

THERMORACK 1201

The Ultimate Chiller for Plasma Etch



Product Manual

Solid State
COOLING SYSTEMS
Temperature Control...Precisely.



CE Declaration of Conformity

We: Solid State Cooling Systems
167 Myers Corners Road
Wappingers Falls, NY 12590
USA

declare under our sole responsibility that the

ThermoRack 1201 (All models)

meets the provisions of the directives:

2004/108/EC EMC Directive
2006/95/EC Low Voltage Directive

EN 61326-1: 2006	Emissions and Immunity
EN 61000-3-2: 2006	Harmonics Emissions
EN 61000-3-3: 2008	Voltage Fluctuations and Flicker

EN 61010-1: 3 rd Edition	Safety	Low Voltage Directive Safety requirements for electrical equipment for measurement, control, and laboratory use.
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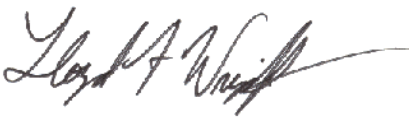
Lloyd F Wright Chief Technology Officer	
Date	10/1/15

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NOT DEFINED.	
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13.3 3M HFE-7100, 7300, 7500	ERROR! BOOKMARK NOT DEFINED.
13.4 ETHYLENE GLYCOL	ERROR! BOOKMARK NOT DEFINED.

SYMBOLS USED ON THE PRODUCT



Read the MSDS for the coolant used and follow all safety precautions listed in the MSDS prior to removing coolant tubes or opening the fill cap as this could result in contact with the coolant inside.



Caution! Risk of electric shock. Disconnect the power cord prior to servicing. This includes changing a fuse or opening the cover for any reason.



Caution! Heavy object. System weighs 70 lbs (2 kg). Two people are required to lift.



Earth Ground Safe operation of the ThermoRack requires that earth ground be connected to pin G of the Harting Plug #09200030620 supplied with the system.



Caution! Risk of entanglement – rotating machinery inside – exposed pump motor.

SYMBOLS USED IN THIS MANUAL



CAUTION

The red CAUTION equilateral triangle symbol appears throughout the manual. Please follow the important instructions accompanying this symbol to avoid significant damage to the chiller.



WARNING

The red WARNING equilateral triangle symbol appears throughout the manual accompanying certain maintenance and repair activities. Please follow the important instructions accompanying this symbol to avoid situations that could cause injury to the operator or other personnel.



DANGER

The red DANGER equilateral triangle symbol appears throughout the manual accompanying certain maintenance and repair activities. Please follow the important instructions accompanying this symbol to avoid injury to the operator. Only trained personnel should undertake any activity marked by the red DANGER triangle.

CAUTIONS

- Safe operation the ThermoRack requires earth ground be connected to Pin G of the Harting power input connector supplied with the system. Do Not Operate the ThermoRack without proper grounding!
 - Operation of the ThermoRack in any manner not recommended in this manual could compromise the safety of operating personnel.
 - Never disassemble the ThermoRack unit as irreparable damage may occur.
 - Never store or operate the ThermoRack Chiller over 90 °C.
 - Never operate the coolant within 5°C of its freezing point.
 - If changing the coolant from Fluorinert/Galden to water/glycol, all coolant lines must be thoroughly flushed. See section 5.5 for details.
 - Never ship the chiller with water inside the liquid cold plate as freezing temperatures may be encountered which would damage the unit. See Sections 5.4 & 5.7 for draining procedures.
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PRODUCT Manual

THERMORACK 1201

1.0 INTRODUCTION

The ThermoRack 1201 is a 19" rack-mount thermoelectric recirculating chiller system with full PID control of both heating and cooling. It provides 3-4 gpm of constant temperature coolant for controlling the operating temperatures of semiconductor equipment, lasers, or any process requiring temperature control. In the ThermoRack 1201-1, all internal wetted materials and the pump are compatible with fluorinated heat transfer oils such as Solvay's Galden or 3M's Fluorinert products for temperature control of RF-powered electrodes.

The ThermoRack does not use Freon or any other replacement gas. This chiller has been designed for long life and ease of use. The only moving parts are one pump and one small fan. The internal thermoelectric modules have lifetimes greater than 200,000 hours.

2.0 SPECIFICATIONS

Operating Range	-10°C to 80°C with N2 Purge Option
Ambient Temperature	10°C to 40°C non-condensing
Stability / Repeatability	± 0.05°C at constant load (even near ambient)
Cooling Capacity	Up to 1200 Watts @ 20°C with 20°C facility water
Heating Capacity	Up to 2000 Watts @ 20°C with 20°C facility water
Coolant / Process Fluid	Glycol / water mix, Fluorinert / Galden or HFE
Process Fluid Fittings	1/2" Swagelok
Pump	14 lpm (3.7 gpm) @ 30 psig with HFE
Tank Volume	5.7 liter (1.5 gal) with 2 level sensors
Facility Water	4-8 lpm (1-2 gpm) @ 10-35°C filtered, treated recirculating facility cooling water, pH 6.5 – 8.2
Facility Water Fittings	1/2" Swagelok (316 stainless steel)
N ₂ /CDA (Optional)	500 sccm -30°C dew point or lower CDA or N ₂ , 30-60 psig (2-4 bar) for low temperature operation
Wetted Materials	Process: Aluminum, stainless steel and polymers Facility: Teflon impregnated anodized aluminum and stainless steel
Size (W x D x H)	19" x 24" x 8.7" 5U (48.3 x 61 x 22.1 cm)
Weight	70 lbs (31 kg)
Power Input	200-240 VAC 1 phase, 50/60 Hz, 10 amp max
Circuit Breaker	16 amp 200-250 VAC 2-pole with 30 mA GFCI
Remote EMO	External dry contact
Communications	Lam analog, AMAT CHX, AMAT analog, and TEL Unity II & M
Alarms	Temperature, fluid level, system or component failure (display, dry contact and machine interface)
Standards	Semi S2-0200, F47 compliant, CE, TUV listed to UL, CAN/CSA and EN 61010-1
Warranty	2 years

FIGURE 1 COOLING CAPACITY

Thermorack 1201 Cooling Capacity Plant Cooling Water: 2 gpm @ 20°C

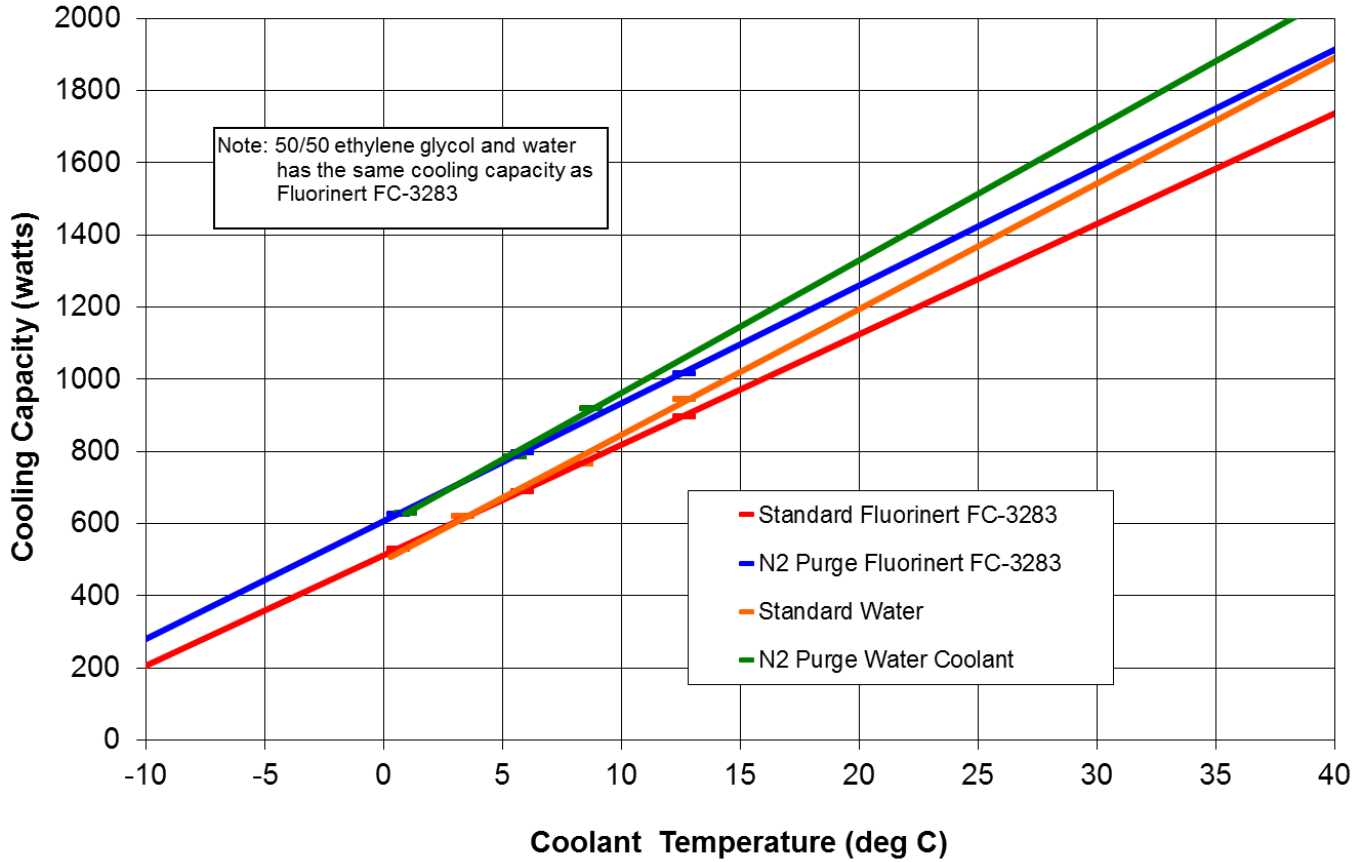
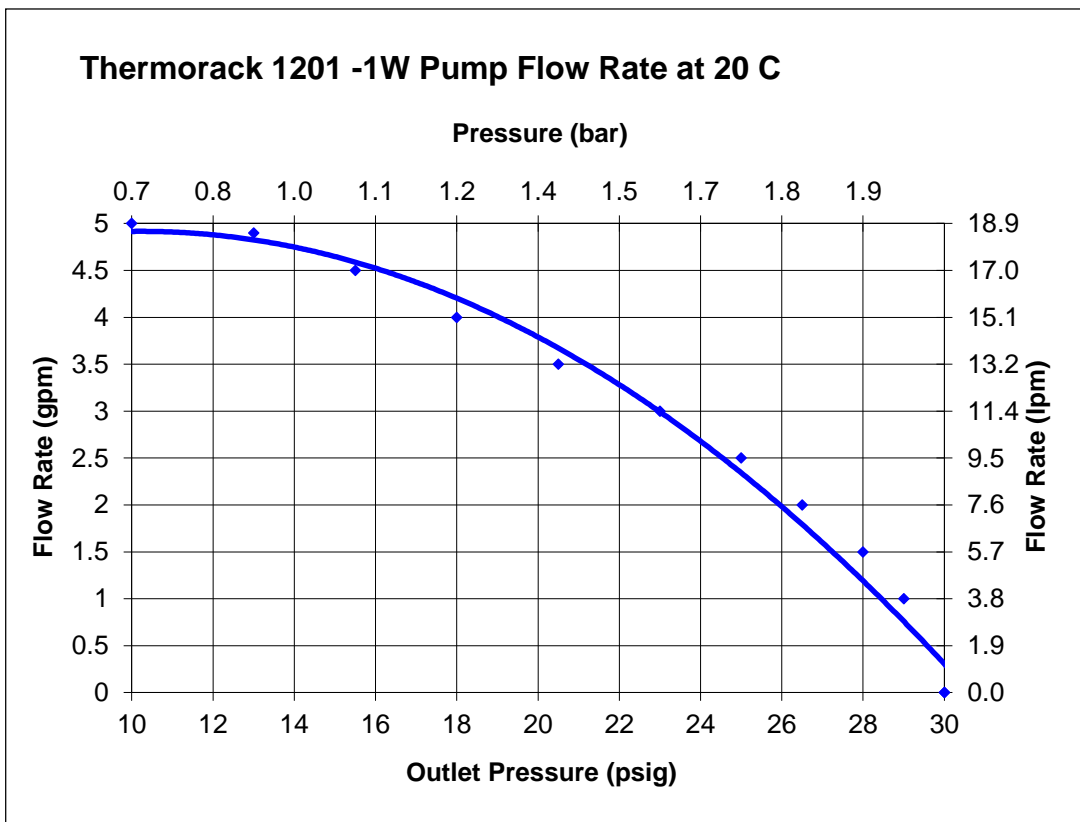
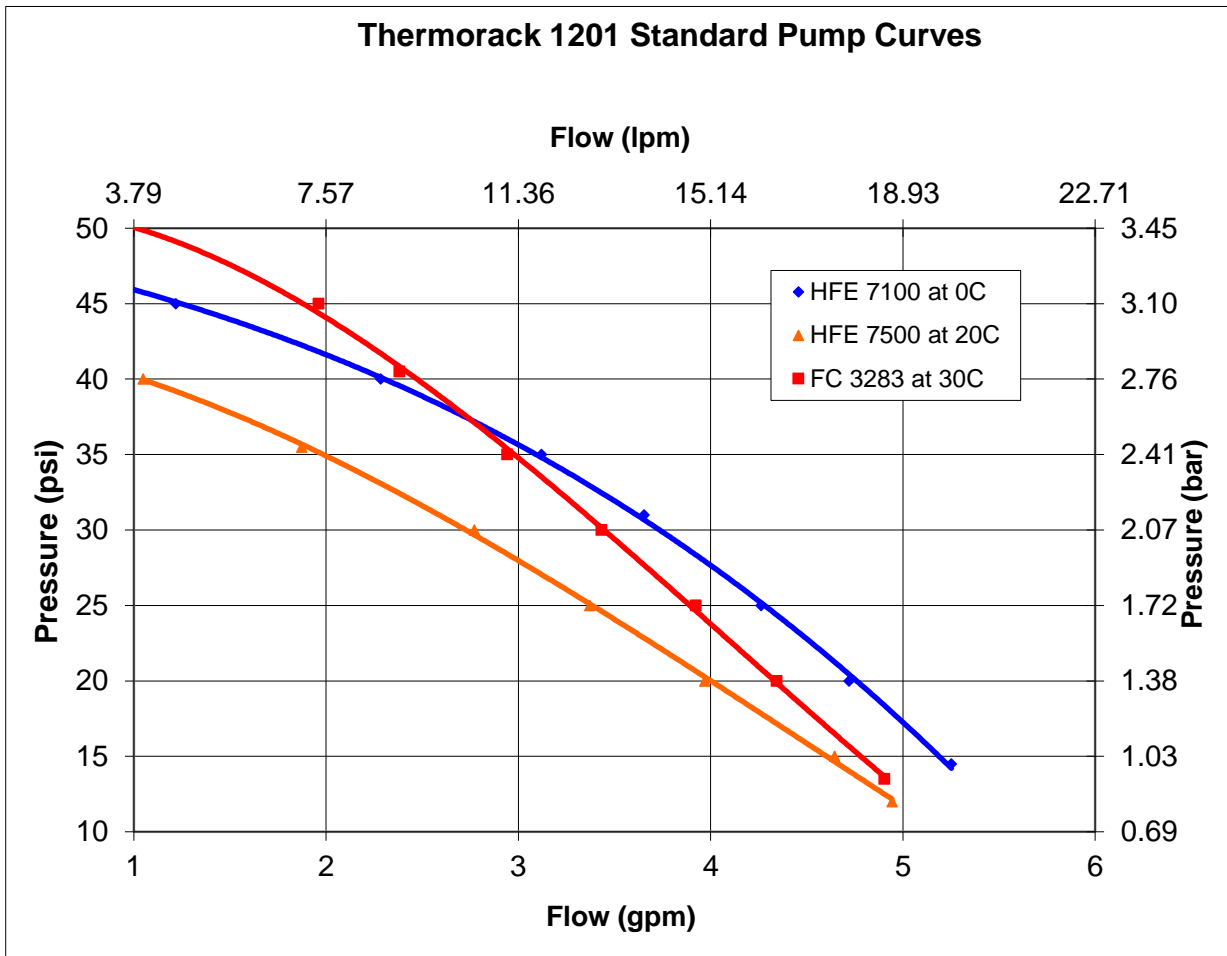


FIGURE 2 PUMP CURVES



3.0 HOOK-UP

3.1 ELECTRICAL CONNECTIONS



CAUTION

Mis-wiring the AC power can damage the Thermorack 1201



WARNING

Failure to connect earth ground to the Green/Yellow stripe conductor will make the Thermorack chassis potential shock hazard

All electrical connections are made on the rear panel (see Figure 3).

AC Power Connection: Connect 200-240 V~ power to the rear of the ThermoRack via the 20ft service cable provided. Connect bare end of service cable as follows:

- Black: Line 1
- White: Line 2 (or neutral)
- Green: Earth ground

The service cable connects to the ThermoRack via a Harting Han Q 5/0 connector which has 5 contacts plus ground, Harting part number 09120153101. Connector pin out: (for reference).

- Pin 1: Line 1
- Pin 2: Line 2 (or Neutral)
- Pin 3: Not Used
- Pin 4: Not Used
- Pin 5: Not Used
- G: Earth Ground

Note: Safe operation of the ThermoRack 1201 requires earth-ground be connected to the G terminal of this plug.

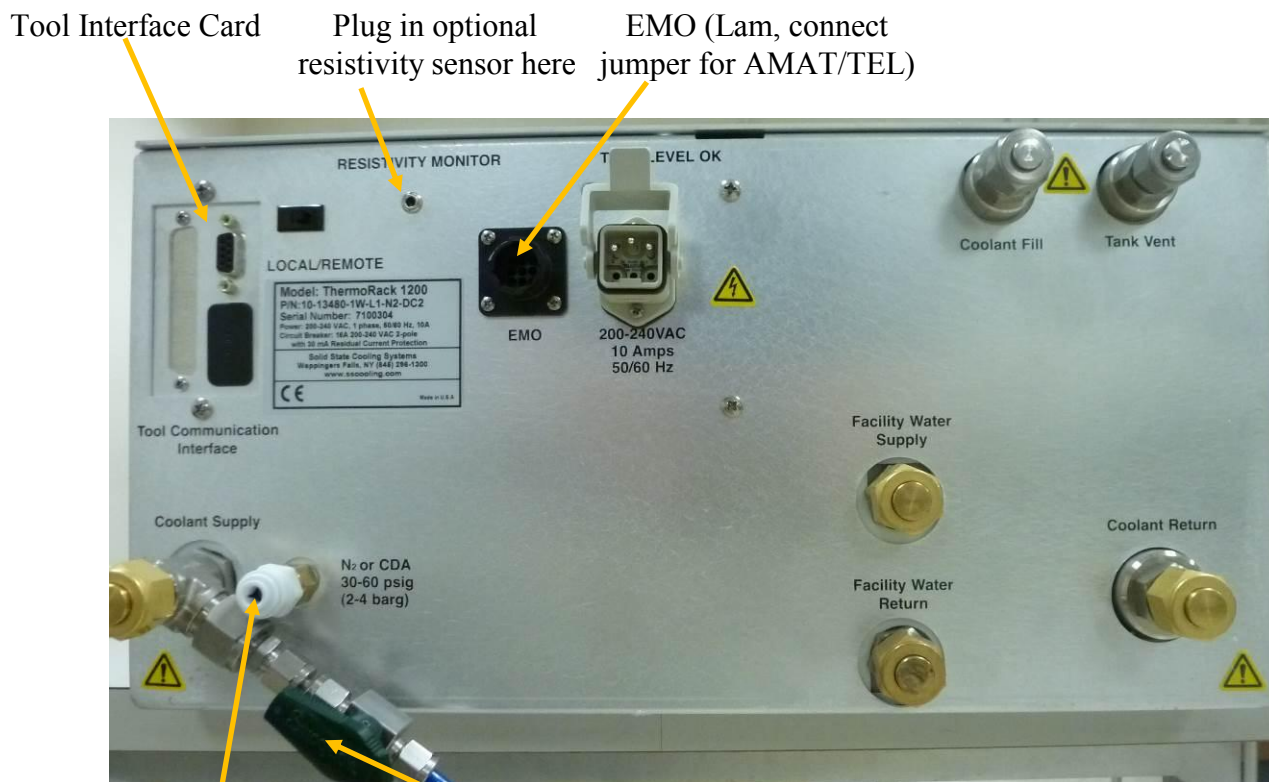
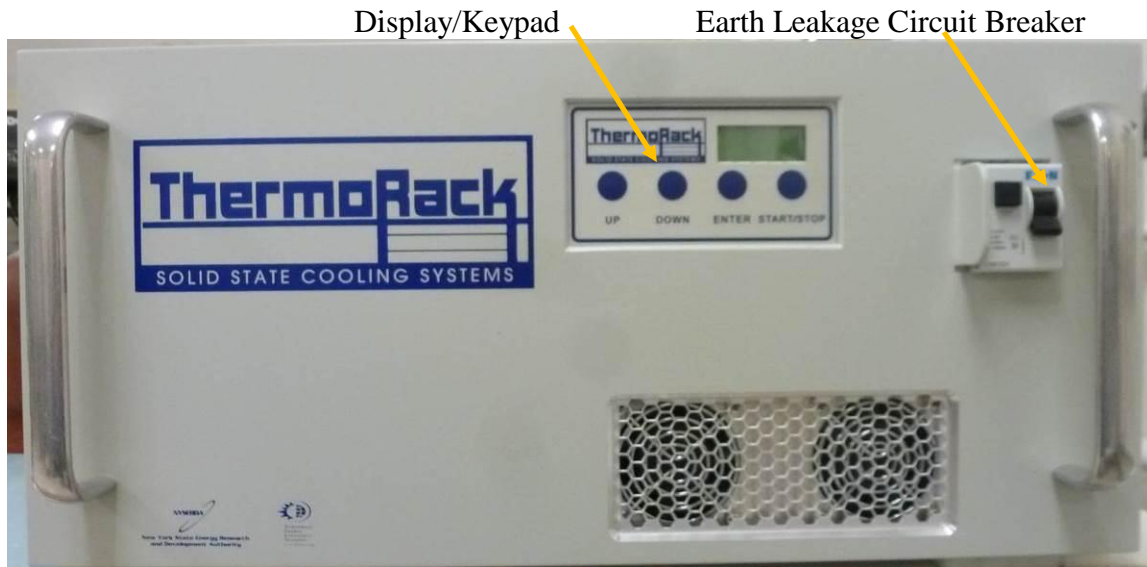
Remote EMO: A remote EMO circuit may be connected to pins 5 and 6 on the 9-pin CPC connector provided, AMP #206708-1, to the socket labeled 72J2. (See Table 1.) If no remote EMO circuit is available (AMAT and TEL tools) connect the jumper shipped with the Thermorack 1201.

Table 1 Connector 72J2 Pin Description

Pin Number	Signal Description
1	Jumpered to Pin 2 (tool EMO loop)
2	Jumpered to Pin 1 (tool EMO loop)
3	24 VAC Remote/Local Switch from etcher
4	24 VAC Remote/Local Switch from etcher return
5	Closed contact from etcher (remote EMO)
6	Closed contact from etcher return (remote EMO)
7	Spare
8	Spare
9	Spare

Local/Remote Switching: The chiller set-point temperature can be entered via keys on the front user interface or via a remote analog signal on the tool interface card. The method of switching from using a locally entered set-point to a remote one depends upon the type of tool interface card used. See section 3.2 for Details.

FIGURE 3 THERMORACK 1201 FRONT AND REAR VIEWS



Optional N₂/CDA Purge Connection Drain Valve

Fuses: The ThermoRack 1201 has fuses on the main AC power, TE power, and 24VAC EMO transformer.

Table 2 Fuses

Fuse Protecting	Fuse Type/Mfg.	Mfg. PN	Rating	SSCS PN
Thermoelectric Modules	Automotive Blade Style Littlefuse	0287030.PXCN	30A	20-25134-30
24VAC Transformer	Slo-Blo 3AG LittleFuse	0313.500MXP	0.5A	20-22700-0.5
System Power	Class G, SC Type Bussmann	SC-15	15A	20-26610-15

3.2 TOOL INTERFACE CARD

The ThermoRack 1201 can communicate with several different types of semiconductor equipment via the tool interface card. The electrical hookup required and method of remote operation varies depending on the tool interface card purchased with the ThermoRack 1201. Tool interface cards may be changed should the ThermoRack be moved from one type of tool to another.

3.2.1 LAM ANALOG INTERFACE CARD

The Lam Analog tool interface card is designed to operate with Lam Research Corporation® plasma-etch tools. This interface card is the ThermoRack default standard. The Lam Analog tool interface is through a 37-pin D-subminiature Female connector labeled 72J1, as shown in Table 3.

Local/Remote Switching: Switching from local to remote operation is accomplished by applying 24 VAC across pins 3 & 4 on the 9-pin CPC connector labeled 72J2. (See Table 1A.) Turning off 24 VAC returns to a locally entered set-point.

System Warning: The ThermoRack warning signal is available on the tool interface card. (See Table 3 “Warn” signal)

Temperature Alarm: The ThermoRack temperature alarm is available on the tool interface card. (See Table 3 “Warn” signal)

System Alarm: The ThermoRack system alarm is available on the tool interface. (See Table 3 “Fail” signal)

Table 3 Connector 72J1 Lam Analog Interface Card Pin Description

Pin Number	Signal Description
All pins not identified are spares.	
24	Set Point Temperature, 0-10VDC, 1V/10°C, 0VDC = 0°C 10VDC = 100°C
5	Set Point Temperature Return
20	Actual Coolant Exit Temperature, 0-10VDC, 1V/10°C, 0VDC = 0°C 10VDC = 100°C
1	Actual Coolant Exit Temperature Return
26	ThermoRack Fail, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
7	ThermoRack Fail Return
28	ThermoRack Warn, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
9	ThermoRack Warn Return

3.2.2 LAM ANALOG 2 INTERFACE CARD FOR LONWORKS® CONVERSION

Connecting to Lam Research Corporation plasma-etch tools that use LonWorks® requires the -L2 interface card PLUS a LonWorks® conversion box purchased from Lam Research Corporation: PN 853-224341-001 for a 2-channel box or 853-801876-015 for a 1-channel box. This interface card communicates all data required by LonWorks® through a 37-pin D-subminiature Female connector, as shown in Table 5C, and a 9-pin D-subminiature Female connector as shown in Table 5D. Drawings for the interconnecting cables are shown in Figures 5 and 6.

Table 5C: J2A Lam Analog to LonWorks® Converter 37-pin dsub connector

FUNCTION	PIN	SIGNAL NAME
Start / Stop Status	1	DI0
Remote / Local Status	2	DI1
Warning Status	3	DI2
Fail Status	4	DI3
Start / Stop Command	5	DO0
Remote / Local Command	6	DO1
Spare	7	DO2
Spare	8	DO3
Source Supply For Digital Inputs	9	24VDC
Source Supply For Digital Inputs	10	24VDC
Temperature Setpoint 1 Command	11	AOUT0
Temperature Setpoint 2 Command (For Dual Channel Only)	12	AOUT1
Spare	13	AOUT2
Spare	14	AOUT3
Temperature Setpoint 1 Readback	15	AIN0(+)
Temperature Setpoint 2 Readback (For Dual Channel Only)	16	AIN1(+)
Temperature Actual 1	17	AIN2(+)
Temperature Actual 2 (For Dual Channel Only)	18	AIN3(+)
Spare	19	AGND
Spare	20	24VRET
Spare	21	24VRET
Spare	22	24VRET
are	23	24VRET
Start / Stop Command Return	24	24VRET
Remote / Local Command Return	25	24VRET
Spare	26	24VRET
Spare	27	24VRET
Source Supply For Digital Inputs	28	24VDC
Not Used	29	NC
Temperature Setpoint 1 Command Return	30	AGND
Temperature Setpoint 2 Command Return (For Dual Channel Only)	31	AGND
Spare	32	AGND
Spare	33	AGND
Temperature Setpoint 1 Readback Return	34	AIN0(-)
Temperature Setpoint 2 Readback Return (For Dual Channel Only)	35	AIN1(-)
Temperature Actual 1 Return	36	AIN2(-)

Figure 5: J2A interconnect cable

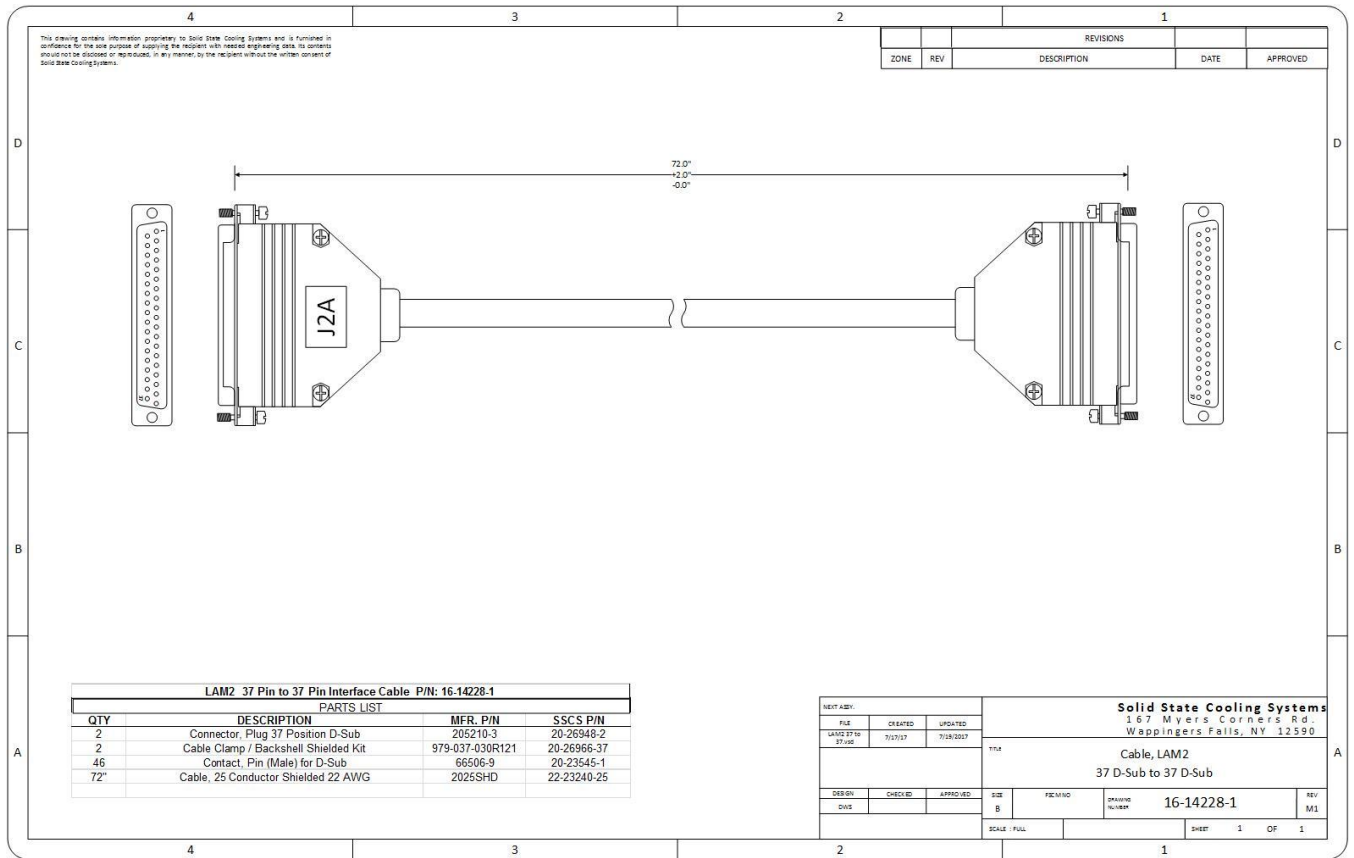
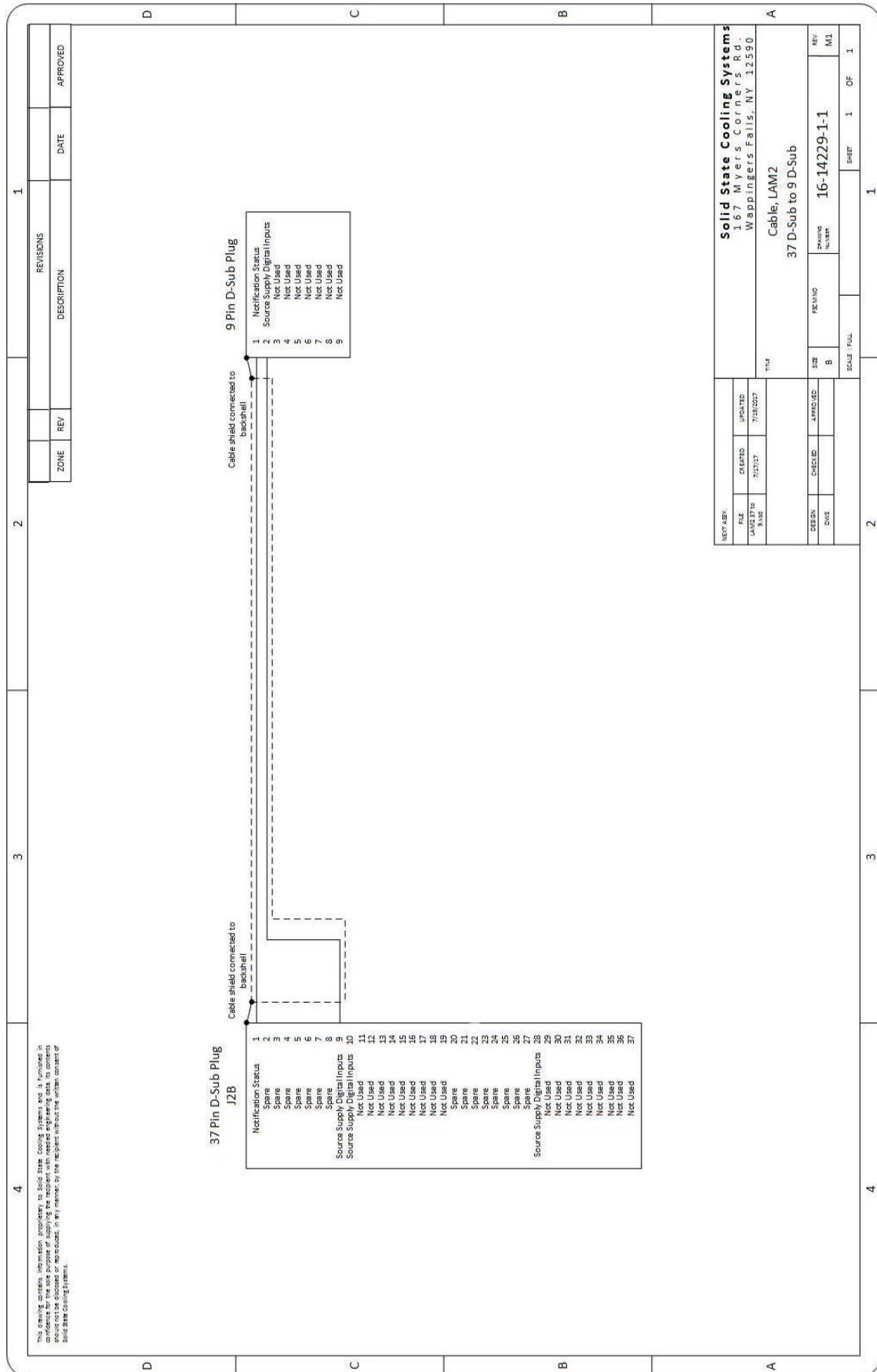


Table 5D J2B Lam Analog to LonWorks® Converter 9-pin dsub connector (Nikola 3K/5K end)

FUNCTION	PIN	SIGNAL NAME
Notification Status	1	DIO
Source Supply For Digital Inputs	2	DI1
Spare	3	
Spare	4	
Spare	5	
Spare	6	
Spare	7	
Spare	8	
Spare	9	

Figure 6: J2B interconnect cable



3.2.3 APPLIED CHX INTERFACE CARD

The Applied CHX interface is designed to operate with Applied Materials® plasma etch and CVD tools with the CHX interface. Communication is made via an RS-485 connection on the upper 9-pin d-sub connector of the tool interface card. (See figure 3.) Table 4 shows the signal description for this connector.

Table 4 Applied CHX RS-485 Pin Description

Pin Number	Signal Description
1	A (-)
5	GND
9	B (+)

Local/Remote Switching: Switching from local to remote operation is accomplished as follows:

- 1) Disconnect AC power from the ThermoRack via the circuit breaker.
- 2) Locate the AMAT CHX interface card at the left rear (as viewed from the rear).
- 3) Enter the slave address for the ThermoRack using the red 4-position dipswitch. The ThermoRack address must match the chiller address on the Applied tool. The AMAT CHX bracket shows the dip switch values for each address (1-16). A dipswitch in the right position is ON, while the left position is OFF. Table 5A shows the dip switch setting for each address.
- 4) Find the Local/Remote toggle switch on the ThermoRack back panel. Flip the switch to Remote.
- 5) Restart the ThermoRack chiller.

Table 5A AMAT CHX Interface Card Dip Switch Settings

Dip Switch Position 1	Dip Switch Position 2	Dip Switch Position 3	Dip Switch Position 4	CHX Address
ON	ON	ON	ON	1
OFF	ON	ON	ON	2
ON	OFF	ON	ON	3*
OFF	OFF	ON	ON	4
ON	ON	OFF	ON	5
OFF	ON	OFF	ON	6
ON	OFF	OFF	ON	7
OFF	OFF	OFF	ON	8
ON	ON	ON	OFF	9
OFF	ON	ON	OFF	10
ON	OFF	ON	OFF	11
OFF	OFF	ON	OFF	12
ON	ON	OFF	OFF	13
OFF	ON	OFF	OFF	14
ON	OFF	OFF	OFF	15
OFF	OFF	OFF	OFF	16

Important Notes:

- 1) Do not use channel 3 as communications errors may occur.
- 2) The ThermoRack 1201 AMAT CHX interface card only transmits “Required Data” (as defined by the AMAT CHX specification PN 0250-35965 rev. C). “Optional data” as defined by the same specification.

Required CHX information transmitted:

- Fault Summary (digital input)
- Warning Summary (digital input)
- Actual Temperature (analog input)

Optional CHX information transmitted:

- Fluid Resistivity (analog input)
- Fluid Flow (analog input)
- Fluid Level Fault (digital input)

Optional CHX information not transmitted:

- Fluid Flow Fault (digital input)
- Facility Water Fault (digital input)

When installing the ThermoRack 1201, configure the Centura Controller to ignore optional data on the heat exchanger configuration screen, located as follows:

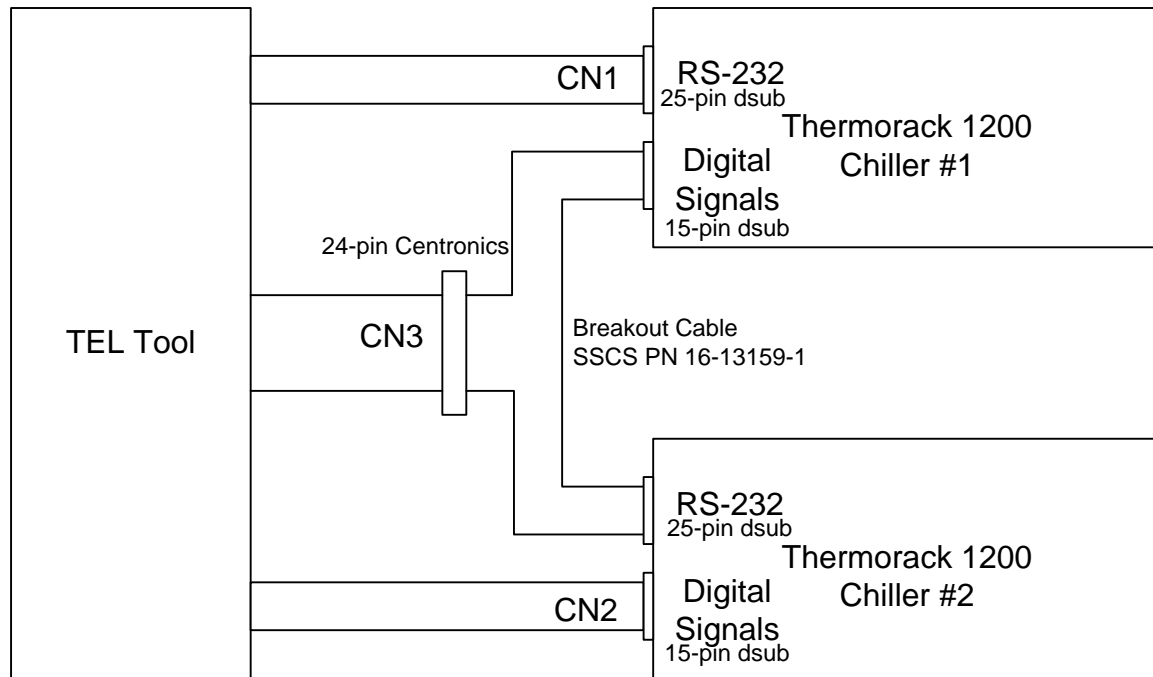
MISC: System Config: Config Heat Exchangers, page 3/3, sheet 2/3

Set all not transmitted values to NO.

3.2.4 TEL Unity II/Unity M Interface Card

The TEL UnityII/UnityM Interface Card option allows communication between the ThermoRack 1201 and a TEL Unity II/M plasma etch tool. Chiller communications from the TEL Unity II/M comprises two 25-pin dsub RS-232 communication cables (one per chiller channel) and one 24-pin Centronics digital signal cable that combines the two chiller channel’s digital signals into one connector. The ThermoRack 1201 TEL interface includes a splitter cable that splits the 24-pin Centronics digital signals into two 15-pin dsub connectors feeding two separate ThermoRack 1201 chillers as shown in Figure 4.

Note: The ThermoRack 1201 TEL Unity II/M interface pre-sets the temperature alarm width to 5°C. This can only be changed via the TEL Unity II/M’s RS-232 communications.

Figure 4 TEL Unity II/M Signal Hook-up**Hook-up:**

- 1) Connect the channel 1 (CN1) 25-pin dsub connector from the TEL tool to ThermoRack chiller #1's rear panel RS-232 tool communications connector (see figure 3).
- 2) Connect the channel 2 (CN2) 25-pin dsub connector from the TEL tool to ThermoRack chiller #2's rear panel RS-232 tool communications connector.
- 3) Connect the Centronics end of the Breakout Cable (SSCS #16-13159-1) to the 24-pin Centronics connector (CN3) from the TEL tool.
- 4) Connect the breakout cable's 15-pin dsub connector labeled Chiller #1 to ThermoRack #1's rear panel Digital Signals tool communications connector.
- 5) Connect the breakout cable's 15-pin dsub connector labeled Chiller #2 to ThermoRack #2's rear panel Digital Signals tool communications connector.

3.2.5 AMAT ANALOG (P5000) INTERFACE CARD

The AMAT Analog (-A3) interface allows the Thermorack 1201 to communicate with an Applied Materials P5000 CVD or Etch tool. The Thermorack 1201 may be connected as a Chiller or a Heat Exchanger. Table 5B shows the Signal Descriptions for each type.

Table 5B –A3 AMAT Analog Interface Signal Descriptions

AMAT Analog Chiller 25-Pin Dsub		AMAT Analog Heat Exchanger 15-Pin Dsub	
Pin	Description	Pin	Description
1	Ground	1	Flow alarm (Normally Open)
2	Chiller ON/OFF	2	Reservoir level alarm (Normally Open)
3	NC	3	NC
4	Chiller Setpoint return (-ve)	4	NC
5	NC	5	Heat exchanger ON/OFF (return)
6	Chiller Alarm (Normally Open)	6	NC
7	RTD Temperature +ve output	7	RTD output
8	Alarm relay daisy chain	8	NC
9	Chiller Alarm return (chiller alarm relay common)	9	24 Volt return (ground)
10	Chiller flow warning relay (B/C chamber normally open)	10	24 Volt input
11	Warning relay daisy chain	11	15 Volt common (NC)
12	Chiller flow warning relay (A/D chamber normally open)	12	+15 Volts (NC)
13	Chiller flow warning relay (A/D chamber common)	13	-15 Volts (NC)
14	Chiller ON/OFF return	14	NC
15	Chiller Setpoint analog input (ground referenced)	15	NC
16	NC		
17	15 Volts NC		
18	Chiller flow warning relay (B/C chamber common)		
19	Ground (daisy chain)		
20	15 Volts NC		
21	NC		
22	Chiller resistivity (shorted to pin 23)		
23	Chiller resistivity (shorted to pin 22)		
24	NC		
25	ON/OFF (daisy chain)		

3.2.6 AMAT ANALOG (J100) INTERFACE CARD

The AMAT Analog (-A4) interface allows the Thermorack 1201 to communicate with an Applied Materials P5000 tools with the J100 connector, either as a chiller or a heat exchanger. The Nikola 3K/5K may be connected as a Chiller or a Heat Exchanger. Tables 5C and 5D shows the Signal Descriptions for each type.

Table 5C: -A4 AMAT Analog Chiller (25-pin dsub) Interface Signal Description

Connector Pin	Direction	Signal Name	Usage
2	Input	Chiller ON	NO relay contact
14	Input	Chiller ON	Relay common
15	Input	Chiller Temperature Setpoint	Setpoint Voltage
4	Input	Chiller Temperature Setpoint	Ground
6	Output	Chiller Warnings - Level/Temp/Resistivity	NO relay contact
9	Output	Warnings - Level/Temp/Resistivity	Relay common
7	Output	Chiller Reservoir Temperature	RTD Voltage
19	Output	Chiller Reservoir Temperature	Ground
10	Output	Chiller Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, B/C chamber
18	Output	Alarms - Level/Flow/RTD/PCW Flow	COM, B/C Chamber
12	Output	Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, A/D chamber
13	Output	Alarms - Level/Flow/RTD/PCW Flow	COM, A/D chamber
20	Input	15VDC	NC
17	Input	15VDC	NC
22	Output	Chiller Resistivity Alarm	NO relay contact
23	Output	Chiller Resistivity Alarm	Relay common
1	Input	Ground	Ground
3, 5, 8, 11, 16, 21, 24, 25	---	NC	NC

Chiller Interlock Status Warning

- Pins 6, 9

Chiller Flow Alarm

- Pins 10, 18 (Channel BC)
- Pins 12, 13 (Channel AD)

Chiller RTD Output

- Pins 7, 19
- Voltage : 0-1 VDC
- 0VDC = 0°C
- 1VDC = 100°C

Chiller ON

- Pins 2, 14
- ON = pins shorted

Chiller Temperature Set-point

- Pins 4, 15
- Voltage : 0-1 VDC
- 0VDC = 0°C
- 1VDC = 100°C
- <30mV = 21°C Set-point

Table 5D: -A4 AMAT Analog Heat Exchanger (15-pin dsub) Interface Signal Description

AMAT Analog Heat Exchanger 15-Pin Dsub			
Pin	Direction	Signal Name	Usage
1	Output	Warnings - Level/Temp/Resistivity	NO Relay Contact
2	Output	Alarms - Level/Flow/RTD/PCW Flow	NO Relay Contact
3		NC	
4		NC	
5	Input	Heat Exchanger ON/OFF (return)	Ground
6		NC	
7	Output	RTD – Coolant Temperature	RTD Voltage
8		NC	
9		24 Volt return (ground)	
10	Input	Heat Exchanger ON/OFF	+24 Volt input
11		15 Volt common	NC
12		+15 Volts	NC
13		-15 Volts	NC
14		NC	
15	Input	Coolant Set Point (°C)	Set Point Voltage

Heat Exchanger Flow Alarm

- Pins 1, 9

Heat Exchanger Level Alarm

- Pins 2, 9

Heat Exchanger RTD Output

- Pins 7, 11
- Voltage : 0-10 VDC
- 0VDC = 0°C
- 10VDC = 100°C

Heat Exchanger ON

- Pins 10, 5
- ON = +24VDC Pin 10

Heat Exchanger Temperature Set-point

- Pins 15, 9
- Voltage : 0-10 VDC
- 2VDC = 20°C
- 4VDC = 40°C
- <30mV = 21°C Set-point

3.2.7 AMAT ANALOG WITH RESISTIVITY –A5 (J100) INTERFACE CARD

The AMAT Analog (-A5) interface allows the Thermorack 1201 to communicate with an Applied Materials P5000 tools with the J100 connector and an analog resistivity value on the Heat Exchanger (15-pin dsub) connector. The Nikola 3K/5K may be connected as a Chiller or a Heat Exchanger. Tables 5E and 5F shows the Signal Descriptions for each type.

Table 5E: -A5 AMAT Analog Chiller (25-pin dsub) Interface Signal Description

Connector Pin	Direction	Signal Name	Usage
2	Input	Chiller ON	NO relay contact
14	Input	Chiller ON	Relay common
15	Input	Chiller Temperature Setpoint	Setpoint Voltage
4	Input	Chiller Temperature Setpoint	Ground
6	Output	Chiller Warnings - Level/Temp/Resistivity	NO relay contact
9	Output	Chiller Warnings - Level/Temp/Resistivity	Relay common
7	Output	Chiller Reservoir Temperature	RTD Voltage
19	Output	Chiller Reservoir Temperature	Ground
10	Output	Chiller Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, B/C chamber
18	Output	Chiller Alarms - Level/Flow/RTD/PCW Flow	COM, B/C Chamber
12	Output	Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, A/D chamber
13	Output	Alarms - Level/Flow/RTD/PCW Flow	COM, A/D chamber
20	Input	15VDC	NC
17	Input	15VDC	NC
22	Output	Chiller Resistivity Alarm	NO relay contact
23	Output	Chiller Resistivity Alarm	Relay common
1	Input	Ground	Ground
3, 5, 8, 11, 16, 21, 24, 25	---	NC	NC

Chiller Interlock Status Warning

- Pins 6, 9

Chiller Flow Alarm

- Pins 10, 18 (Channel BC)
- Pins 12, 13 (Channel AD)

Chiller RTD Output

- Pins 7, 1
- Voltage : 0-1 VDC
- 0VDC = 0°C
- 1VDC = 100°C

Chiller ON

- Pins 2, 14
- ON = pins shorted

Chiller Temperature Setpoint

- Pins 4, 15
- Voltage : 0-1 VDC
- 0VDC = 0°C
- 1VDC = 100°C
- <30mV = 21°C Set-point

Table 5F: -A5 AMAT Analog Heat Exchanger (15-pin dsub) Interface Signal Description

AMAT Analog Heat Exchanger 15-Pin Dsub			
Pin	Direction	Signal Name	Usage
1	Output	Warnings - Level/Temp/Resistivity	NO Relay Contact
2	Output	Alarms - Level/Flow/RTD/PCW Flow	NO Relay Contact
3		NC	
4		NC	
5	Input	Heat Exchanger ON/OFF (return)	Ground
6		NC	
7	Output	RTD output	RTD Voltage
8	Output	Resistivity	Resistivity Voltage
9	Output	24 Volt return	Signal Ground
10	Input	Heat Exchanger ON/OFF	+24 Volt input
11		15 Volt common	NC
12		+15 Volts	NC
13		-15 Volts	NC
14		NC	
15	Input	Set Point (°C)	Set Point Voltage

Heat Exchanger Warnings

- Pins 1, 9

Heat Exchanger Alarms

- Pins 2, 9

Heat Exchanger RTD Output

- Pins 7, 11
- Voltage : 0-10 VDC
- 0VDC = 0°C
- 10VDC = 100°C

Heat Exchanger ON/OFF

- Pins 10, 5
- ON = +24VDC Pin 10

Heat Exchanger Temperature Set-point

- Pins 15, 9
- Voltage : 0-10 VDC
- 2VDC = 20°C
- 4VDC = 40°C
- <30mV = 21°C Set-point

Heat Exchanger Resistivity

- 0-10VDC
- Pins 8, 9
- Resistivity (megΩ-cm)= 2*Voltage

3.3 PLUMBING CONNECTIONS

All plumbing connections are made on the chiller rear panel (see figure 3).

Coolant Connections: The coolant supply and return connections are made via 1/2" stainless steel Swagelok fittings. Coolant supply (out) is located on the left side of the rear panel and coolant return (in) is located on the right side. The normal coolant flow rate is 3 - 4.5 gpm (see Figure 2). For optimal performance, minimize flow restrictions in the lines between the ThermoRack 1201 and the process tool. Flow restrictions typically occur in fittings, quick disconnect shut-offs (use the largest size possible), tubing kinks, and long lengths of tubing.

Facility Cooling Water: Facility (Plant) cooling water must be 10-35 °C, filtered with a 75 micron or better filter, treated re-circulating water, pH 6.5 – 8.2, non-condensing. Facility cooling water connections are made via 1/2" stainless steel Swagelok fittings located on the left side of the rear panel. The facility cooling water supply (in) connection is above the return (out) connection. The required cooling water flow rate is 1-2 gpm.

Drain Valve: The system drain valve is a 1/4" plug valve shipped in a separate bag inside the ThermoRack 1201 box. Use a 7/8" wrench to tighten the 1/2" Swagelok nut to the branch of the 1/2" Coolant Outlet tee located at the lower left of the ThermoRack rear panel (figure 3).

3.4 AIR CONSIDERATIONS

The ThermoRack 1201 has one 20 cfm fan, located on the right side, for cooling its electronics and pump. Do not block airflow into this fan or the perforations on the left side. Only 0.375" of clearance is required. Typical 19" rack enclosures provide plenty of clearance.

3.5 WETTED MATERIAL COMPATIBILITY

Plant Cooling Water (PCW): The ThermoRack 1201 PCW lines are made from stainless steel and HCR Magnaplate coated aluminum. The chiller is compatible with filtered plant cooling water with a pH of 6.5-8.2 treated against calcium deposits.

Coolant: The ThermoRack 1201 PCW lines are made from stainless steel and aluminum. The chiller is compatible with any Fluorinated heat transfer oil made by 3M (Fluorinert or Novec Fluids) or San Gobain (Galden). In addition, the chiller is compatible with de-ionized water or any combination of de-ionized water and propylene or ethylene glycol with a resistivity between 1 meg-ohm and 10 meg-ohms.

4.0 COOLANT FILL/START-UP

4.1 COOLANT TYPE

The ThermoRack 1201 is designed to run with a fluorinated heat transfer fluid or water/glycol mixtures as the coolant. Selection of the coolant type is important to the proper operation of the ThermoRack 1201 and is dependent upon the fluid set point desired. Operation with the wrong coolant can lead to cavitation in the pump and premature failure. Table 6 below lists the recommended coolant types:

Table 6 Recommended Coolant Types

Set Point Temperature	3M Fluorinert® Coolant Type	3M Novec® Coolant Type	Galden® Coolant Type	Propylene Glycol/Water	Ethylene Glycol/Water
-10 to 20°C	FC-72	HFE-7100, 7200, or 7500	None tested	50% Propylene Glycol/Water	50% Ethylene Glycol/Water
10 to 50 °C	FC-77 or FC-777	HFE-7500	HT-110	25% Propylene Glycol/Water	25% Ethylene Glycol/Water
20 to 80 °C	FC-3283	HFE-7500	HT-200	25% Propylene Glycol/Water	25% Ethylene Glycol/Water

4.2 FILL/START-UP



Read coolant and PCW SDS before handling. Wear protective gear listed in SDS when filling the Thermorack 1201.

Once hook-up has been completed as per Section 3, follow the instructions below for filling the tank with coolant and starting the ThermoRack. Note: the ThermoRack has a 1.5-gallon (6 liter) tank.

- 1) Turn on the facility water flow to 1-2 gpm (more cooling water increases the cooling capacity).
- 2) Using a 5/8" open end wrench, remove Swagelok cap on the Tank Vent port.
- 3) Using an 11/16" open-ended wrench, remove the Swagelok cap on the Fill port.
- 4) Connect the funnel provided with the ThermoRack chiller to the Fill port, hand-tighten only.
- 5) Turn on power to the ThermoRack via the circuit breaker. (Do not press the start button.)
- 6) Fill the tank with one gallon of coolant. (The green Tank Level OK light will come on before one gallon is added, but add the entire gallon as it probably will be required to fill the lines to the tool at start-up.
- 7) Check that any exterior valves attached to the coolant lines are open.
- 8) Turn off the front circuit breaker, wait 30 seconds, and then turn the circuit breaker back on. If the ThermoRack is in remote mode it will start up automatically, otherwise press the START/STOP key to begin operation.

Note: On units with the system enable/disable option, the green enable button must be pressed prior to pressing the START/STOP key.

- 9) The ThermoRack will now enter its Pump-Prime sequence. If the Tank Level Low signal appears on the front display add more coolant through the funnel until Tank Level OK Light turns on.
- 10) The ThermoRack Pump Prime sequence will cycle the pump on and off up to ten times (30 seconds per cycle). If PUMP FLOW LOW appears after the sequence completes, turn off the ThermoRack via the circuit breaker, **wait 30 seconds**, and then turn the circuit breaker back on. Place a container under the drain valve and open the drain valve. When the pump turns on to allow coolant to flow out of the ThermoRack. This will help remove trapped gas bubbles.
- 11) Once the pump has primed, remove the coolant funnel and replace the Swagelok cap on the fill and vent ports. Tighten the caps ¼-turn past hand tight.
- 12) The ThermoRack will now control at the most recent set-point or at the initial factory set-point of 22 °C.

Drain Valve



Important Notes:

- 1) Operating the Thermorack at a set point of 5°C or less requires the N2 Purge option. This option is recommended for operation at 10°C or less as it increases the Thermorack's cooling capacity.
- 2) When operating the ThermoRack at a set point of 5°C or lower, leave the tank vented during the initial cool down to set point. Tighten the caps ¼ –turn past hand tight once set point has been reached. When operating with a water/ethylene or propylene glycol mixture at temperatures over 70 °C, leave the tank vent open until the coolant temperature reaches set point. This allows dissolved gas to vent out of the system.

5.0 OPERATION

The ThermoRack is operated via the control panel located on the front panel. The control panel has a 16-character LCD display and four input keys: UP, DOWN, ENTER, and START/STOP. These keys work as follows:

Table 7 Using the Keypad

Key	Action
UP	Pressing the UP key raises the parameter value displayed.
DOWN	Pressing the DOWN key lowers the parameter value displayed.
ENTER	Pressing the ENTER key momentarily enters the parameter changed.
ENTER	Pressing and holding the ENTER key for 3 seconds changes the LCD display menu.
START	Pressing the START key turns on temperature control.
START	Pressing the START key while the chiller is operating turns off temperature control.

5.1 SIMPLE OPERATION

The ThermoRack comes with preset operating parameters that will work well for most applications. If temperature control at one temperature is desired, follow the steps below.

- 1) Turn on ThermoRack and wait for display to read TEMP.
- 2) Press the UP or DOWN keys to change SETTEMP 1 to the desired set point.
- 3) Press the START key.

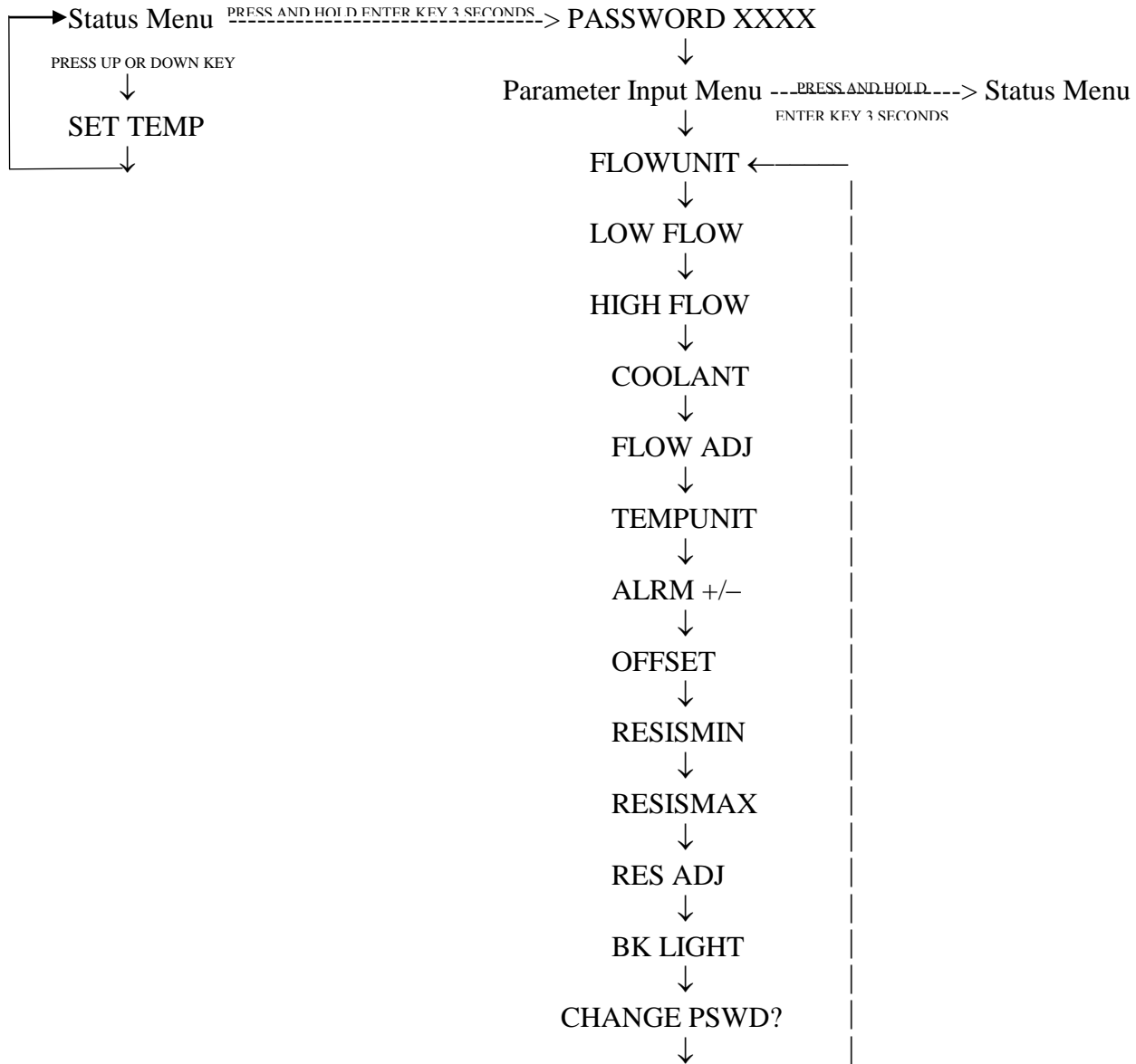
The ThermoRack will now control to the set point temperature. To change the set point temperatures just press the UP or DOWN keys again to change SETTEMP 1 to the new set point, followed by the START/STOP key.

Note on Dual Channel Start-up: Turn on the circuit breaker of ThermoRack #2 first, followed by ThermoRack #1. Both units will turn on upon start-up on ThermoRack #1.

5.2 ADVANCED OPERATION

The ThermoRack controller has two menus: the Status Menu and the Parameter Input Menu. The Status Menu shows the chiller operating status, current temperature of coolant leaving the chiller, and current coolant flow rate if the enter key is pressed momentarily. The Status Menu also allows input of new coolant temperature set points when the cycling feature is off. The Parameter Input Menu allows input of set point temperatures, soak times, number of cycles (if cycling between two temperatures), temperature alarm points, a temperature display offset, temperature units, coolant flow units, and the minimum coolant flow before triggering a pump flow low alarm.

Figure 6 Menu Structure



Press and release the ENTER key to scroll between the Parameter Menu items (↓).

Press the UP or DOWN keys followed by the ENTER key to change the set point locally in the Status Menu.

Press and hold ENTER key for 3 seconds to scroll between menus.

A 4-digit password is required to enter the Parameter Input Menu. **The Factory Default Password is 0000.** Use the UP or DOWN key to change individual numbers; use the ENTER key to enter each number and move to the next. If an incorrect password is entered the user is returned to the Status Menu. The password may be changed via the CHG PASSWORD command in the Parameter Menu.

Notes:

- 1) If the user enters the parameter input and does not press a key for 30 seconds the display will revert back to the Status menu.
- 2) Operating the ThermoRack 1201 remotely via the tool interface card locks out the front keypad.

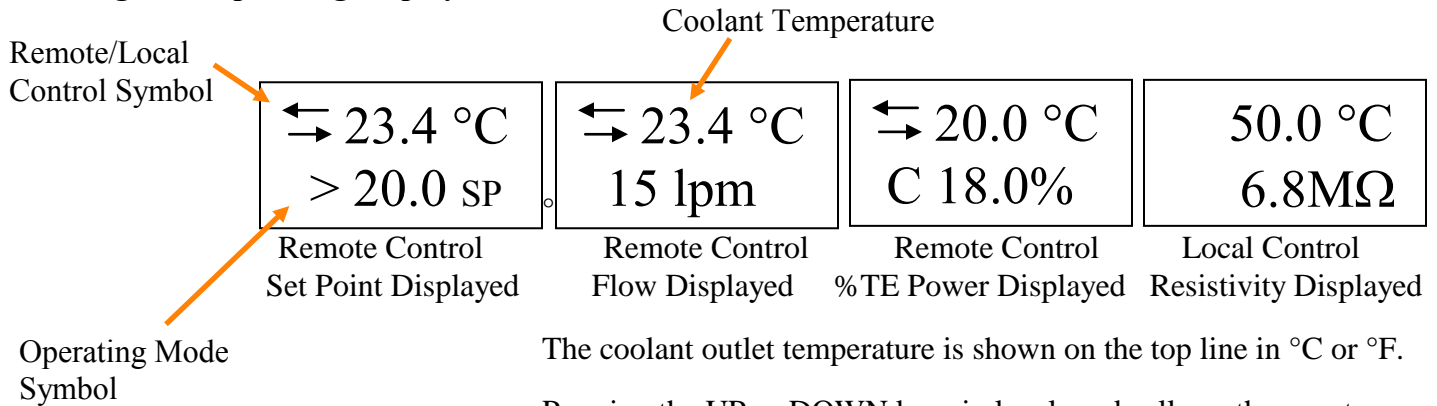
Status Menu: The status menu displays the chiller control mode (remote or local) and coolant temperature on the top line, and the operating mode (heating, cooling, or above/below the temperature alarm range)

plus the set point, coolant flow, %TE power, and resistivity (DI water units only) alternating on the lower line.

Operating Mode Symbols:

- * = Standby mode, no temperature control
- H = Heating mode with temperature control
- C = Cooling mode with temperature control
- > = Current temperature is above the set point + ALARM TEMP
- < = Current temperature is below the set point – ALARM TEMP
- ↔ → Indicates remote control through the tool interface card.

Figure 7 Operating Display



The coolant outlet temperature is shown on the top line in °C or °F.

Pressing the UP or DOWN keys in local mode allows the user to change the set point temperature upon pressing the ENTER key.

Parameter Input Menu: The parameter input menu allows input of all operating parameters. Use the UP or DOWN keys to change values. Press ENTER when complete.

FLOW UNIT = Flow units displayed when the enter key is pressed in the Status Menu, gpm or lpm. **Factory Default is gpm.**

LOW FLOW = Coolant low flow rate at which the ThermoRack will shut off the coolant pump and thermoelectric power triggering an alarm signal and displaying PUMP FLOW LOW on the screen.
Factory Default Value: 1.0 gpm.

HIGH FLOW = Coolant high flow rate at which the ThermoRack will shut off the coolant pump and thermoelectric power triggering an alarm signal and displaying PUMP FLOW LOW on the screen.
Factory Default Value: 10.0 gpm.

COOLANT = Type of coolant used. This is used to calculate flow and pressure. Options are: Fluorinert (calibrated to FC-3283)
50/50WEG (calibrated for 50% water/ethylene glycol)
Factory Default is Set by Model Configuration

FLOW ADJ = Offsets the coolant flow measured by the amount entered to match an external flowmeter. Use the UP or DOWN keys to adjust the flow displayed. The Thermorack will then scale its flow measurements based on this adjustment. **Factory Default is 0.0 gpm or lpm.**

TEMP UNIT = Temperature units used, °C or °F. **Factory Default is °C**

- ALRM +/- = Deviation from set point that triggers a warning signal, displaying the < or > symbol on the screen. No interlock action is taken.
Range: +/- 0-15°C from set point. **Factory Default Value 3.0°C**
- OFFSET T = Offsets the temperature measured by the ThermoRack by the amount entered. Range: +/- 0-15°C. Used to equalize the ThermoRack temperature displayed with tool's measured temperature. Once the ThermoRack has stabilized at a set point, enter the following value:
Tool Temperature – Set Point. **Factory Default Value: 0.0 °C**
- RESISMIN = The DI water resistivity low level that trips a warning to the tool and the front display, units in megohm-cm. **Factory Default is 0.1M**
- RESISMAX= The DI water resistivity high level that trips a warning to the tool and the front display, units in megohm-cm. **Factory Default is 20M**
- RES ADJ = Adjust Resistivity to match an external resistivity meter. Display shows the current measured resistivity. Use the UP or DOWN keys to adjust the resistivity displayed. The Thermorack will then scale its resistivity measurements based on this adjustment.
Factory default is 0megΩ-cm
- BK LIGHT = Turns the display light ON or OFF. **Factory Default is ON.**
- CHANGE PSWD? = Allows user to change the four digit password. Change the password by toggling the N to a Y and then enter a new four-digit number.

5.3 ALARMS/INTERLOCKS

5.3.1 STANDARD INTERLOCKS

The ThermoRack 1201 has several interlocks and alarms to prevent hazardous operation in the event of system failures or operation outside of prescribed limits. The response of the ThermoRack to alarms and warnings is shown in Table 8. In the event of a system failure, the alarm type will be shown on the front display. A description of these alarms can be found in section 6.

Table 8 ThermoRack 1201 Interlock Chart

Sensor/Interlock	Trip Level	Display	Action		Alarm Type
			TE	Pump	
Tank Level Low	open	Tank Low	On	On	Warn ¹
Temp Alarm Out of Range	User Sets +/- alarm	> Or <	On	On	Warn
PFC Shut Down	N/A	PFC Off	On	On	Warn ¹
Water Resistivity Low (water units)	1 megΩcm		On	On	Warn ²
Tank Level Empty	open	Tank Level Empty	Off	Off	Soft
Facility Water Flow Low	open	Water Flow Low	Off	On	Soft
Pump Current Low	User Sets Low Flow	Pump Flow Low	Off	Off	Soft
RTD Fault	open	RTD Open/RTD Fail	Off	On	soft
Coolant Flow Low Switch	½ gpm	Pump Flow Low	Off	Off	Hard
GFCI	> 30 mA	None	Off	Off	Hard ³
Coolant Overtemp	100 °C	None	Off	Off	Hard ³
External EMO	Open	None	Off	Off	Hard ³

Notes:

- 1) Tank Low will also cause the green tank level OK LED on the rear panel to turn off.
- 2) The Resistivity Low warning is an alarm for DI water units only. See section 5.3.2.
- 3) These alarms will shut off power to the ThermoRack via the main contactor, turning off the front display.

5.3.2 COOLANT RESISTIVITY LOW INTERLOCK FOR WATER BASED COOLANTS

The ThermoRack 1201 has a remote resistivity sensor option available, –WS, for DI water based coolants. This sensor ties into the ThermoRack warning loop, sending a warning to the process tool and flashing Resistivity Low on the front display. See section 7.2 for more details.

5.4 DRAINING THE SYSTEM OF COOLANT



WARNING

Read coolant and PCW SDS before handling. Wear protective gear listed in SDS and follow local regulatory statues when disposing of coolants or PCW drained from the chiller

Draining the ThermoRack of coolant is accomplished by using the following procedure:

- 1) Unscrew the tank vent cap.
- 2) Connect a tube to the 1/4" drain valve located on the coolant supply line.
- 3) Place the tube into a suitable container and open the drain valve (turn the handle to point toward the drain tube).
- 4) Turn on the ThermoRack circuit breaker and press START.

Coolant will now drain from the ThermoRack. The ThermoRack will stop pumping when the tank empties. Turn off the circuit breaker when the pump stops. A small amount of coolant will still remain in the ThermoRack and external coolant lines when the coolant has stopped draining out. To recover the remaining coolant, close the drain valve and connect a nitrogen line up to the tank vent. Pressurize the tank with 10-15 psig of nitrogen. Shut off the nitrogen and reopen the drain valve. More coolant will drain out. Repeating this process three times will normally remove 95% of the coolant.

5.5 CHANGING COOLANTS



WARNING

Read coolant and PCW SDS before handling. Wear protective gear listed in SDS and follow local regulatory statues when disposing of coolants or PCW drained from the chiller

Changing coolant type requires changing the Thermorack controller software (contact SSCS for details) and completely removing the original coolant prior to switching to the new coolant, especially when changing from Fluorinert/Galden to water/glycol. Failure to remove all fluorinated coolants prior to operating with water/glycol will result in a frothy mixture being produced that will reduce heat transfer rates. When changing coolants, use the following procedure:

- 1) Connect a 1/4" tube to the drain valve, placing the other end into a 2 gallon or larger container.
- 2) Open the drain valve.
- 3) Turn on the ThermoRack in local mode and press start. The ThermoRack will pump out the coolant until tank level empty is reached.
- 4) Turn off the ThermoRack circuit breaker and allow coolant to continue to drain for 30 minutes. If compressed air or nitrogen at 50 psig or less is available, connect it to the 3/8" Tank Vent connection to facilitate coolant removal.
- 5) Remove the coolant lines to the tool and purge all coolant out with clean dry air or nitrogen.
- 6) Fill the ThermoRack and coolant lines with water and run the ThermoRack for 5 minutes. (See section 4.2.)
- 7) Drain the water as per steps 1-5.
- 8) Flush the system two more times as per steps 1-7.
- 9) Fill the ThermoRack with the new coolant.
- 10) Re-start the ThermoRack as per section 4.2.

5.6 CLEANING THE THERMORACK

The external surfaces of the ThermoRack may be cleaned with a clean, dry cloth or a clean dry cloth with isopropyl alcohol. Do not clean the internal surfaces.

5.7 DRAINING THE FACILITY WATER (PLANT COOLING WATER) LINES



WARNING

Read coolant and PCW SDS before handling. Wear protective gear listed in SDS and follow local regulatory statues when disposing of coolants or PCW drained from the chiller

Drain the ThermoRack 1201 internal facility water lines using the following procedure:

- 1) Turn off the facility water (plant cooling water or PCW).
- 2) Place a bucket under the facility water fittings.
- 3) Disconnect the facility water return fitting, placing the hose in the bucket.
- 4) Slowly disconnect the facility water supply fitting, letting the water flow into the bucket. Place the hose in the bucket.
- 5) Connect clean dry air (CDA) to the facility water supply fitting and blow out the remaining water into the bucket.
- 6) Turn off and disconnect the CDA once all water has been blown out of the ThermoRack.

6.0 LAM DUAL CHANNEL CHILLER OPTION



WARNING

Channel #2 alarms and warnings will not be communicated to Lam tools with a 10 or 12-pin communication cable unless the –DC1A option is chosen.

The dual channel chiller option allows control of two ThermoRack 1201's to via a single tool interface cable, as is typical in some etch tools where an upper and lower electrode are controlled at different temperatures. When this option is selected, the signals from the tool connect to the primary (Lower Electrode/Chuck) Chiller #1. A signal interconnect cable connects the primary Chiller #1 to the secondary (Upper Electrode/Chamber Walls) Chiller #2. The two ThermoRacks in a dual channel system are labeled as Chiller #1 and Chiller #2 and are not interchangeable.

Important note:

Lam Dual Channel Chiller 37-pin Analog/Digital communication cables come in two types, one with 16 pins and one with 10 or 12 pins. Those with 16 pins require the –DC1 option while those with 10 or 12 pins require the –DC1A option. (See table 10 for details.)

6.1 ELECTRICAL HOOK-UP OF DUAL CHANNEL OPTION TO A LAM ETCHER

All electrical connections are made on the rear panel of each Chiller (see Figure 3).



CAUTION

Mis-wiring the AC power can damage the Thermorack 1201

AC Power Connections: Two separate power cables are required for the Dual Channel Option. Connect 200-240 V~ power to the rear of both ThermoRacks via the 20ft service cables provided. Connect bare end of service cables as follows:

- Black: Line 1
- White: Line 2 (or neutral)
- Green/Yellow stripe: Earth ground

The service cable connects to the ThermoRack via a Harting Han Q 5/0 connector which has 5 contacts plus ground plug number 09120153101. Connector pin out: (for reference).

- Pin 1: Line 1
- Pin 2: Line 2 (or Neutral)
- Pin 3: Not Used
- Pin 4: Not Used
- Pin 5: Not Used
- G: Earth Ground

Note: Safe operation of the ThermoRack 1201 requires earth-ground be connected to the G terminal of this plug.



WARNING

Failure to connect earth ground to the Green/Yellow stripe conductor will make the Thermorack chassis potential shock hazard

Remote EMO: Connect the remote EMO circuit to CHILLER #1 via pins 5 and 6 on the 9-pin CPC connector provided, AMP #206708-1, to the socket labeled 72J2. (See Table 3.) If no remote EMO circuit is available these two pins must be jumpered together or the ThermoRack 1201 will not turn on. Note: triggering the EMO circuit will shut down both Chiller #1 and Chiller #2. The remote EMO connection to Chiller #2 is not used.

Table 9 Lam Dual Channel Chiller #1 Connector 72J2 Pin Description

Pin Number	Signal Description
1	Jumpered to Pin 2 (tool EMO loop)
2	Jumpered to Pin 1 (tool EMO loop)
3	24 VAC Remote/Local Switch from etcher
4	24 VAC Remote/Local Switch from etcher return
5	Closed contact from etcher (remote EMO)
6	Closed contact from etcher return (remote EMO)
7	Spare
8	Spare
9	Spare

Analog Signal Interface: The Lam Analog tool interface card is designed to operate with Lam Research Corporation® plasma-etch tools. This interface card is the ThermoRack default standard. Connect the Lam Dual Channel Analog tool interface to Chiller #1 via the 37-pin D-subminiature Female connector labeled 72J1, as shown in Table 10.

Local/Remote Switching: Switching from local to remote operation on both is accomplished by applying 24 VAC across pins 3 & 4 on the 9-pin CPC connector labeled 72J2 on Chiller #1. (See Table 3.) This switches both Chiller #1 and Chiller #2 to remote operation. Turning off 24 VAC returns both Chillers to a locally entered set-point.

System Warning: System warning signals from both Thermorack channels are available on the tool interface card. (See Table 10 “Warn” signal)

Temperature Alarm: Coolant temperature out of range warnings from both Thermorack channels are available on the tool interface card. (See Table 10 “Warn” signal)

System Alarms: System alarm signals from both Thermorack channels are available on the tool interface card. (See Table 10 “Warn” signal)

Table 10 Connector 72J1 Lam Dual Channel Chiller Analog Interface Card Pin Description

Pin Number	Signal Description
24	Chiller #1 Set Point Temperature, 0-10VDC, 0VDC = 0°C 10VDC = 100°C
5	Chiller #1 Set Point Temperature Return
20	Chiller #1 Coolant Exit Temperature, 0-10VDC, 0VDC = 0°C 10VDC = 100°C
1	Chiller #1 Coolant Exit Temperature Return
26	Chiller #1 Fail, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
7	Chiller #1 Fail Return
28	Chiller #1 Warn, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
9	Chiller #1 Warn Return
25	Chiller #2 Set Point Temperature, 0-10VDC, 0VDC = 0°C 10VDC = 100°C
2	Chiller #2 Set Point Temperature Return
21	Chiller #2 Coolant Exit Temperature, 0-10VDC, 0VDC = 0°C 10VDC = 100°C
6	Chiller #2 Coolant Exit Temperature Return
29	Chiller #2 Fail, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
10	Chiller #2 Fail Return
30	Chiller #2 Warn, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
11	Chiller #2 Warn Return

- Notes:
- 1) All pins not identified above are spares.
 - 2) The signals highlighted in yellow are combined into the Chiller #1 Fail Signal with the –DC1A option. All signals are used in –DC1 units

Dual Channel Chiller Interconnect cable: A 6 ft. interconnect cable is provided for connecting signals from Chiller #1 to Chiller #2. Connect this cable to the upper 9-pin dsub connector among the tool interface connectors at the rear of each chiller (see figure 3). Failure to install this cable will prevent Chiller #2 from powering up and will cause Chiller #1 to lock-up and not control temperature.

6.2 PLUMBING HOOK-UP OF THE DUAL CHANNEL OPTION

Plumb each chiller independently to their respective electrodes as described in section 3.3

6.3 COOLANT FILL/START-UP WITH THE DUAL CHANNEL OPTION



WARNING

Read coolant and PCW SDS before handling. Wear protective gear listed in SDS when filling.

The coolant fill and start-up of the dual channel ThermoRack chillers is identical to starting up two individual chillers as per section 4.1 with one exception: The circuit breaker of Chiller #2 must be turned on first, followed by the circuit breaker of Chiller #1. Due to the EMO loop, Chiller #2 will not power up until Chiller #1 powers up. Turning on Chiller #1 first can result in a communications lock-up between the two Chillers. Should this occur, turn off the circuit breakers of both Chillers, wait at least 10 seconds, the turn on Chiller #2 first.

7.0 OTHER OPTIONS

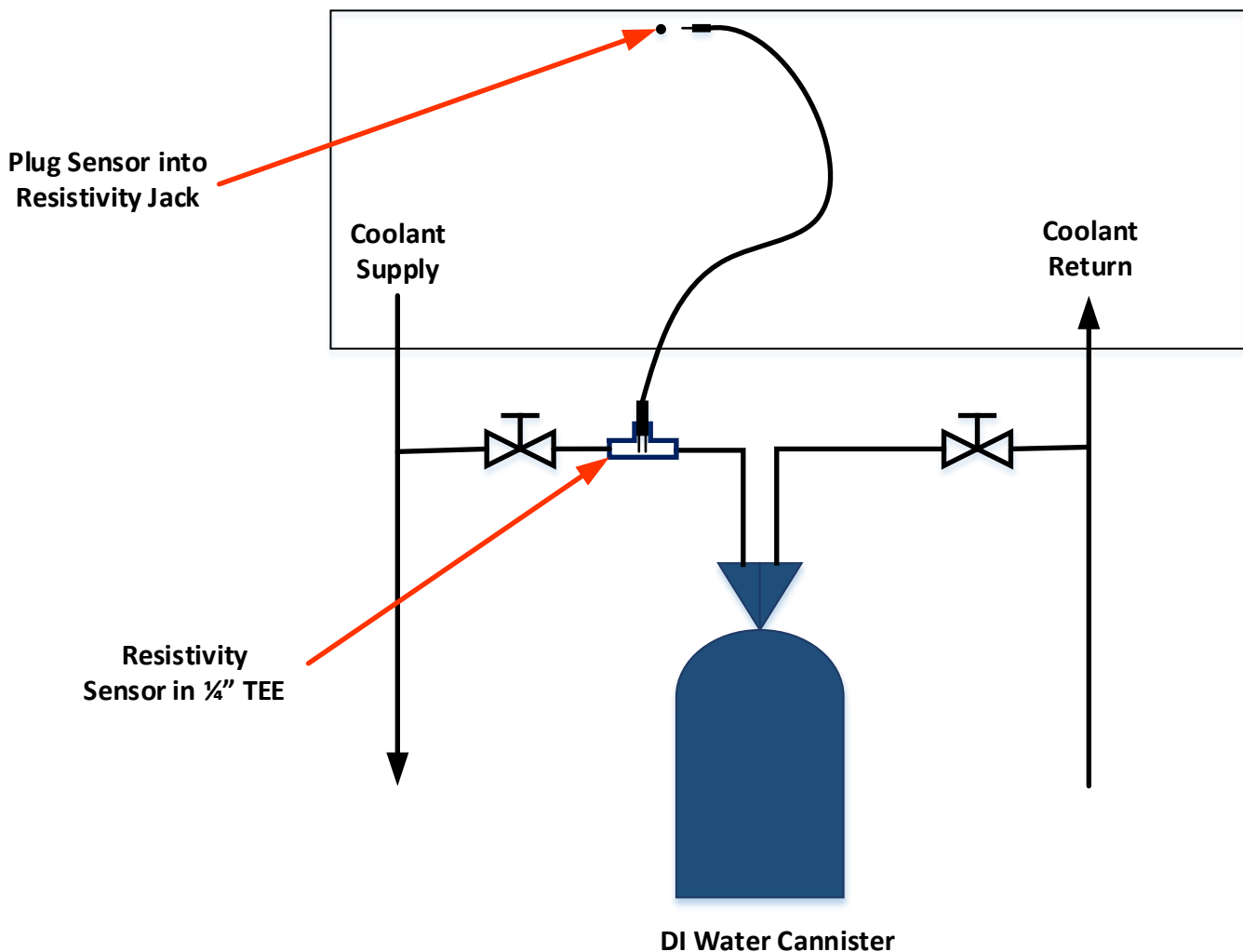
7.1 –1W DI WATER/ETHYLENE OR PROPYLENE GLYCOL COOLANT OPTION

When this option is chosen, SSCS will configure for and test the unit with water/glycol. The Thermorack will not measure the coolant resistivity unless the –WS resistivity option is purchased.

7.2 –WS RESISTIVITY SENSOR OPTION

The –WS resistivity sensor option provides an external DI water resistivity sensor and two ¼" valved TEE's for plumbing the DI water canister in parallel to the Thermorack 1201 coolant loop as shown in figure 5 below. This sensor will measure the DI water/Ethylene Glycol resistivity and signal a warning if the measured resistivity falls below 1 megohm-cm or if it reads above 20 megohm-cm.

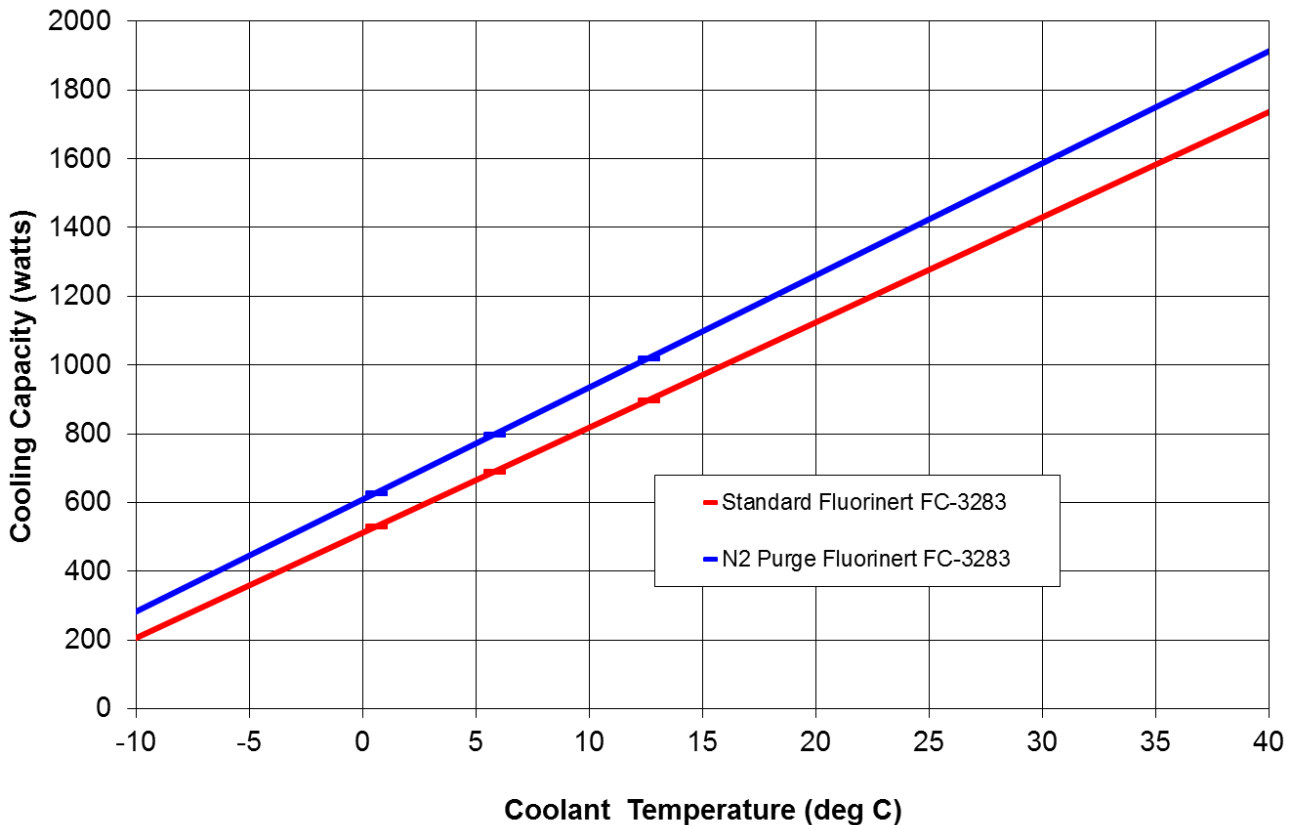
Figure 5 DI Water Sensor Hook-up



7.3 –N2 N2/CDA PURGE OPTION

This option purges the thermoelectric modules with nitrogen (N₂) or clean dry air (CDA). The dew point of the purge stream must be -30 °C or lower. This improves the ThermoRack 1201’s low temperature cooling capacity by up to 25%, as shown in figure 6 below. A supply of 500 sccm of 30 psig nitrogen or CDA is required. A ¼” John Guest® Speed-fit connection is provided on the rear panel for this purge. Just push a ¼” O.D. N₂ or CDA tube into the fitting.

Figure 6
Thermorack 1201 Improved Cooling Capacity with N2/CDA Purge
 Plant Cooling Water: 2 gpm @ 20°C



7.4 –RF FRONT RTD OPTION

This option moves the temperature control RTD from the ThermoRack coolant outlet to a location at the front of the ThermoRack, between the pump and thermoelectric heat exchanger. This alternative RTD location improves process control in some applications.

8.0 SYSTEM ALARMS/TROUBLESHOOTING

The ThermoRack 1201 has two warnings and four system alarms that when triggered will show on the display. When an alarm is displayed the system will not attempt to heat or cool the coolant.

8.1 WARNINGS

Tank Low: Warning only. The front display will read Tank Low and the rear panel green Tank Level Ok light will go dark. The tank needs refilling at the earliest convenience. The Thermorack 1201 coolant loop is a sealed system. A tank level low warning indicates the presence of a leak. See section 9.6 of this manual.

Resistivity Low/High: If the Resistivity Low or High warning is displayed and the -WS option has been purchased, then the DI water resistivity has fallen below the low or high limits. The factory default values are 1 megohm-cm on the low end and 20 megohm-cm on the high end. This indicates that the DI canisters are spent and require replacement (low) or a sensor fail/disconnection has occurred at the high end. If the Thermorack does not include the DI option, then contact SSCS technical support.

Temp out of Range: (< or > Symbol at left edge of display): Warning only. The coolant temperature leaving the chiller is outside the maximum deviation range set in the parameter input menu.

8.2 ALARMS



DANGER

Always disconnect the AC power cord before opening the ThermoRack 1201 cover as electrical shock hazards exist

Tank Level Empty: The level of coolant in the tank has become so low that it endangers the operation of the coolant pump. The coolant pump and thermoelectric power is shut off.

RTD Open or RTD Fail: The temperature sensor has failed or its connector has come loose. Thermoelectric power is shut off.

Turn off the ThermoRack and disconnect the AC power cord. Open the cover and check if the 5-pin connector is firmly attached to the controller board located inside the front panel. If the connector is firmly attached, contact SSCS for a replacement RTD, or for an RMA number to return the unit for RTD replacement.

Water Flow Low: Facility cooling water flow is insufficient, causing the liquid heat exchanger plate cooling the thermoelectrics to become too hot or too cold. Thermoelectric power is shut off.

Pump Flow Low: The flow rate of coolant has dropped below the low flow limit set in the parameter menu. The coolant pump and thermoelectric power is shut off.

Coolant Flow Low Switch: A coolant flow below 1 gpm (4 lpm) opens a flow switch, located on the pump outlet, and provides a hard interlock on the coolant flow as a backup to the pump flow low measurement. The coolant pump and thermoelectric power are shut off.

Important:

The Tank Level Low, Resistivity Low, and Temp Out of Range warnings will automatically reset when corrected (see table 2). All other alarms will not clear until the system is power cycled via the circuit breaker.

8.3 OTHER PROBLEMS

Temperature Control Poor:

If no other alarms are present, poor temperature control indicates the heat load is too great for the chiller, the TE cooling/heating engine is not receiving power or has failed, or the PID constants have been corrupted. *Contact SSCS for technical support.*

9.0 SAFETY

9.1 HAZARDS



DANGER

9.1.1 ELECTRICAL HAZARDS

The ThermoRack 1201 operates on 200-240 VAC single power. As a result, it has hazardous voltage present inside its covers. Only qualified personnel should work on the unit with the covers removed.



WARNING

9.1.2 CHEMICAL HAZARDS

The ThermoRack 1201 contains no hazardous chemicals except for the coolant chosen by the customer. MSDS's for coolants recommended by SSCS are included in section 12 of this manual. The user should thoroughly read the MSDS of any coolant chosen prior to filling and operating the ThermoRack 1201. Only qualified personnel should handle coolants used in the ThermoRack 1201.

The user should contact SSCS prior to using any coolant not recommended in this manual.



WARNING

9.1.3 SPILL HAZARDS

The ThermoRack 1201's recommended coolants present a slip hazard if spilled on the floor. All coolant spills should be immediately wiped from the floor and disposed of in accordance with local and national regulations and the guidelines found in the coolant MSDS's in section 12 of this manual.

9.2 LIFTING THE THERMORACK 1201



WARNING

The ThermoRack 1201 weighs 70lbs (32 kg) and is designed to be installed into a 19" EIA standard electronics rack. Two people are required for lifting the ThermoRack 1201 into this rack.

9.3 ELECTRICAL ENERGY ISOLATION

For installations requiring adherence to SEMI S2 guidelines, the customer must install a circuit breaker rated in accordance with local AJH (authorities having jurisdiction) and NEC requirements.

9.4 ELECTRICAL LOCK OUT/TAG OUT



DANGER

9.4.1 LOCK OUT

Lock out the main AC power via the following procedure:

- 1) Disconnect AC power by turning off the customer supplied electrical disconnect device (see section 9.3).
- 2) Unlatch the main AC power plug (on the rear panel) and remove the plug.
- 3) Place a safety padlock through the ThermoRack 1201's main AC power connector latch. AC power cannot be plugged into the ThermoRack AC power receptacle with the padlock in place.

9.4.2 TAG OUT

When locking out the main AC power receptacle, place a lockout tag through the main AC power connector latch to identify contact person/phone number. Never attach a lockout tag without first locking out the connector latch with a padlock.

9.5 ELECTRICAL DISCONNECT REQUIREMENTS

9.5.1-UNIT OUT OF SERVICE

When the ThermoRack 1201 is out of service, disconnect the main AC power via the customer installed circuit breaker described in manual section 9.3. SSCS recommends leaving the AC power cord connected unless the system's covers are to be removed.

9.5.2 MAINTENANCE



DANGER

When performing repairs or maintenance on the ThermoRack 1201 that require removing one or more of the system's covers, disconnect electrical power as follows:

- 1) Open the user installed main AC power circuit breaker described in section 9.3.
- 2) Disconnect the main AC power plug.
- 3) Lockout main AC power as per section 9.4.

9.6 LEAKS

9.6.1 COOLANT LEAKS



WARNING

Read coolant and PCW SDS before handling. Wear protective gear listed in SDS and follow local regulatory statues when disposing of coolants or PCW drained from the chiller

Two types of coolant leaks can occur when operating the ThermoRack 1201: internal and external leaks. Internally, the ThermoRack 1201 utilizes stainless steel plumbing with SAE-style o-ring sealed fittings to minimize the likelihood of leaks. Should a coolant leak occur, it should be immediately wiped up and properly disposed of as per sections 9.1.2 and 9.1.3 of this manual. The ThermoRack 1201 has an optional leak detection alarm that notifies the user and the tool being cooled that a leak has occurred, even a very small leak. The leak detect system can also be used to shut down the chiller, if desired. Contact SSCS for details.

The ThermoRack 1201 plumbing area chassis serves as secondary containment for the coolant tank and holds up to 2.5 gallons, or 180% of the 1.375 gallon tank volume. If the leak detection option is not chosen, the operator can use the Tank Level Low warning, which displays a warning on the front screen and notifies the etch tool controller via the tool interface card, to indicate the presence of a leak somewhere in the coolant loop. A Tank Level Low occurs when the coolant volume in the tank falls to 1.2 gallons, indicating a leak of up to 0.175 gallons (1.9 liters) has occurred. The chiller will continue to run normally when a Tank Level Low warning is present. If the leak continues without action from the operator, the next alarm is Tank Level Empty.

A Tank Level Empty alarm occurs when the tank level drops to 0.67 gallons, indicating a leak of up to 0.70 gallons. A Tank Level Empty alarm will shut down the ThermoRack 1201.



DANGER

Should a Tank Level Low warning or Tank Level Empty alarm occur, the operator should immediately check for leaks. If the coolant is a fluorinated heat transfer fluid, such as Fluorinert, Galden, or Novec, a halogen leak detector works well for finding leaks. For water based coolants, visual inspection must suffice. First check the external plumbing lines for leaks. If no leaks are found in the external plumbing, then the open the ThermoRack 1201's cover and inspect the plumbing section (on the left as viewed from the front. Only trained maintenance personnel should remove the cover as hazardous voltages are present inside. If coolant is found in the chassis, schedule maintenance on the chiller. Follow the safety guidelines in section 7.4. prior to performing maintenance.

9.6.2 PLANT COOLING WATER LEAKS



Read coolant and PCW SDS before handling. Wear protective gear listed in SDS and follow local regulatory statues when disposing of coolants or PCW drained from the chiller

Two types of plant cooling water (PCW) leaks can occur when operating the ThermoRack 1201: internal and external leaks. Internally, the ThermoRack 1201 utilizes stainless steel plumbing with SAE-style o-ring sealed fittings to minimize the likelihood of leaks. Should a PCW leak occur, it may contain treatment chemicals and should be immediately wiped up as per sections 9.1.2 and 9.1.3 of this manual. The ThermoRack 1201 has an optional leak detection alarm that notifies the user and the tool being cooled that a leak has occurred, even a very small leak. The leak detect system can also be used to shut down the chiller, if desired. Contact SSCS for details. If this option is not chosen, the ThermoRack has no means of detecting PCW leaks. As a result, the leak will fill the ThermoRack 1201's secondary containment until the total volume reaches 2.5 gallons. Once the leak has reached 2.5 gallons, PCW will flow out of the ThermoRack onto the surrounding floor, creating a slip hazard.

The ThermoRack 1201's main circuit breaker does have a ground fault circuit interrupt feature. Should a water leak come in contact with electrically live components, this circuit breaker will disconnect the main AC power.

To identify the source of an internal PCW leak, first disconnect main AC power as per section 9.4.2 of this manual. (Leave the PCW flow on.) Open the ThermoRack 1201 cover and look for water. The only PCW plumbing line is located under the tank. If a leak is present, disconnect the PCW as per section 9.6 and return the ThermoRack 1201 to SSCS for repair.

External water leaks will also not be contained nor detected by the ThermoRack 1201.

9.7 DISCONNECTING PLANT COOLING WATER



Plant cooling water (PCW) is often under high pressures on both the supply and return sides, typically 100 psig (7 bar) on the supply side and 80 psig (5.5 bar) on the return side. As a result, maintenance personnel should take care in disconnecting (PCW) lines. SSCS recommends the use of single or double ended shut off valves on PCW lines for easy and safe disconnection of plant cooling water. See section 3.3 of this manual for details. If quick disconnect valves are not employed, then prior to disconnecting PCW lines from the chiller, the user must shut off and tag the factory's cooling water shut-off valves.

9.7.1 DISCONNECTING PLANT COOLING WATER USING DOUBLE-ENDED SHUT-OFF VALVES:

- 1) Unplug the supply side PCW quick-disconnect fitting.
- 2) Unplug the return side PCW quick disconnect fitting.

9.7.2 DISCONNECTING PLANT COOLING WATER USING SINGLE-ENDED SHUT-OFF VALVES:

- 1) Place a drip pan under the PCW quick-disconnect fittings.
- 2) Unplug the supply side PCW quick-disconnect fitting.
- 3) Unplug the return side PCW quick disconnect fitting.

9.7.3 DISCONNECTING PLANT COOLING WATER USING THE FACILITY'S SHUT-OFF VALVES:

- 1) Shut-off and tag the factory's plant cooling water valves to the chiller.
- 2) Place a drip pan under the PCW fittings at the rear of the chiller.
- 3) Using a 7/8" wrench, disconnect the supply side PCW Swagelok[®] fitting.
- 4) Using a 7/8" wrench, disconnect the return side PCW Swagelok[®] fitting.

Note: Since PCW may contain hazardous treatment chemicals, dispose of any spilled or drained PCW in accordance with sections 9.1.2 and 9.1.3 of this manual.

9.8 COOLANT DISPOSAL



Dispose of any coolants spilled or drained from the ThermoRack 1201 in accordance with national and local guidelines and the coolant's MSDS found in section 11 of this manual.

9.9 SEISMIC PROTECTION

The ThermoRack 1201 may be anchored to seismically rated EIA standard electronics racks by placing support rails under the ThermoRack and clamping bars across the top.

For reference, the center of gravity of the ThermoRack 1201 is located as follows:

9.0 inches (228 mm) right from the left side

12.75 inches (324 mm) back from the front face

3.75 inches (95 mm) above the chassis base.

9.10 MINIMUM PERSONAL PROTECTIVE

9.10.1 MANUAL OPERATION EQUIPMENT

No personal protective equipment is required for normal operation of the ThermoRack 1201.



9.10.2 HANDLING COOLANT

When filling the tank with coolant, the operator should wear the proper protective equipment recommended by the MSDS of the coolant used. See section 12 of this manual.

9.10.3 PCW SPILLS

When handling PCW spills, always follow your factory spill handling procedures.



9.10.4 COOLANT SPILLS

When handling coolant spills, the operator must wear the personal protective equipment recommended in the MSDS of the coolant spilled. See section 12 of this manual.

10.0 TECHNICAL SUPPORT

Delighting our customers is our highest priority. Please contact us immediately for technical assistance whenever you have questions or concerns.

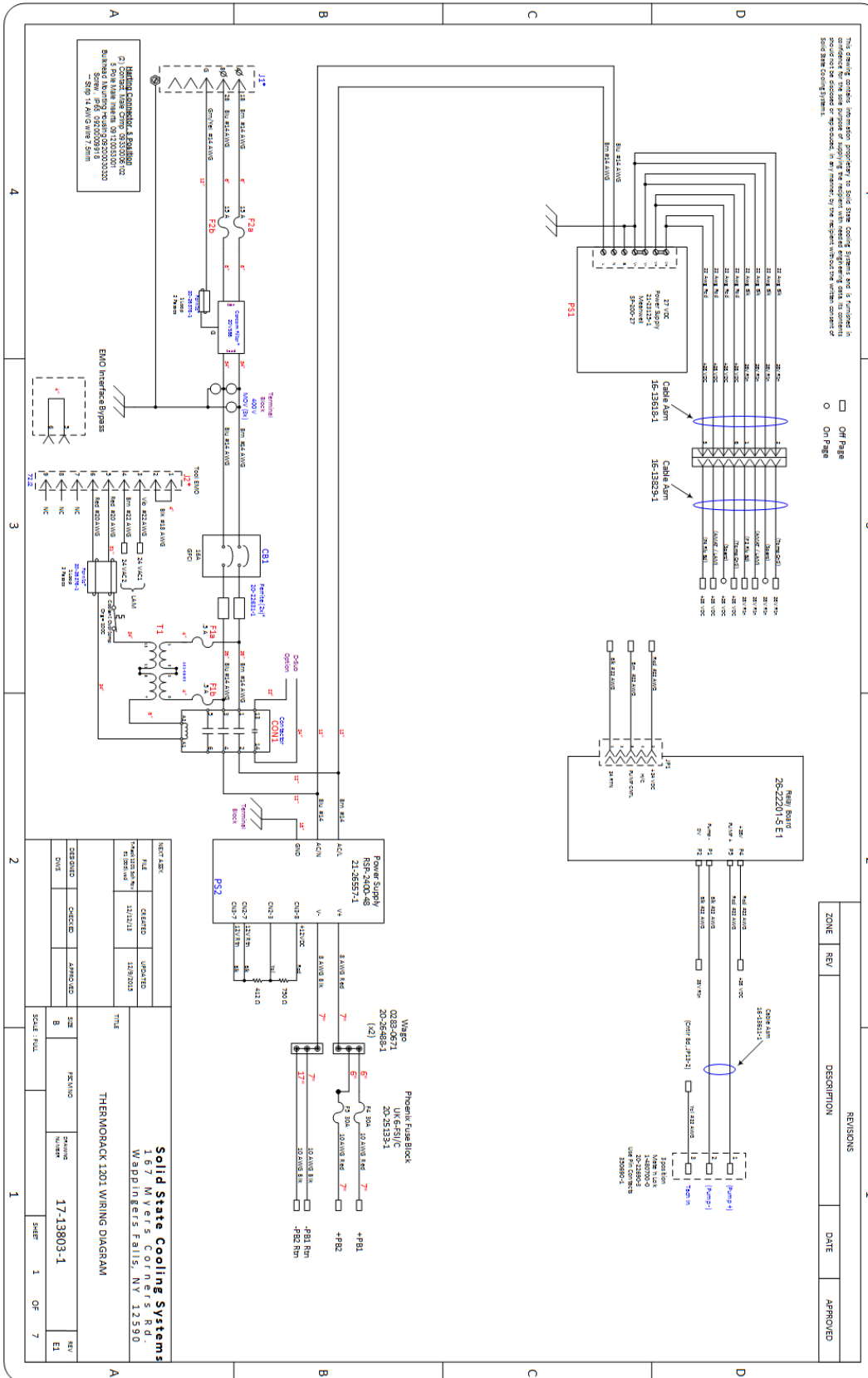
Hours: 8 a.m. to 5 p.m. E.S.T., weekdays

Telephone: (845) 296-1300

Fax: (845) 296-1303

E-mail: info1@sscooling.com

11.0 SYSTEM SCHEMATIC



Standard Components & Ratings
 21 1/2" ROW MAIN PANEL OR 1200X1000
 6" ROW MAIN PANEL OR 1200X1000
 6" ROW MAIN PANEL OR 1200X1000
 6" ROW MAIN PANEL OR 1200X1000
 - SHIP 1/4" AVG BWR 7.5mm

DATE	BY	CHECKED	UPDATES
12/21/13			
12/19/13			

Solid State Cooling Systems
 167 MYERS CORNERS RD.
 WAPPINGERS FALLS, NY 12590

THERMORACK 1201 WIRING DIAGRAM

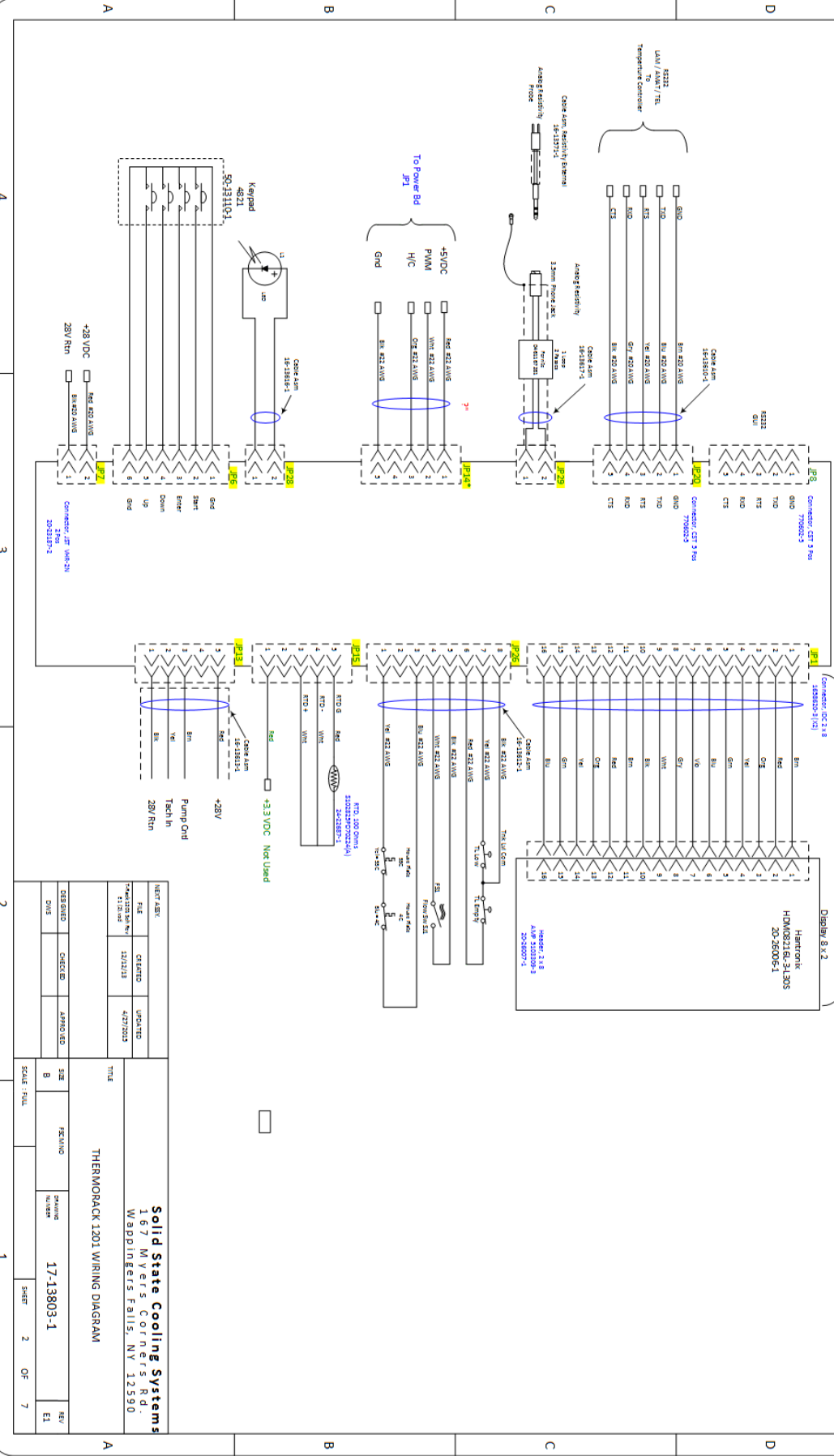
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 Temperature Controller
 26-12833-1
 Rev E21

Display with Attached Cable
 39-26005-1

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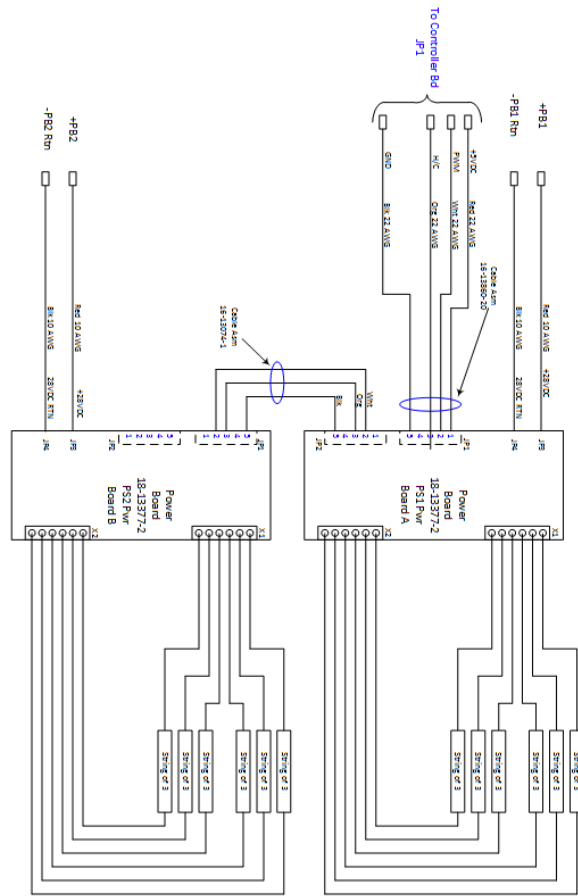


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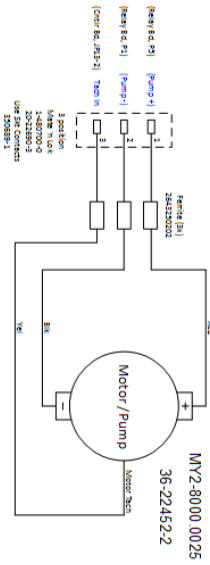
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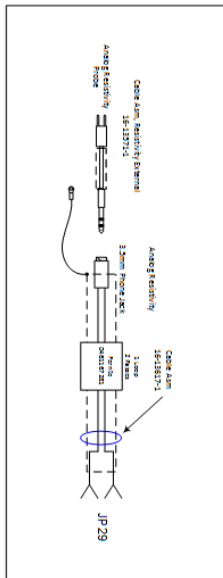
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STANDARD 4 GPM MAG DRIVE CENTRIFUGAL



Resistivity Sensor Option



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ZONE	REV	DESCRIPTION	DATE	DATE	APPROVED

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12/12/11	12/12/11	UPDATES
12/17/11	12/17/11	UPDATES

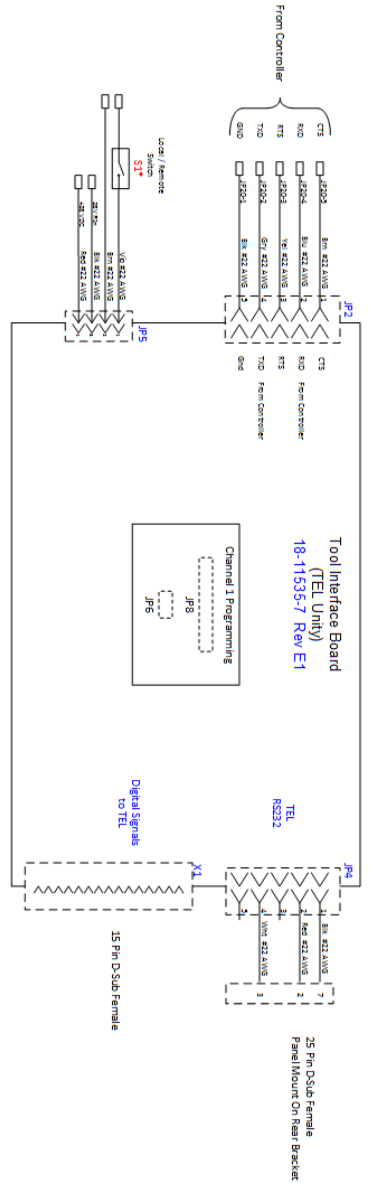
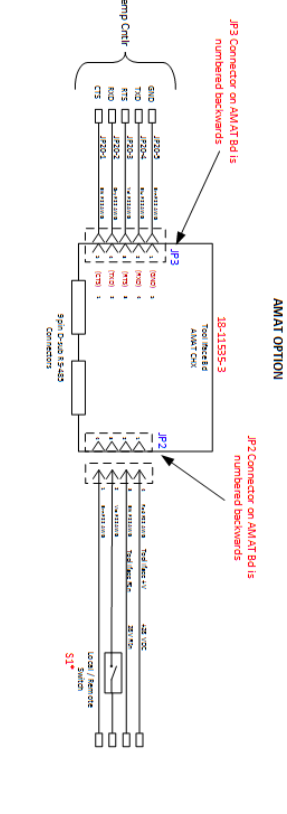
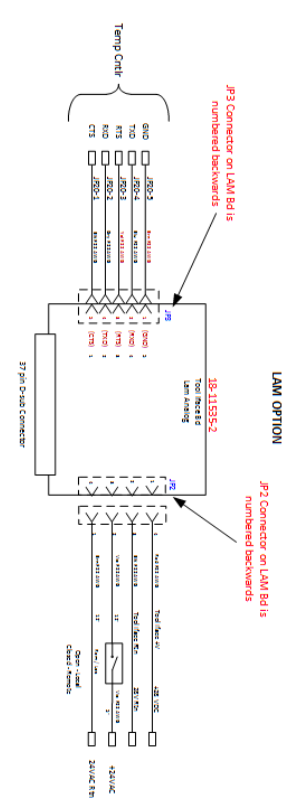
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FILE	1201-13803-1	DATE	12/21/11
REV#	1	DATE	12/21/11

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2	12/21/11			
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Solid State Cooling Systems
167 MYERS CORNERS ROAD
WAPPINGERS FALLS, NY 12590

ThermoRack 1201 WIRING DIAGRAM

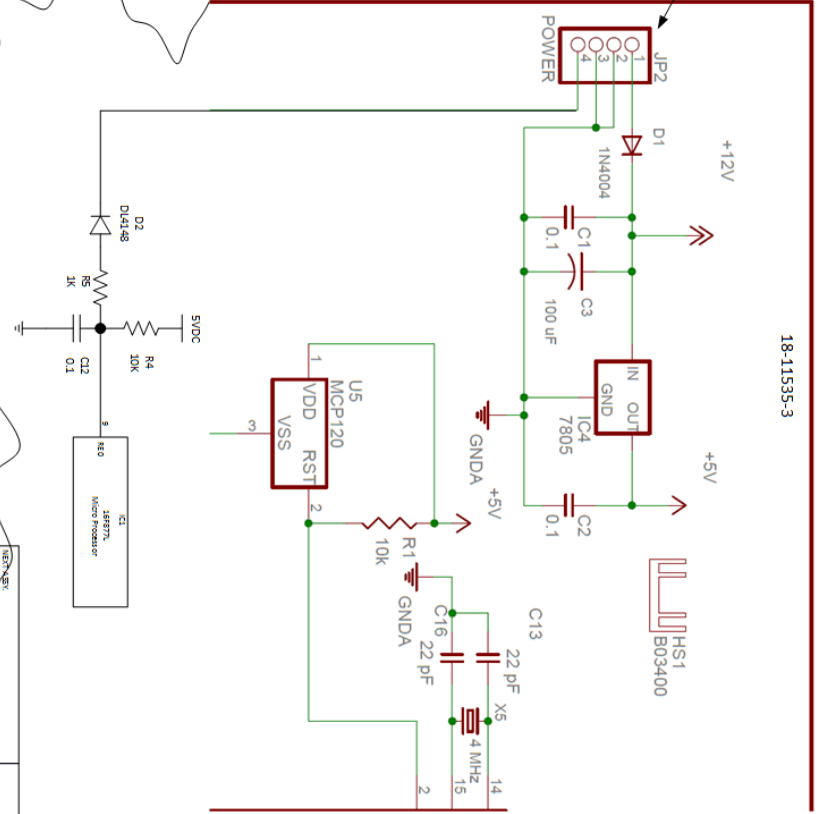
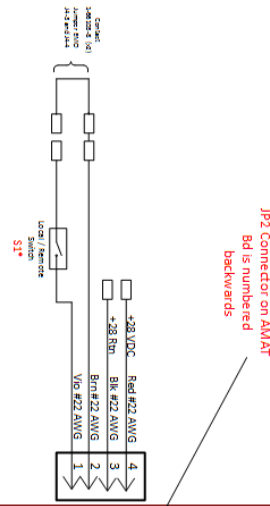
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AMAT BOARD

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Wappingers Falls, NY 12590

THERMORACK 1201 WIRING DIAGRAM

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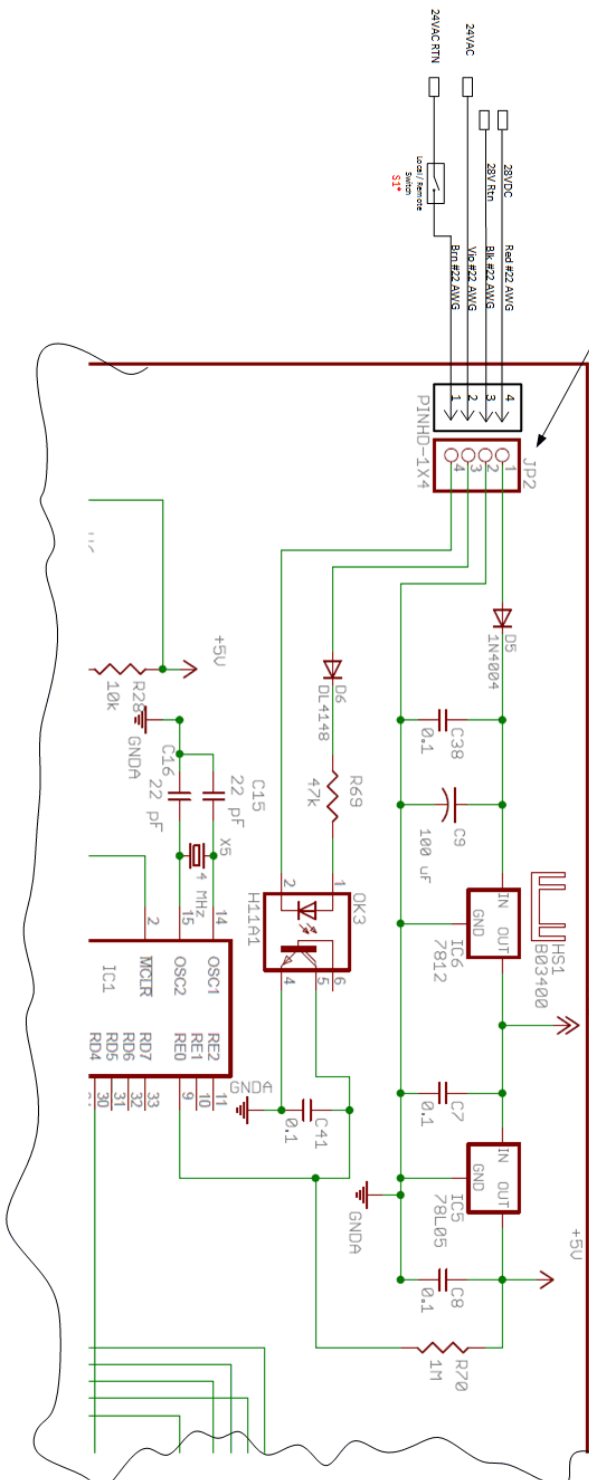
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JP2 Connector on LAM Board is numbered backwards

LAM BOARD

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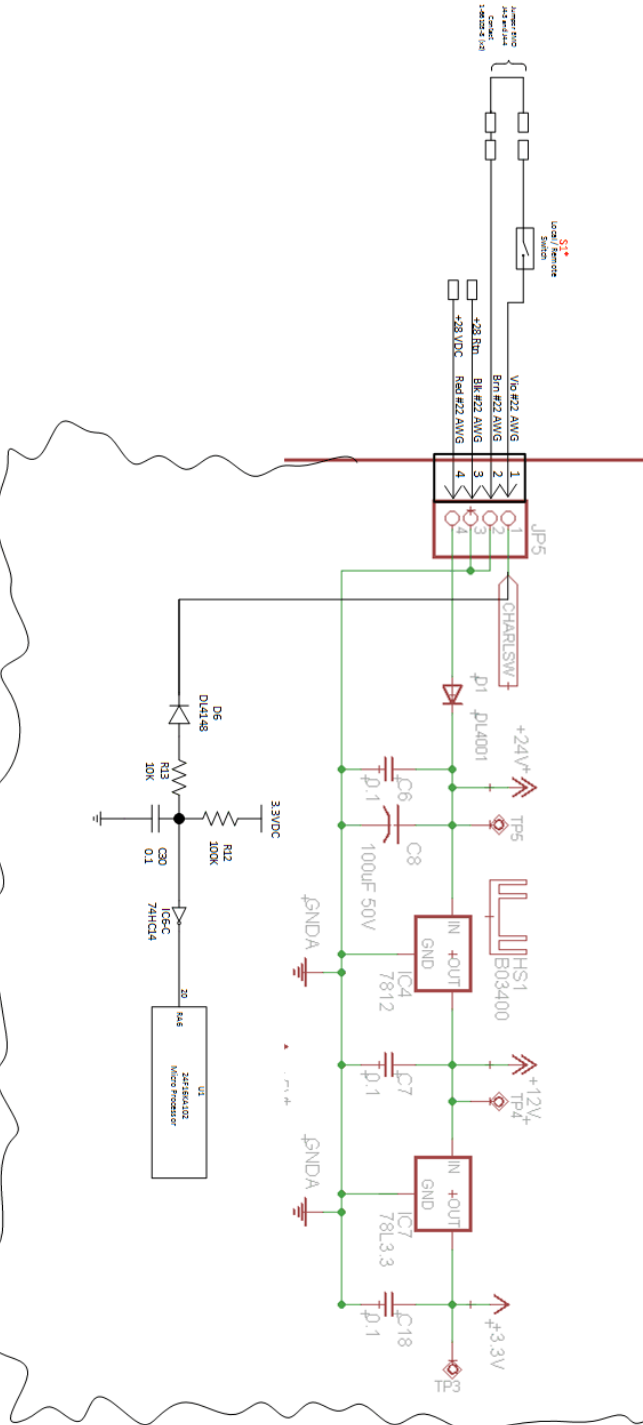
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167 MYERS CORNERS ROAD	
WAPPINGERS FALLS, NY 12590	

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TEL BOARD

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					REV
					E1

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12.0 WARRANTY POLICY

This ThermoRack 1201 chiller is covered under a two-year parts and labor warranty. The length of a warranty is product-specific, depending on the type and planned usage of the product, but will be specified in the quotation upon which a purchase order is made. Prototypes are not covered under warranty, but will be repaired/adjusted after original shipment until they meet the agreed-upon specifications.

Malfunctioning products should be returned to Solid State Cooling Systems by the method described below. Solid State Cooling Systems will provide a Failure Analysis Report to the customer and will determine if the problem is covered under the warranty.

Warranty Coverage:

Products with defects in components or manufacturing which are reported to Solid State Cooling Systems before the end of the warranty period will be repaired or replaced at no cost (see below for reporting requirements). The warranty period begins on the date the product was initially shipped from Solid State Cooling System's factory.

Excluded from Warranty:

Excluded from warranty is any damage caused to the product occurring during, but not limited to, such events as shipment, installation, storage, or usage occurring during a situation specifically cautioned against or noted in the product manual.

Specific situations, which invalidate the warranty, include (but are not limited to):

- Removing the serial number label.
- Any disassembly (partial or complete) of a heat exchanger, which includes removing the tape on the sides, loosening or removing the bolts, or separating the heat sinks.
- Subjecting a heat exchanger to temperatures below the freezing point of the heat transfer fluid contained inside the unit.
- Subjecting a heat exchanger to unfiltered water.
- Subjecting any product to temperature, voltage, current, or pressure (internal or external) greater than that specified in the product manual.
- Any actions prohibited in the "Caution" section of the product manual.

Returned Goods Procedure and Reporting Requirements

Before a failed product is returned to the factory, a Returned Materials Authorization (RMA) number must be obtained from Customer Service at (845) 296-1300. The date the RMA is requested will be the reporting date noted and relevant to the warranty. Products, which have received an RMA, must be received at Solid State Cooling System's factory within 30 days or the reporting date will be moved ahead 30 days and a new 30-day waiting period will begin.

All out of warranty returned goods will require a \$450 evaluation purchase order prior to receipt at SSCS. The evaluation costs will be deducted from the cost of any repairs required.

13.0 SAFETY DATA SHEETS

13.1 3M™ FLUORINERT™ FC-3283 ELECTRONIC LIQUID SDS



SAFETY DATA SHEET

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Document Group: 06-4521-8
Issue Date: 01/18/18

Version Number: 31.06
Supersedes Date: 06/26/17

SECTION 1: Identification

1.1. Product identifier

3M™ Fluorinert™ FC-3283 Electronic Liquid

Product Identification Numbers

ID Number	UPC	ID Number	UPC
98-0212-2908-7	00-51135-70349-6	98-0212-4878-0	000 51138 99254 5
98-0212-4879-8	000 51138 99255 2	98-0212-4880-6	000 51138 99256 9
HB-0042-0654-4		ZF-0002-1344-5	
ZF-0002-1345-2		ZF-0002-1356-9	

1.2. Recommended use and restrictions on use

Recommended use

For Industrial Use Only. Not Intended for Use as a Medical Device or Drug., Testing Fluid or Heat Transfer Fluid for Electronics

Restrictions on use

Fluorinert™ Electronic Liquids are used in a wide variety of applications, including but not limited to precision cleaning of medical devices and as lubricant deposition solvents for medical devices. When the product is used for applications where the finished device is implanted into the human body, no residual Fluorinert solvent may remain on the parts. It is highly recommended that the supporting test results and protocol be cited during FDA registration.

3M Electronics Markets Materials Division (EMMD) will not knowingly sample, support, or sell its products for incorporation in medical and pharmaceutical products and applications in which the 3M product will be temporarily or permanently implanted into humans or animals. The customer is responsible for evaluating and determining that a 3M

EMMD product is suitable and appropriate for its particular use and intended application. The conditions of evaluation, selection, and use of a 3M product can vary widely and affect the use and intended application of a 3M product. Because many of these conditions are uniquely within the user's knowledge and control, it is essential that the user evaluate and determine whether the 3M product is suitable and appropriate for a particular use and intended application, and complies with all local applicable laws, regulations, standards, and guidance.

1.3. Supplier's details

MANUFACTURER: 3M
DIVISION: Electronics Materials Solutions Division
ADDRESS: 3M Center, St. Paul, MN 55144-1000, USA
Telephone: 1-888-3M HELPS (1-888-364-3577)

1.4. Emergency telephone number: 1-800-364-3577 or (651) 737-6501 (24 hours)

SECTION 2: Hazard identification

2.1. Hazard classification

Not classified as hazardous according to OSHA Hazard Communication Standard, 29 CFR 1910.1200.

2.2. Label elements

Signal word

Not applicable.

Symbols

Not applicable.

Pictograms

Not applicable.

SECTION 3: Composition/information on ingredients

Ingredient	C.A.S. No.	% by Wt
PERFLUORO COMPOUNDS, C5-18	86508-42-1	100 (typically 100)

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:

No need for first aid is anticipated.

Skin Contact:

Wash with soap and water. If signs/symptoms develop, get medical attention.

Eye Contact:

Flush with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. If signs/symptoms persist, get medical attention.

If Swallowed:

Rinse mouth. If you feel unwell, get medical attention.

4.2. Most important symptoms and effects, both acute and delayed

See Section 11.1. Information on toxicological effects.

4.3. Indication of any immediate medical attention and special treatment required

Not applicable

SECTION 5: Fire-fighting measures

5.1. Suitable extinguishing media

Material will not burn. Use a fire fighting agent suitable for the surrounding fire.

5.2. Special hazards arising from the substance or mixture

Exposure to extreme heat can give rise to thermal decomposition.

Hazardous Decomposition or By-Products

Substance

Carbon monoxide

Carbon dioxide

Condition

During Combustion

During Combustion

5.3. Special protective actions for fire-fighters

When fire fighting conditions are severe and total thermal decomposition of the product is possible, wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Evacuate area. Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Refer to other sections of this SDS for information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

6.2. Environmental precautions

Avoid release to the environment. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water.

6.3. Methods and material for containment and cleaning up

Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible. Place in a closed container approved for transportation by appropriate authorities. Clean up residue with an appropriate solvent selected by a qualified and authorized person. Ventilate the area with fresh air. Read and follow safety precautions on the solvent label and SDS. Seal the container. Dispose of collected material as soon as possible in accordance with applicable local/regional/national/international regulations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Do not breathe thermal decomposition products. Avoid skin contact with hot material. For industrial or professional use only. Store work clothes separately from other clothing, food and tobacco products. Do not eat, drink or smoke when using this product. Wash thoroughly after handling. Avoid release to the environment. No smoking: Smoking while using this product can result in contamination of the tobacco and/or smoke and lead to the formation of hazardous decomposition products.

7.2. Conditions for safe storage including any incompatibilities

Store away from heat.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational exposure limits

No occupational exposure limit values exist for any of the components listed in Section 3 of this SDS.

8.2. Exposure controls

8.2.1. Engineering controls

Provide appropriate local exhaust when product is heated.

8.2.2. Personal protective equipment (PPE)

Eye/face protection

None required.

Skin/hand protection

Select and use gloves and/or protective clothing approved to relevant local standards to prevent skin contact based on the results of an exposure assessment. Selection should be based on use factors such as exposure levels, concentration of the substance or mixture, frequency and duration, physical challenges such as temperature extremes, and other use conditions. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible gloves/protective clothing. Note: Nitrile gloves may be worn over polymer laminate gloves to improve dexterity. Gloves made from the following material(s) are recommended: Polymer laminate

Respiratory protection

During heating:

Use a positive pressure supplied-air respirator if there is a potential for over exposure from an uncontrolled release, exposure levels are not known, or under any other circumstances where air-purifying respirators may not provide adequate protection.

Thermal hazards

Wear heat insulating gloves when handling hot material to prevent thermal burns.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

General Physical Form:	Liquid
Specific Physical Form:	Liquid
Odor, Color, Grade:	Colorless, odorless liquid.
Odor threshold	<i>No Data Available</i>
pH	<i>Not Applicable</i>
Melting point	<i>Not Applicable</i>
Boiling Point	123 - 133 °C
Flash Point	No flash point
Evaporation rate	< 1 [<i>Ref Std:BUOAC=1</i>]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	14 mmHg [<i>@ 23 °C</i>]
Vapor Density	18 [<i>@ 23 °C</i>] [<i>Ref Std:AIR=1</i>]
Density	1.8 g/ml
Specific Gravity	1.8 [<i>Ref Std:WATER=1</i>]
Solubility in Water	Nil
Solubility- non-water	<i>No Data Available</i>
Partition coefficient: n-octanol/ water	<i>No Data Available</i>
Autoignition temperature	<i>No Data Available</i>
Decomposition temperature	<i>Not Applicable</i>
Viscosity	0.7 centistoke [<i>@ 25 °C</i>]
Molecular weight	<i>No Data Available</i>
Volatile Organic Compounds	[<i>Details:Exempt</i>]
Percent volatile	100 %
VOC Less H2O & Exempt Solvents	[<i>Details:Exempt</i>]

SECTION 10: Stability and reactivity

10.1. Reactivity

This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

10.2. Chemical stability

Stable.

10.3. Possibility of hazardous reactions

Hazardous polymerization will not occur.

10.4. Conditions to avoid

Heat

10.5. Incompatible materials

Finely divided active metals

Alkali and alkaline earth metals

10.6. Hazardous decomposition products**Substance**

Hydrogen Fluoride

Perfluoroisobutylene (PFIB)

Condition

At Elevated Temperatures - greater than 200 °C

At Elevated Temperatures - greater than 200 °C

Refer to section 5.2 for hazardous decomposition products during combustion.

If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur.

SECTION 11: Toxicological information

The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.

11.1. Information on Toxicological effects**Signs and Symptoms of Exposure**

Based on test data and/or information on the components, this material may produce the following health effects:

Inhalation:

No known health effects.

Skin Contact:

Contact with the skin during product use is not expected to result in significant irritation.

Eye Contact:

Contact with the eyes during product use is not expected to result in significant irritation.

Ingestion:

Ingestion:

May be harmful if swallowed.

Additional Information:

A Material Toxicity Summary Sheet (MTSS) has been developed for this product. Please contact the address listed on the first page of this SDS to obtain a copy of the MTSS for this product.

Toxicological Data

If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

Acute Toxicity

Name	Route	Species	Value
PERFLUORO COMPOUNDS, C5-18	Dermal		LD50 estimated to be > 5,000 mg/kg
PERFLUORO COMPOUNDS, C5-18	Inhalation-Vapor (4 hours)	Rat	LC50 > 41 mg/l
PERFLUORO COMPOUNDS, C5-18	Ingestion	Rat	

ATE = acute toxicity estimate

Skin Corrosion/Irritation

Name	Species	Value
PERFLUORO COMPOUNDS, C5-18	Rabbit	No significant irritation

Serious Eye Damage/Irritation

Name	Species	Value
PERFLUORO COMPOUNDS, C5-18	Rabbit	No significant irritation

Skin Sensitization

For the component/components, either no data are currently available or the data are not sufficient for classification.

Respiratory Sensitization

For the component/components, either no data are currently available or the data are not sufficient for classification.

Germ Cell Mutagenicity

Name	Species	Value
PERFLUORO COMPOUNDS, C5-18	In Vitro	Not mutagenic

Carcinogenicity

For the component/components, either no data are currently available or the data are not sufficient for classification.

Reproductive Toxicity**Reproductive and/or Developmental Effects**

For the component/components, either no data are currently available or the data are not sufficient for classification.

Target Organ(s)**Specific Target Organ Toxicity - single exposure**

For the component/components, either no data are currently available or the data are not sufficient for classification.

Specific Target Organ Toxicity - repeated exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
PERFLUORO COMPOUNDS, C5-18	Inhalation	heart endocrine system bone, teeth, nails, and/or hair hematopoietic system liver immune system nervous system eyes kidney and/or bladder respiratory system	Not classified	Rat	NOAEL 49,821 ppm	13 weeks
PERFLUORO COMPOUNDS, C5-18	Ingestion	heart endocrine system hematopoietic system liver nervous system kidney and/or bladder respiratory system	Not classified		NOAEL 2,000 mg/kg/day	28 days

Aspiration Hazard

For the component/components, either no data are currently available or the data are not sufficient for classification.

Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.

SECTION 12: Ecological information**Ecotoxicological information**

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

SECTION 13: Disposal considerations**13.1. Disposal methods**

Dispose of contents/ container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. Combustion products will include HF. Facility must be capable of handling halogenated materials. Empty drums/barrels/containers used for transporting and handling hazardous chemicals (chemical substances/mixtures/preparations classified as Hazardous as per applicable regulations) shall be considered, stored, treated & disposed of as hazardous wastes unless otherwise defined by applicable waste regulations. Consult with the respective regulating authorities to determine the available treatment and disposal facilities.

EPA Hazardous Waste Number (RCRA): Not regulated

SECTION 14: Transport Information

Not regulated per U.S. DOT, IATA or IMO.

These transportation classifications are provided as a customer service. As the shipper YOU remain responsible for complying with all applicable laws and regulations, including proper transportation classification and packaging. 3M transportation classifications are based on product formulation, packaging, 3M policies and 3M understanding of applicable current regulations. 3M does not guarantee the accuracy of this classification information. This information applies only to transportation classification and not the packaging, labeling, or marking requirements. The original 3M package is certified for U.S. ground shipment only. If you are shipping by air or ocean, the package may not meet applicable regulatory requirements.

SECTION 15: Regulatory Information**15.1. US Federal Regulations**

Contact 3M for more information.

Physical Hazards

Not applicable

Health Hazards

Not applicable

15.2. State Regulations

Contact 3M for more information.

15.3. Chemical Inventories

The components of this material are in compliance with the provisions of Australia National Industrial Chemical Notification and Assessment Scheme (NICNAS). Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the new substance notification requirements of CEPA.

The components of this material are in compliance with the China "Measures on Environmental Management of New Chemical Substance". Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of the Korean Toxic Chemical Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Japan Chemical Substance Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Philippines RA 6969 requirements. Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the chemical notification requirements of TSCA.

Contact 3M for more information.

15.4. International Regulations

Contact 3M for more information.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: Other Information**NFPA Hazard Classification**

Health: 3 **Flammability:** 0 **Instability:** 0 **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification

Health: 0 **Flammability:** 0 **Physical Hazard:** 0 **Personal Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS® IV) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® IV ratings are to be used with a fully implemented HMIS® IV program. HMIS® is a registered mark of the American Coatings Association (ACA).

Document Group:	06-4521-8	Version Number:	31.06
Issue Date:	01/18/18	Supersedes Date:	06/26/17

Reason for Reissue

Conversion to GHS format SDS.

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3M provides information in electronic form as a service to its customers. Due to the remote possibility that electronic transfer may have resulted in errors, omissions or alterations in this information, 3M makes no representations as to its completeness or accuracy. In addition, information obtained from a database may not be as current as the information in the SDS available directly from 3M.

3M USA SDSs are available at www.3M.com

End of SDS

13.2 3M™ NOVEC™ 7100 ENGINEERED FLUID SDS



SAFETY DATA SHEET

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Document Group: 07-6378-9
Issue Date: 01/18/18

Version Number: 69.03
Supersedes Date: 09/06/16

SECTION 1: Identification

1.1. Product identifier

3M™ Novec™ 7100 Engineered Fluid

Product Identification Numbers

ID Number	UPC	ID Number	UPC
98-0211-8940-6	00-51135-11037-9	98-0211-8941-4	00-51135-11038-6
98-0211-8946-3	00-51135-11043-0	98-0212-1011-1	00-51135-45035-2
98-0212-1102-8	00-51135-45124-3	98-0212-1128-3	00-51135-45146-5
98-0212-1148-1	00-51135-63012-9	98-0212-3554-8	
98-0212-3635-5			

1.2. Recommended use and restrictions on use

Recommended use

For Industrial Use Only. Not Intended for Use as a Medical Device or Drug.,

Restrictions on use

Novec™ Engineered Fluids are used in a wide variety of applications, including but not limited to precision cleaning of medical devices and as lubricant deposition solvents for medical devices. When the product is used for applications where the finished device is implanted into the human body, no residual Novec solvent may remain on the parts. It is highly recommended that the supporting test results and protocol be cited during FDA registration.

3M Electronics Markets Materials Division (EMMD) will not knowingly sample, support, or sell its products for incorporation in medical and pharmaceutical products and applications in which the 3M product will be temporarily or permanently implanted into humans or animals. The customer is responsible for evaluating and determining that a 3M EMMD product is suitable and appropriate for its particular use and intended application. The conditions of evaluation, selection, and use of a 3M product can vary widely and affect the use and intended application of a 3M product. Because many of these conditions are uniquely within the user's knowledge and control, it is essential that the user evaluate and determine whether the 3M product is suitable and appropriate for a particular use and intended application, and complies with all local applicable laws, regulations, standards, and guidance.

1.3. Supplier's details

MANUFACTURER: 3M
DIVISION: Electronics Materials Solutions Division
ADDRESS: 3M Center, St. Paul, MN 55144-1000, USA
Telephone: 1-888-3M HELPS (1-888-364-3577)

1.4. Emergency telephone number: 1-800-364-3577 or (651) 737-6501 (24 hours)

SECTION 2: Hazard identification**2.1. Hazard classification**

Not classified as hazardous according to OSHA Hazard Communication Standard, 29 CFR 1910.1200.

2.2. Label elements**Signal word**

Not applicable.

Symbols

Not applicable.

Pictograms

Not applicable.

SECTION 3: Composition/information on ingredients

Ingredient	C.A.S. No.	% by Wt
Methyl nonafluorobutyl ether	163702-07-6	20 - 80
Methyl nonafluoroisobutyl ether	163702-08-7	20 - 80

SECTION 4: First aid measures**4.1. Description of first aid measures****Inhalation:**

Remove person to fresh air. If you feel unwell, get medical attention.

Skin Contact:

Wash with soap and water. If signs/symptoms develop, get medical attention.

Eye Contact:

Flush with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. If signs/symptoms persist, get medical attention.

If Swallowed:

Rinse mouth. If you feel unwell, get medical attention.

4.2. Most important symptoms and effects, both acute and delayed

See Section 11.1. Information on toxicological effects.

4.3. Indication of any immediate medical attention and special treatment required

Not applicable

SECTION 5: Fire-fighting measures

5.1. Suitable extinguishing media

Non-combustible. Use a fire fighting agent suitable for surrounding fire.

5.2. Special hazards arising from the substance or mixture

Exposure to extreme heat can give rise to thermal decomposition.

Hazardous Decomposition or By-Products**Substance**

Carbon monoxide

Carbon dioxide

Hydrogen Fluoride

Condition

During Combustion

During Combustion

During Composition - at elevated

temperatures

5.3. Special protective actions for fire-fighters

When fire fighting conditions are severe and total thermal decomposition of the product is possible, wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Refer to other sections of this SDS for information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

6.2. Environmental precautions

Avoid release to the environment. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water.

6.3. Methods and material for containment and cleaning up

Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible. Place in a closed container approved for transportation by appropriate authorities. Clean up residue with an appropriate solvent selected by a qualified and authorized person. Ventilate the area with fresh air. Read and follow safety precautions on the solvent label and SDS. Seal the container. Dispose of collected material as soon as possible in accordance with applicable local/regional/national/international regulations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Do not breathe thermal decomposition products. Avoid skin contact with hot material. For industrial or professional use only. Store work clothes separately from other clothing, food and tobacco products. Avoid release to the environment. Avoid contact with oxidizing agents (eg. chlorine, chromic acid etc.) No smoking: Smoking while using this product can result in contamination of the tobacco and/or smoke and lead to the formation of hazardous decomposition products.

7.2. Conditions for safe storage including any incompatibilities

Keep container tightly closed. Store away from heat. Store away from acids. Store away from strong bases. Store away from oxidizing agents.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational exposure limits

If a component is disclosed in section 3 but does not appear in the table below, an occupational exposure limit is not available for the component.

Ingredient	C.A.S. No.	Agency	Limit Type	Additional Comments
Methyl nonafluorobutyl ether	163702-07-6	AIHA	TWA: 750 ppm	
Methyl nonafluoroisobutyl ether	163702-08-7	AIHA	TWA: 750 ppm	

ACGIH : American Conference of Governmental Industrial Hygienists

AIHA : American Industrial Hygiene Association

CMRG : Chemical Manufacturer's Recommended Guidelines

OSHA : United States Department of Labor - Occupational Safety and Health Administration

TWA: Time-Weighted-Average

STEL: Short Term Exposure Limit

CELL: Ceiling

8.2. Exposure controls

8.2.1. Engineering controls

Provide appropriate local exhaust when product is heated. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below relevant Exposure Limits and/or control dust/fume/gas/mist/vapors/spray. If ventilation is not adequate, use respiratory protection equipment.

8.2.2. Personal protective equipment (PPE)

Eye/face protection

Select and use eye/face protection to prevent contact based on the results of an exposure assessment. The following eye/face protection(s) are recommended:

Safety Glasses with side shields

Skin/hand protection

No chemical protective gloves are required.

Respiratory protection

During heating:

Use a positive pressure supplied-air respirator if there is a potential for over exposure from an uncontrolled release, exposure levels are not known, or under any other circumstances where air-purifying respirators may not provide adequate protection.

Thermal hazards

Wear heat insulating gloves when handling hot material to prevent thermal burns.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

General Physical Form:	Liquid
Specific Physical Form:	Liquid
Odor, Color, Grade:	Clear colorless, odorless liquid with slight ether odor
Odor threshold	<i>No Data Available</i>
pH	<i>Not Applicable</i>
Melting point	-135 °C
Boiling Point	61 °C [@ 760 mmHg]
Flash Point	No flash point
Evaporation rate	49 [<i>Ref Std:BUOAC=1</i>]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	202 mmHg [@ 25 °C]
Vapor Density	8.6 [<i>Ref Std:AIR=1</i>]
Density	1.5 g/ml
Specific Gravity	1.5 [<i>Ref Std:WATER=1</i>]
Solubility in Water	, 12 ppm
Solubility- non-water	<i>No Data Available</i>
Partition coefficient: n-octanol/ water	3.9 [<i>Details:30 °C</i>]
Autoignition temperature	405 °C [<i>Details:(ASTM E659-84)</i>]
Decomposition temperature	<i>Not Applicable</i>
Viscosity	0.6 centistoke [@ 23 °C]
Molecular weight	<i>No Data Available</i>
Percent volatile	100 %

SECTION 10: Stability and reactivity

10.1. Reactivity

This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

10.2. Chemical stability

Stable.

10.3. Possibility of hazardous reactions

Hazardous polymerization will not occur.

10.4. Conditions to avoid

None known.

10.5. Incompatible materials

Strong acids
Strong bases
Strong oxidizing agents

10.6. Hazardous decomposition products

<u>Substance</u>	<u>Condition</u>
Perfluoroisobutylene (PFIB)	At Elevated Temperatures - extreme conditions of heat
Toxic Vapor, Gas, Particulate	At Elevated Temperatures - extreme conditions of heat

Refer to section 5.2 for hazardous decomposition products during combustion.

If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur.

SECTION 11: Toxicological information

The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.

11.1. Information on Toxicological effects

Signs and Symptoms of Exposure

Based on test data and/or information on the components, this material may produce the following health effects:

Inhalation:

No known health effects.

Skin Contact:

Contact with the skin during product use is not expected to result in significant irritation.

Eye Contact:

Contact with the eyes during product use is not expected to result in significant irritation.

Ingestion:

Ingestion:

No known health effects.

Toxicological Data

If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

Acute Toxicity

Name	Route	Species	Value
Methyl nonafluoroisobutyl ether	Dermal		LD50 estimated to be > 5,000 mg/kg
Methyl nonafluoroisobutyl ether	Inhalation-Vapor (4 hours)	Rat	LC50 > 1,000 mg/l
Methyl nonafluoroisobutyl ether	Ingestion	Rat	LD50 > 5,000 mg/kg
Methyl nonafluorobutyl ether	Dermal		LD50 estimated to be > 5,000 mg/kg
Methyl nonafluorobutyl ether	Inhalation-Vapor (4 hours)	Rat	LC50 > 1,000 mg/l
Methyl nonafluorobutyl ether	Ingestion	Rat	LD50 > 5,000 mg/kg

ATE = acute toxicity estimate

Skin Corrosion/Irritation

Name	Species	Value
Methyl nonafluoroisobutyl ether	Rabbit	No significant irritation
Methyl nonafluorobutyl ether	Rabbit	No significant irritation

Serious Eye Damage/Irritation

Name	Species	Value
Methyl nonafluoroisobutyl ether	Rabbit	No significant irritation
Methyl nonafluorobutyl ether	Rabbit	No significant irritation

Skin Sensitization

Name	Species	Value
Methyl nonafluoroisobutyl ether	Guinea Pig	No significant irritation
Methyl nonafluorobutyl ether	Guinea Pig	No significant irritation

Respiratory Sensitization

For the component/components, either no data are currently available or the data are not sufficient for classification.

Germ Cell Mutagenicity

Name	Species	Value
Methyl nonafluoroisobutyl ether	In Vitro	Not mutagenic
Methyl nonafluoroisobutyl ether	In vivo	Not mutagenic
Methyl nonafluorobutyl ether	In Vitro	Not mutagenic
Methyl nonafluorobutyl ether	In vivo	Not mutagenic

Carcinogenicity

For the component/components, either no data are currently available or the data are not sufficient for classification.

Reproductive Toxicity**Reproductive and/or Developmental Effects**

Name	Route	Value	Species	Test Result	Exposure Duration
Methyl nonafluoroisobutyl ether	Inhalation	Not classified for female reproduction	Rat	NOAEL 129 mg/1	1 generation
Methyl nonafluoroisobutyl ether	Inhalation	Not classified for male reproduction	Rat	NOAEL 129 mg/1	1 generation
Methyl nonafluoroisobutyl ether	Inhalation	Not classified for development	Rat	NOAEL 307 mg/1	during gestation
Methyl nonafluorobutyl ether	Inhalation	Not classified for female reproduction	Rat	NOAEL 129 mg/1	1 generation
Methyl nonafluorobutyl ether	Inhalation	Not classified for male reproduction	Rat	NOAEL 129 mg/1	1 generation
Methyl nonafluorobutyl ether	Inhalation	Not classified for development	Rat	NOAEL 307 mg/1	during gestation

Target Organ(s)**Specific Target Organ Toxicity - single exposure**

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
Methyl nonafluoroisobutyl ether	Inhalation	nervous system	Not classified	Dog	NOAEL 913 mg/l	10 minutes
Methyl nonafluoroisobutyl ether	Inhalation	cardiac sensitization	Not classified	Dog	NOAEL 913 mg/l	10 minutes
Methyl nonafluorobutyl ether	Inhalation	nervous system	Not classified	Dog	NOAEL 913 mg/l	10 minutes
Methyl nonafluorobutyl ether	Inhalation	cardiac sensitization	Not classified	Dog	NOAEL 913 mg/l	10 minutes

Specific Target Organ Toxicity - repeated exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
Methyl nonafluoroisobutyl ether	Inhalation	liver	Not classified	Rat	NOAEL 155 mg/l	13 weeks
Methyl nonafluoroisobutyl ether	Inhalation	bone, teeth, nails, and/or hair	Not classified	Rat	NOAEL 129 mg/l	11 weeks
Methyl nonafluoroisobutyl ether	Inhalation	heart skin endocrine system hematopoietic system immune system muscles nervous system eyes kidney and/or bladder respiratory system	Not classified	Rat	NOAEL 155 mg/l	13 weeks
Methyl nonafluoroisobutyl ether	Ingestion	endocrine system hematopoietic system immune system muscles nervous system eyes kidney and/or bladder respiratory system	Not classified	Rat	NOAEL 1,000 mg/kg/day	28 days

Methyl nonafluorobutyl ether	Inhalation	liver	Not classified	Rat	NOAEL 155 mg/l	13 weeks
Methyl nonafluorobutyl ether	Inhalation	bone, teeth, nails, and/or hair	Not classified	Rat	NOAEL 129 mg/l	11 weeks
Methyl nonafluorobutyl ether	Inhalation	heart skin endocrine system hematopoietic system immune system muscles nervous system eyes kidney and/or bladder respiratory system	Not classified	Rat	NOAEL 155 mg/l	13 weeks
Methyl nonafluorobutyl ether	Ingestion	endocrine system hematopoietic system immune system muscles nervous system eyes kidney and/or bladder respiratory system	Not classified	Rat	NOAEL 1,000 mg/kg/day	28 days

Aspiration Hazard

For the component/components, either no data are currently available or the data are not sufficient for classification.

Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.

SECTION 12: Ecological information**Ecotoxicological information**

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

SECTION 13: Disposal considerations**13.1. Disposal methods**

Dispose of contents/ container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. Combustion products will include HF. Facility must be capable of handling halogenated materials. Empty drums/barrels/containers used for transporting and handling hazardous chemicals (chemical substances/mixtures/preparations classified as Hazardous as per applicable regulations) shall be considered, stored, treated & disposed of as hazardous wastes unless otherwise defined by applicable waste regulations. Consult with the respective regulating authorities to determine the available treatment and disposal facilities.

EPA Hazardous Waste Number (RCRA): Not regulated

SECTION 14: Transport Information

Not regulated per U.S. DOT, IATA or IMO.

These transportation classifications are provided as a customer service. As the shipper YOU remain responsible for complying with all applicable laws and regulations, including proper transportation classification and packaging. 3M transportation classifications are based on product formulation, packaging, 3M policies and 3M understanding of applicable current regulations. 3M does not guarantee the accuracy of this classification information. This information applies only to transportation classification and not the packaging, labeling, or marking requirements. The original 3M package is certified for U.S. ground shipment only. If you are shipping by air or ocean, the package may not meet applicable regulatory requirements.

SECTION 15: Regulatory Information

15.1. US Federal Regulations

Contact 3M for more information.

Physical Hazards

Not applicable

Health Hazards

Not applicable

15.2. State Regulations

Contact 3M for more information.

15.3. Chemical Inventories

The components of this material are in compliance with the provisions of Australia National Industrial Chemical Notification and Assessment Scheme (NICNAS). Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the new substance notification requirements of CEPA.

The components of this material are in compliance with the China "Measures on Environmental Management of New Chemical Substance". Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of the Korean Toxic Chemical Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Japan Chemical Substance Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Philippines RA 6969 requirements. Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the chemical notification requirements of TSCA.

Contact 3M for more information.

15.4. International Regulations

Contact 3M for more information.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: Other Information

NFPA Hazard Classification

Health: 3 **Flammability:** 0 **Instability:** 0 **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification**Health:** 0 **Flammability:** 0 **Physical Hazard:** 0 **Personal Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS® IV) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® IV ratings are to be used with a fully implemented HMIS® IV program. HMIS® is a registered mark of the American Coatings Association (ACA).

Document Group:	07-6378-9	Version Number:	69.03
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Reason for Reissue

Conversion to GHS format SDS.

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End of SDS

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

3.1.1. Concentration

Substance name:	Concentration
1-Propene, 1,1,2,3,3,3-hexafluoro-, oxidized, polymd.	> 99.9 %
CAS-No.: 69991-67-9 / EC-No.: - / Index-No.: -	

SECTION 4. FIRST AID MEASURES

4.1. Description of first aid measures

4.1.1. If inhaled

- Move to fresh air in case of accidental inhalation of fumes from overheating or combustion.
- Oxygen or artificial respiration if needed.

4.1.2. In case of eye contact

- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- If eye irritation persists, consult a specialist.

4.1.3. In case of skin contact

- Wash off with soap and water.

4.1.4. If swallowed

- Drink 1 or 2 glasses of water.
- Do NOT induce vomiting.
- If symptoms persist, call a physician.

4.2. Most important symptoms and effects, both acute and delayed

4.2.1. Inhalation

- No known effect.

4.2.2. Skin contact

- Symptoms: Redness, Irritation

4.2.3. Eye contact

- Contact with eyes may cause irritation.
- Redness

4.2.4. Ingestion

- Ingestion may provoke the following symptoms:
- Symptoms: Nausea, Vomiting, Diarrhoea

4.3. Indication of any immediate medical attention and special treatment needed

SECTION 5. FIREFIGHTING MEASURES

5.1. Extinguishing media

5.1.1. Suitable extinguishing media

- Water
- powder
- Foam
- Dry chemical
- Carbon dioxide (CO₂)

5.1.2. Unsuitable extinguishing media

- None.

5.2. Special hazards arising from the substance or mixture

- The product is not flammable.
- Not explosive
- In case of fire hazardous decomposition products may be produced such as: Gaseous hydrogen fluoride (HF), Fluorophosgene

5.3. Advice for firefighters

- Wear self-contained breathing apparatus and protective suit.
- When intervention in close proximity wear acid resistant over suit.
- Evacuate personnel to safe areas.
- Approach from upwind.
- Protect intervention team with a water spray as they approach the fire.
- Keep containers and surroundings cool with water spray.
- Keep product and empty container away from heat and sources of ignition.

SECTION 6. ACCIDENTAL RELEASE MEASURES**6.1. Personal precautions, protective equipment and emergency procedures****6.1.1. Advice for non-emergency personnel**

- Prevent further leakage or spillage if safe to do so.

6.1.2. Advice for emergency responders

- Ensure adequate ventilation.
- Material can create slippery conditions.
- Sweep up to prevent slipping hazard.
- Keep away from open flames, hot surfaces and sources of ignition.

6.2. Environmental precautions

- Should not be released into the environment.
- Do not flush into surface water or sanitary sewer system.

6.3. Methods and materials for containment and cleaning up

- Soak up with inert absorbent material.
- Suitable material for picking up
- Dry sand
- Earth
- Shovel into suitable container for disposal.

6.4. Reference to other sections

- Refer to protective measures listed in sections 7 and 8.

SECTION 7. HANDLING AND STORAGE**7.1. Precautions for safe handling**

- Ensure adequate ventilation.
- Use personal protective equipment.
- Keep away from heat and sources of ignition.
- To avoid thermal decomposition, do not overheat.
- Take measures to prevent the build up of electrostatic charge.
- Clean and dry piping circuits and equipment before any operations.
- Ensure all equipment is electrically grounded before beginning transfer operations.

7.2. Conditions for storage, including incompatibilities

7.2.1. Storage

- Keep away from heat and sources of ignition.
- Keep in properly labelled containers.
- Keep away from combustible material.
- Keep away from incompatible products
- Provide tight electrical equipment well protected against corrosion.
- Refer to protective measures listed in sections 7 and 8.

7.2.2. Packaging material

7.2.2.1. Suitable material

- glass
- Plastic material

7.3. Specific end use(s)

- For further information, please contact: Supplier

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

8.1.1. Exposure Limit Values

Remarks:

- Threshold limit values of by-products from thermal decomposition

Hydrogen fluoride anhydrous

- UK. EH40 Workplace Exposure Limits (WELs) 12 2011
time weighted average = 1.8 ppm
time weighted average = 1.5 mg/m³
Remarks: as F
- UK. EH40 Workplace Exposure Limits (WELs) 12 2011
Short term exposure limit = 3 ppm
Short term exposure limit = 2.5 mg/m³
Remarks: as F
- US. ACGIH Threshold Limit Values 03 2013
time weighted average = 0.5 ppm
Remarks: as F
- US. ACGIH Threshold Limit Values 03 2013
Ceiling Limit Value = 2 ppm
Remarks: as F
- EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU 12 2009
time weighted average = 1.8 ppm
time weighted average = 1.5 mg/m³
Remarks: Indicative
- EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU 12 2009
Short term exposure limit = 3 ppm
Short term exposure limit = 2.5 mg/m³
Remarks: Indicative
- US. ACGIH Threshold Limit Values 03 2013
Remarks: as F, Can be absorbed through skin.
Carbonyl difluoride
- US. ACGIH Threshold Limit Values 03 2013
time weighted average = 2 ppm
- US. ACGIH Threshold Limit Values 03 2013
Short term exposure limit = 5 ppm
- UK. EH40 Workplace Exposure Limits (WELs) 12 2011
time weighted average = 2.5 mg/m³
Remarks: as F

- EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU 12 2009
- time weighted average = 2.5 mg/m³
Remarks: Indicative

8.2. Exposure controls

8.2.1. Appropriate engineering controls

- Provide local ventilation appropriate to the product decomposition risk (see section 10).
- Refer to protective measures listed in sections 7 and 8.
- Apply technical measures to comply with the occupational exposure limits.

8.2.2. Individual protection measures

8.2.2.1. Respiratory protection

- In case of decomposition (see section 10), use an air breathing apparatus with face mask.
- Use only respiratory protection that conforms to international/ national standards.

8.2.2.2. Hand protection

- Wear protective gloves.
- Suitable material: Nitrile rubber, PVC, Neoprene gloves, butyl-rubber
- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).

8.2.2.3. Eye protection

- Tightly fitting safety goggles

8.2.2.4. Skin and body protection

- Wear work overall and safety shoes.

8.2.2.5. Hygiene measures

- Ensure that eyewash stations and safety showers are close to the workstation location.
- When using, do not eat, drink or smoke.
- Wash hands before breaks and at the end of workday.
- Handle in accordance with good industrial hygiene and safety practice.

8.2.3. Environmental exposure controls

- Dispose of rinse water in accordance with local and national regulations.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

9.1.1. General Information

▪	Appearance	liquid
▪	Colour	colourless
▪	Odour	odourless
▪	Odour Threshold	No data
▪	Molecular weight	Range of values: 430 - 610

9.1.2. Important health safety and environmental information

▪	pH	No data
▪	pKa	No data
▪	Melting point/freezing point	not applicable
▪	Boiling point/boiling range	80 - 135 °C
▪	Flash point	The product is not flammable.
▪	Evaporation rate	No data
▪	Flammability (solid, gas)	No data
▪	Flammability	The product is not flammable.
▪	Explosive properties	Not explosive
▪	Vapour pressure	ca. 10.5 - 140 hPa

- **Vapour density** No data
- **Density** 1.69 - 1.72 g/cm³
Temperature: 25 °C
- **Relative density** No data
- **Bulk density** No data
- **Solubility(ies)** insoluble, Water
insoluble, fluorinated solvents
- **Solubility/qualitative** No data
- **Partition coefficient: n-octanol/water** No data
- **Auto-ignition temperature** No data
- **Decomposition temperature** > 290 °C
- **Viscosity** ca. 0.95 - 1.7 mPa.s
- **Oxidizing properties** Non oxidizer

9.2. Other information

Remarks No data

SECTION 10. STABILITY AND REACTIVITY

10.1. Reactivity

- No dangerous reaction known under conditions of normal use.

10.2. Chemical stability

- Stable under recommended storage conditions.
- Metals promote and lower decomposition temperature
- In presence of titanium and its alloys the decomposition temperature decreases to 260°C.

10.3. Possibility of hazardous reactions

- No dangerous reaction known under conditions of normal use.

10.4. Conditions to avoid

- Avoid to use in presence of high voltage electric arc and in absence of oxygen.
- Keep away from flames.
- To avoid thermal decomposition, do not overheat.

10.5. Incompatible materials

- non-aqueous alkalis, Lewis acids (Friedel-Crafts) above 100°C, Aluminum and magnesium in powder form above 200°C

10.6. Hazardous decomposition products

- Gaseous hydrogen fluoride (HF), Fluorophosgene

SECTION 11. TOXICOLOGICAL INFORMATION

11.1. Acute toxicity

11.1.1. Acute oral toxicity

- LD50, rat, > 5,000 mg/kg

11.1.2. Acute inhalation toxicity

- LC50, rat, > 1,826 mg/l

11.1.3. Acute dermal toxicity

- LD50, rat, > 2,000 mg/kg

11.2. Skin corrosion/irritation

- rabbit, No skin irritation

11.3. Serious eye damage/eye irritation

- rabbit, No eye irritation

11.4. Respiratory or skin sensitisation

- guinea pig, Did not cause sensitisation on laboratory animals., Dermal

11.5. Germ cell mutagenicity

- Not mutagenic in Ames Test.
- Chromosome aberration test in vitro, negative

11.6. Carcinogenicity

- no data available

11.7. Reproductive toxicity

- no data available

11.8. Specific target organ toxicity - single exposure

- Remarks: no data available

11.9. Specific target organ toxicity - repeated exposure

- Oral, 28 d, rats, > 1000 mg/kg, Remarks: NOEL
- Remarks: Subacute toxicity

11.10. Aspiration hazard

- no data available

11.11. Other information

- Description of possible hazardous to health effects is based on experience and/or toxicological characteristics of several components.
- The product is biologically inert.
- Thermal decomposition can lead to release of toxic and corrosive gases.
- Exposure to decomposition products
- Causes severe irritation of eyes, skin and mucous membranes.

SECTION 12. ECOLOGICAL INFORMATION**12.1. Toxicity**

- no data available

12.2. Persistence and degradability**12.2.1. Abiotic degradation**

- Result: no data available

12.2.2. Biodegradation

- no data available

12.3. Bioaccumulative potential

- Result: no data available

12.4. Mobility in soil

- no data available

12.5. Results of PBT and vPvB assessment

- no data available

12.6. Other adverse effects

- Ecological injuries are not known or expected under normal use.

SECTION 13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

- Can be incinerated, when in compliance with local regulations.
- The incinerator must be equipped with a system for the neutralisation or recovery of HF.
- Dispose of in accordance with local regulations.

13.2. Contaminated packaging

- Empty containers can be landfilled, when in accordance with the local regulations.

SECTION 14. TRANSPORT INFORMATION

International transport regulations

- Sea (IMO/IMDG)
- not regulated
- Air (ICAO/IATA)
- not regulated
- European Road/Rail (ADR/RID)
- not regulated
- Inland waterway transport
- not regulated

SECTION 15. REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, as amended
- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), as amended
 - European Waste Catalogue
 - Waste codes should be assigned by the user based on the application for which the product was used.

15.1.1. Notification status

Inventory Information	Status
USA. Toxic Substances Control Act (TSCA)	- Listed on inventory
Australia. Inventory of Chemical Substances (AICS)	- Listed on inventory
Canada. Domestic Substances List (DSL)	- Listed on inventory
Korea. Existing Chemicals Inventory (KECI (KR))	- Listed on inventory
China. Inventory of Existing Chemical Substances (IECSC)	- Listed on inventory
Japan. Industrial Safety & Health Law Inventory (ISHL (JP))	- Listed on inventory
Japan. Inventory of Existing & New Chemical Substances (ENCS)	- Listed on inventory
Philippine. Inventory of Chemicals and Chemical Substances (PICCS)	- Listed on inventory
New Zealand. Inventory of Chemicals (NZIOC)	- Listed on inventory
Taiwan. National Existing Chemical Substance Inventory (NECSI)	- Listed on inventory
EU. European Registration, Evaluation, Authorisation and Restriction of Chemical (REACH)	- If product is purchased from Solvay in Europe it is in compliance with REACH, if not please contact the supplier.

15.2. Chemical Safety Assessment

- A Chemical Safety Assessment is not required for this substance.

SECTION 16. OTHER INFORMATION

16.1. Other information

- New (SDS)
- Distribute new edition to clients

This SDS is only intended for the indicated country to which it is applicable. The European SDS format compliant with the applicable European legislation is not intended for use nor distribution in countries outside the European Union with the exception of Norway and Switzerland. Safety datasheets applicable in other countries/regions are available upon request.

The information given corresponds to the current state of our knowledge and experience of the product, and is not exhaustive. This applies to product which conforms to the specification, unless otherwise stated. In this case of combinations and mixtures one must make sure that no new dangers can arise. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and protection of human welfare and the environment.

Print Date: 28.10.2014

End of SDS

12.4 ETHYLENE GLYCOL

ThermoFisher
SCIENTIFIC

SAFETY DATA SHEET

Creation Date: 02-Feb-2010

Revision Date: 17-Jan-2018

Revision Number 4

1. Identification

Product Name Ethylene glycol

Cat No. : E177-4; E177-20

CAS-No 107-21-1

Synonyms Monoethylene glycol; 1,2-Ethanediol

Recommended Use Laboratory chemicals.

Uses advised against Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet**Company**

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number

CHEMTRECO, Inside the USA: 800-424-9300
CHEMTRECO, Outside the USA: 001-703-527-3887

2. Hazard(s) Identification**Classification**

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute oral toxicity	Category 4
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2

Label Elements**Signal Word**

Warning

Hazard Statements

Harmful if swallowed
May cause drowsiness or dizziness
May cause damage to organs through prolonged or repeated exposure



Precautionary Statements

Prevention

Wash face, hands and any exposed skin thoroughly after handling
 Do not eat, drink or smoke when using this product
 Do not breathe dust/fume/gas/mist/vapors/spray
 Use only outdoors or in a well-ventilated area

Response

Get medical attention/advice if you feel unwell

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
 Call a POISON CENTER or doctor/physician if you feel unwell

Ingestion

IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell

Rinse mouth

Storage

Store in a well-ventilated place. Keep container tightly closed

Store locked up

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

WARNING. Reproductive Harm - <https://www.p65warnings.ca.gov/>.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Ethylene Glycol	107-21-1	>95

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur.
Inhalation	Move to fresh air. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Get medical attention immediately if symptoms occur. If not breathing, give artificial respiration.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms and effects	Breathing difficulties.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Unsuitable Extinguishing Media No information available
Flash Point 111 °C / 231.8 °F
Method - DIN 51758

Autoignition Temperature 413 °C / 775.4 °F

Explosion Limits
Upper 15.30 vol %
Lower 3.20 vol %
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products

Carbon monoxide (CO) Carbon dioxide (CO₂)

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full

protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	1	1	N/A

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment.

Environmental Precautions Should not be released into the environment. See Section 12 for additional ecological information.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling Wear personal protective equipment. Ensure adequate ventilation. Do not breathe vapors or spray mist. Avoid contact with skin, eyes and clothing.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
ethylene glycol	TWA: 25 ppm STEL: 50 ppm STEL: 10 mg/m ³	(vacated) Ceiling: 50 ppm (Vacated) Ceiling: 125 mg/m ³		Ceiling: 100 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

OSHA - Occupational Safety and Health Administration

Engineering Measures

Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment**Eye/face Protection**

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection

Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Viscous liquid Liquid
Appearance	Colorless
Odor	Odorless
Odor Threshold	No information available
pH	5.5-7.5 50% aq. sol
Melting Point/Range	-13 °C / 8.6 °F
Boiling Point/Range	196 - 198 °C / 384.8 - 388.4 °F @ 760 mmHg
Flash Point	111 °C / 231.8 °F
Method -	DIN 51758
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	15.30 vol %
Lower	3.20 vol %
Vapor Pressure	0.12 mmHg @ 20 °C
Vapor Density	2.14 (Air = 1.0)
Specific Gravity	1.113
Solubility	miscible
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	413 °C / 775.4 °F
Decomposition Temperature	> 500°C
Viscosity	21 cP (20°C)
Molecular Formula	C2 H6 O2
Molecular Weight	62.06

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Hygroscopic.
Conditions to Avoid	Incompatible products. Excess heat. Exposure to moist air or water.
Incompatible Materials	Strong oxidizing agents, Strong acids, Strong bases, Aldehydes
Hazardous Decomposition Products	Carbon monoxide (CO), Carbon dioxide (CO2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological Information

Acute Toxicity

Product Information Component Information

Component	LD50 Oral	LD50 Dermal	LD50 Inhalation
Ethylene glycol	7712 mg/kg (Rat)	9530 µL/kg (Rabbit) 10600 mg.kg (Rat)	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation May cause eye, skin, and respiratory tract irritation

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Ethylene glycol	107-21-1	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Central nervous system (CNS)

STOT - repeated exposure Kidney Liver

Aspiration hazard No information available

Symptoms/effects, both acute & delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological Information

Ecotoxicity

Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Ethylene glycol	EC50: 6500 - 13000 mg/L, 96h (Pseudokirchneriella subcapitata)	LC50: = 16000 mg/L, 96h static (Poecilia reticulata) LC50: 40000 - 60000 mg/L, 96h static (Pimephales promelas) LC50: = 40761 mg/L, 96h static (Oncorhynchus mykiss) LC50: = 41000 mg/L, 96h (Oncorhynchus mykiss) LC50: 14 - 18 mL/L, 96h static (Oncorhynchus mykiss) LC50: = 27540 mg/L, 96h static (Lepomis macrochirus)	Not listed	EC50: = 46300 mg/L, 48h (Daphnia magna)

Persistence and Degradability	Persistence is unlikely
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Ethylene glycol	-1.93

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.
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14. Transport information

DOT	Not regulated
TDG	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Ethylene glycol	X	X	-	203-473-3	-		X	X	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).

Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 Threshold Values %
Ethylene glycol	107-21-1	>95	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Ethylene glycol	X		-

OSHA Occupational Safety and Health Administration Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Ethylene glycol	5000 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Ethylene glycol	X	X	X	X	-

U.S. Department of Transportation

Reportable Quantity (RQ): Y
 DOT Marine Pollutant N
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade Slight risk, Grade 1

16. Other information

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Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS