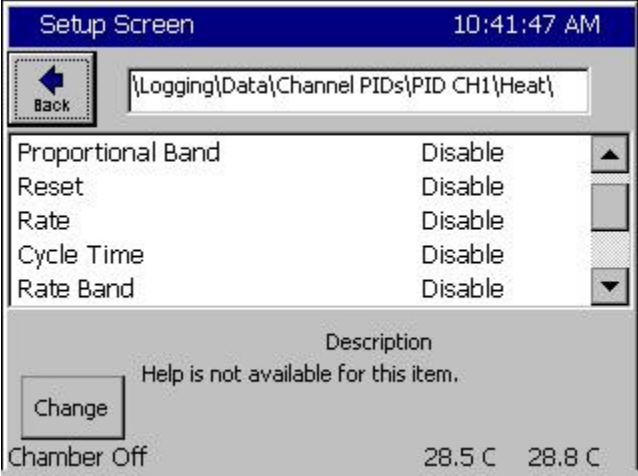


In addition, the Heat and Cool PID value logging can be enabled for all the channels of interest. These values are very helpful when evaluating the controller tuning.



SYNERGY QUATTRO

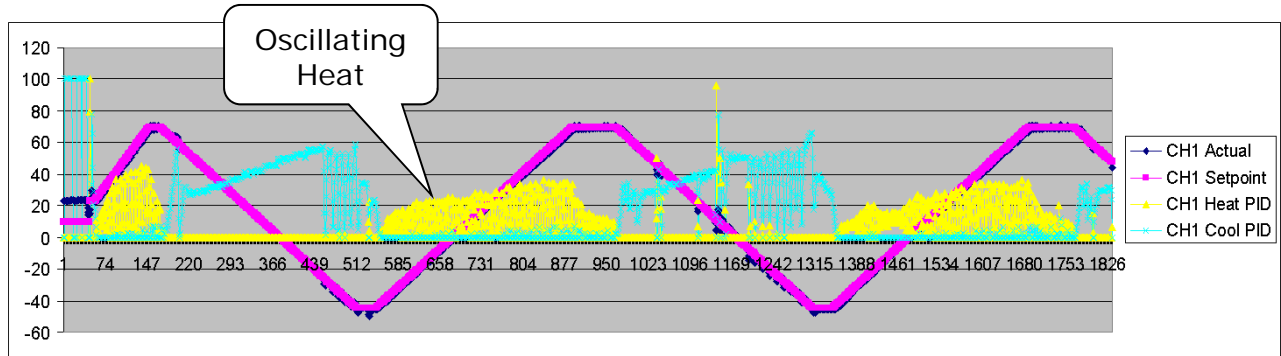
Logging the PID constants can also be helpful during tuning experiments since the tuning constants such as Proportional Band, Reset, and Cycle time are then recorded with the PID Outputs and process data. This makes it easy to see which tuning changes improved the performance and which tuning changes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



Tuning versus Control System Issues

Control system non-linearities, refrigeration, and other issues can disrupt chamber performance and can appear to be symptoms of PID tuning problems.

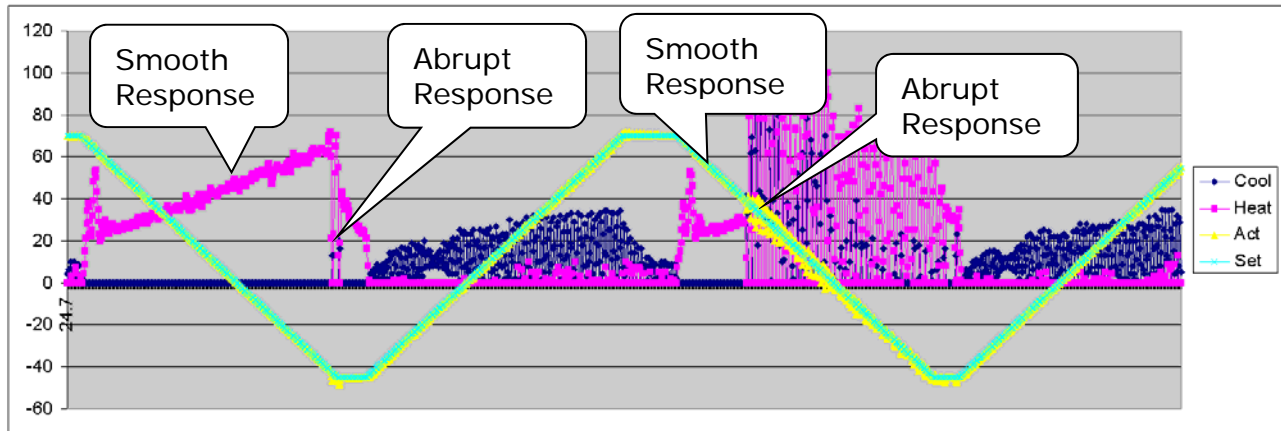
On the other hand, in the following chart the heating control loop is clearly unstable. This was corrected by increasing the Heat Proportional band for 7 to 14.



SYNERGY QUATTRO

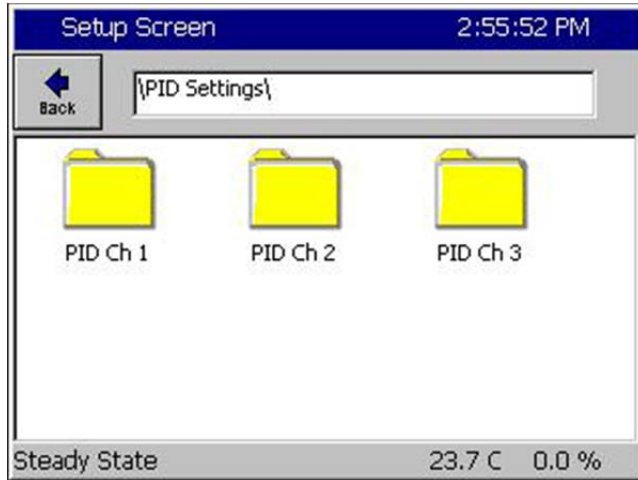
The following chart shows the log file of a control system issue that wasn't caused by PID tuning. In this case, the boost cooling system was turning on during the linear portion of a cooling ramp and causing substantial perturbations in the control system as a result of the system gain.

The following chart shows the log file of this issue. In this plot, the actual (Act) temperature in yellow shows significant fluctuations

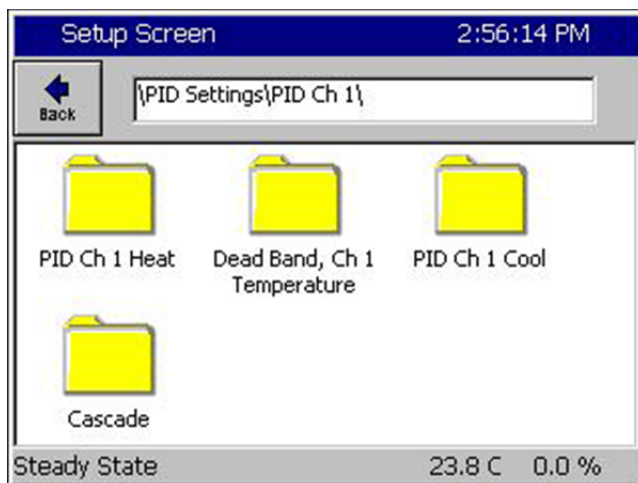


SYNERGY QUATTRO

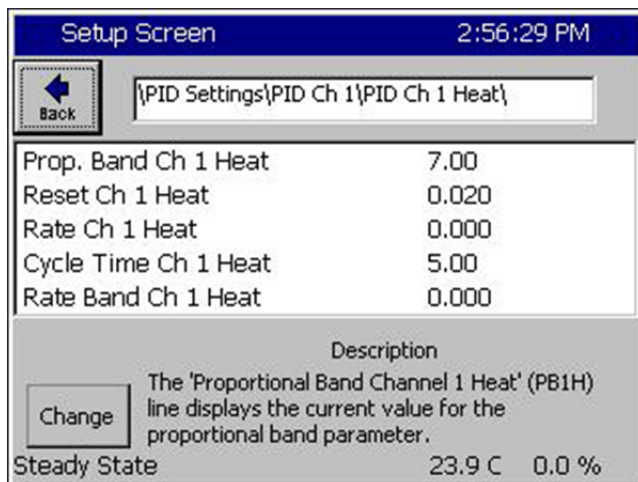
The PID Settings screen is used to edit the PID constants that control the PID algorithms. In general, PID adjustment should only be performed by a qualified technician. For more information on PID control refer to a resource book dedicated to the subject.



To modify your PID settings, navigate to *Setup \ PID Settings*. Then select the desired channels PID folder.



Select the Heat PID or Cool PID folder. For information concerning cascade control see the fully Synergy Quattro Technical Manual.



Within the Heat or Cool PID folders are settings for:

- ◆ Prop. Band Ch n Heating
- ◆ Reset Channel n Heating
- ◆ Rate Channel n Heating
- ◆ Cycle Time for Ch n Heating
- ◆ Rate Band for Ch n Heating

These settings are discussed in greater detail on the following pages.

Where n is the Channel of interest.

SYNERGY QUATTRO

You can monitor the performance of your PID settings using the Channel PIDs screen in the Maintenance directory.

| Property | Heat | Cool | Cascade |
|----------|---------|----------|---------|
| Pn | 0.0000 | 100.0000 | |
| In | 0.0000 | 0.0000 | |
| Dn | 0.0000 | 0.0000 | |
| PID | 0.0000 | 100.0000 | |
| Err | 0.0000 | 17.9870 | |
| Setpoint | 52.0000 | 52.0000 | |
| Actual | 69.9870 | 69.9870 | |
| P.B. | 7.0000 | 5.0000 | |
| Reset | 0.0200 | 0.0700 | |
| Rate | 0.0000 | 0.0000 | |

Channel PIDs

Select channel with the Ch1, Ch 2, and Ch 3 buttons along the top. The following values are displayed.

- ◆ Pn - Proportional Term
- ◆ In - Integral Term
- ◆ Dn - Derivative Term
- ◆ PID - PID Output Sum of Pn, In, Dn Terms
- ◆ Err - Error or difference between SP and PV
- ◆ Setpoint - SP
- ◆ Actual- PV
- ◆ P.B- Constant
- ◆ Reset- Constant
- ◆ Rate - Constant

PID

PID is the abbreviation for Proportional, Integral, and Derivative and is a popular control algorithm used to regulate a process variable (temperature, humidity, etc) at a fixed or moving setpoint. The setpoint is the desired level of the process variable. The PID control variable is the output of the controller. The output of a PID controller changes in response to a change in process value or setpoint.

$$PID\ Output = Proportional + Integral + Derivative$$

The Proportional Band, Reset and Rate constants are used in the calculation of the PIDs.

$$\begin{array}{ll} P & Proportional\ Band = 100/gain \\ I & Integral = 1/reset \quad (units\ of\ time) \\ D & Derivative = rate \quad (units\ of\ time) \end{array}$$

Error – Err

Error is the difference between setpoint and process variable.

$$Error = SP - PV \text{ (measurement)}$$

Proportional Band

The proportional band is the range of error that forces the output from 1 to 100%. In the proportional band, the proportional controller output is proportional to the error. Decreasing the proportional band increases the controller gain; increasing the controller gain can help the PV respond faster but can also make it less stable.

If error < the proportional band

$$Proportional\ Output = (error) * 100 / (proportional\ band)$$

Else

$$Proportional\ Output = 100\%.$$

Integral – In

With integral action, the integral portion of the controller output is proportional to the integral of the Error. Integral action is used to eliminate the steady state error of a strictly proportional control. Increasing the reset (the integral gain) can speed the chamber response, decreasing the reset can stabilize and slow the system response.

$$Integral\ Output = \int (100/proportional\ band * Reset * Error)$$

Derivative – Dn

The derivative portion of the controller output is proportional to the rate of change of the error.

$$\text{Derivative Output} = 100/(\text{proportional band}) * \text{Rate} * d(\text{error}) / dt$$

Proportional Output – Pn

Proportional output is the difference between setpoint and actual value divided by the proportional band. As an example: if the proportional band is 10 and the actual temperature is 90C and the setpoint is 100 then the Pn term is 100%. When the actual value reaches 95 degrees the Pn term is at 50%, at 99C the Pn term is 10%, at 100C the Pn term is 0%.

Reset Constant

Reset controls the integral portion of the PID algorithm. The larger this value the faster the integration term will change. Increasing reset adds gain to the system. A lower Reset slows the controller response and increases stability.

Rate Constant

The Rate is used to scale the rate of change with time and controls the calculation of the derivative. The derivative aids in canceling out the oscillation that can occur with PID calculations.

Cycle Time Constant

Cycle Time controls the time period of the proportional cycle. The output goes through one on and off cycle each period. Faster Cycle times reduce the size of steps on the output but may put more strain on the output devices such as valves. Slow cycle times may increase the size of steps but can also increase the life span of certain chamber hardware.

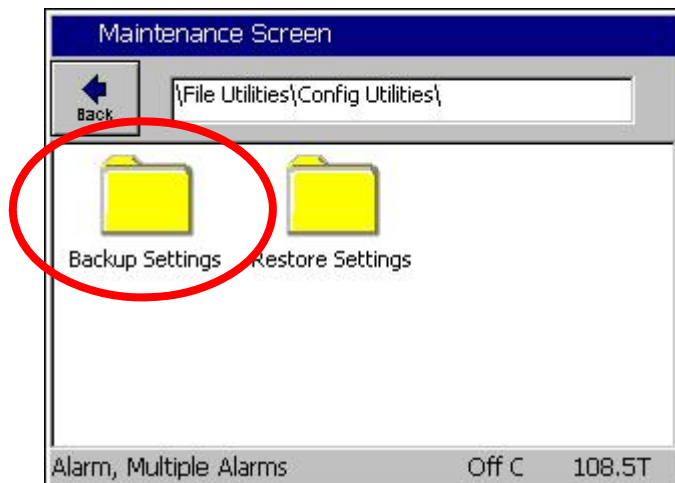
6. Configuration Backup

After the controller is setup, tuned and calibrated for the test chamber it is a good idea to backup the settings in case the configuration is accidentally changed, a hardware failure requires a controller replacement, or you need to configure additional controllers for similar test chambers.. The Synergy Controller's "Backup Settings" and "Restore settings" feature in the Maintenance/File Utilities folder makes this easy.

The controller settings can be backed up to the controllers Storage Card and/or to a removal USB Flash drive. We recommend both.

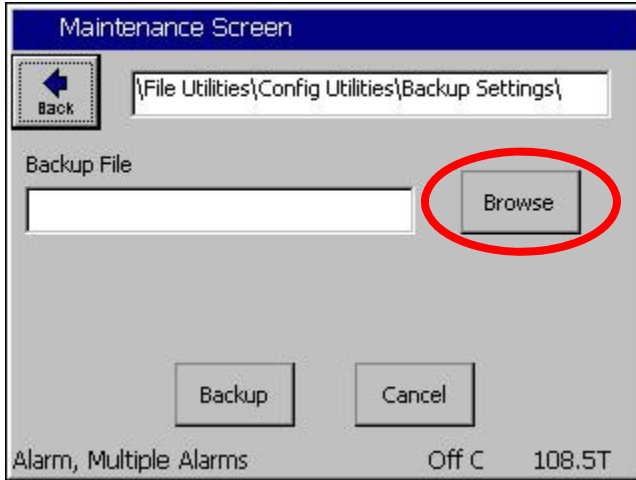
Note that the Backup and Restore Setting function doesn't handle Test Programs or the Chamber Definition. Test Programs (AKA Profiles) can be backed up separately using the Profile Utilities Screen.

To backup the controller settings follow these steps

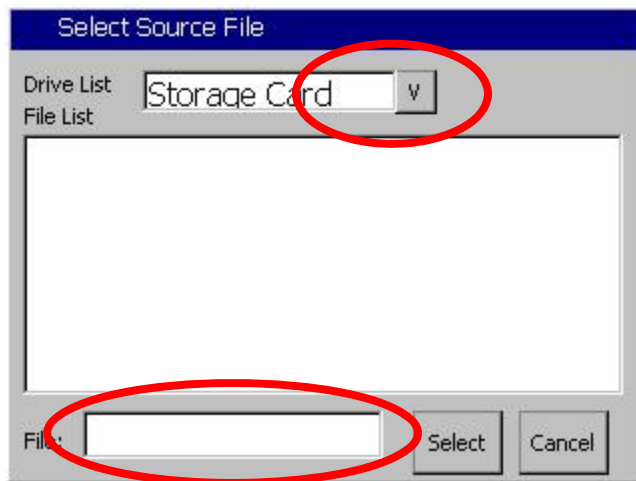


Browse to the Maintenance Screen's **\File Utilities\Config Utilities** folder and open the **Backup Settings** folder.

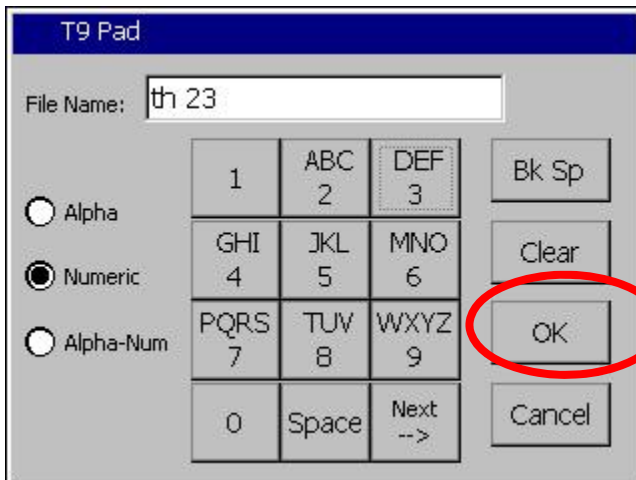
SYNERGY QUATTRO



From the Maintenance Screen's \File Utilities\Config Utilities\Backup Settings folder Press the **Browse** button.

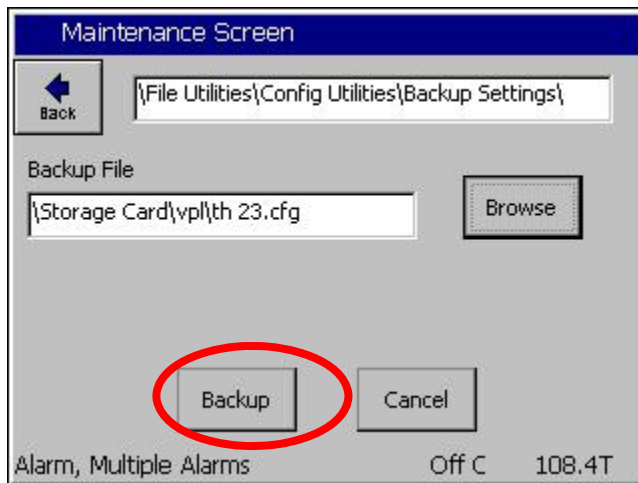


Then select either the Storage Card or the USB Hard Disk from the Drive List and press the **File:** text box at the bottom of the screen.

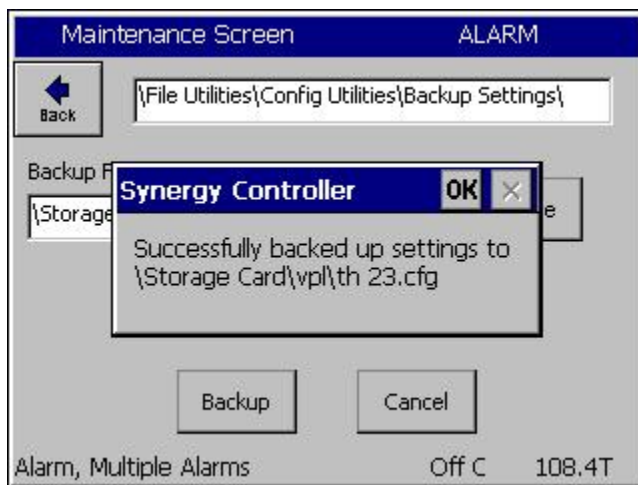


Enter the File Name using the T9 Pad. Then press OK.

SYNERGY QUATTRO



The file name appears in the Backup File text box. Press Backup.

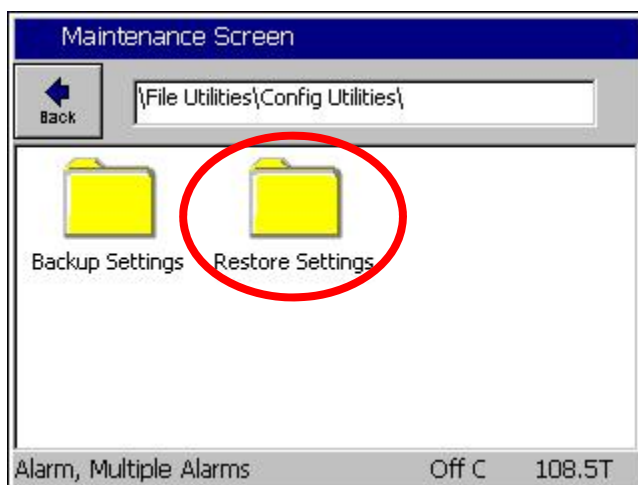


The controller will confirm that the settings were backed up successfully as shown at the left.

Acknowledge the window by pressing **OK**.

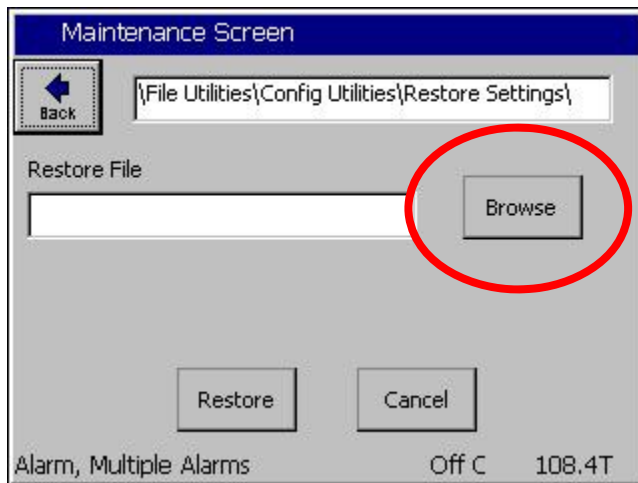
Restore Settings

In this section we will restore the settings from the backup.



Browse to the Maintenance Screen \File Utilities\Config Utilities folder and open the Backup Settings Folder. Then press the Restore Settings Folder.

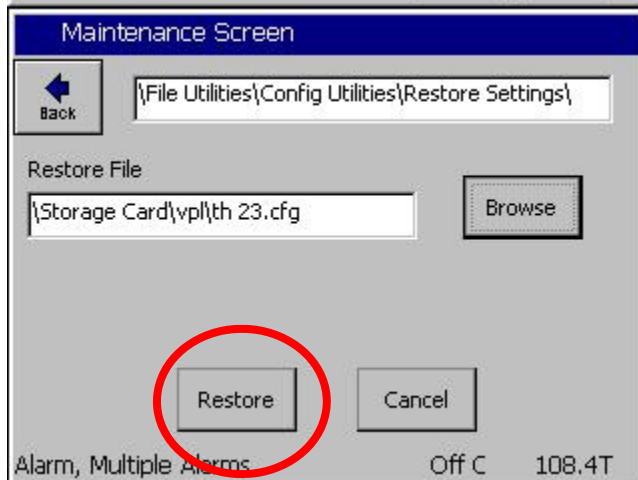
SYNERGY QUATTRO



Press the Browse button.

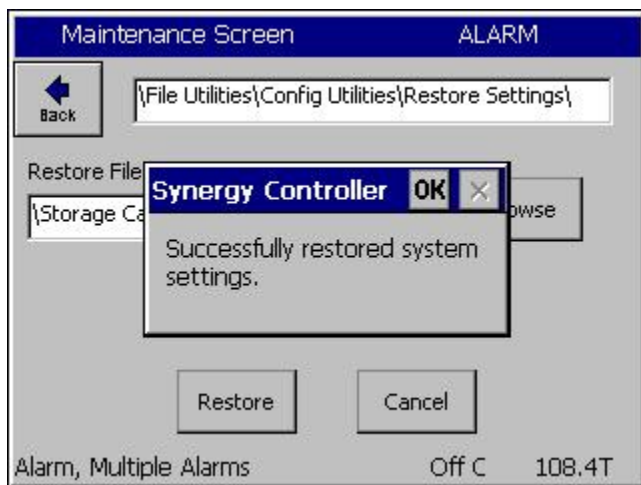


Then select either the **Storage Card** or the USB Hard Disk from the Drive List. Then select the appropriate file from the list and press **Select**.



Confirm the File Name that appears in the Restore File text box and then press **Restore**.

SYNERGY QUATTRO



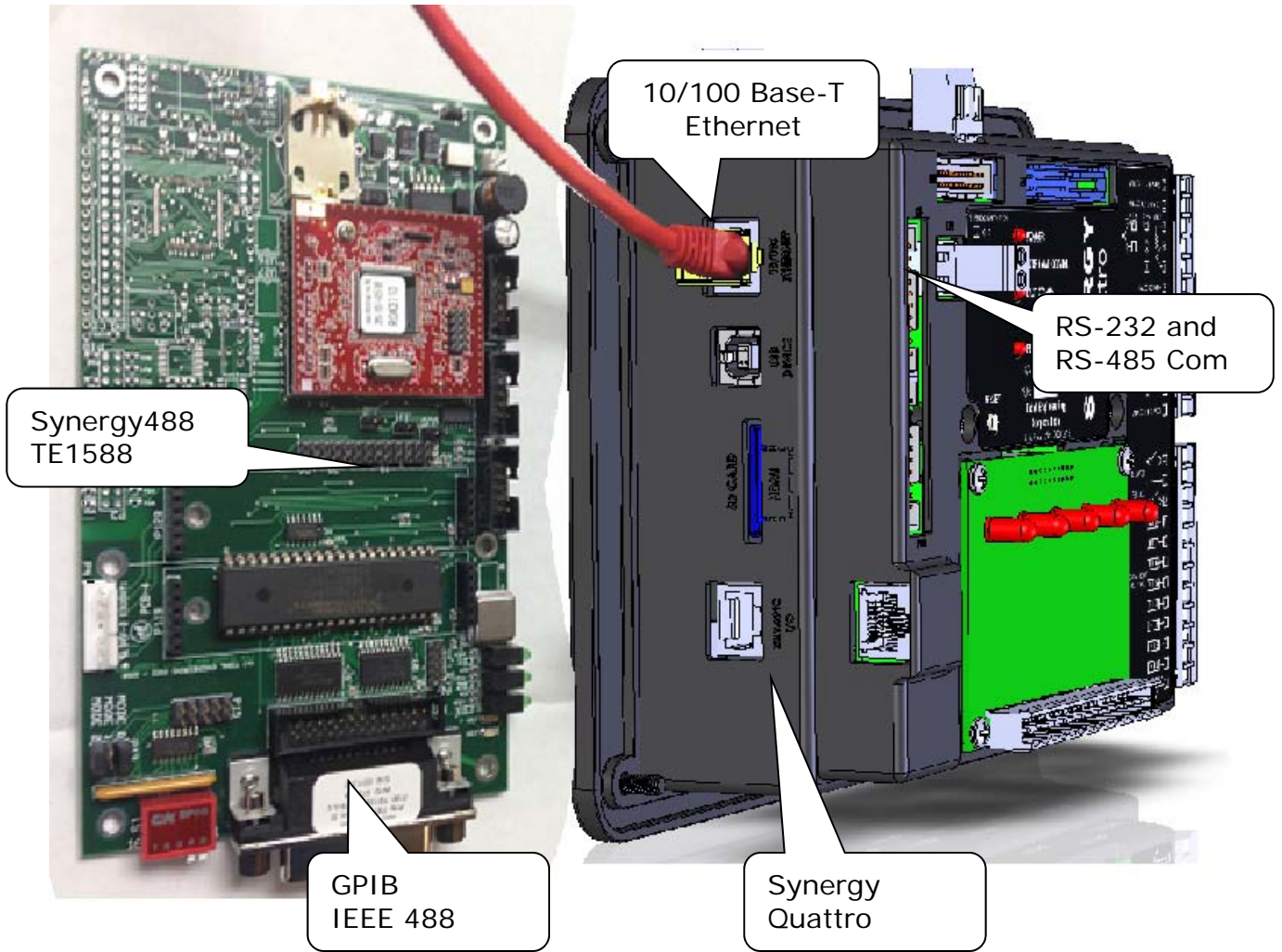
The Controller will confirm that the settings were restored.

The controller's Backup and Restore features can be used to store multiple PID sets for different product/environment conditions.

SYNERGY QUATTRO

7. Communications

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



SYNERGY QUATTRO

Ethernet

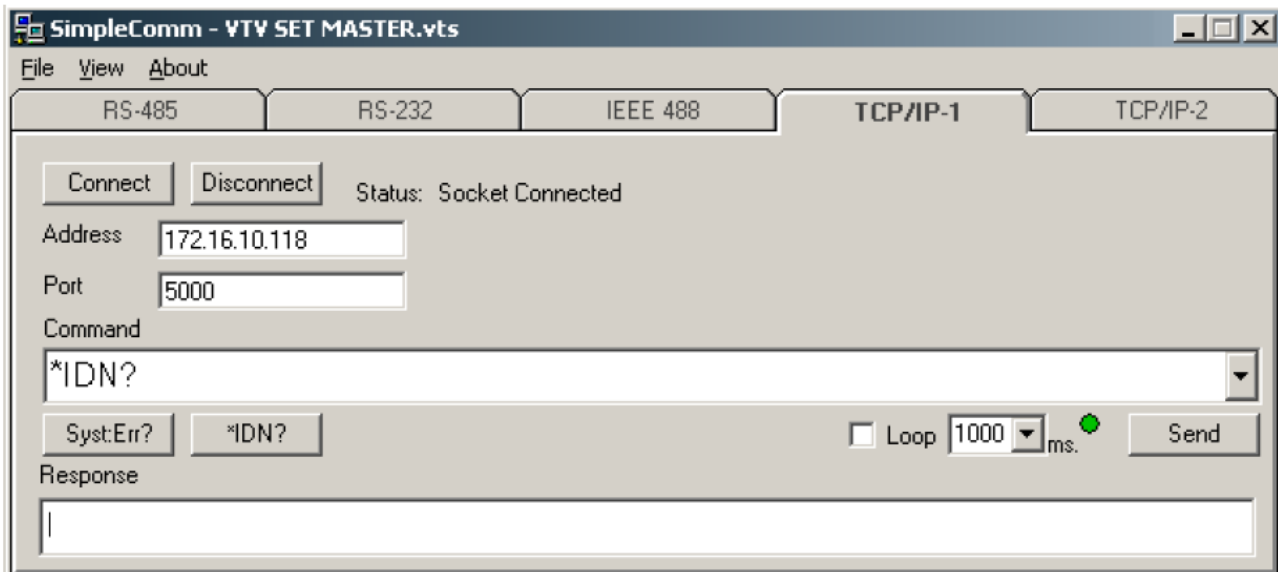
The Synergy Quattro features a 10/100 BaseT Ethernet port. See X6 in the figure above.

RS-232

The Synergy Quattro 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 QUATTRO

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



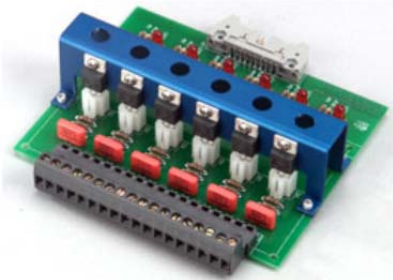
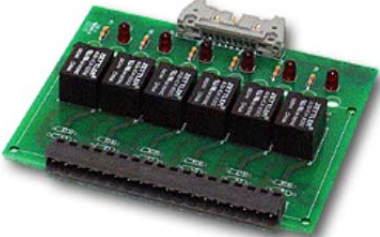
| Application | Communication Port | | | Remote Control | | Remote Monitor | File Transfer |
|------------------------|--------------------|--------|-------|----------------|-------|----------------|---------------|
| | Ethernet | RS-232 | GPIB* | Web Browser | Other | | |
| WebTouch Remote™ | ✓ | | | ✓ | | ✓ | |
| 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.


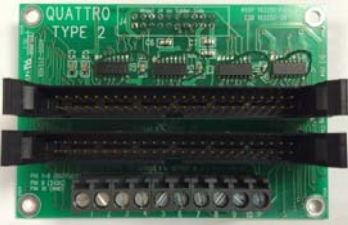
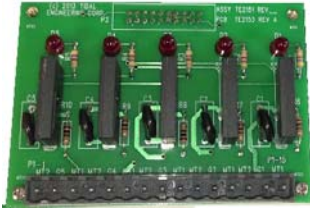

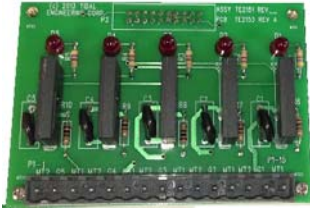
SYNERGY QUATTRO

Appendix A: Accessories and 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 |  |

SYNERGY QUATTRO

Appendix A: Accessories and Options-Continued

| | | |
|----------------------|--|--|
| <p>TYPE 1</p> | <p>P/N TE2251-1 8-Channel Expansion 4 x Ribbon Cable connections</p> |  |
| <p>TYPE 2</p> | <p>P/N TE2251-2 OPTO-22 I/O Board</p> |  |
| <p>TYPE 3</p> | <p>P/N TE2251-3 LED Outputs</p> |  |
| <p>TYPE 4</p> | <p>P/N TE2251-4 I/O Expander 8-Digital Inputs 8-Analog Inputs 8-Digital Outputs</p> |  |
| <p>TYPE 5</p> | <p>P/N TE2251-5 5-SSR Board 2 Amp SSRs</p> |  |

Appendix B: Output Primitive Descriptions

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)

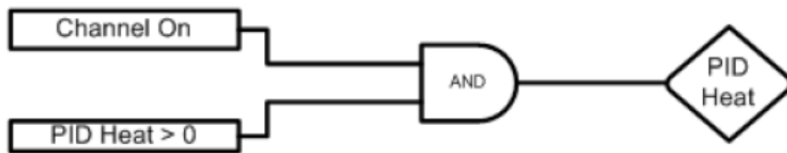
Other Outputs

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

SYNERGY QUATTRO

PID Heat

Time Proportioning output that controls the heaters.



| Affected By: | Default Value: | Range: |
|----------------------------------|----------------|------------------------|
| Channel 1 Proportional Band | 7 | 0 - 50 Degrees C |
| Reset for Channel 1 Heating | 0.02 | 0 - 9.9 Repeats/minute |
| Rate for Channel 1 Heating | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 1 Heating | 5 | 1 - 60 Seconds |
| Rate Band for Channel 1 Heating | 0 | 0 - 7 Seconds |

The PID Heat is the time proportioning output that controls the heater(s). This output is only enabled when the associated temperature Channel is on. The output typically controls the Solid State Relay (SSR) powering the heater.

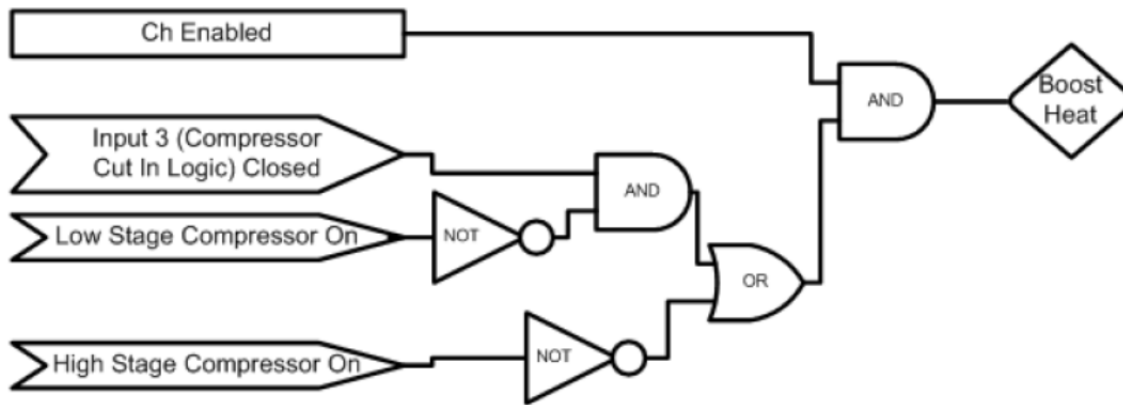
The PID Heat output is also used in conjunction with the Boot Heat output to provide a time proportioning signal to the boost heaters.

The PID tuning for the heating system is controlled by the channel PID Heat Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

SYNERGY QUATTRO

Boost Heat

Provides extra heating capabilities when cooling compressors are off.



| | | |
|-----------------------------------|---|---------------|
| Output is On/Off | | |
| Affected By: | Default Value: | Range: |
| Compressor Cut In Logic (Input 3) | When closed, selects Compressor Cut In Logic. Uses a pressure switch. | |

Note: The Boost Heat output must be wired in series with the PID Heat output and not wired to control the Boost Heaters directly.

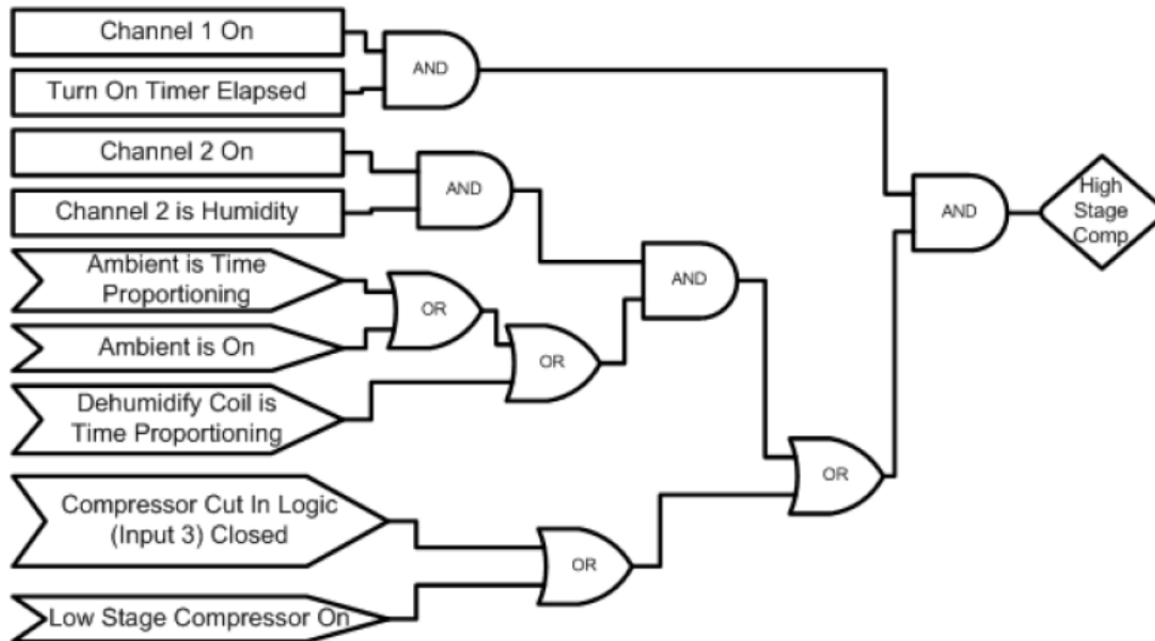
The Boost Heat primitive enables extra heating capacity when the compressors are off. The Boost Heat output is typically wired in series with the PID Heat output to provide time proportioning control for boost heaters.

Boost heat is enabled when the High stage compressor is off or when the Low stage compressor is off or the compressor cut in logic (Input 3) is closed.

SYNERGY QUATTRO

High Stage Compressor

This output energizes the high stage compressor in a cascade refrigeration system.



Notes:

There is a one-minute turn on timer that is reset while the compressor is off.

Compressor Cut-In Logic (Input 3) when closed, selects Compressor Cut In Logic. For a pressure switch

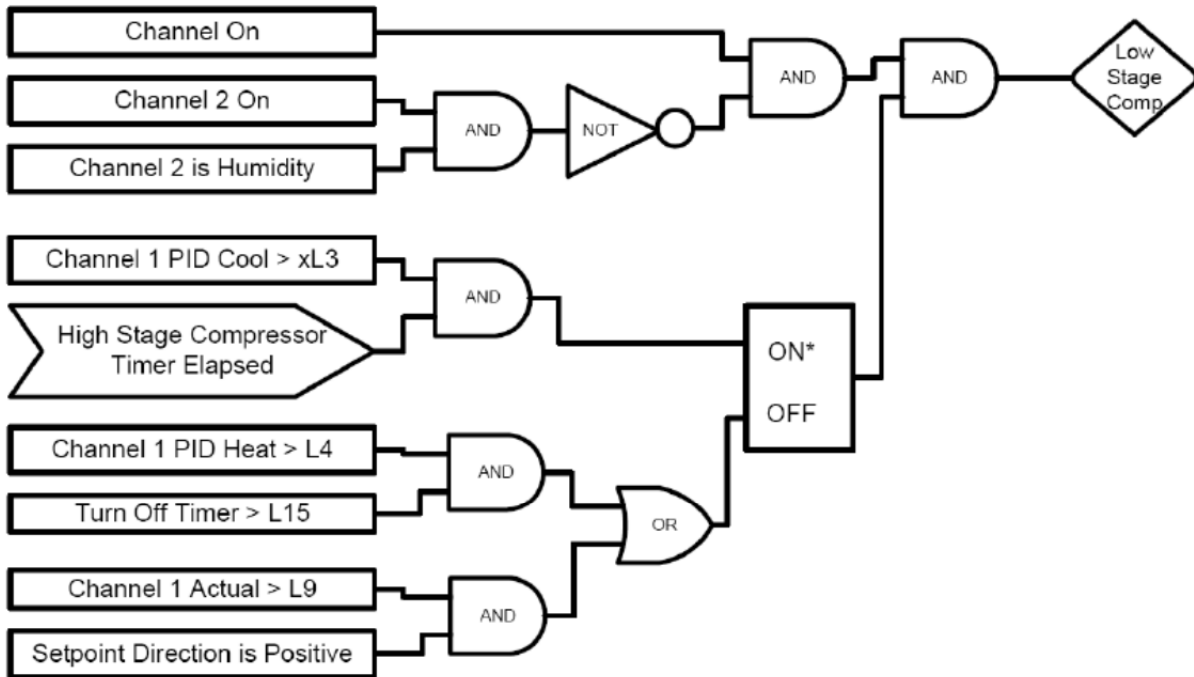
The High Stage Compressor output is used to control the high stage compressor on systems equipped with Cascade Refrigeration.

Note: for single stage systems, the Compressor output is used to controller the compressor. The High Stage Compressor is enabled when Channel 1 is on and after the Turn-On Timer expires. The Turn-on timer prevents the compressor from short cycle if power fails.

SYNERGY QUATTRO

Low Stage Compressor

This output controls the low stage compressor in a cascade refrigeration system.



| | | |
|---|---------------------------|------------------------------|
| L3 Channel 1 Main Cooling Turn On | Default Value: 20% | Range: 0 to 100% |
| Percent cooling that turns on the low stage compressor | | |
| L4 Channel 1 Main Cooling Turn Off | Default Value: 80% | Range: 0 to 100% |
| Percent heat that turns off the low stage compressor | | |
| L9 Ramp Up Cooling | Default Value: 80% | Range: 0 to 100% |
| Temperature at which the cooling compressor turns off while heating | | |
| L15 Compressor Turn-Off Delay | Default Value: 1 | Range: 0 to 5 Minutes |
| Number of minutes after Main Cooling Turn off before compressor turns off. This value is used to limit compressor cycling | | |

Notes:

The Turn-Off Timer is reset when Channel 1 PID Cool > 0%.

* Denotes that the ON input signal has priority if both ON and OFF are true.

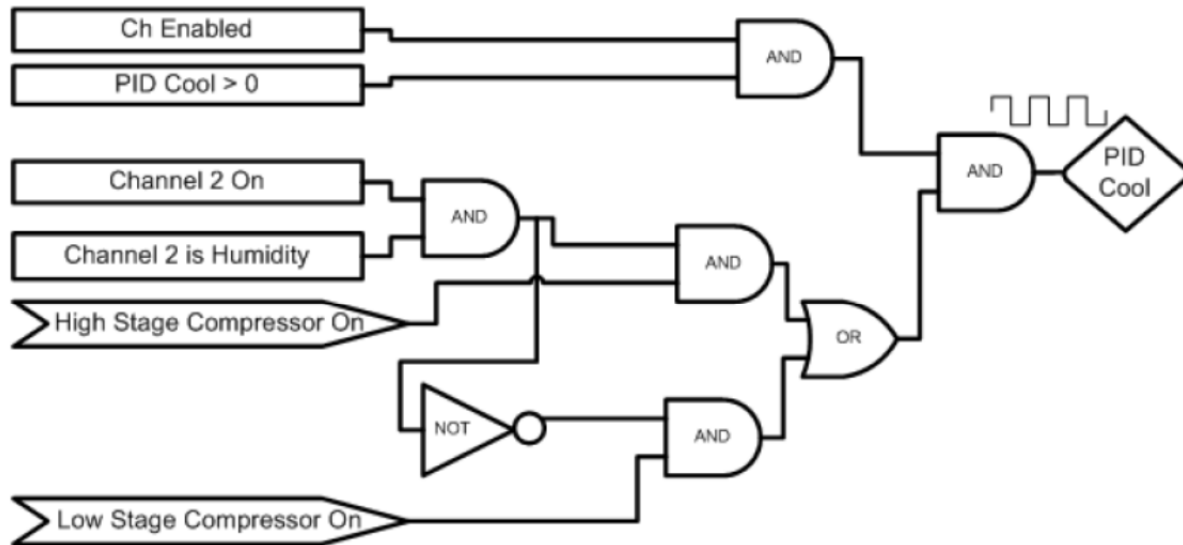
The Low Stage Compressor output is used to control the Low Stage Compressor in Cascade refrigeration system, for Temperature only, and for Temperature Humidity chambers.

Note: for single stage systems, the Compressor output is used to controller the compressor.

SYNERGY QUATTRO

PID Cool

This is a time proportioning output that energizes the cool solenoid permitting refrigerant flow to the evaporator coil.



| Affected By: | Default Value: | Range: |
|----------------------------------|----------------|------------------------|
| Channel 1 Proportional Band | 5 | 0 - 50 Degrees C |
| Reset for Channel 1 Cooling | 0.07 | 0 - 9.9 Repeats/minute |
| Rate for Channel 1 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 1 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 1 Cooling | 0 | 0 - 7 Seconds |

The PID Cool output is the time proportioning output that controls the cooling solenoid on a Temperature/Humidity chamber. This output is only enabled when its Channel is on.

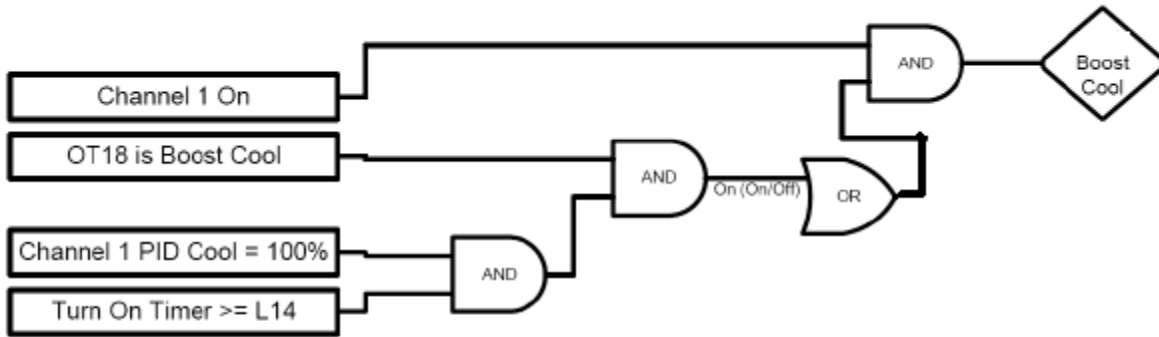
The PID tuning for the cooling system is controlled by the channel Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

When the humidity channel is on, the PID Cooling output is enabled when the High Stage compressor is on. When the humidity channel is off or humidity is not supported, the PID Cooling output is enabled when the Low Stage compressor is on.

Note: On Temperature Only or T-Shock chambers the PIDCTOTT primitive controls the cooling solenoid.

SYNERGY QUATTRO

. Boost Cool



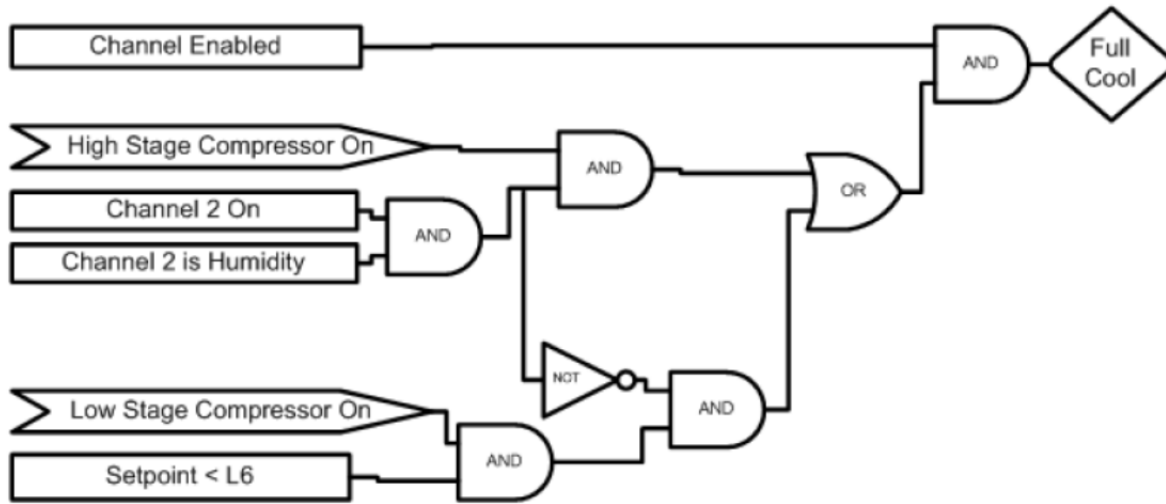
| | |
|---|---|
| Output is On/Off | |
| OT18 | Selects the Control logic for the Vent – Boost Cool device |
| L14 Time Delay Boost Cool | Time delay (in seconds) required before Boost Cool is enabled |
| Turn On Timer is reset when Channel 1 PID Cool < 100% | |

The Boost Cool primitive enables extra cooling capacity after the system is calling for 100% cooling for more than the Boost Cool Time delay. The Boost Cool output is typically wired in series with the PID Cool output to provide the time proportioned control for a large liquid solenoid..

SYNERGY QUATTRO

Full Cool Device

This output will turn on at low temperatures and enable full cooling capabilities. When this output is off only reduced cooling is available. This results in more precise control at higher temperatures.



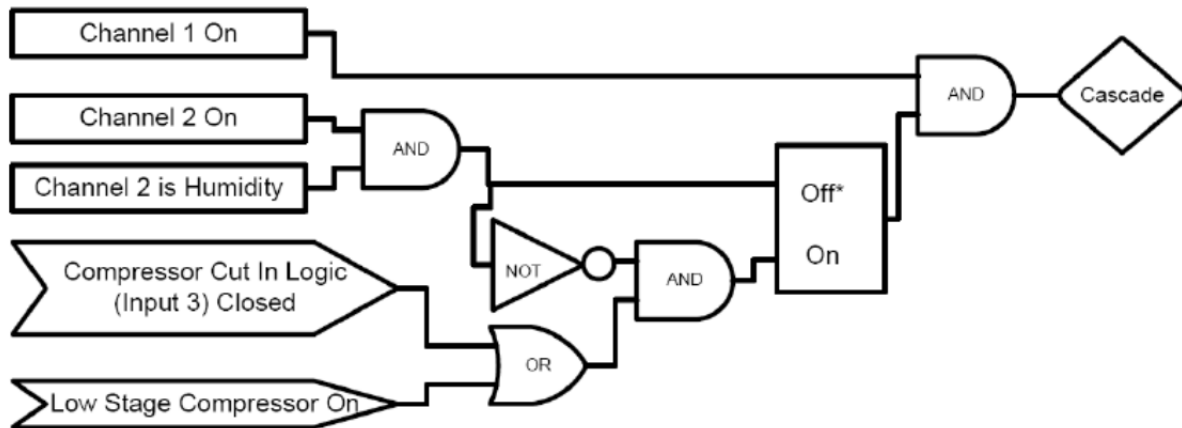
| Control Values: | Default Value: | Range: |
|---|----------------|------------------|
| L6 Full Cooling Switch Over Setpoint Temperature setpoint at which full cooling switches on. | 20 C | -100 C to +100 C |
| | | |
| | | |

The Full Cool output comes on when Channel 1 is on and the hi-stage compressor is on with humidity or when the load stage is on without humidity and the temperature setpoint is less than the value of L6 temperature.

SYNERGY QUATTRO

Cascade Condenser

This output turns on whenever cooling is needed. It energizes the solenoid that feeds liquid refrigerant to the evaporator coil.



Notes:

The Turn-Off Timer is reset when Channel 1 PID Cool > 0%.

Denotes that the OFF input signal has priority if both ON and OFF are true.

Compressor Cut -in Logic (Input 3) when closed, selects Compressor Cut-In Logic. For a pressure switch

The Cascade Condenser output comes on when the Low Stage Compressor is on.

SYNERGY QUATTRO

High Artificial Load



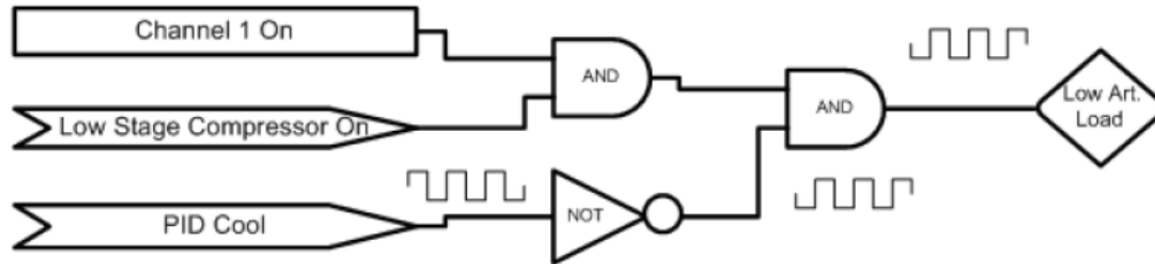
Output follows the High Stage Compressor Output

High Artificial load is enabled whenever the High Stage compressor is on.

SYNERGY QUATTRO

Low Artificial Load

This output energizes the Artificial Loading bypass solenoid to provide refrigerant flow to the compressor when operating with temperature control only. This output is Time Proportioning and the inverse of the PID Cool output.



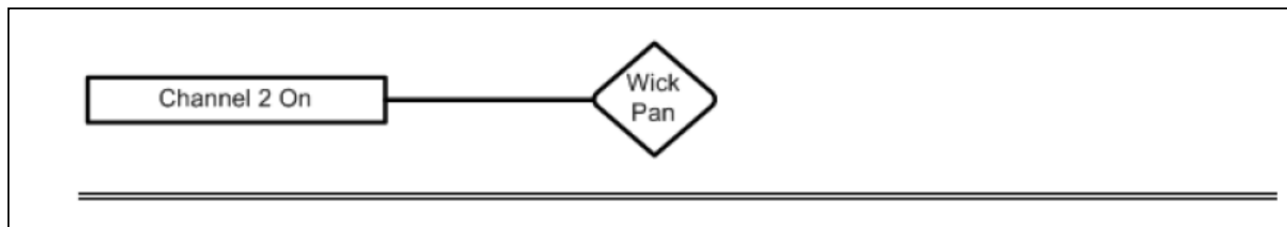
| Affected By: | Default Value: | Range: |
|-------------------------------------|----------------|------------------------|
| Channel 1 Proportional Band Cooling | 5 | 0 - 50 Degrees C |
| Reset for Channel 1 Cooling | 0.07 | 0 - 9.9 Repeats/minute |
| Rate for Channel 1 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 1 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 1 Cooling | 0 | 0 - 7 Seconds |

The Low Artificial load output controls the hot gas bypass solenoid on the Low-Stage Compressor.

SYNERGY QUATTRO

HUMIDITY OUTPUTS

Wick Pan

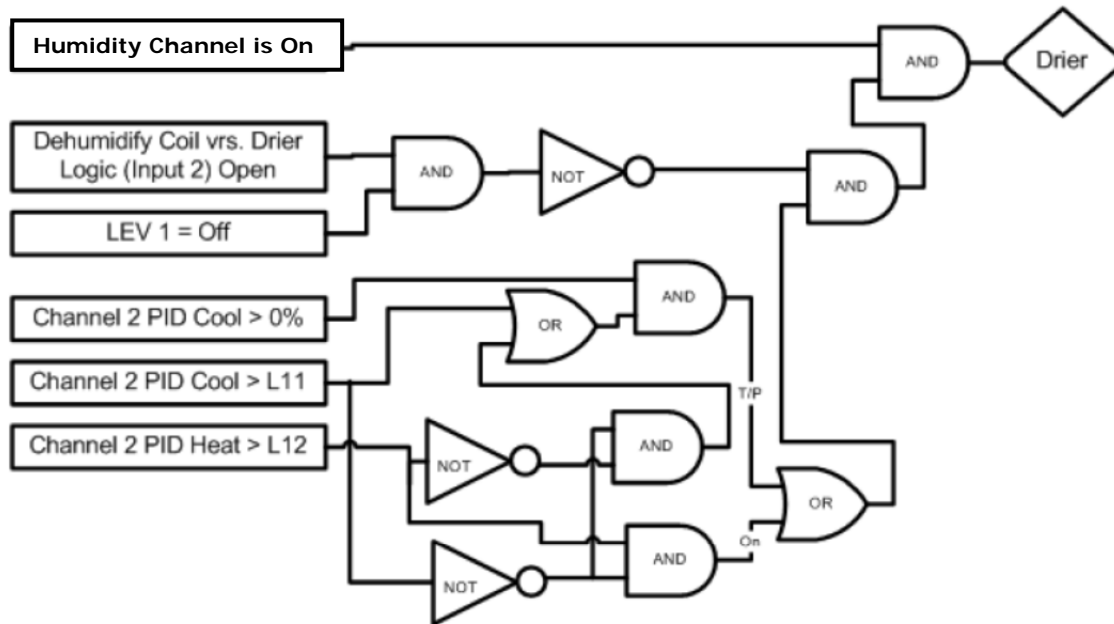


The Wick Pan output comes on whenever the Humidity Channel is on and can be used to control the wick pan water supply for Wet-Bulb/Dry-Bulb humidity applications. It can also drive any signals that require a humidity enable output.

SYNERGY QUATTRO

Drier Device

This output controls the Air Drier for dehumidification.



| | | |
|---|---|------------------------|
| Output is either Time Proportioning or On/Off | | |
| L11 Dehumidify On | Percent dehumidify required to enable dehumidify device | |
| L12 Dehumidify Off | Percent humidity required to turn off dehumidify device | |
| LEV 1 | Selects whether to use the Dehumidify Coil or the Drier Device (Drier requires the Input 2 to be open) | |
| Dehumidify Coil vs. Drier Logic (Input 2) | When closed selects using the Dehumidify Coil. When open, and when LEV 1 is set to Use Drier, it will disable the dehumidify coil and use the Drier device instead. | |
| Affected By: | Default Value: | Range: |
| Channel 2 Proportional Band Cooling | 40 | 0 - 50 Degrees C |
| Reset for Channel 2 Cooling | 0.1 | 0 - 9.9 Repeats/minute |
| Rate for Channel 2 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 2 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 2 Cooling | 0 | 0 - 7 Seconds |

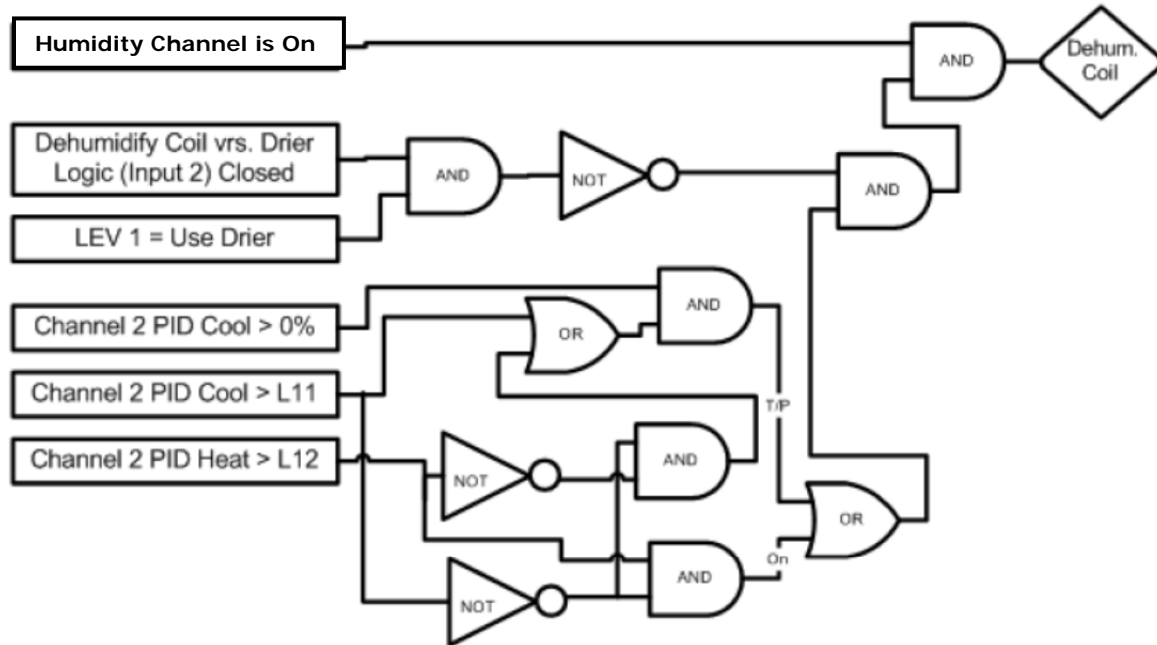
The Drier output is the time proportioning output that can be used to provide very low humidity. This output is enabled when the Humidity Channel is on and the LEV1 and Digital Input 2 are set appropriately. This output typically energizes the Desiccant De-humidifier.

The PID tuning for de-humidification is controlled by the channel's Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

SYNERGY QUATTRO

Dehumidify Coil

This output operates the dehumidify coil for dehumidification.



| | | |
|---|---|------------------------|
| Output is either Time Proportioning or On/Off | | |
| L11 Dehumidify On | Percent dehumidify required to enable dehumidify device | |
| L12 Dehumidify Off | Percent humidity required to turn off dehumidify device | |
| LEV 1 | Selects the Drier Device when Input 2 is closed, otherwise the Dehumidify Coil is selected. | |
| Dehumidify Coil vs. Drier Logic (Input 2) | When closed and when LEV 1 is set to Use Drier, disables the dehumidify coil and uses the Drier device instead. | |
| Affected By: | Default Value: | Range: |
| Channel 2 Proportional Band Cooling | 40 | 0 - 50 Degrees C |
| Reset for Channel 2 Cooling | 0.1 | 0 - 9.9 Repeats/minute |
| Rate for Channel 2 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 2 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 2 Cooling | 0 | 0 - 7 Seconds |

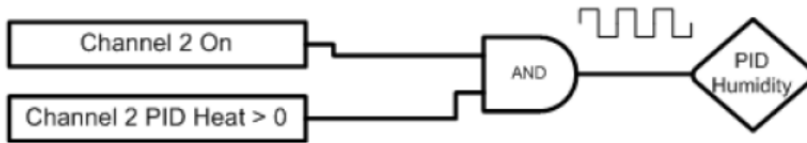
The Dehumidify Coil output is the time proportioning output that controls de-humidification. This output is enabled when the Humidity Channel is on and typically energizes the de-humidification solenoid valve.

The PID tuning for de-humidification is controlled by the channel's Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

SYNERGY QUATTRO

PID Humidify

This output energizes the humidity generator and controls water vapor injection into the chamber.



| | | |
|-----------------------------------|---------------------|----------------------------------|
| Channel 2 Prop. Band Humidify | Default Value: 42% | Range: 0 to50% |
| Reset for Channel 2 Humidify | Default Value: 0.02 | Range: 0 - 9.9 Repeats/minute |
| Rate for Channel 2 Humidify | Default Value: 0.0 | Range: 0 - 9.9 |
| Cycle Time for Channel 2 Humidify | Default Value: 1 | Range: 1 - 60 Seconds |
| Rate Band for Channel 2 Humidify | Default Value: 0 | Range: 0 - 7 Seconds |

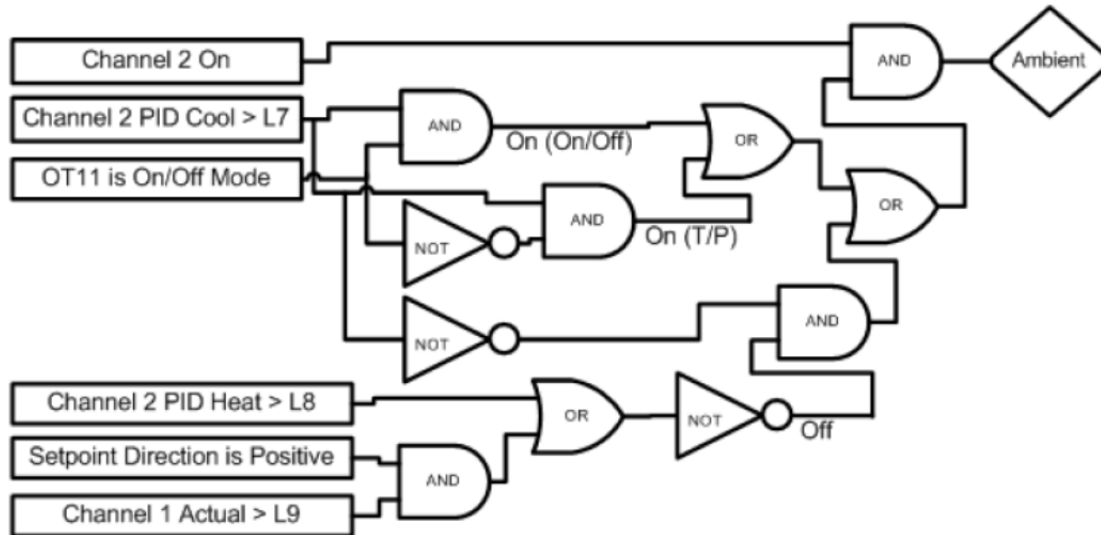
The PID Humidify output is the time proportioning output that controls the humidification system. This output is enabled when the Humidity Channel is on and typically energizes an immersion heater (in a water bath) or steam generator.

The PID tuning for the humidification system is controlled by the channel's Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

SYNERGY QUATTRO

Ambient Device

This output is used when cooling is required with humidity control



| | | |
|---|---|------------------------|
| Output is either Time Proportioning or On/Off | | |
| L7 Ambient Cooling Turn On | Percent cooling required to turn on the cooling compressor | |
| L8 Heat Ambient Cooling Turn Off | Percent heat required to turn off the cooling compressor | |
| L9 Ramp Up Cooling | Temperature at which the cooling compressor is turned off while heating | |
| Affected By: | Default Value: | Range: |
| Channel 2 Proportional Band Heating | 42 | 0 - 50 Degrees C |
| Reset for Channel 2 Heating | 0.02 | 0 - 9.9 Repeats/minute |
| Rate for Channel 2 Heating | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 2 Heating | 1 | 1 - 60 Seconds |
| Rate Band for Channel 2 Heating | 0 | 0 - 7 Seconds |
| Channel 2 Proportional Band Cooling | 40 | 0 - 50 Degrees C |
| Reset for Channel 2 Cooling | 0.1 | 0 - 9.9 Repeats/minute |
| Rate for Channel 2 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 2 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 2 Cooling | 0 | 0 - 7 Seconds |

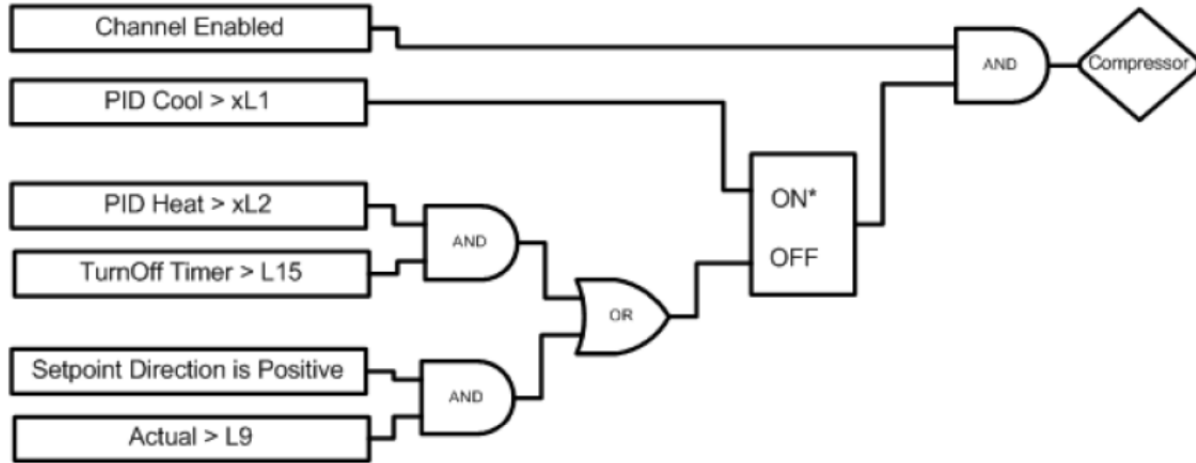
The Ambient Coil output controls the ambient cooling coil when the Humidity channel is on and cooling is required.

SYNERGY QUATTRO

Single State Temperature Control Outputs

Compressor

This output controls a compressor for Temperature Only and Thermal Shock Chambers.



| | | |
|---|----------------------------|--------------------------------|
| xL1 Channel x Main Cooling Turn On: | Default Value: 10% | Range: 0 to 100% |
| Cooling output percentage that turns on channel x compressor | | |
| xL2 Channel x Main Cooling Turn Off | Default Value: 50% | Range: 0 to 100% |
| Heat output percentage that turns off channel x compressor | | |
| L9 Ramp Up Cooling | Default Value: 50 C | Range: -100 C to +100 C |
| Temperature at which the cooling compressor shuts off while heating. | | |
| L15 Compressor Turn-Off Delay | Default Value: 1 | Range: 0 to 5 Minutes |
| Number of minutes after Main Cooling Turn off before compressor turns off. This value is used to limit compressor cycling | | |

Notes:

Setpoint direction is Positive only when ramping a setpoint in a profile.

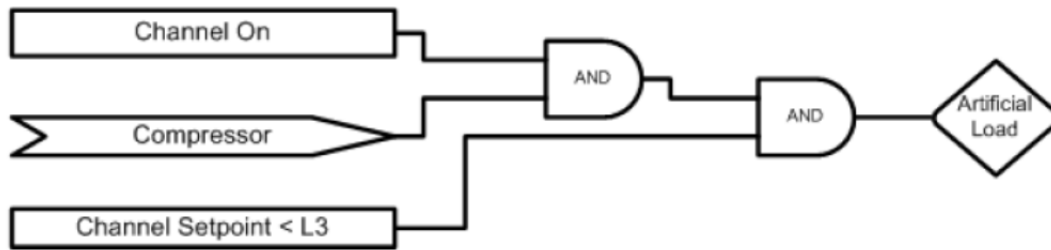
* Denotes that the ON input signal has priority if both ON and OFF are true.

The compressor output energizes the compressor in single stage refrigeration systems.

Note: The High Compressor and Low Compressor primitives are used on Cascade refrigeration systems equipped with a high and low stage compressor.

SYNERGY QUATTRO

Artificial Load



| Control Values: | Default Value: | Range: |
|------------------------------------|----------------|------------------|
| xL3 Ch x Setpoint Transfer Setting | 20 C | -100 C to +100 C |

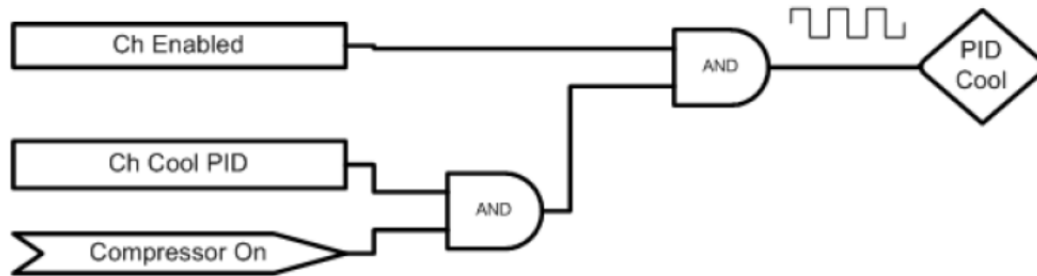
The Artificial load (hot gas bypass) output allows refrigerant to cool the compressor when it running but the cooling (liquid) output is off to prevent the compressor from overheating. This output is used on Temperature only systems.

The High Artificial Load and Low Artificial load primitives are used on Cascade refrigeration systems equipped with a high and low stage compressor.

SYNERGY QUATTRO

PID Cool (Temp Only, Temp-Temp Configuration)

This is a time proportioning output that energizes the cool solenoid permitting refrigerant flow to the Evaporator Coil. This logic is only used on Temp Only and Temp-Temp (thermal shock) configurations.



| Affected By: | Default Value: | Range: |
|-------------------------------------|----------------|------------------------|
| Channel 1 Proportional Band Cooling | 5 | 0 - 50 Degrees C |
| Reset for Channel 1 Cooling | 0.07 | 0 - 9.9 Repeats/minute |
| Rate for Channel 1 Cooling | 0 | 0 - 9.9 Minutes |
| Cycle Time for Channel 1 Cooling | 7 | 1 - 60 Seconds |
| Rate Band for Channel 1 Cooling | 0 | 0 - 7 Seconds |

This PID Cool output (PIDCTOTT) is a time proportioning output that controls refrigerant flow to the evaporator on a Temperature Only or Thermal Shock chamber. This output is only enabled when its Channel is on and the compressor is on. The output typically energizes the cooling solenoid.

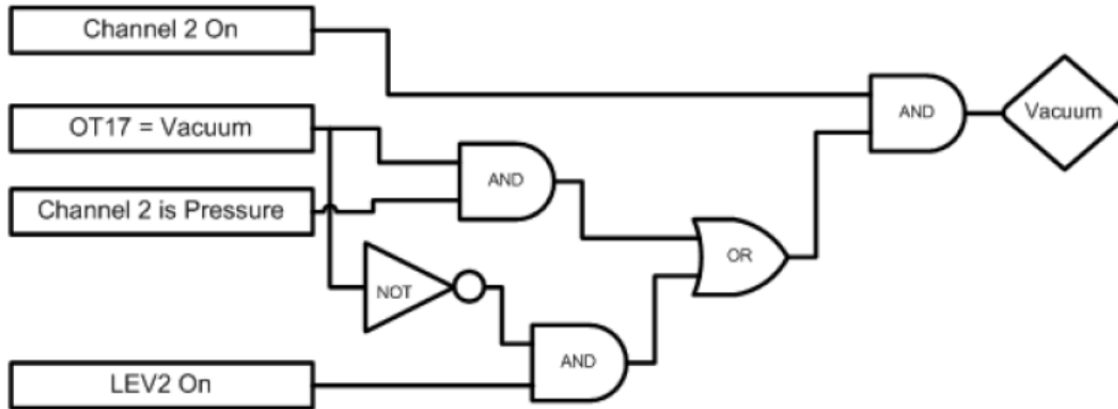
The PID tuning for the cooling system is controlled using the channels Proportional Band, Reset, Rate, and Cycle time as shown in the above table.

Note: On Temperature Humidity chambers, the PID cool primitive controls the cooling solenoid.

Altitude Control Outputs

Vacuum

This output controls the vacuum device on altitude chambers.



| OT17 – Output 17 Control Type | Default Value: Vacuum | Range: Vacuum or Purge |
|--|-----------------------|------------------------|
| Selects the control logic for the Vacuum device. Can be either Vacuum or Purge | | |

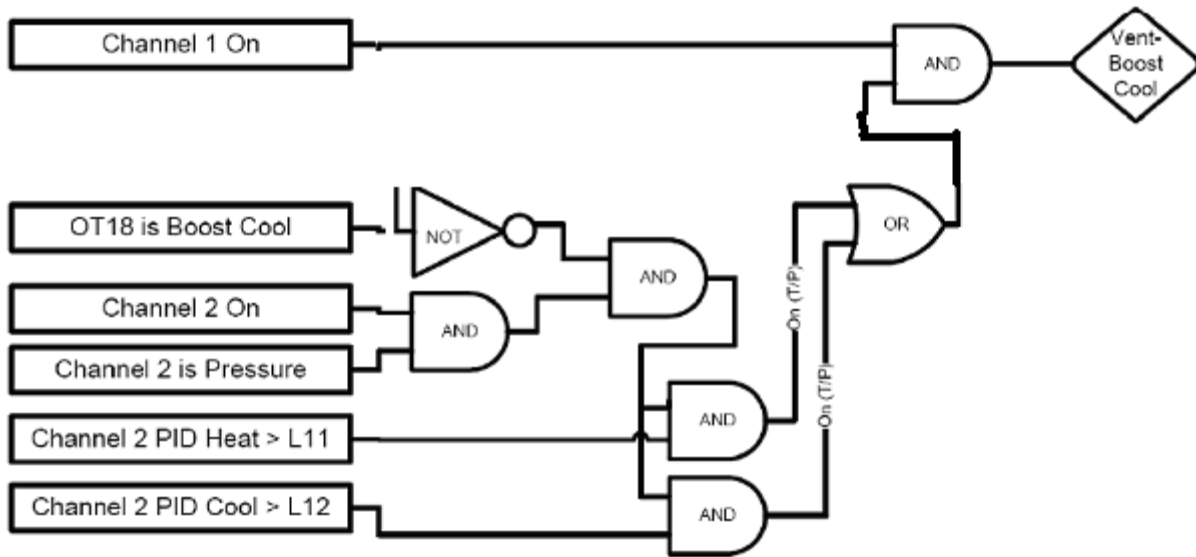
Notes:

LEV 2 Controls Vacuum device when OT17 is set to Purge.

The Vacuum output is used on Altitude chambers to raise the altitude; i.e. Decrease the chamber pressure. This output is time proportioning.

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Vent

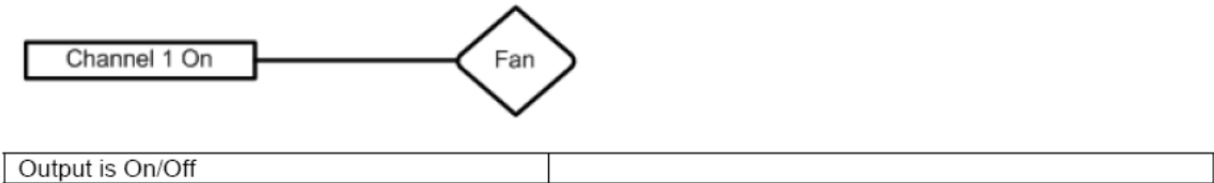


| | |
|---|---|
| Output is On/Off | |
| OT18 | Selects the Control logic for the Vent – Boost Cool device |
| L14 Time Delay Boost Cool | Time delay (in seconds) required before Boost Cool is enabled |
| Turn On Timer is reset when Channel 1 PID Cool < 100% | |

The Vent output is used on Altitude chambers to lower the altitude; i.e. increase the chamber pressure. This output is time proportioning.

Other Outputs

Fan Primitive

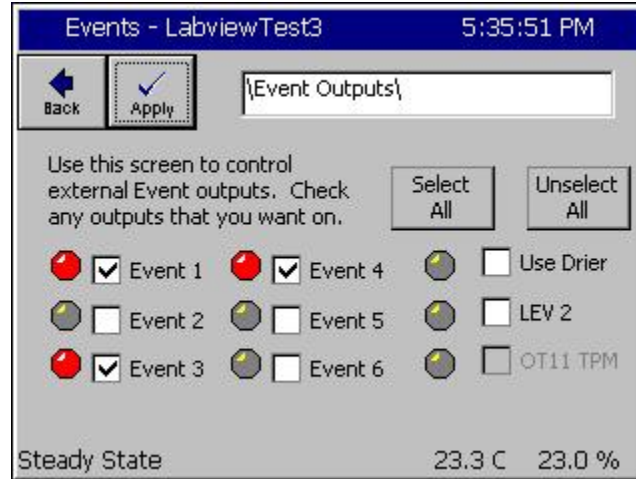


The Fan Output is a primitive that can be used to control the fan (aka air circulator). It can also be used to turn on any chamber function that must be enabled whenever the chamber is turned on. The Fan is controlled by the state of Channel 1; i.e. it is on when Channel 1 is on and Off when Channel 1 is off.

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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.

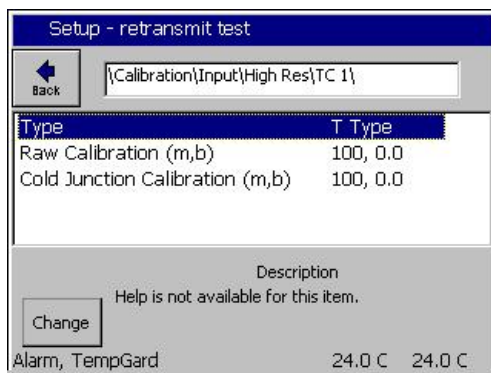
Appendix C: Frequently Asked Questions, FAQ

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?

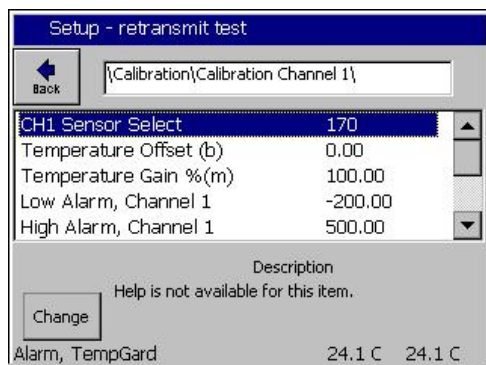
A1: The Synergy Quattro, Synergy Nano TE1858-1, -2, and -3 models support RTD’s, T/C’s, Process voltage and Process current inputs. A default Sensor ID for each channel is loaded when you select a chamber definition file (CDF). The default Sensor ID defines the input assigned to each channel control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

Follow these two steps:

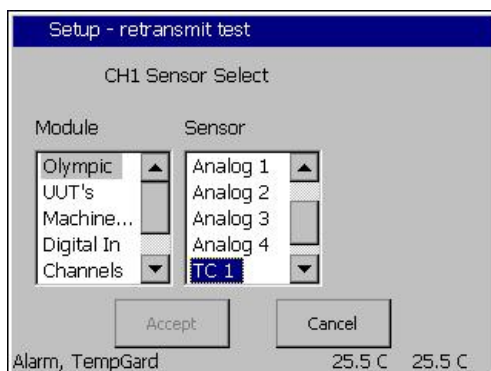
1. Setup either T/C Input for the appropriate T/C Type.
2. Assign the Sensor ID for the sensor in step 1 to the channel on the SETUP/Calibration/Channel 1 Calibration screen,



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**.



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.

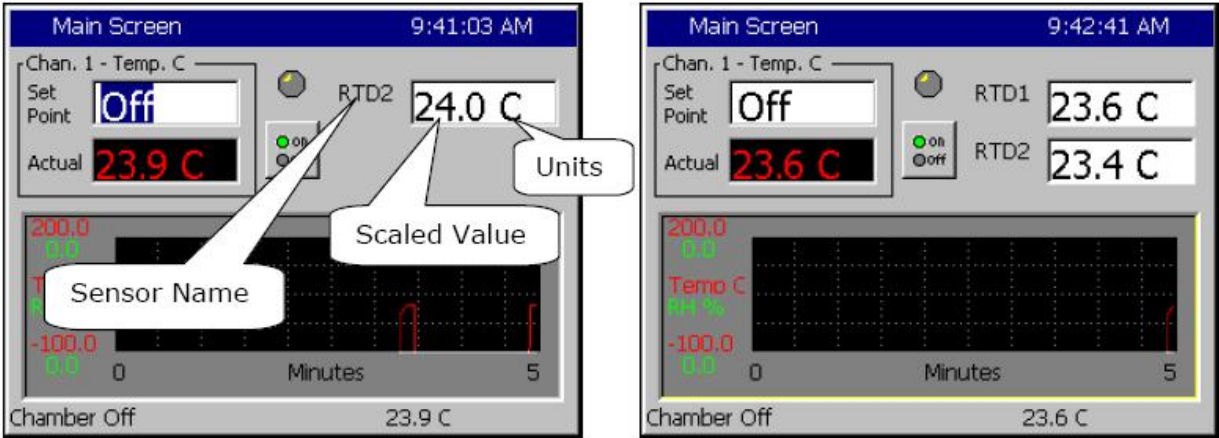
Note that with the default virtual pressure sensor settings, the reading will transfer to the 10 Torr sensor when the 10 Torr sensor reads below 8 Torr and transfer back to the 1000 Torr Sensor when the 10 Torr sensor reads above 10 Torr.

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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.

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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?

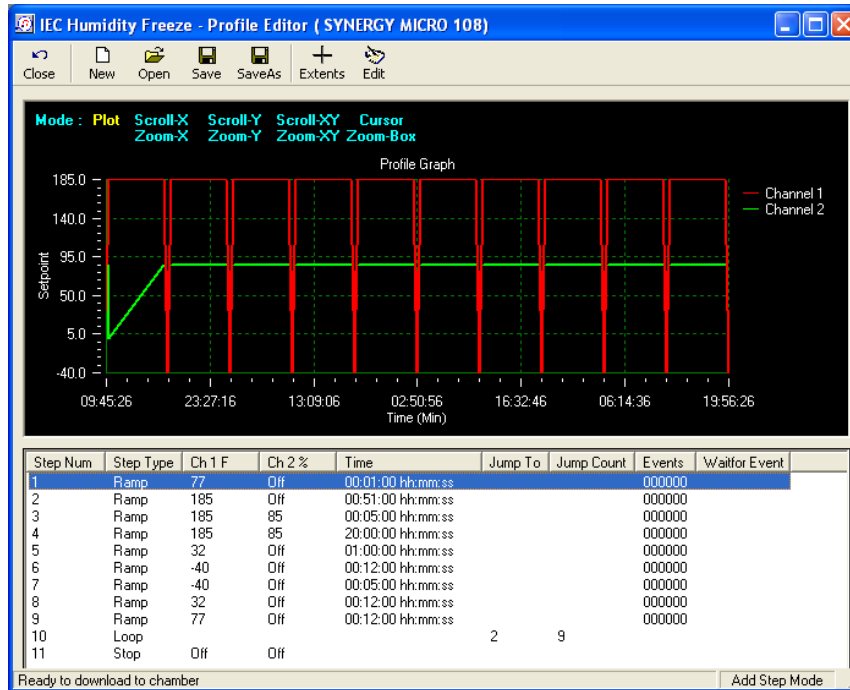
A15: In addition to the UUT Module itself, the following items are included with the TE1299-16.

| 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 |

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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.

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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.

Tidal Engineering Corporation
2 Emery Avenue
Randolph, NJ 07869
Tel: 973/328-1173
Fax: 973/328-2302
www.TidalEng.com
info@tidaleng.com

