Stirling Gas Conditioner

App K

APEX INSTRUMENTS, INC.

SGC-4000 Stirling Chiller

Operator's Manual

Issue 9-22-08

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Introduction

The SGC-4000 system is a low energy, environmentally-friendly (Stirling Cooler) gas cooling unit. It is designed to accommodate two heated sample lines and condition the sample gases to a user selectable temperature.

Cooler System Information

This section contains information about the theory and configuration of the SGC-4000 Stirling Cooler system.

Operational Summary

The SGC-4000 unit is based around a Free Piston Stirling Cooler (FPSC). The FPSC constantly cools the input gas flow path through a common aluminum manifold (heat exchanger). Using an integrated block heater and a temperature controller the output gas temperature can be accurately controlled.

System Gas Flow

The Source Sample gas from the heated sample line is introduced into a Filtration Unit. The first stage filter / scrubber glass bottle is filled with *ALUMA-SORB* beads designed to extract moisture and scrub other contaminants from the sample gas. From this collector, the gas is directed trough the cooling aluminum manifold (heat exchanger). The manifold is coupled to the cold side of the FPSC, cooling the source gas to the desired temperature.

FPSC Operation

The SGC-4000 system employs a (Stirling Cooler) FPSC cooling unit to cool sample gas. A FPSC utilizes compressed helium gas to transfer heat from the surface surrounding its cooling fins. This is accomplished using a linear motor to drive a piston connected to a displacer. There are four phases of motion that serve to compress the helium and prevent reverse heat flow into the displacer and coolant gas. Repeating this process continues to remove heat from the cooling fins and sample gas. Refer to **Figure 1** for FPSC system information.

Temperature Regulation

The SGC-4000 system is configured to maintain a desired temperature for the output sample gas. A Watlow model SD31 temperature controller is used to control the temperature output of the FPSC. When the output gas is cooled below the set point, the controller will activate a heater attached to the manifold until the output thermocouple maintains the set point temperature. The controller adjustment can be calibrated using the Auto-Tuning feature described in the **Usage Instructions** section.

Components

- Watlow SD31 Temperature Controller
- Stirling FPSC Cooler
- Chiller Logic Board
- Aluminum Manifold
- Block Heater
- Glass Condensate Collector
- Glass Filtration Unit

Stirling FPSC Cooler

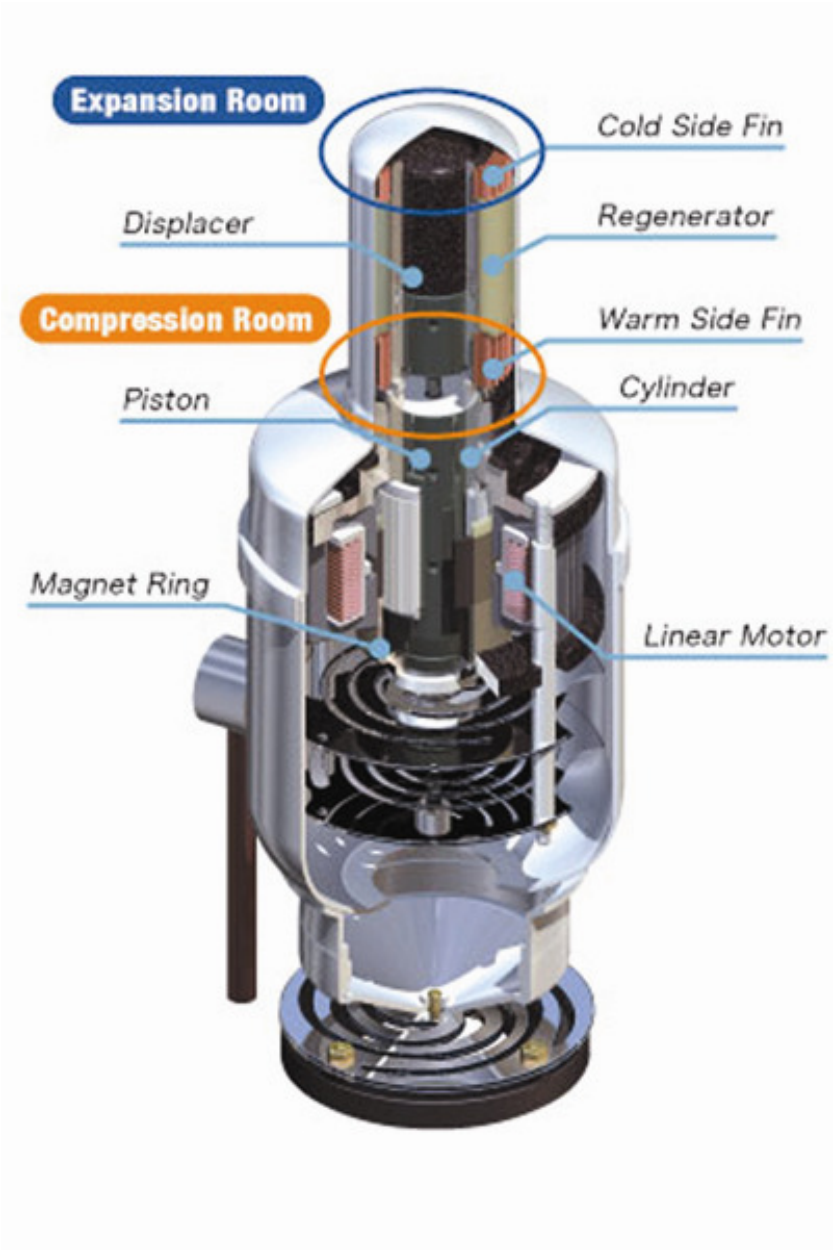
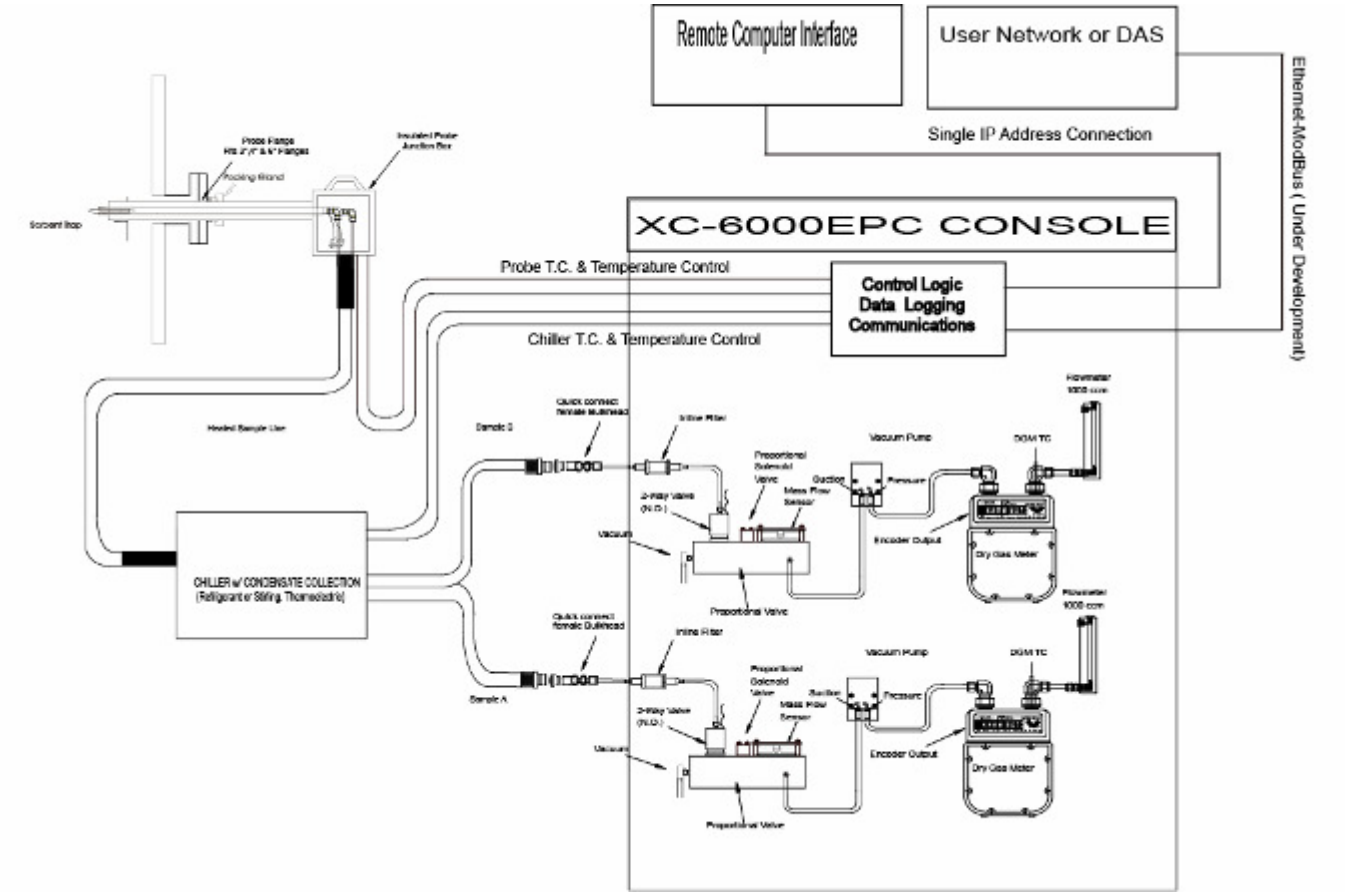


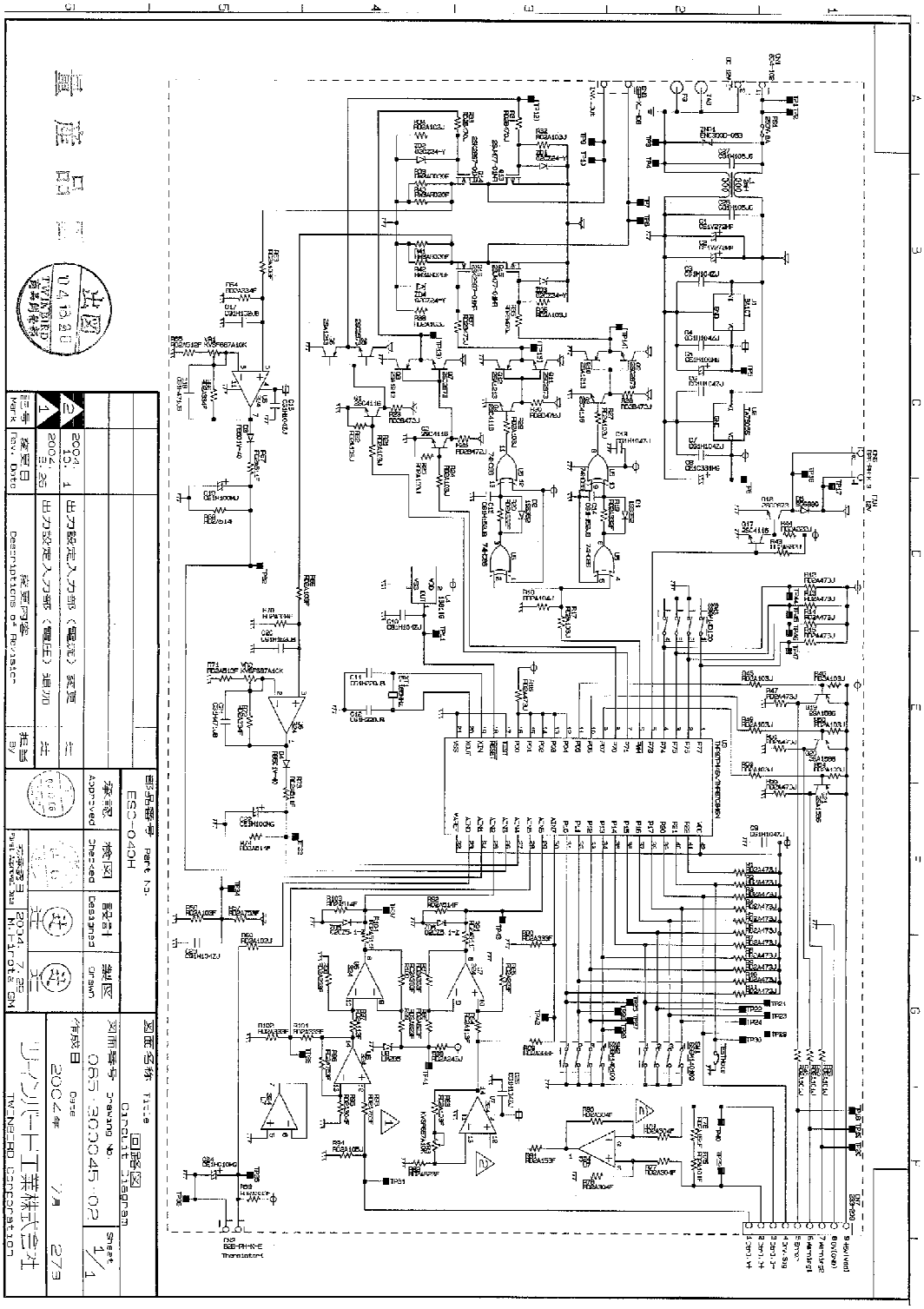
Figure 1

Sample Flow Schematic

This section contains the flow schematic of the SGC-4000 Stirling Cooler system used in conjunction with the XC-6000 MercSampler.



FPSC Controller Schematic



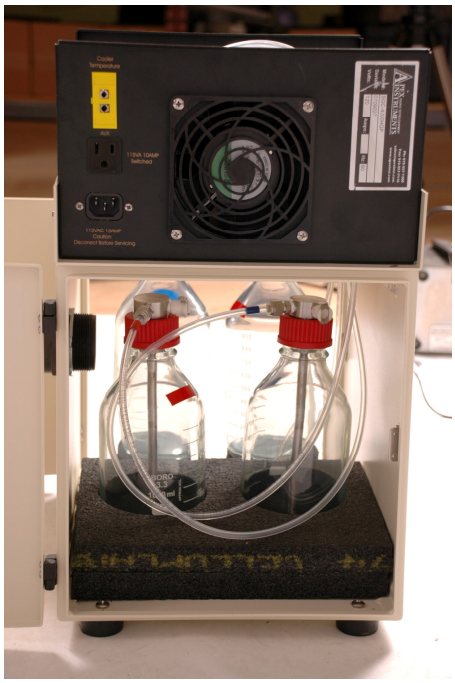
SGC-4000 Electrical Connections and Controls

The SGC-4000 connects to a 110V/15A circuit at the back of the unit and is controlled by a switch labeled Main on the front panel. The Main switch is also a circuit breaker. In the event the circuit breaker is tripped it can be reset by turning off then back on.

A 110V outlet is provided to power the HSRL (Heated Self Regulated Line) and is controlled by a switch labeled AUX on the front panel. The AUX switch is also a circuit breaker. In the event the circuit breaker is tripped it can be reset by turning off then back on.

A female Type-K TC is provided to connect the SGC-4000 to the XC-6000 for monitoring the SGC-4000 temperature.

The Temperature Controller displays the SGC-4000 current temperature and is used to set the desired temperature. See the section for Temperature Controller Instructions for additional information.



Rear View

Front View

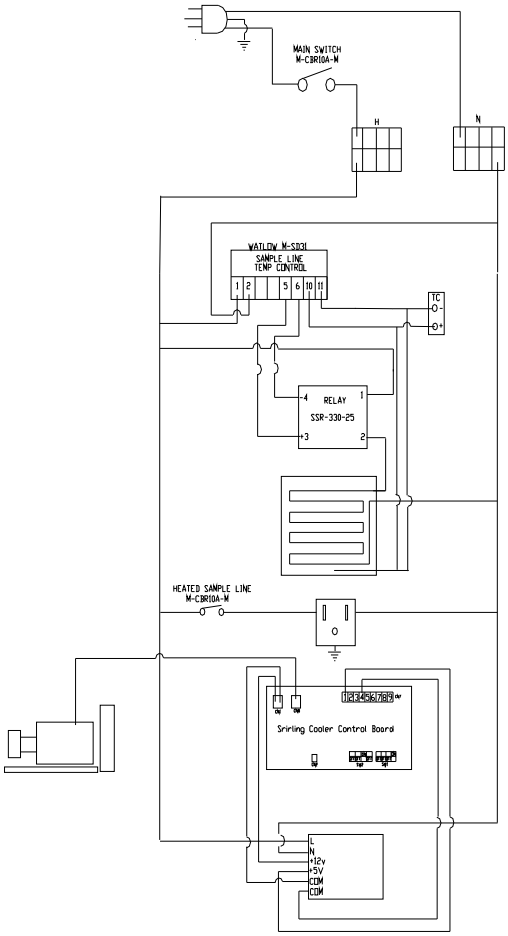
SGC-4000 Plumbing Connections

The HSRL from the Probe contains 2 sample lines. The A line is marked with RED and the B line is marked with BLUE. This color scheme is followed throughout the SGC-4000.

The sample lines from the Probe to the SGC-4000 are connected to the Input A and Input B connectors, following the RED-BLUE color coding, which internally are connected to the chiller and the condensate bottles before passing to the *ALUMA-SORB* canisters/bottles.

Another jumper line is connected from the SGC-4000 to the XC-6000. Using the RED-BLUE color coding, connect the jumper from the SGC-4000 *ALUMA-SORB* canisters/bottles outlet to the XC-6000 Sample Line A and B In connectors. Also connect the TC in the jumper to the back of the SGC-4000 and the back of the XC-6000 to monitor the SGC-4000 temperature on the SC-6000.

SGC-4000 Interconnection Schematic



SGC-4000 Setup

Prior to use the Condensate bottles need to be checked and emptied if required. The beads in the *ALUMA-SORB* bottles/canisters must be checked for discoloration and changed if required.

Connect the SGC-4000 to the Probe and the XC-6000 per site specific configurations.

Power on the unit and verify the temperature displayed on the Temperature Controller is approaching the set point.

Setup the test profile on the XC-6000 and perform the Pre-leak test, correct any leaks if required. Select Set Probe and verify the SGC-4000 temperature is correct. Refer to the XC-6000 MercSampler Operators Manual for information setting up the XC-6000 and running tests.

Temperature Controller Instructions

This section contains procedures necessary for operating the SGC-4000 Stirling Cooler.

Reset Configuration

This section will describe how to restore a SGC-4000 Stirling to the factory settings.

1. Power on the unit
2. Press and hold both arrow keys (six seconds) until FACt is displayed
3. Press and release the down arrow key until dFLt is displayed
4. Press and hold SET
5. Press Down ▼ until YES is displayed
6. Release SET
7. Press ∞
8. Press and hold Up ▲ and Down ▼ for three seconds, until SEt is displayed
9. Press and release the Down ▼ until L in is displayed
10. Press and hold SET
11. Press Down ▼ until H is displayed
12. Release SET
13. Press and release the Down ▼ until C-F is displayed
14. Press and hold SET
15. Press Down ▼ until F is displayed

16. Release SET
17. Press

Temperature Configuration

This section will describe how to specify the desired maintenance temperature on the SGC-4000 Cooler system.

1. Power on the unit
2. Press and hold SET
3. Use the Up ▲ and Down ▼ keys to modify the displayed temperature
4. When desired temperature is reached, release SET

Tuning Procedure

This section will describe how to perform an auto-tuning procedure on the Stirling Cooler. Performing this operation will ensure the unit operates in an efficient manner.

1. Power on the unit
2. Ensure the unit has been configured for the desired maintenance temperature
3. Press and hold ∞ for three seconds, until the OPEr menu is displayed
4. Press and release Down ▼ until AUt is displayed
5. Press and hold SET
6. Press ▼ until On is displayed
7. Release SET
8. Press the ∞
9. The auto-tuning process will now begin
10. The display will flash tunE until the process is complete
11. Once complete, you may power off the unit or continue normal operation

NOTE: The gas temperature must pass the set point a minimum of four times for the auto-tune process to complete.

SGC-4000 Controller Board Connections and Settings

Pin	Specification
[CN7] WAGO 233-209 Acceptable Wire: 0.08 – 0.5 mm², 28 – 20 AWG (Stranded conductor, Solid conductor) Strip Length: 5 – 6 mm	
1	Setting of Output 1 Input: DC 1.0~5.0 V Output(CN8): AC 2.0~8.5 V
2(+) 3(–)	Setting of output 2 Input: DC 4~20 mA Output(CN8): AC 2.0~8.5 V
4	Drive / Stop of FPSC Input: High / Low Function: Stop / Drive
5	Emergency Signal Output Output: High / Low Status: Emergency / Normal
6	Alarm Signal 1 Output Output: High / Low Status: Alarm / Normal
7	Alarm Signal 2 Output Output: High / Low Status: Alarm / Normal
8(0V) 9(+5V)	Reference Voltage Output Output Voltage: DC 5.0 V (±10%) Output Current Capacity: 50 mA
[CN2] JST B2B-PH-K-E (Blue) Acceptable Connector: JST PHR-2	
1 2	Warm Side Thermistor
[CN6] JST B2B-PH-K-S (White) Acceptable Connector: JST PHR-2	
1(–) 2(+)	Output to Fan Output Voltage: Power Source Voltage +0/–0.3 V Output Current Capacity: 500 mA
[CN8] JST S02P-XL-HDB (White) Acceptable Connector: JST XLP-02V	
1 2	Output to FPSC Output Voltage Range: AC 2.0~8.5 V (RMS) Output Current Capacity: 7 A (RMS)
[CN1] WAGO 804-102 Acceptable Wire: Stranded conductor 0.5 – 2.5 mm², 20 – 12 AWG Solid conductor ϕ 0.8 – 2.0 mm Strip Length: 10 – 11 mm	
1(+) 2(–)	Power Source Input Input Voltage: DC 12 V (± 10 %) Maximum Current: 6 A (RMS) (at 12 V Input)
[TAB] 187 Type (6.3 mm)	
–	GND
[FG] ϕ 1.8 mm (Hole)	
–	GND

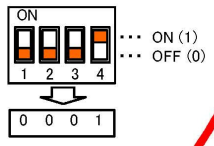
[SW1] DIP SW
Setting of Output Voltage Change

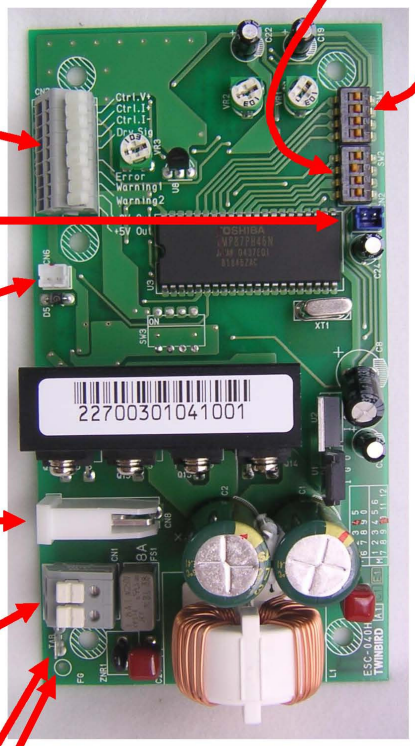
No.	ON	OFF
4	1	0
3	1	0
2	1	0
1	1	0

[SW2] DIP SW
Setting of Warm Side Temperature Limit Setting

No.	ON	OFF
4	1	0
3	1	0
2	1	0
1	1	0

Example of DIP SW and the Value

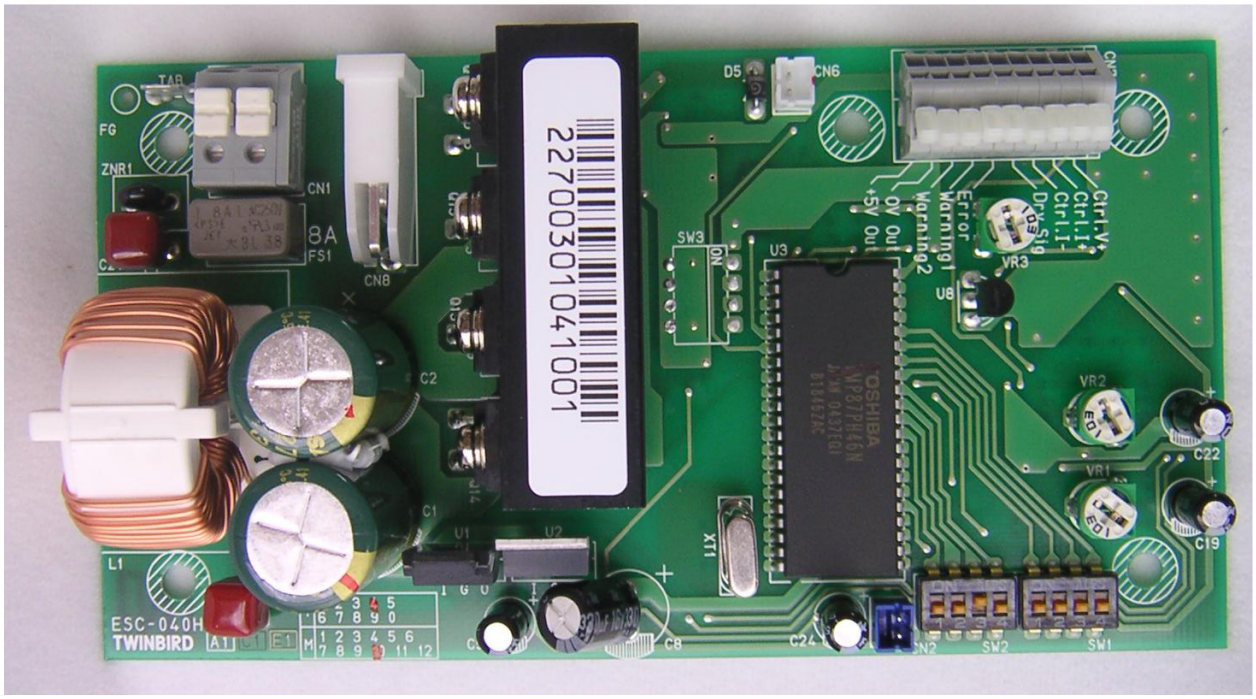




Switch 1 is preset at the factory to 1110 and should not be changed without contacting Customer Service at Apex Instruments.

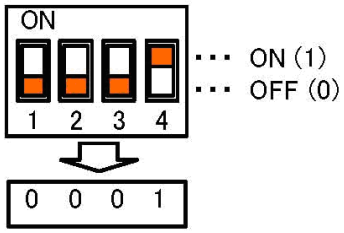
Switch 2 is used to set the thermal cutoff circuit used to protect the Stiriling Chiller in the event of overheating.

The default setting for Switch 2 is 0111 which sets the cutoff temperature to 147ºF/64ºC. In extreme operating conditions it may be necessary to change this setting. Caution must be used to ensure the unit does not overheat causing the unit to fail.

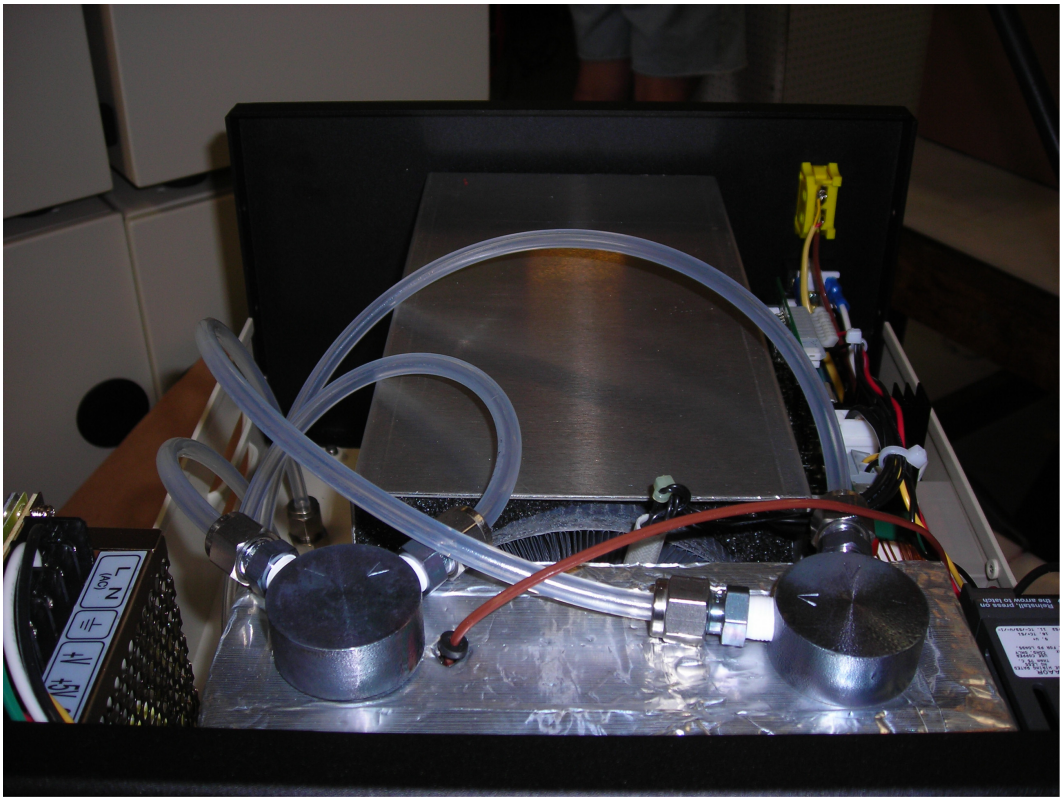


SW2 Value	0000	0001	0010	0011	0100	0101	0110	0111
Temp. Limit	122ºF/ 50ºC	125ºF/ 52ºC	129ºF/ 54ºC	133ºF/ 56ºC	136ºF/ 58ºC	140ºF/ 60ºC	144ºF/ 62ºC	147ºF/ 64ºC
SW2 Value	1000	1001	1010	1011	1100	1101	1110	1111
Temp. Limit	151ºF/ 66ºC	154ºF/ 68ºC	158ºF/ 70ºC	162ºF/ 72ºC	165ºF 74ºC	169ºF/ 76ºC	172ºF/ 78ºC	176ºF/ 80ºC

Example of DIP SW and the Value



Images



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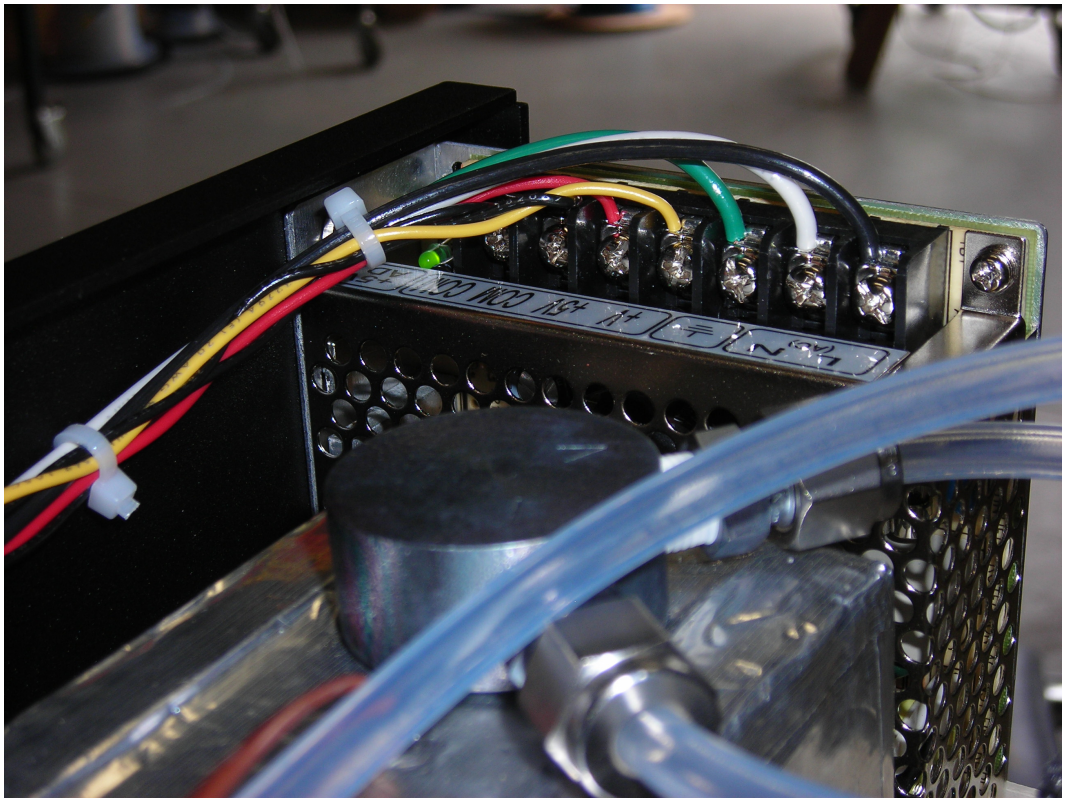
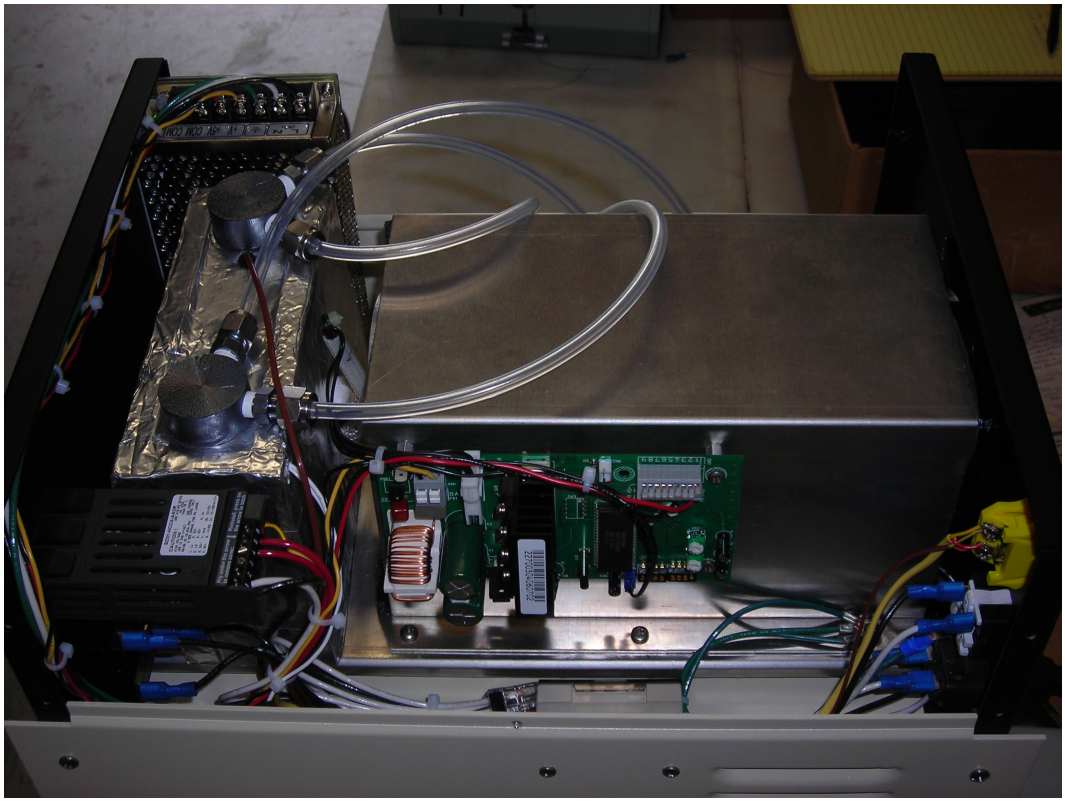


Power Supply

Temperature Controller



Heat Exchanger and Installed Controller Board