NIKOLA 3K/5K

Efficient and Reliable Temperature Control for Plasma Etch

Product Manual

Solid State COOLING SYSTEMS
Temperature Control...Precisely.

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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

Nikola 3K/5K (all models)

meets the provisions of the directives:

IEC/EN 61000-4-2 Electrostatic Discharge Immunity
IEC/EN 61000-4-3 Radiated Radio Frequency (RF) Immunity
IEC/EN 61000-4-4 Electrical Fast Transient/Burst Immunity
IEC/EN 61000-4-5 Surge Immunity
IEC/EN 61000-4-6 Conducted RF Disturbance Immunity
CFR Title 47 FCC Part 15 Subpart B, Class A
ICES-003, Issue 5, Class A
AS/NZS CISPR 11:2009 per EN 55011:2009 + A1:2010
EN 61326-1:2013 per EN55011:2009 + A1:2010
Group 1 Class A Equipment

EN 61010-1: 3rd Edition Safety Low Voltage Directive Safety requirements for electrical equipment for measurement, control, and laboratory use.

Lloyd F Wright Chief Technology Officer	
Date	July 8, 2015

SYMBOLS USED ON THE PRODUCT

SYMBOLS ON THE PRODUCT

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

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

SYMBOLS IN THE 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

- Operation of the Nikola 3K/5K in any manner not recommended in this manual could compromise the safety of operating personnel.
- Never disassemble the Nikola 3K/5K unit as irreparable damage may occur.
- Never store the Nikola 3K/5K Chiller over 50 °C.
- Never operate the Nikola 3K/5K Chiller over 80 °C.
- Never operate the coolant within 5°C above its freezing point.
- Never ship the chiller with water inside the liquid cold plate as freezing temperatures may be encountered which would damage the unit. For drainage information, see Section 5.3.

Solid State COOLING SYSTEMS
*Temperature Control...***Precisely.**

PRODUCT MANUAL

NIKOLA 3K/5K INSTALLATION OPERATION

1.0 GENERAL INFORMATION

The Nikola 3K/5K is a thermoelectric recirculating liquid chiller with full Proportional Integral Derivative (PID) temperature control coolant for both cooling and heating. Two cooling capacities are available: the 3K with 3,000 watts of cooling and the 3K/5K with 5,000 watts of cooling. Two pump are also available: an energy efficient turbine pump capable of pressures up to 45 psig and a high pressure turbine pump capable of pressures up to 110 psig.

The Nikola 3K/5K has several tool interface options, including Lam ADIO, Lam Analog 2, AMAT CHX, AMAT analog, AMAT J100 analog, TEL Unity II, TEL Unity M, TEL Telius, and RS-232. Contact SSCS for more details.

The system provides PID coolant pressure control allowing the customer to optimize pump performance for their application. The Nikola 3K/5K is environmentally friendly eliminating Freon or replacement refrigerants and consuming up to 80% less power than comparable Freon-based chillers. It reduces operating costs, saving on energy, water and air conditioning needs.

All internal wetted materials and the pump are compatible with DI water/glycol coolants as well as fluorinated heat transfer oils such as Solvay's Galden or 3M's Fluorinert and HFE products.

The system has been designed for long life and ease of use. The only moving parts are one pump and two fans.

2.0 SPECIFICATIONS

Coolant Operating Temperature Range:	-10°C to 80°C, (70 - 80°C operation requires Galden/Fluorinert and -2 High Pressure Turbine Pump)
Coolant Type:	Fluorinert FC fluids, NOVEC 7000 series fluids (HFE), Galden HT fluids, ethylene/propylene glycol/water or DI Water (requires DI water pump -2WA)
Set Point Range:	-20°C to 80 °C
Control Accuracy:	± 0.05 °C at constant load
Coolant Pump Type:	Magnetically Coupled Peripheral Turbine
Coolant Flow Rate:	Up to 10 gpm (see figure 1B)
Coolant Fluid Connections:	3/4" Swagelok, (316 stainless steel)
Drain Connection:	1/4" Swagelok (316 stainless steel)
Tank Volume:	2.6 gallons (10 liters)
Facility Cooling Water Required:	16-23 lpm (4-6 gpm), 7°C - 25°C, filtered, treated recirculating facility cooling water, pH 6.5 – 8.2
Facility Cooling Water Connections:	3/4" Swagelok (316 Stainless Steel)
N2/CDA Required:	500sccm -30°C dew-point or lower CDA or N2, 30-60 psig (2-4 bar)
Power Required:	200-240V +/-5%, ~ 3 phase, 20A, 50/60 Hz
Circuit Breaker:	25 AMP 240VAC 3 Pole/30mA Ground Fault Leakage Current Interrupt
Remote EMO:	External dry contact
Dimensions:	Height: 35.5", 903mm (with casters) Width: 22.5", 572mm Depth: 31.0", 786mm
Weight:	300 lbs. (Dry)
External Tool Interface Options:	LAM Research ADIO Applied CHX, Applied analog and Applied J100 analog TEL Unity II, TEL Unity M, TEL Telius
Safety Certifications:	EN 61010-1: 3rd Edition, Semi S2

2.1 NIKOLA 5K COOLING CAPACITY CURVES

Figure 1A: Nikola 5K Cooling Capacity with 50/50 Water/Ethylene Glycol

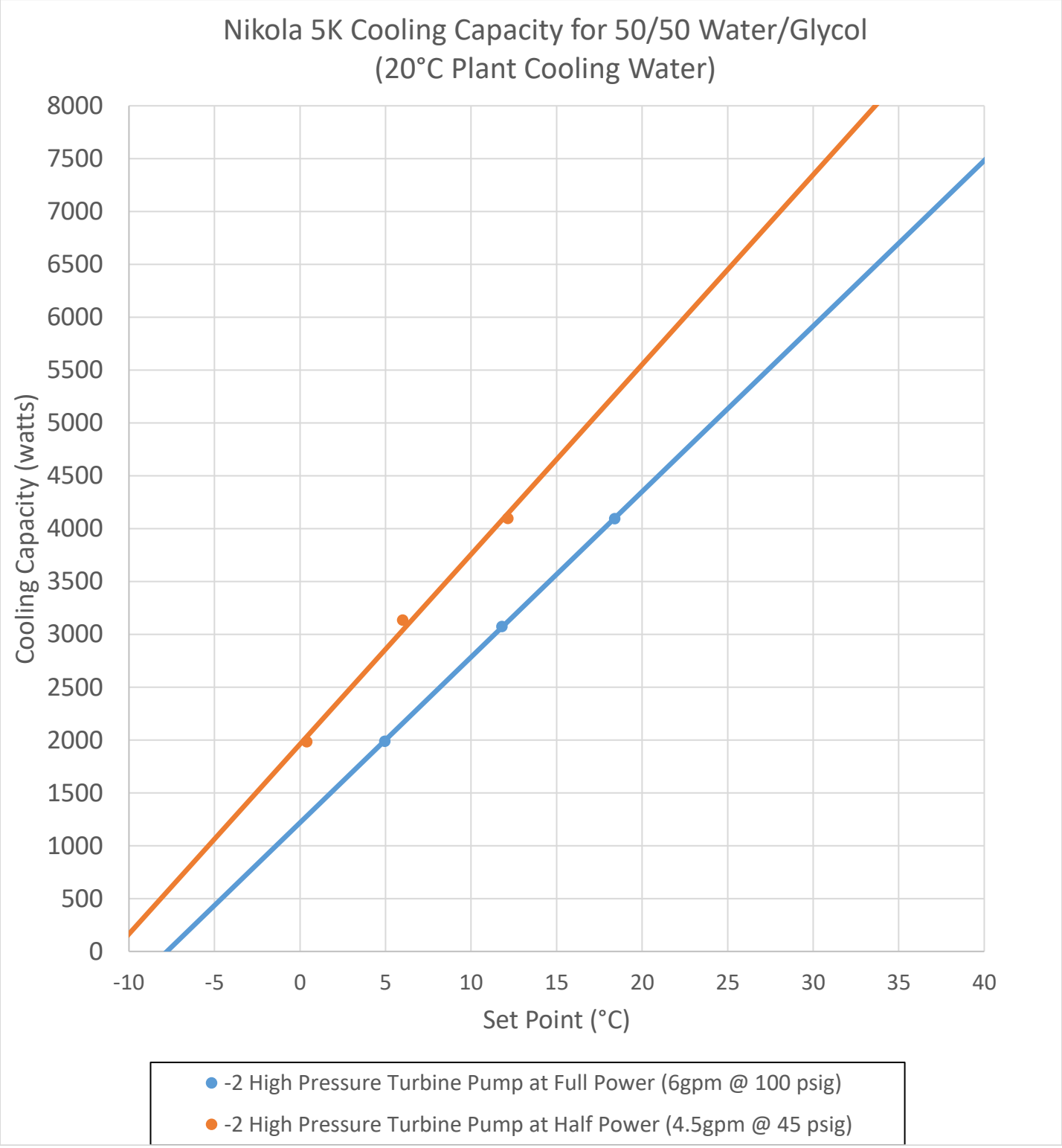
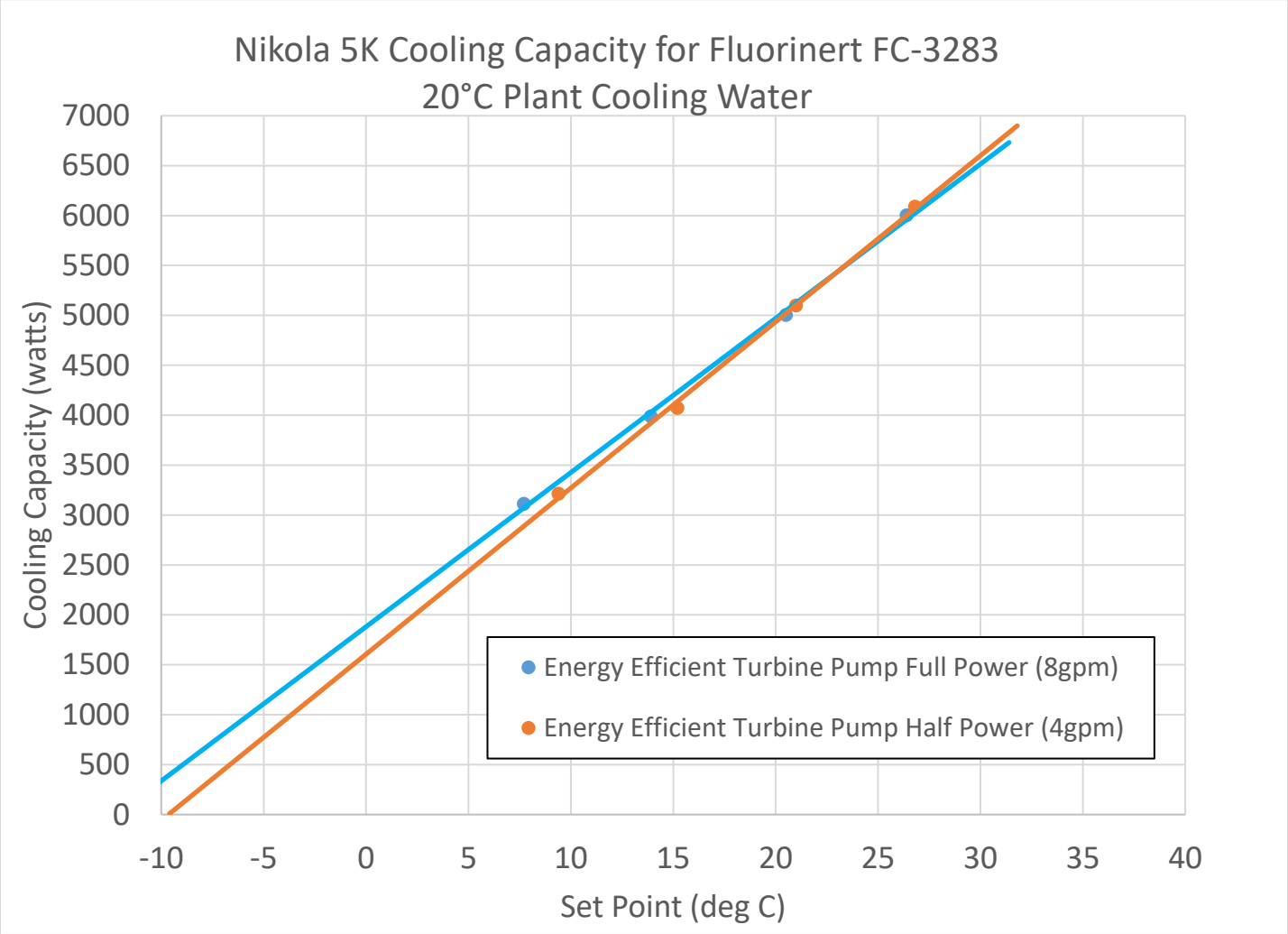


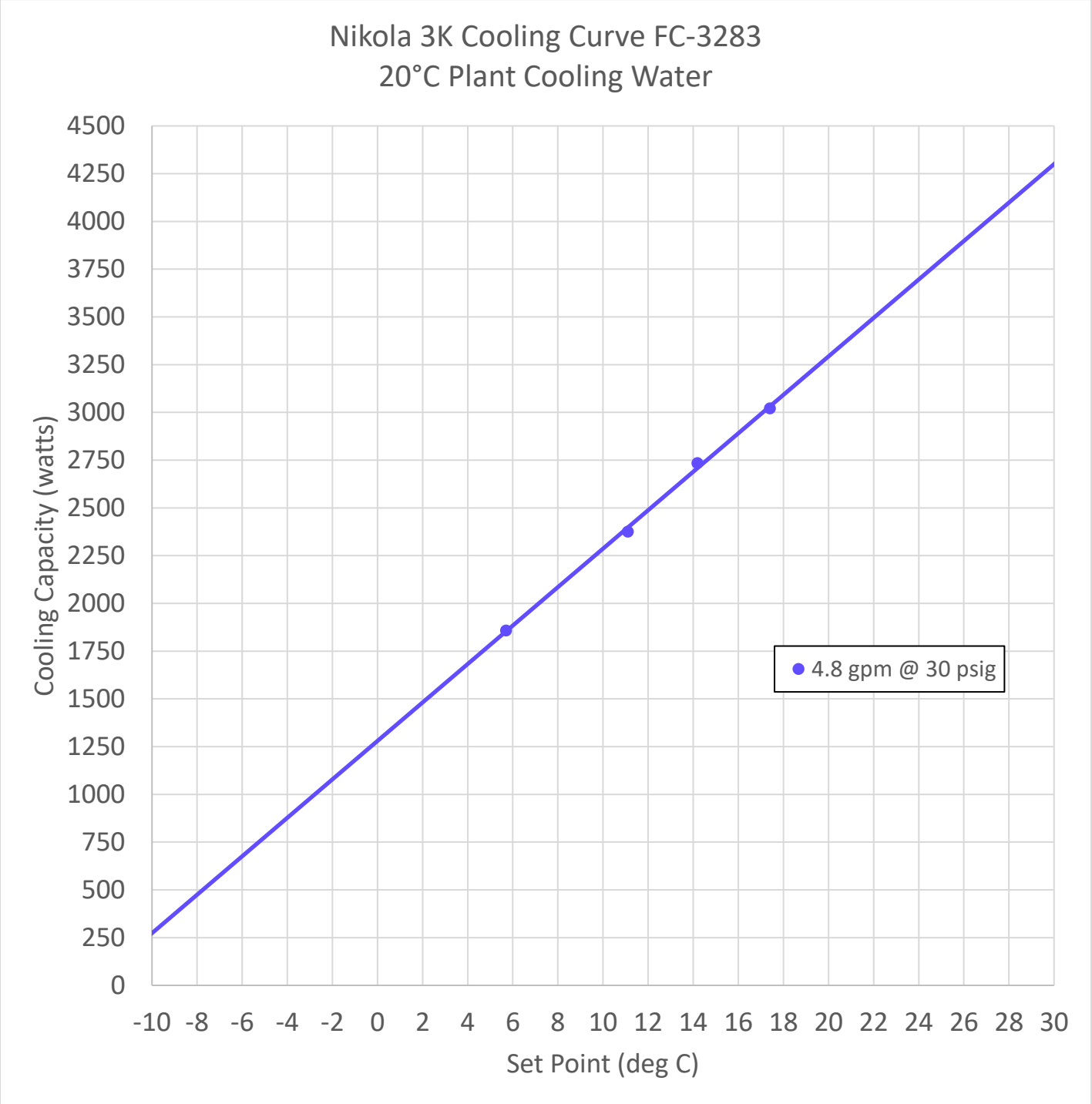
Figure 1B: Nikola 5K Cooling Capacity with Fluorinert or Galden Fluids



Note: Running the high pressure turbine pump can reduce cooling capacity by up to 1200 watts

2.2 NIKOLA 3K COOLING CAPACITY CURVES

Figure 1C: Nikola 3K Cooling Capacity with Fluorinert or Galden Fluids



2.3 PUMP PERFORMANCE CURVES

Figure 2A: Nikola 3K/5K Pump Operating Window - 50/50 Water/Ethylene Glycol

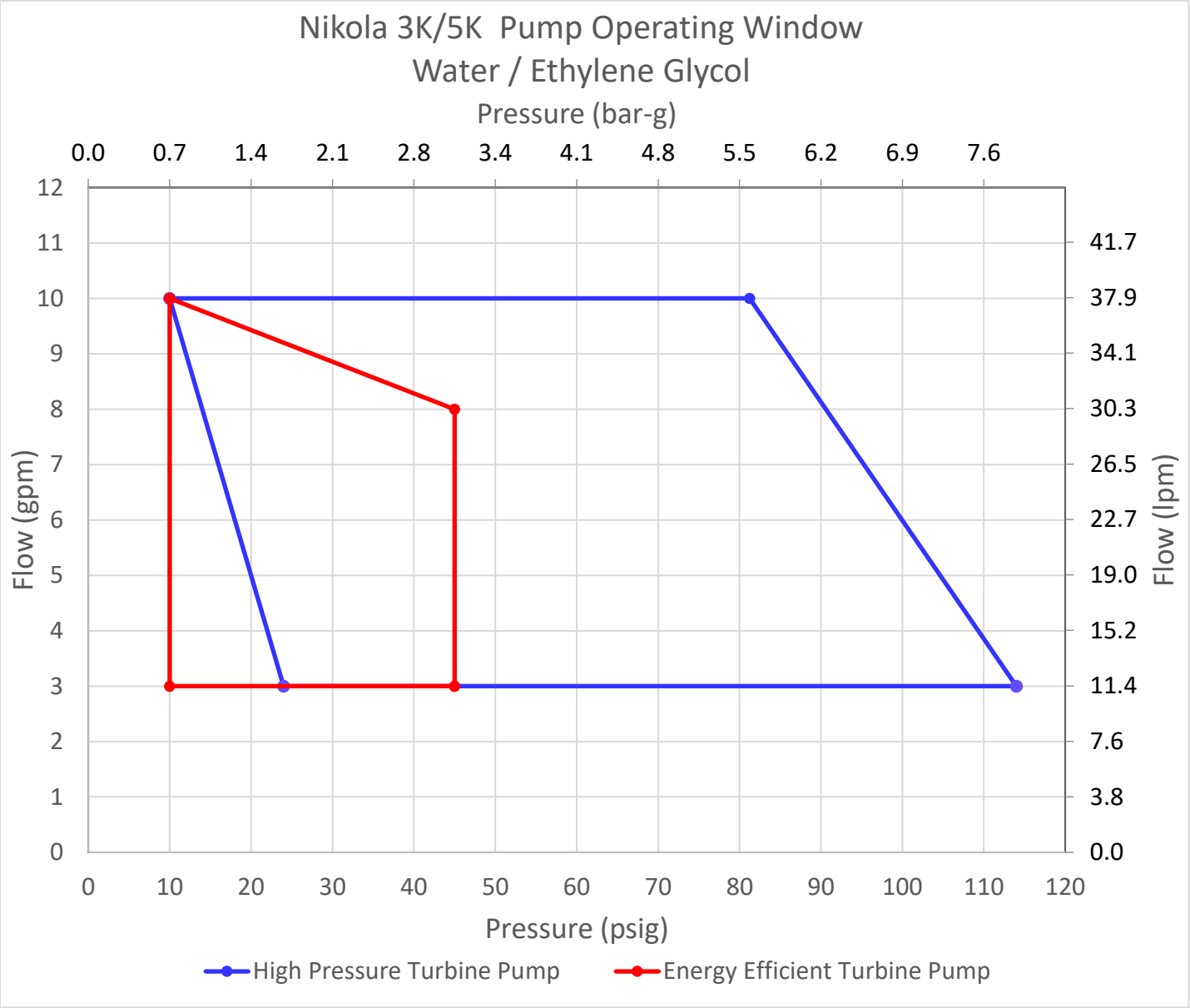


Figure 2B: Nikola 3K/5K Pump Operating Window 50/50 Water/Ethylene Glycol

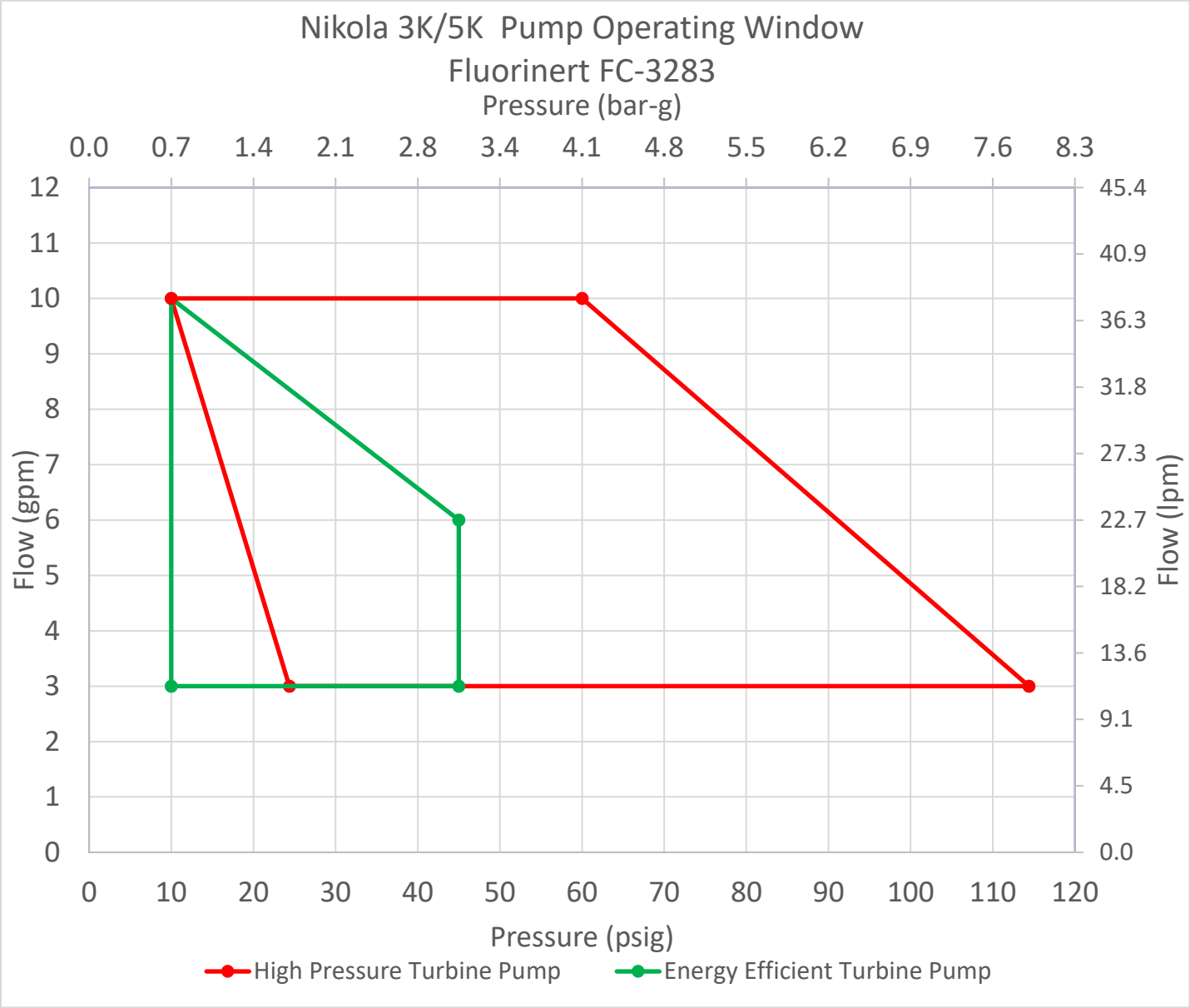
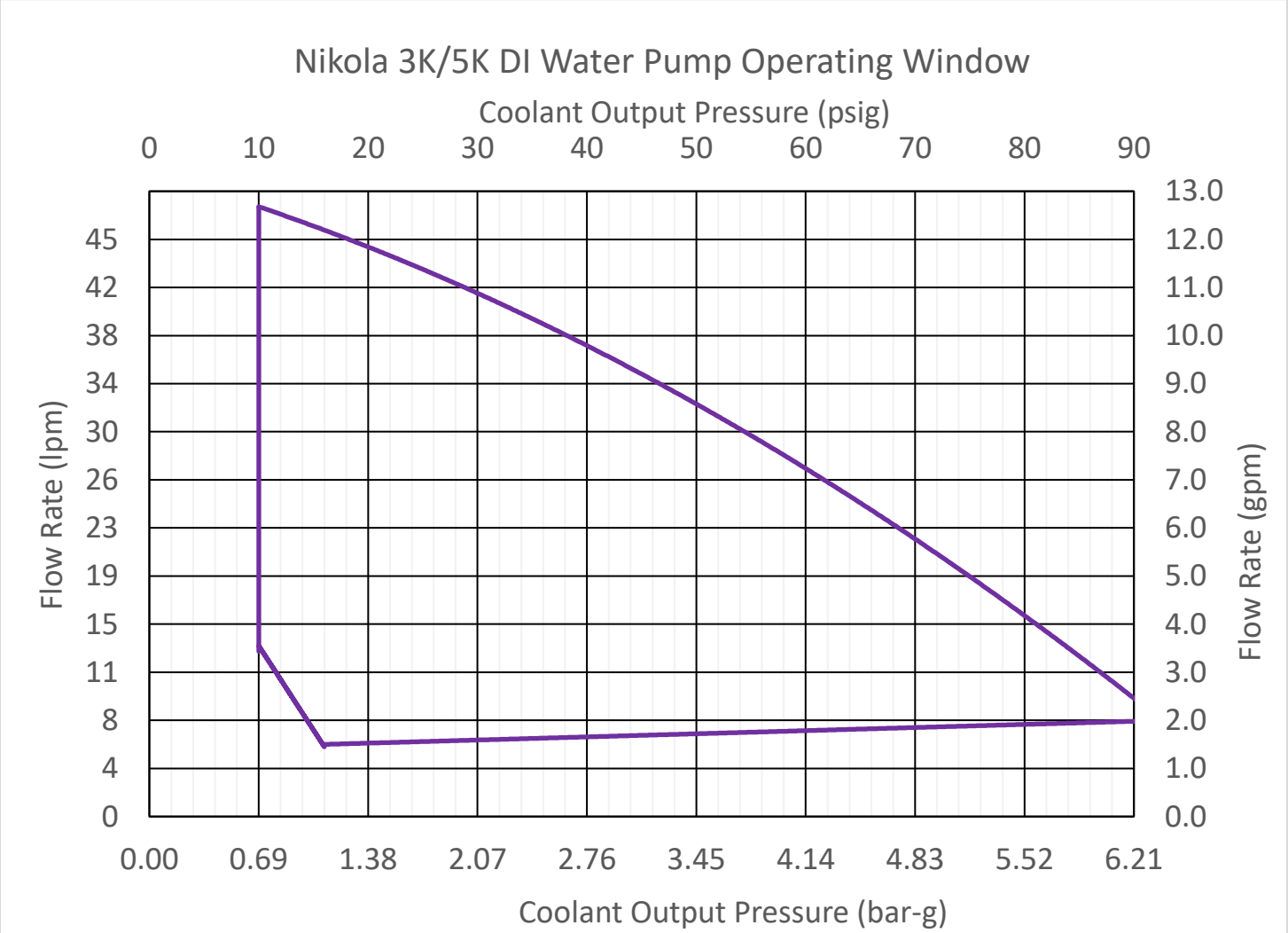


Figure 2C: Nikola 3K/5K Special 100% DI Water Pump[1] Operating Window

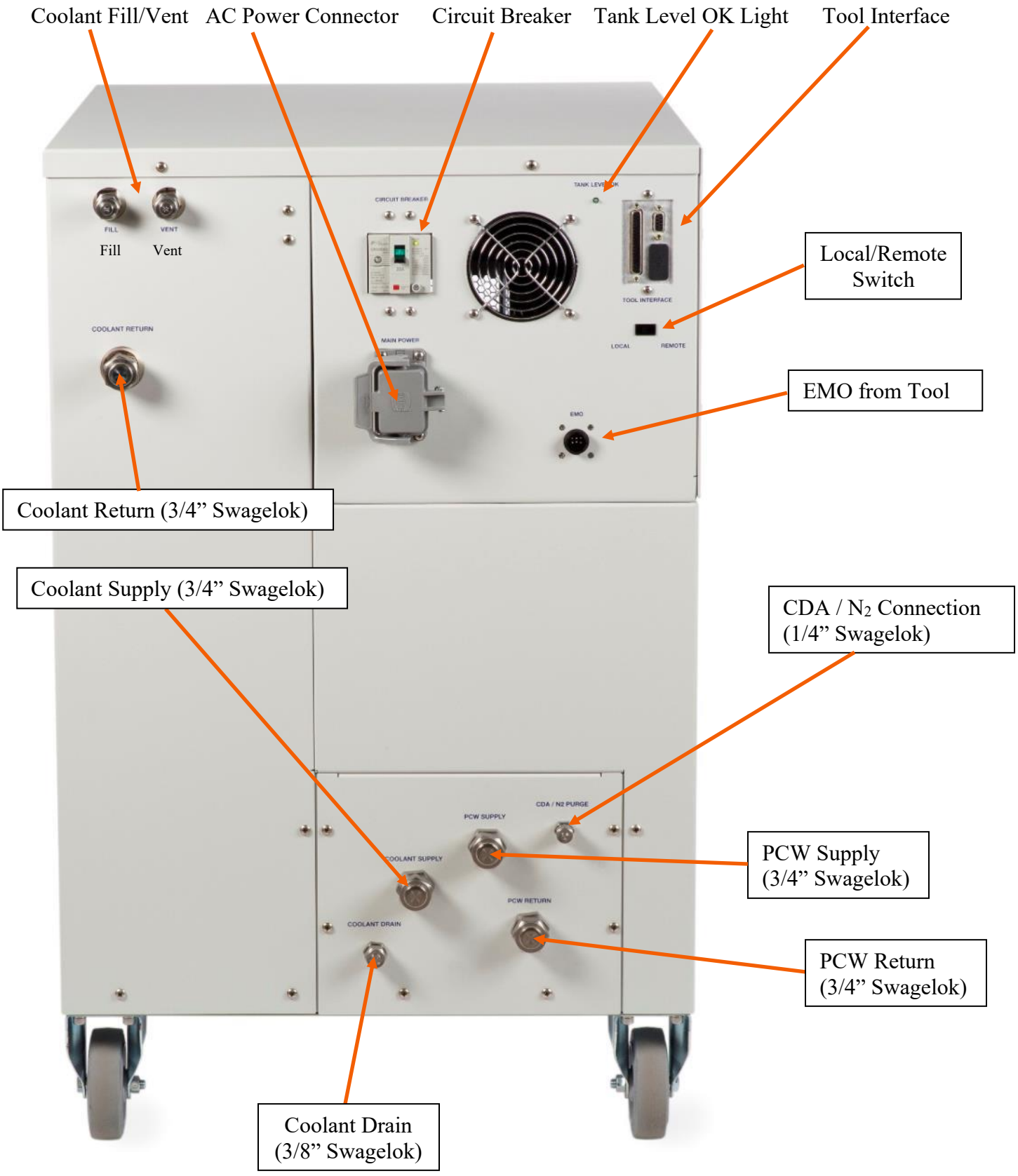


Note 1: Choose the "-2WA" pump when operating the Nikola 3K/5K with Pure DI water or DI Water/Ethylene Glycol mixtures with under 10% Glycol.

2.4 FRONT AND REAR VIEWS

Figure 3A: Front View

Figure 3: Rear View



3.0 INSTALLATION

3.1 ELECTRICAL CONNECTIONS

All electrical connections are made on the rear panel as seen in Figures 2B.

AC Power Connection: Connect 200-240 VAC/3phase power to the rear panel of the Nikola 3K/5K using the 20-foot service cable provided. Connect the bare end of the service cable as follows:

BLK 1: phase A
BLK 2: phase B
BLK 3: phase C
GRN/YEL: Earth Ground

Note: Phase angle is not important and one of the black conductors is not used.

The service cable connects to the Nikola 3K/5K using a Harting Han connector, which has contacts plus ground. Connector pin out:

Pin 1B: ph A
Pin 2B: ph B
Pin 3B: ph C
Pin 1A: Not used
Pin 2A: Not used
Pin 3A: Not used

Remote EMO: A remote EMO circuit may be connected to pin 5 and 6 on the 9-pin CPC connector provided, AMP #206708-1, to the socket labeled EMO. See Table 1. If no remote EMO circuit is available these two pins must be jumpered together or the Nikola 3K/5K will not turn on.

Table 1: Connector J4 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 tool (LAM only)
4	24 VAC Remote/Local Switch from tool return (LAM only)
5	Close contact from tool (remote EMO)
6	Closed Contact from tool return (remote EMO)
7	Spare
8	Spare
9	Spare

Local/Remote Switching: The chiller set point temperature can be entered using keys on the front user interface or remote using the tool interface card. The method of switching from using a locally entered set point to a remote one depends on the type of tool interface card used (this feature is not available in RS-232 units). See section 7.0 for details.

Fuses: The Nikola 3K/5K 24V ~ transformer used in the EMO/input circuit is protected by two (2) 1 Amp fast-acting fuses, located inside the electrical module on the main DIN rail; labeled F1a & F1b. The fuse type is Littelfuse part number 312001.HXP.

The Allen-Bradley VFD motor controller is protected using three (3) 25 AMP fuses across the AC lines located inside the electrical module on the aux DIN rail and labeled F3. The fuse type is Ferraz Shawmut p/n HSJ10.

The 24VDC power supply is protected using two (2) 2 Amp fast-acting fuses, located inside the electrical module on the aux DIN rail labeled F2a & F2b. The fuse type is Littelfuse part number 312002.HXP.

3.2 TOOL INTERFACE CARDS

The Nikola 3K/5K can communicate with several different types of semiconductor equipment using the tool interface card. The electrical installation required, and the method of remote operation depends on the tool interface purchased with the Nikola 3K/5K. Tool interfaces may be changed should the Nikola 3K/5K be moved from one type of tool to another. Refer to Section 6 for information regarding tool interface options.

3.3 PLUMBING CONNECTIONS

The plumbing connections for the tank fill and vent ports are on the front panel of the system. All other plumbing connections are on the rear panel of the system. See Figure 2B. Several open end wrench sizes are required:

- 1 1/8”, 1 3/16”, 9/16”, 5/8”, 19mm

Coolant Connections: The coolant supply and return connections are made using ¾” stainless steel Swagelok fittings. They require a 1 1/8” open-ended wrench with a 1 3/16” open ended backing wrench. The coolant drain connection is made using a ¼” stainless steel Swagelok fitting. It requires a 9/16” open-ended wrench with a 5/8” backing wrench. These connections are located on the bottom right of the rear panel. The use of a drain valve is recommended. Swagelok part number SS-4P4T with port connector part number SS-401-PC.

Plant Cooling Water (PCW): Plant cooling water must be < 7-25 °C filtered and treated plant cooling water with a pH of 6.5-8.2 treated against calcium deposits. Plant cooling water connections are made using 3/4" stainless steel Swagelok fittings located on the right bottom of the rear panel. They require a 1 1/8"" open-ended wrench with a 1 3/16" back wrench. The PCW supply (in) connection is to the left of the return (out) connection. The required cooling flow rate is 4 – 6 gpm.

N_2/CDA: Connect a ¼" O.D. tube to the ¼" John Guest® Speed-fit fitting labeled CDA/N2 (see figure 2C). The dew point of the purge stream must be -30 °C or lower. A supply of 500sccm of 30-60 psig (2-4 bar) nitrogen or CDA is required. The N_2/CDA prevents ice build-up in the pump head when operating below 0°C.

Figure 3C: CDA/N_2 Facilities Connection

CDA/N_2 Connection: Remove the plug by pressing the small white ring and pulling out the plug.

Insert a 1/4" O.D. tube into the fitting shown. (Note: the tube should inserted 5/8", (16mm), into the fitting before bottoming out.

3.4 WETTED MATERIAL COMPATIBILITY

Plant Cooling Water (PCW): The Nikola 3K/5K PCW lines are made from stainless steel and aluminum coated with a Teflon impregnated anodization corrosion resistant coating. The chiller is compatible with filtered plant cooling water with a pH of 6.5-8.2 treated against calcium deposits.

Coolant: The Nikola 3K/5K process 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 0.1 meg-ohm cm and 10 meg-ohm cm.

3.5 AIR CONSIDERATIONS

The Nikola 3K/5K requires one-foot clearance for proper air circulation to cool its electronics and pump. Refer to Figure 2B.

4.0 COOLANT FILL AND START-UP

4.1 COOLANT TYPE

The Nikola 3K/5K is designed to run with a fluorinated heat transfer fluid (or DI Water / Glycol mix) as the coolant. Selection is important to the proper operation of the Nikola 3K/5K and is dependent on the fluid set point desired. Note that the Nikola 3K/5K systems are configured for a specific fluid type, which is reflected in the part number of the system. A "W" in the part number indicated the system was configured for DI Water / Glycol. Operation with the wrong coolant can lead to cavitation in the pump and premature failure. Table 2 below lists the recommended coolant types:

Table 2: Recommended Cooling Types

Set Point Temperature	3M Fluorinert® Coolant Type	3M Novec® Coolant Type	Galden® Coolant Type	DI Water/Glycol % Ethylene Glycol
-10 to 20 °C	FC – 72	HFE-7100, 7200 or 7500	None Tested	50%
10 to 50°C	FC-77	HFE – 7500	HT-110	0 - 50%
20 to 80°C	FC-3283	HFE-7500	HT-200	Not Recommended above 50°C due to low resistivity

4.2 FILL/START-UP

Once installation has been completed as per Section 4, follow the instructions below for filling the tank with coolant and starting the Nikola 3K/5K.

The Nikola 3K/5K has a 2.6 gallon (10 liter) tank.

1) Turn on the facility water flow (5-6 gpm recommended.)
2) Using 19mm (3/4") open-ended wrench, remove the Swagelok cap on the Tank Vent Fill ports.
3) Connect the funnel provided with the Nikola 3K/5K system to the Fill port, hand tighten only.
4) Turn on power to the Nikola 3K/5K pressing the green ENABLE button located on the front panel of the system. The front display will show "Tank Level Empty".
5) Fill the tank with 2½ - 3 gallons of coolant until the green Tank Level Ok light comes on.
6) Turn off AC power for 30 seconds, then turn back on to clear the tank level empty. Important note: If you do not wait 30 seconds prior to turning the power back on, you may receive a VFD Fault alarm.
7) Check to see that all exterior valves attached to the coolant lines are open.
8) Press the 'START' button to begin operation.
9) If the Tank Level Ok light goes out, add more coolant through the funnel until the Tank Level Ok light comes back on.
10) Remove the coolant funnel and replace the Swagelok cap on the fill port. Tighten the cap ¼ turn past hand tight. Allow the chiller to operate at set-point for two hours, then replace the Swagelok cap on the vent port. Tighten the cap ¼ turn past hand tight.

Note: At the initial startup or when changing the set-point the Nikola 3K/5K tank should be vented (by removing the cap) for a period of two hours to equalize the pressure caused by dissolved gases. Tighten the caps ¼ turn past hand tight once equilibrium has been reached.

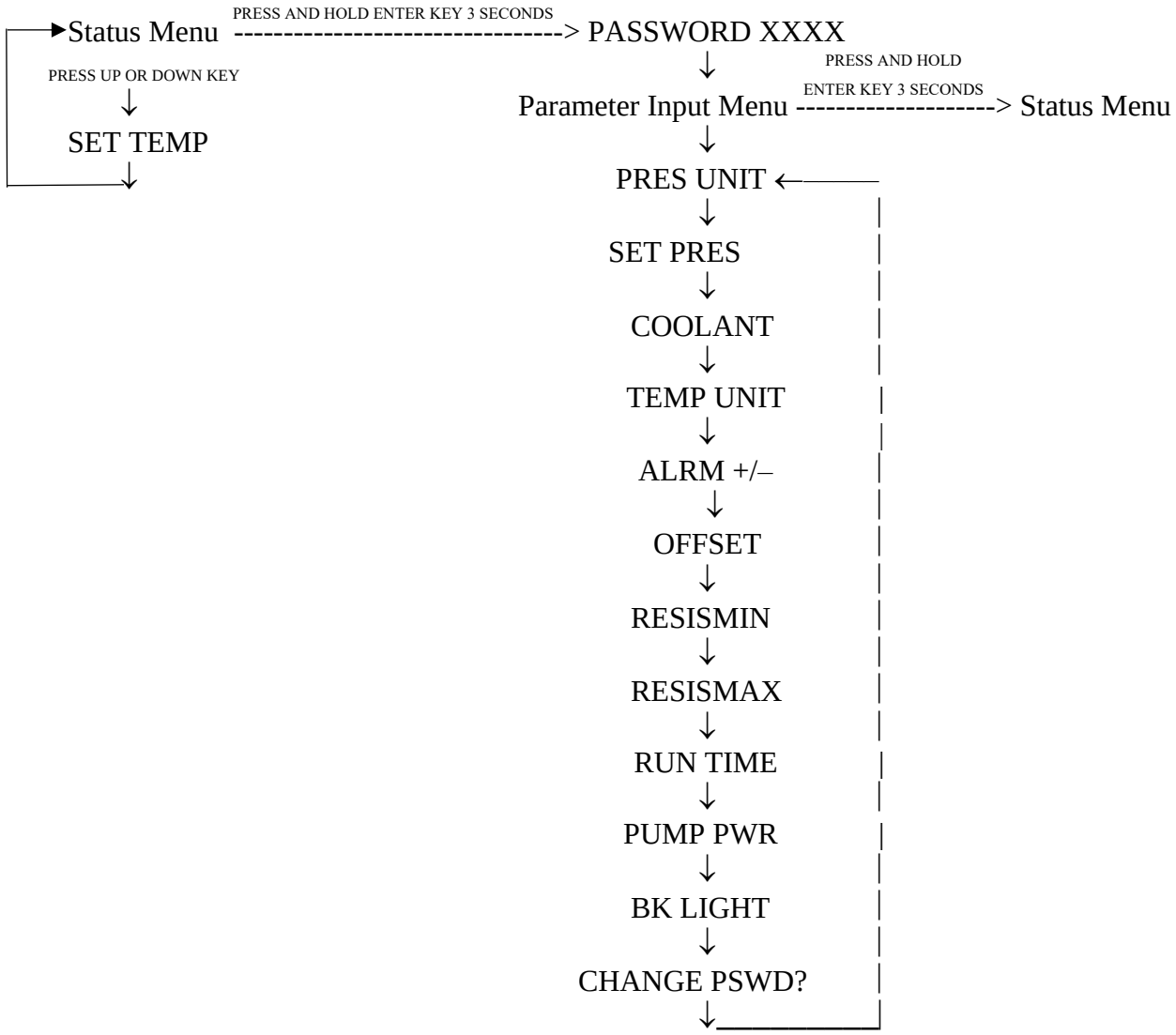
5.0 OPERATION

5.1 INTRODUCTION

The Nikola 3K/5K is operated using a series of screens on the controller display located on the front panel of the system as shown in Figure 2A. The screens are manipulated by using the blue buttons beneath the display screen. Each button function corresponds to the symbol displayed above it. Figure 4 below shows the system status screen on the display with the blue buttons underneath that manipulate the screen.

The Nikola 3K/5K controller has two menus: the Status Menu and the Parameter Input Menu. The Status Menu shows the chiller operating status, (standby, heating, or cooling), current temperature of coolant leaving the chiller, the coolant supply (outlet) pressure, an indication of if the chiller operation is from the local keypad or remote from the tool, and any alarms or warnings present. The Parameter Input Menu allows input of the coolant pressure units, the pressure set-point, the coolant type, the temperature units, the temperature alarm range, the temperature offset (used to match the chiller temperature reading to the tool's reading), the resistivity warning levels (high and low) and the option of turning the display backlight on or off or entering a new password.

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.

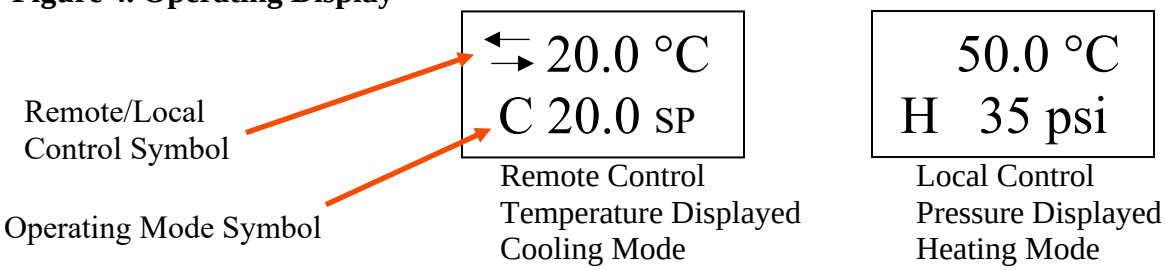
Press and hold ENTER key for 3 seconds to scroll between menus.
A 4-digit password is required to enter the Parameter Input Menu. **The Factory Default Password is 0000.** Use the UP or DOWN key to change individual numbers; use the ENTER key to enter each number and move to the next. If an incorrect 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 Nikola 3K/5K remotely via the tool interface card locks out the front keypad.

Status Menu: The status menu displays the chiller operating status mode, coolant temperature, and will flash between set point.

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 4. Operating Display



Remote Control
Temperature Displayed
Cooling Mode

Local Control
Pressure Displayed
Heating Mode

The coolant outlet temperature is shown on the top line in °C
The coolant outlet temperature is shown on the bottom in in psig or barg.

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.

PRES UNIT = Coolant outlet pressure units displayed when the enter key is pressed in the Status Menu, gpm or lpm. **Factory Default is gpm.**

SET PRES = Set point for coolant outlet pressure.

Factory Default Value: 45 psig.

COOLANT = Type of coolant used. This is used to calculate flow and pressure. Options are: Fluorinert, calibrated to FC-3283 **(Factory Default)** Galden, calibrated for Galden HT-200) 50/50WEG, calibrated for 50% water/ethylene glycol

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 Nikola 3K/5K by the amount entered. Range: +/- 0-15°C. Used to equalize the Nikola 3K/5K temperature displayed with tool's measured temperature. Once the Nikola 3K/5K 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 resistivity fault warning to the tool and the front display, units in megohm-cm. **Factory Default is 20M**

RUN TIME = Displays the total time the Pump has been running since leaving the factory. Note that the time increments by 10's of hours. Therefore the last digit will always be "0" and a number like 840 means the pump has been running for > 840, but < 850 hours.

PUMP PWR = Displays the current power consumption of the Pump in kWatts.

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.

5.2 ALARMS/INTERLOCKS

Standard Interlocks: The Nikola 3K/5K 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 Nikola 3K/5K to alarms and warnings is shown in Table 3. 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 9.

Table 3: Nikola 3K/5K Interlock Chart

Sensor/Interlock	Trip Level	Display	Action		Alarm Type
			TE Power	Pump	
Tank Level Low	open	Tank Low	On	On	Warn
Temp Alarm Out of Range	User Sets	> Or <	On	On	Warn
Coolant Resistivity Low	0.1 megΩcm	Resistiv Low	On	On	Warn[1]
Resistivity Sensor Fail	>20megΩcm	Resistiv Fault	On	On	Warn[1]
Tank Level Empty	open	Tank Empty	Off	Off	Soft
Facility Water Flow Low	open	PCW Flow Low	Off	On	Soft
RTD Fault	open	RTD Fault	Off	On	soft
Pump Fault	message	VFD Not Ready	Off	Off	Soft
GFCI	> 30 mA	None	Off	Off	Hard[2]
Coolant Overtemp	100 °C	None	Off	Off	Hard[2]
External EMO	Open	None	Off	Off	Hard[2]

Notes:

1) The Resistivity Low warning is an alarm for DI water units only. See section 5.3.2.
2) These alarms will shut off power to the Nikola 3K/5K via the main contactor, turning off the front display.

Resistivity Low Interlock (for water based coolants): The Nikola 3K/5K -1W DI water option includes a coolant resistivity sensor and resistivity low interlock for DI water based coolants. This interlock ties into the Nikola 3K/5K warning loop, sending a warning to the process tool and flashing Resistivity Low/High on the front display. See section 7.1 for more details.

5.3 DRAINING THE COOLANT

Use the following procedure to drain the Nikola 3K/5K of coolant:

1) Unscrew the tank vent cap (located on the front panel of the system.)
2) Connect a ¼" OD tube into the drain valve located to the left of the coolant supply line (rear panel). If this is a bare tube, insert the tube fully into the Swagelok nut on the valve and tighten clockwise 1¼ turns past hand tight.
3) Place the tube into a suitable container and open the drain valve.
4) A small amount of coolant will still remain in the tank 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 to the tank vent. Pressurize the tank with 10-15 psig of nitrogen. Shut off the nitrogen and re-open the drain valve. More coolant will drain out. Repeating this process three times will normally remove 90% of the coolant.

Caution: Do not pressurize the Nikola 3K/5K tank over 20 psig.

5.4 CLEANING THE NIKOLA 3K/5K

The external surfaces of the Nikola 3K/5K may be cleaned with a clean, dry cloth or a clean cloth with isopropyl alcohol. Do not clean the internal surfaces.

6.0 TOOL INTERFACE OPTIONS

The Nikola 3K/5K can communicate with several different types of semiconductor equipment using the tool interface card. The electrical hookup required and method of remote operation varies depending on the tool interface purchased with the Nikola 3K/5K. Tool interface cards may be changed should the Nikola 3K/5K be moved from one type of tool to another.

6.1 LAM INTERFACE CARD

The Lam Analog tool interface card is designed to operate with Lam Research Corporation® plasma-etch tools. This interface card is the Nikola 3K/5K default standard. The Lam Analog tool interface is through a 37-pin D-subminiature located on the rear panel. Refer to Figure 3B.

Remote EMO: A remote EMO circuit may be connected to pin 5 and 6 on the 9-pin CPC connector provided, AMP #206708-1, to the socket labeled EMO (See Table 4A). **If no remote EMO circuit is available, these two pins must be jumpered together or the Nikola 3K/5K will not turn on.**

Table 4A: EMO Connector Pin Description (Singular Channel 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: Switching from local to remote operation is accomplished by applying 24 VAC across pins 3 and 4 on the 9-pin CPC connector labeled EMO as shown in Table 4A. The chiller temperature set point can be entered using keys on the front display screen or remotely using the tool interface card.

The Local/Remote switch on the rear panel allows the user to manually switch between local and remote modes.

System Warning: The Nikola 3K/5K warning signal is available on the tool interface card. See Table 4B for "Warn" signal.

Temperature Alarm: The Nikola 3K/5K temperature alarm is available on the tool interface card. See Table 4B for "Alarm" signal.

Table 4B: Connector 72J1 Lam Analog Interface Card Pin Description

Pin Number	Signal Description
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	Nikola 3K/5K Fail, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
7	Nikola 3K/5K Fail Return
28	Nikola 3K/5K Warn, Normally Closed Opto-isolated transistor, Ic=125mA Vbce(off)=30V
9	Nikola 3K/5K Warn Return

Note: Any pins not identified above are spares.

6.2 LAM DUAL CHANNEL OPTION

WARNING

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

The dual channel chiller option allows control of two Nikola 3K chillers or one Nikola 3K and one ThermoRack 1201 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 chillers 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 12pins. Those with 16 pins require the –DC1 option while those with 10 or 12pins require the –DC1A option. (See table 4B for details.)

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

CAUTION

All electrical connections are made on the rear panel of each chiller.

AC Power Connections: Two separate power cables are required for the Dual Channel Option. Connect 200-240 V~ power to the rear of both Chillers via the 20ft service cables provided per section 3.1.

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 4C). 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 4C: Lam Dual Channel Chiller #1 Connector 72J2 Pin Description

Pin Number	Signal Description
1	Spare
2	Spare
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 4D.

Local/Remote Switching: Switching from local to remote operation on both chillers is accomplished by applying 24 VAC across pins 3 & 4 on the 9-pin CPC connector labeled 72J2 on Chiller #1 (see Table 4C). 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 4D "Warn" signal)

Temperature Alarm: Coolant temperature out of range warnings from both Thermorack channels are available on the tool interface card. (See Table 4D "Warn" signal)

System Alarms: System alarm signals from both Thermorack channels are available on the tool interface card. (See Table 4D "Warn" signal)

Table 4D: 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 3B). Failure to install this cable will prevent Chiller #2 from powering up and will cause Chiller #1 to lock-up and not control temperature.

6.4 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 Figure 5 and Table 5C, plus a 9-pin D-subminiature Female connector as shown in Figure 6 and Table 5B.

Figure 5: J2A interconnect cable

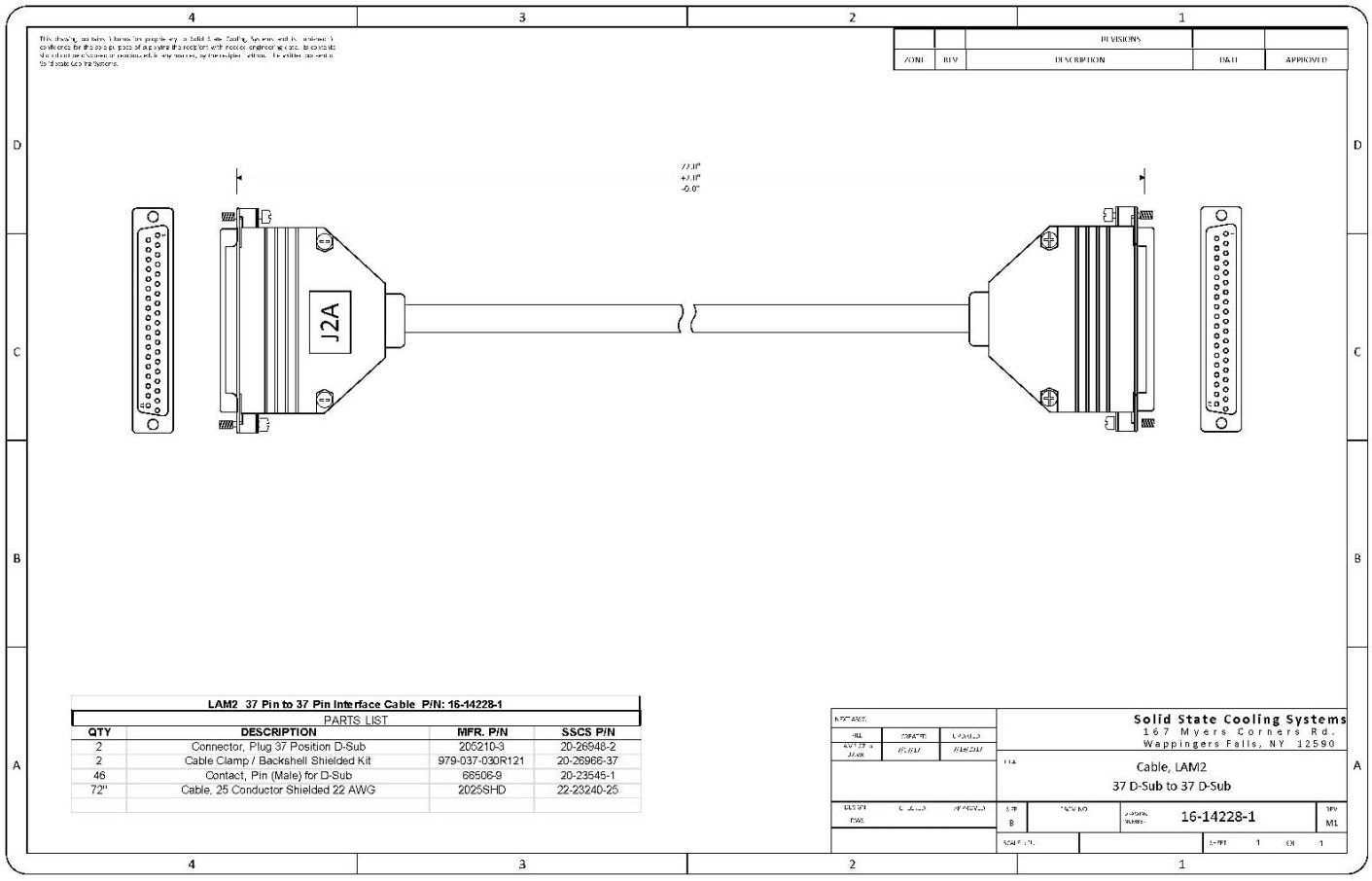


Table 5A: J2A Lam Analog to LonWorks® Converter 37-pin dsub connector

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
Spare	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(-)
Temperature Actual 2 Return	37	AIN3(-)

Figure 6: J2B interconnect cable

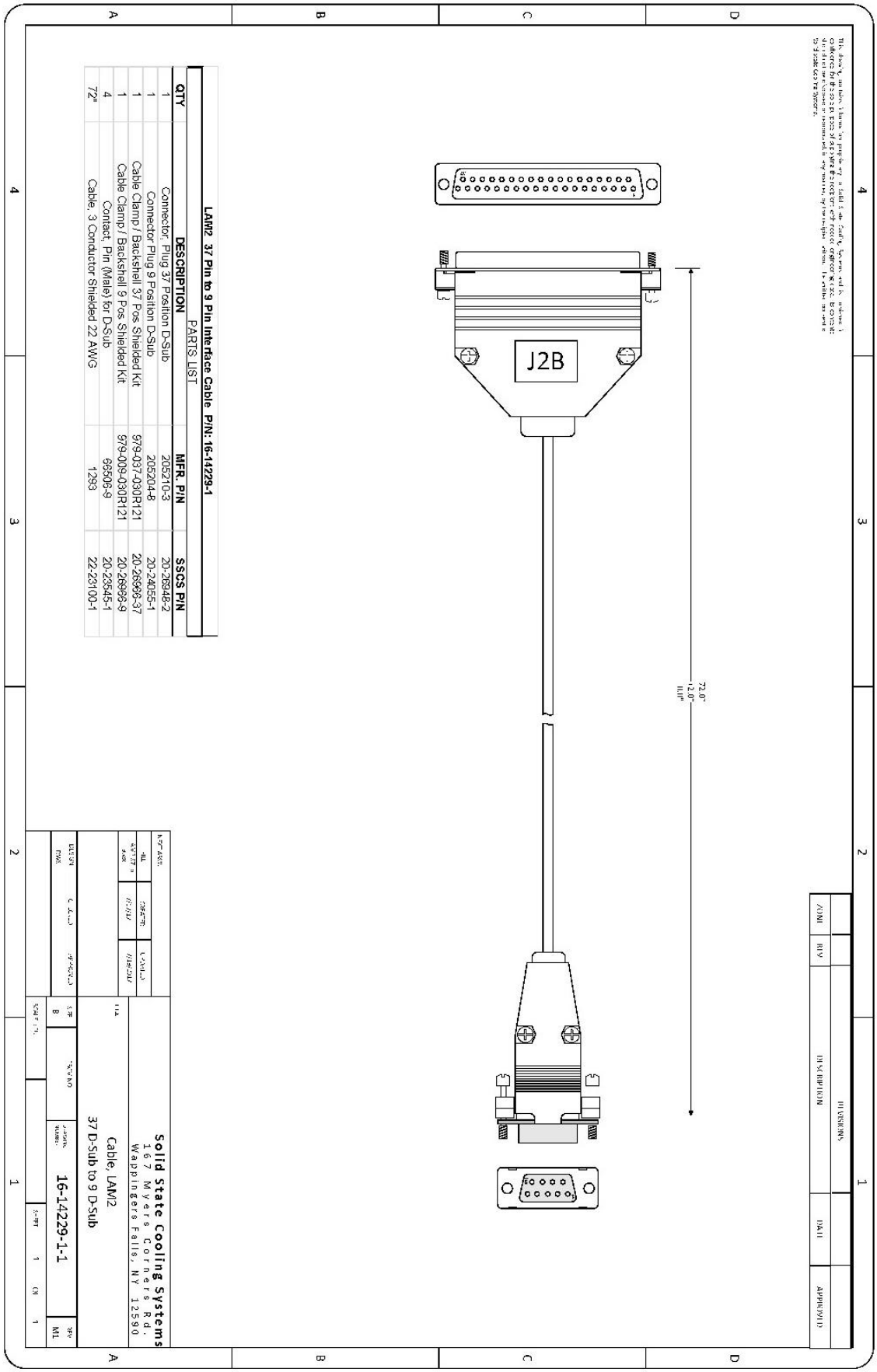


Table 5B: J2B Lam Analog to LonWorks® Converter Cable (Nikola 3K/5K end)

37 PIN D-SUB CONNECTOR	
FUNCTION	**PIN**
Notification Status	1
Spare	2
Spare	3
Spare	4
Spare	5
Spare	6
Spare	7
Spare	8
Source Supply Digital Inputs	9
Source Supply Digital Inputs	10
Not Used	11
Not Used	12
Not Used	13
Not Used	14
Not Used	15
Not Used	16
Not Used	17
Not Used	18
Not Used	19
Spare	20
Spare	21
Spare	22
Spare	23
Spare	24
Spare	25
Spare	26
Spare	27
Source Supply Digital Inputs	28
Not Used	29
Not Used	30
Not Used	31
Not Used	32
Not Used	33
Not Used	34
Not Used	35
Not Used	36
Not Used	37

9 PIN DSUB CONNECTOR		
FUNCTION	**PIN**	**SIGNAL NAME**
Notification Status	1	DI0
Source Supply For Digital Inputs	2	DI1
Spare	3	
Spare	4	
Spare	5	
Spare	6	
Spare	7	
Spare	8	
Spare	9	

6.5 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 3A). Table 6A shows the signal description for this connector.

Table 6A: Applied CHX RS-485 Pin Description

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

All pins not identified above are spares

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

Disconnect AC power from the Nikola 3K/5K via the circuit breaker.

Locate the AMAT CHX interface card at the left rear (viewed from the rear).

Enter the slave address for the Nikola 3K/5K using the red 4-position dipswitch. The Nikola 3K/5K address must match the chiller address on the Applied tool. The AMAT CHX bracket shows the dipswitch values for each address (1-16). A dipswitch in the right position is ON, while the left position is OFF. Table 6B shows the dipswitch setting for each address

Find the Local/Remote toggle switch on the Nikola 3K/5K back panel. Flip the switch to Remote.

Restart the Nikola 3K/5K chiller.

Table 6B: DIP Switch Settings for Slave (Chiller) Address

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 Note: The Nikola 3K/5K AMAT CHX interface card only transmits "Required Data" (as defined by the AMAT CHX specification), not the "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 Level Fault (digital input)

Optional CHX information not transmitted:

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

When installing the Nikola 3K/5K configure the Centura Controller to ignore optional data not transmitted on the heat exchanger configuration screen, located as follows:

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

Set all values to NO.

6.6 AMAT ANALOG –A3 (P5000) INTERFACE CARD

The AMAT Analog (-A3) interface allows the Nikola 3K/5K to communicate with an Applied Materials P5000 CVD or Etch tool. The Nikola 3K/5K may be connected as a Chiller or a Heat Exchanger. Table 7 shows the Signal Descriptions for each type.

Table 7: 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	Heat Exchanger ON/OFF 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)		

6.7 AMAT ANALOG –A4 (J100) INTERFACE CARD

The AMAT Analog (-A4) interface allows the Nikola 3K/5K 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 8A and 8B show the Signal Descriptions for each type.

Table 8A: -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	Chiller Alarms - Level/Flow/RTD/PCW Flow	COM, B/C Chamber
12	Output	Chiller Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, A/D chamber
13	Output	Chiller 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 8B: -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

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

The AMAT Analog (-A5) interface allows the Nikola 3K/5K 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. Table 9A and 9B show the Signal Descriptions for each type.

Table 9A: -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	Chiller Alarms - Level/Flow/RTD/PCW Flow	NO relay contact, A/D chamber
13	Output	Chiller 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 9B: -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

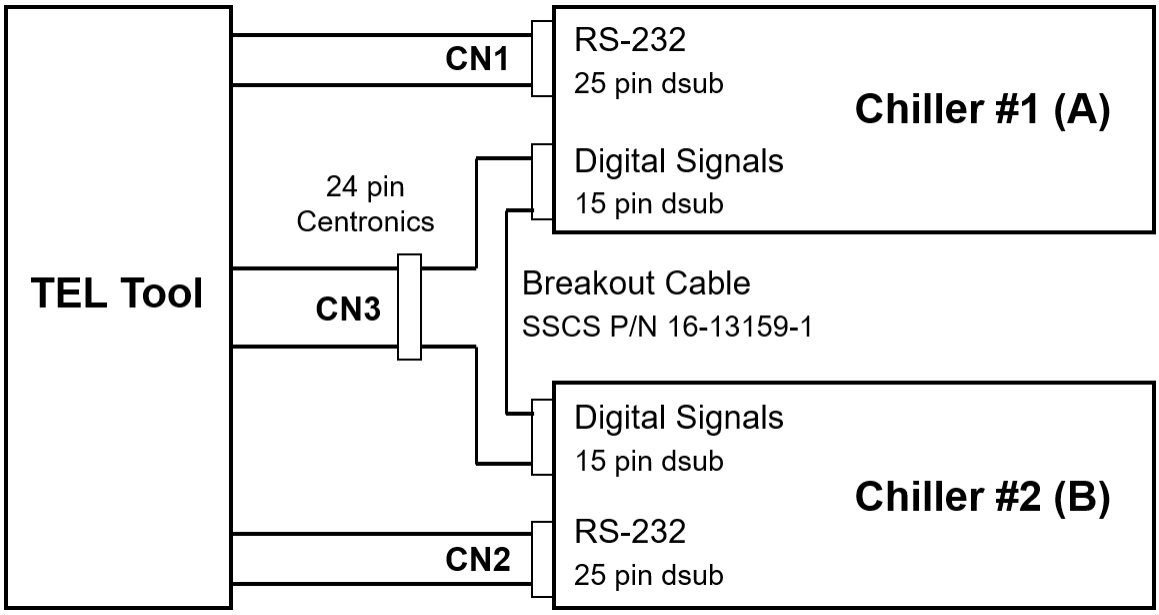
- 0-10VDC
- Pins 8, 9
- Resistivity (megΩ-cm)= 2*Voltage

6.9 TEL UNITY II (T1) OR UNITY M (T2) INTERFACE CARDS

The TEL Unity II or Unity M Interface Card option allows communication between the Nikola 3K/5K and a TEL Unity II or Unity M plasma etch tool. Chiller communications from the TEL Unity II or Unity 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 Nikola 3K/5K TEL interface includes a splitter cable that splits the 24-pin Centronics digital signals into two 15-pin dsub connectors feeding two separate Nikola 3K/5K or ThermoRack 1201/1801 chillers as shown below.

Note: The Nikola 3K/5K TEL Unity II or Unity M interface pre-sets the temperature alarm width to 5°C. This can only be changed via the TEL Unity II or Unity M's RS-232 communications.

Figure 7: TEL Unity II or Unity M Signal Hook-up



Hook-up:

1) Connect the channel 1 (CN1) 25-pin dsub connector from the TEL tool to Chiller #1's (A) rear panel RS-232 tool communications connector (see figure 7).
2) Connect the channel 2 (CN2) 25-pin dsub connector from the TEL tool to Chiller #2's (B) 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 (A) to Chiller #1's (A) rear panel Digital Signals tool communications connector.
5) Connect the breakout cable's 15-pin dsub connector labeled Chiller #2 (B) to Chiller #2's (B) rear panel Digital Signals tool communications connector.

Table 10: TEL UNITY II and UNITY M CN3 24-Pin Centronics Connector Pin-Out

Pin	Description	Pin	Description
1	Channel A Start/Stop	13	12VDC Return
2	Channel A Remote/Local	14	Channel A Common
3	Channel A Run LED	15	Channel A Ready LED
4	Channel A Alarm 1 LED	16	+12VDC
5	Channel A Alarm 2 LED	17	Channel A Remote/Local LED
6	Channel B Remote/Local	18	Channel B Common
7	Channel B Run LED	19	Channel B Ready LED
8	Channel B Alarm 1 LED	20	+12VDC
9	Channel B Alarm 2 LED	21	Channel B Remote/Local LED
10	Channel B Start/Stop	22	12VDC Return
11	Channel A Stop	23	Channel B Stop
12	EMO Connection	24	EMO Connection

Note: The difference between TEL Unity II and TEL Unity M is the Start/Stop Signals for Channel A&B. TEL Unity II tools use a continuous Start/Stop On signal to run the chiller (high=run, low=stop) while TEL Unity M uses a momentary Start/Stop signal to start and stop the chiller.

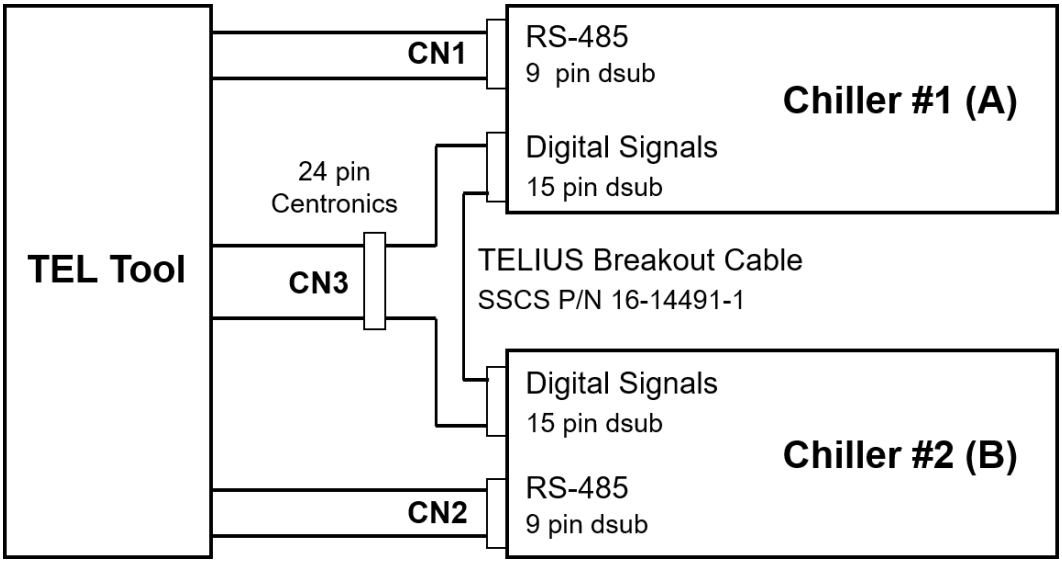
6.10 TELIUS (T3) INTERFACE CARD

The TELIUS Interface Card option allows communication between the Nikola 3K/5K and a TEL 300mm plasma etch tool. Chiller communications from the TELIUS tool comprises two 9-pin dsub RS-485 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 1801 TELIUS interface includes a splitter cable that splits the 24-pin Centronics digital signals into two 15-pin dsub connectors feeding two separate Nikola 3K/5K chillers or one Thermorack 1801 and one Nikola 3K/5K chiller as shown in Figure 5.

Notes:
1) The Telius interface requires special controller software.
2) The Nikola 3K/5K TELIUS interface pre-sets the temperature alarm width to 5°C. This can only be changed via the TELIUS RS-485 communications.
3) The Nikola 3K/5K has a flow adjust parameter added to its parameter input menu when Telius software is installed. This adjusts the flow communicated to the Telius tool.
4) The pin-out for digital signals cable CN3 can be found in Table 11.

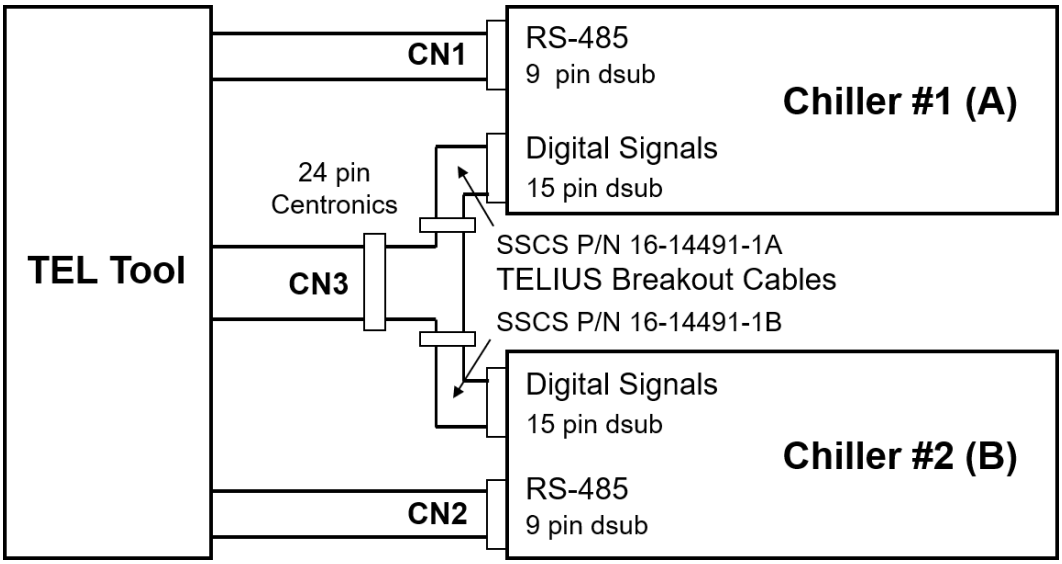
There are two TELIUS cable hook-ups we have experienced:

Figure 8A: TELIUS Signal Hook-up #1 (Standard – T3 units ship with Cable P/N 16-14491-1)



- Connect the channel 1 (CN1) 9-pin dsub connector from the TELIUS tool to ThermoRack chiller #1's (A) rear panel RS-485 tool communications connector.
- Connect the channel 2 (CN2) 9-pin dsub connector from the TELIUS tool to ThermoRack chiller #2's (B) rear panel RS-485 tool communications connector.
- Connect the Centronics end of the Breakout Cable (SSCS #16-14491-1) to the 24-pin Centronics connector (CN3) from the TELIUS tool.
- Connect the breakout cable's 15-pin dsub connector labeled Chiller #1 (A) to ThermoRack #1's rear panel Digital Signals tool communications connector.
- Connect the breakout cable's 15-pin dsub connector labeled Chiller #2 (B) to ThermoRack #2's rear panel Digital Signals tool communications connector.

Figure 8B: TELIUS Signal Hook-up #2 (Optional: These cables must be ordered separately)



- Connect the channel 1 (CN1) 9-pin dsub connector from the TELIUS tool to chiller #1's (A) rear panel RS-485 tool communications connector.
- Connect the channel 2 (CN2) 9-pin dsub connector from the TELIUS tool to chiller #2's (B) rear panel RS-485 tool communications connector.
- Connect the Centronics end of the Breakout Cable (SSCS #16-13159-1A) to the 24-pin Centronics connector (CN3 for Channel A) from the TELIUS tool and the other end to the 15-pin dsub connector on Chiller #1 (A).
- Connect the Centronics end of the Breakout Cable (SSCS #16-13159-1B) to the 24-pin Centronics connector (CN3 for Channel B) from the TELIUS tool and the other end to the 15-pin dsub connector on Chiller #2 (B).

Table 11 TELIUS CN3 24-Pin Centronics Connector Pin-Out

Pin	Channel	Application	Category	Pin	Channel	Application	Category
1	CH1	Run / Stop signal	IN	13	Common	input/output common (COM)	IN
2	CH1	RUN mode signal	OUT	14	CH1	operation mode output common	OUT
3	CH1	RUN signal	OUT	15	CH1	Temperature OK signal	OUT
4	CH1	Error-signal (Operation stop)	OUT	16	Common	RF matcher Power OFF	IN
5	CH1	Abnormal-signal (Operation continuation)	OUT	17	CH1	RUN mode signal	OUT
6	CH2	operation mode signal	OUT	18	CH2	operation mode output common	OUT
7	CH2	operation signal	OUT	19	CH2	Temperature OK signal	OUT
8	CH2	Error-signal (Operation stop)	OUT	20	Common	RF matcher Power OFF	IN
9	CH2	Abnormal-signal (Operation continuation)	OUT	21	CH2	RUN mode signal	OUT
10	CH2	Run / Stop signal	IN	22	Common	input/output common (COM)	IN
11	CH2	RUN mode signal	OUT	23	CH2	Stop signal	OUT
12	CH1	Brine collect	IN	24	CH2	Brine collect	IN

Notes:

1. When using a Thermorack 1801 with a Nikola 3K/5K chiller, the Nikola 3K/5K should be channel #1 and the Thermorack 1801 channel #2.
2. When the CN3 cable is split into two cables with 24-pin Centronics connectors, the pin-outs are the same as shown in Table 11, except Channel A's signals are on one cable and Channel B's on the other.

6.11 RS-232 COMMUNICATIONS OPTION

The Nikola 3K/5K can come with optional RS-232 serial communications that can receive a remote set point, return the current temperature, and signal an alarm has occurred. The protocol is shown below.

Wiring: Proper wiring depends upon whether the equipment being cooled (the Host) is wired as Data Computer Equipment (DCE) or Data Terminal Equipment (DTE)

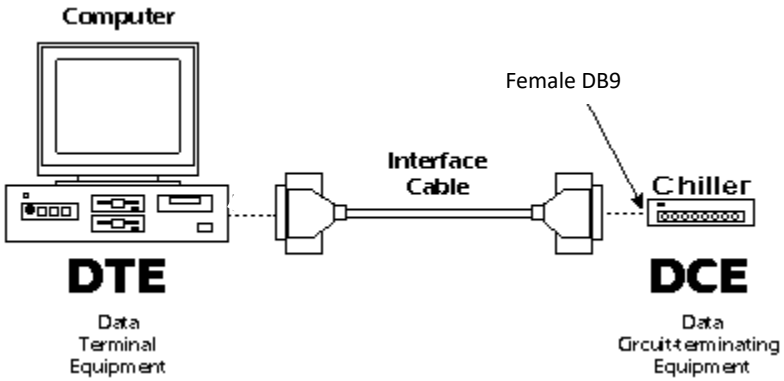


Table 14: Signal definition and wiring for Host wired as DCE

Host / Master (DCE) 9-Pin D-sub Pin #	**Nikola 3K/5K / Slave (DTE)** 9-Pin Female D-sub Pin#
2 (Receive – RXD)	2 (Transmit – TXD)
3 (Transmit – TXD)	3 (Receive – RXD)
5 (Ground)	5 (Ground)

Note: Use a null modem cable if your RS-232 is set up as a DTE.

Communication Specification

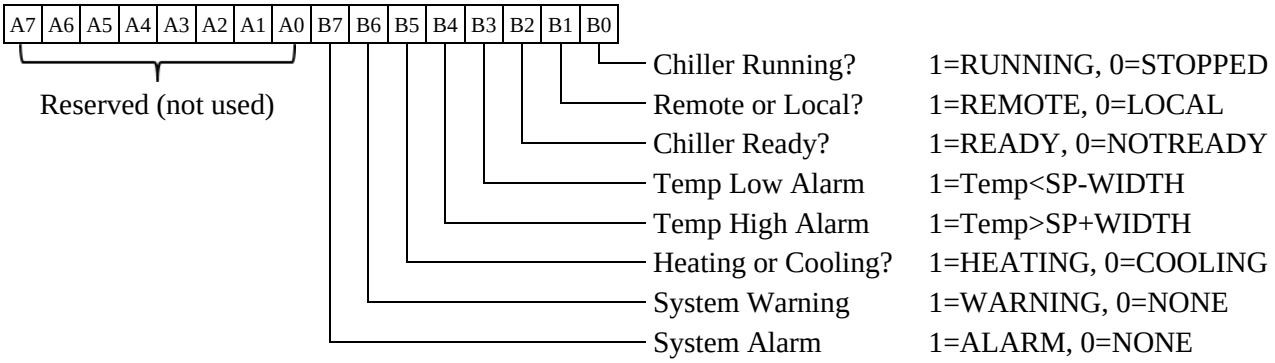
Speed:	57,600 baud
Data Flow Control:	None
Data Format:	8-bit serial
Number of Stop bits:	1
Parity:	None
Master/Slave:	ThermoCube is always the SLAVE (DTE)
Interrupts Reported:	None, must be polled for status
Transmission Length:	≤ 15 meters
Data Update Frequency:	Once per second
Maximum Polling Frequency:	Two commands per second
Data Format:	ASCII

Insert a carriage return, 0D (hex), at the end of each command string.

Table 15: RS-232 Commands

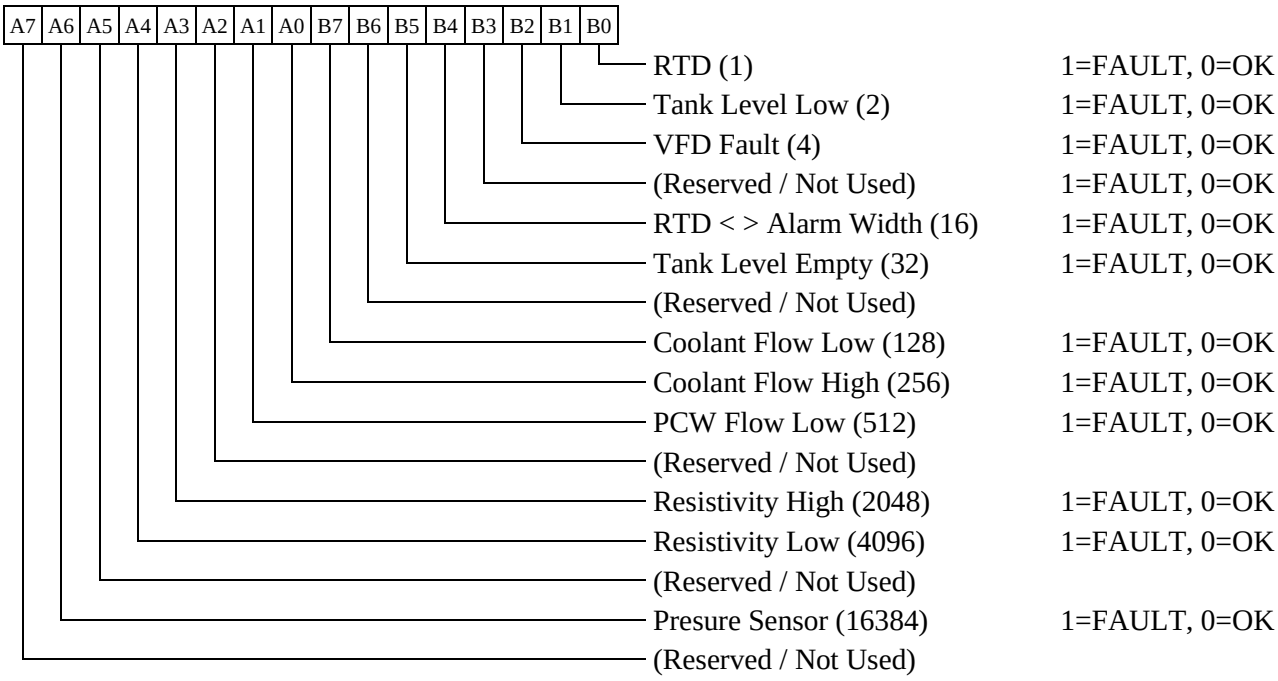
PARAMETER	To GET Data	To PUT Data (or control)
show everything implemented	ALLOFME	-
mfr, model, ser#, sw version	IDN	-
Clear Alarms/Restart the chiller	-	RESTART
Chiller Run, Stop	RUN? {RUNNING, STOPPED}	RUN, STOP
Coolant temp	TEMP? (+/- XXX.X)	-
Coolant Temp Offset	RTDOFFSET? (+/- XX.X)	RTDOFFSET XX.X
Coolant Setpoint	SETTEMP? (+/- XXX.X)	SETTEMP XX.X
Coolant Temp Alarm Width	WIDTH? (+XX.X)	WIDTH XX.X
backlight off	-	BLOFF
backlight on	-	BLON
Coolant Pressure Setpoint	VFDPRESSURE? (XXX)	VFDPRESSURESP (XXX)
VFD temp	VFDTEMP? (XX)	-
Coolant pressure	VFDACTPRESSURE? (XXX)	-
VFD freq	VFDFREQ? (XXX)	-
VFD power (in KWatts)	VFDPWR? (X.XXX)	-
VFD runtime (nearest 10hrs)	VFDRUNTIME? (XXX)	-
VFD fault1	VFDFAULT1? (#XXX)	-
VFD fault2	VFDFAULT2? (#XXX)	-
VFD fault3	VFDFAULT3? (#XXX)	-
actual TE PWM %	PWM? (+/- XX.X)	-
status word 1 (5 ASCII bytes)	STAT1A? (XXXXX) {0, 65535}	-
faults word 1 (5 ASCII bytes)	FLTS1A? (XXXXX) {0, 65535}	-

STAT1A Bit Field Definition (16 bit Word, 5 ASCII bytes):



The Warning bit is triggered by tank level low and a temperature outside of the +/- alarm width.
The Alarm bit is triggered by an RTD fault, a pump fault, or a facility water fault.

FLTS1A Bit Field Definition (Fault="1") (16 bit Word, 5 ASCII bytes (decimal value in parentheses)



Notes:
1) All commands terminate with a carriage return (0x0Dh)
2) All commands are case sensitive

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. In addition, the unit will include a DI water resistivity sensor installed in the coolant outlet plumbing. The Nikola 3K/5K will measure the DI water/Ethylene Glycol resistivity and signal a warning if the measured resistivity falls below 1 megohm-cm or it reads above 20 megohm-cm; these values can be changed via the Parameter Input Menu (see section 5). This feature is only active when coolant type 50/50 WEG is chosen from the parameter menu.

7.2 –RF FRONT RTD OPTION

This option moves the temperature control RTD from the Nikola 3K/5K coolant outlet to a location at the front of the Nikola 3K/5K, between the pump and thermoelectric heat exchanger. This alternative RTD location improves process control in some applications. Contact SSCS for details.

8.0 SAFETY

8.1 HAZARDS

DANGER

Electrical Hazards

The Nikola 3K/5K operates on 200-240 VAC 3-phase power. As a result, it has hazardous voltage present inside its covers. Only qualified personnel should work on the unit with the covers removed.

DANGER

Chemical Hazards

The Nikola 3K/5K 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 Nikola 3K/5K. Only qualified personnel should handle coolants used in the Nikola 3K/5K.

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

WARNING

Spill Hazards

The Nikola 3K/5K'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.

8.2 LIFTING THE NIKOLA 3K/5K

The Nikola 3K/5K weighs 300 lbs. (136 kg) and is designed to be rolled into position on its casters, do not lift with personnel. The front side of its shipping crate is designed to act as a ramp to roll the unit out of its crate. If the unit must be lifted, use a forklift or pallet jack, inserting the forks between the casters on the either long side of the chiller.

8.3 ELECTRICAL ENERGY ISOLATION

For installations requiring adherence to SEMI S2 guidelines, the customer must install a circuit breaker rated in accordance with UL 489, subject to local AHJ (authorities having jurisdiction) and NEC requirements, with a minimum 10,000 amp interrupt rating on the AC power connecting to the Nikola 3K/5K.

8.4 ELECTRICAL LOCK OUT/TAG OUT

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 7.3).
2) Unlatch the main AC power plug (on the rear panel) and remove the plug.
3) Place a safety padlock through the Nikola 3K/5K's main AC power connector latch. AC power cannot be plugged into the Nikola 3K/5K AC power receptacle with the padlock in place.

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.

8.5 ELECTRICAL DISCONNECT REQUIREMENTS

Unit Out of Service

When the Nikola 3K/5K is out of service, disconnect the main AC power via the customer installed circuit breaker described in manual section 8.3. SSCS recommends leaving the AC power cord connected unless the system's covers are to be removed.

Maintenance

When performing repairs or maintenance on the Nikola 3K/5K 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 8.3.
2) Disconnect the main AC power plug.
3) Lockout main AC power as per section 8.4.

8.6 LEAKS

Coolant Leaks

Two types of coolant leaks can occur when operating the Nikola 3K/5K: internal and external leaks. Internally, the Nikola 3K/5K 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 7.1.2 and 7.1.3 of this manual.

The Nikola 3K/5K chassis serves as secondary containment for the coolant tank and holds up to 3 gallons, or 133% of the 2.25 gallon tank volume. If the leak detection option is not chosen, the operator can use the Tank Level Low warning, which display's 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 1.6, indicating a leak of up to 0.6 gallons (2.3 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 0.75 gallons, indicating a leak of up to 1.5 gallons. A Tank Level Empty alarm will shut down the Nikola 3K/5K.

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 Nikola 3K/5K's plumbing access panel (located on the left side) to find the leak. Only trained maintenance personnel should remove plumbing access panel as hazardous voltages are present inside. If coolant is found in the chassis, schedule maintenance on the chiller. Follow the safety guidelines in section 8.4 prior to performing maintenance.

8.7 PLANT COOLING WATER LEAKS

Two types of plant cooling water (PCW) leaks can occur when operating the Nikola 3K/5K: internal and external leaks. Internally, the Nikola 3K/5K 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 7.12 and 7.1.3 of this manual. The Nikola 3K/5K has no means of detecting PCW leaks. As a result, the leak will fill the Nikola 3K/5K's secondary containment until the total volume reaches 3 gallons. Once the leak has reached 3 gallons, PCW will flow out of the Nikola 3K/5K onto the surrounding floor, creating a slip hazard.

The Nikola 3K/5K'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 8.4 of this manual. (Leave the PCW flow on.) Open the Nikola 3K/5K plumbing access panel (located on the left side) and inspect the blue PCW hoses and attached fittings. Once the leak is found, disconnect the PCW as per section 8.6 and repair the leak.

External water leaks will also not be contained nor detected by the Nikola 3K/5K.

8.8 DISCONNECTING PLANT COOLING WATER

WARNING

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.

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.

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.

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 11/8" wrench, disconnect the supply side PCW Swagelok® fitting.
4) Using a 11/8" 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 MSDS (see section 13 of this manual).

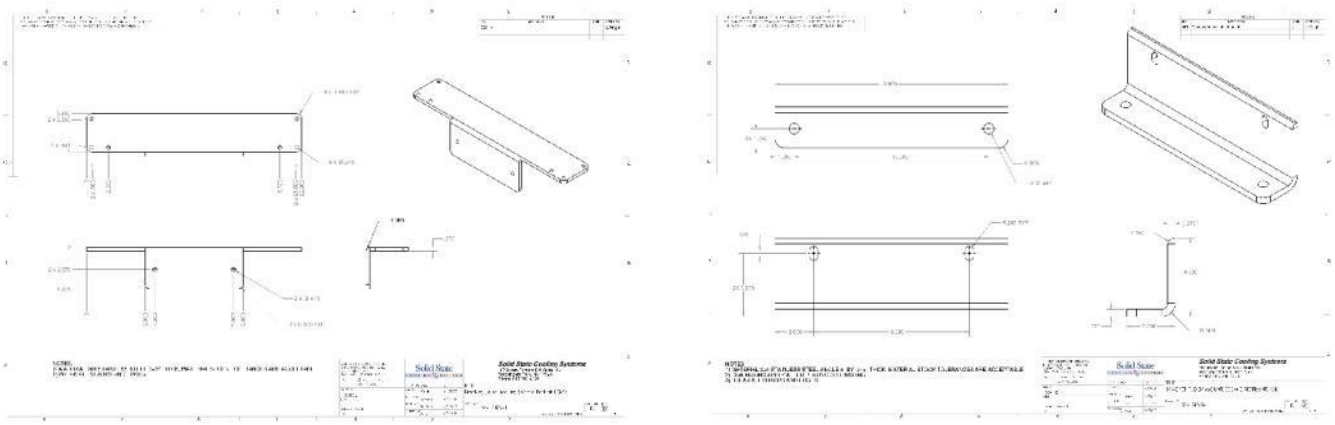
8.9 COOLANT DISPOSAL

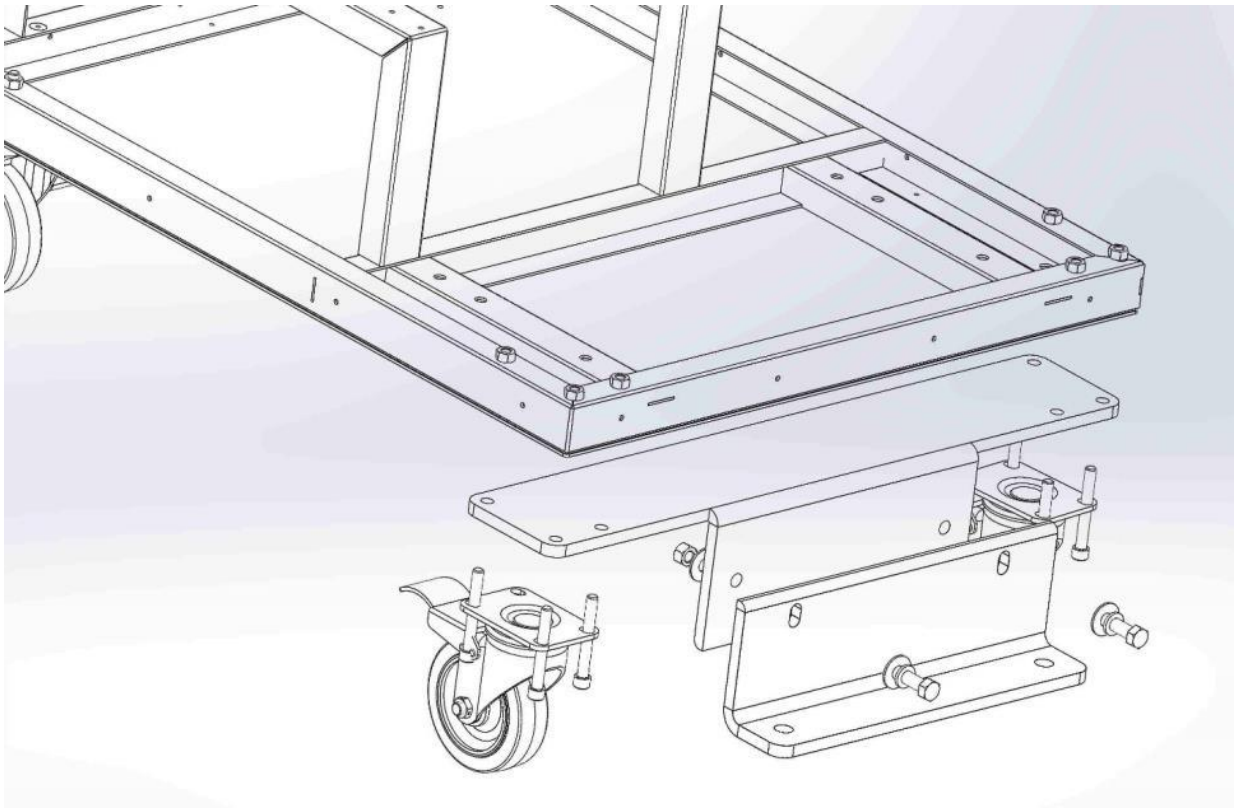
Dispose of any coolants spilled or drained from the Nikola 3K/5K in accordance with national and local guidelines and the coolant's MSDS found in section 13 of this manual.

8.10 SEISMIC PROTECTION

The Nikola 3K/5K may be anchored to the factory floor to protect against movement or damage during seismic events. Figure 14 shows the location for mounting seismic braces (2) to the chiller. These braces mount under the front and rear ends of the chiller. The seismic mounting kit may be purchased from Solid State Cooling Systems under the part number 14-14189-1.

Figure 14 Seismic Mounting Brackets & Assembly Diagram





8.11 MINIMUM PERSONAL PROTECTIVE

Manual Operation Equipment

No personal protective equipment is required for normal operation of the Nikola 3K/5K.

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.

PCW Spills

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

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.

9.0 MAINTENANCE

9.1 PRODUCT LIFE:

The Nikola 3K/5K requires no routine maintenance when operated in a dust free environment. The only moving parts in the Nikola 3K/5K are the fan and the pump. The fan has a B10 life of 70,000 hours (8 years) while the pump has an estimated life of 5 years. The thermoelectric modules used for heating and cooling have estimated lifetimes that exceed 200,000 hours (23 years). With regular pump replacement every five years and fan replacement every 8 years, the product should have a life of 20 years.

SSCS recommends the following regular inspections to verify the unit is operating properly so its lifetime is not impaired:

9.2 RECOMMENDED WEEKLY INSPECTION:

1) Check the front display to verify the coolant level is ok. If the coolant level is low, follow the procedure in section 4.2 to add coolant.
2) Vent the tank: using an 11/16” open ended wrench, loosen the tank vent nut to vent the tank, then re-tighten ¼ turn past finger tight.
3) Check that the rear fan is rotating and free of dust. Blow off any dust with compressed air or nitrogen.

9.3 RECOMMENDED ANNUAL INSPECTION:

1) Verify that the coolant outlet pressure is at set point +/- 3 psig (0.2 bar); a coolant pressure lower than this is sign of pump wear while a coolant pressure higher than this is a sign of a problem with the variable frequency drive (VFD).
2) Check that the rear fan is rotating and free of dust. Blow off any dust with compressed air or nitrogen.
3) If using ethylene or propylene glycol/water mixtures, sample and analyze the coolant annually to ensure no glycol degradation has occurred.

9.4 WIPE DOWN:

The Nikola 3K/5K exterior may be wiped down with IPA wetted clean room wipes to remove any dust or dirt as desired.

10.0 SYSTEM ALARMS AND TROUBLESHOOTING

The Nikola 3K/5K has hardware interlocks and software warnings and faults to prevent hazardous operation of the system in the event of failures or operation outside the prescribed limits. These are shown on the display screen and can also be seen on the Fault screen. If there is an action you can take listed in the table below then do it, otherwise, **call for service**. **Do not take the covers off of the system.** Table 16 shows and describes the hardware interlocks. Table 17 shows and describes the warnings and alarms.

Table 16: Nikola 3K/5K Hardware Interlocks

Interlock	Description	Correction
GFCI	Unit main power GFCI breaker detects a ground current > 30mA A short to ground has occurred somewhere in the chiller.	Check for water leaks or a short in the thermoelectric heat exchanger. Correct the leak or replace the thermoelectric heat exchanger
EMO	Emergency off activates the main power shutoff	Rotate EMO button counter-clockwise and restart the chiller.

Table 17: Nikola 3K/5K Warnings and Alarms

Display	Warning/ Alarm	Description/Correction	TEs	Pump
Tank Low	Warning	The level of coolant in the tank is low. The tank needs refilling at the earliest convenience.	On	On
Tank Empty	Alarm	The level of coolant in the tank has become so low that it endangers the operation of the coolant pump. Refill the tank with coolant.	Off	Off
RTD Fault	Alarm	The temperature sensor (RTD) has failed or its connector has come loose. Check connections or replace the RTD	Off	On
Resistiv Low (DI Water)	Warning	The coolant resistivity is lower than the user set minimum. Change the DI water ion-exchange resin canister.	On	On
Resistiv High	Warning	The resistivity sensor has failed or the coolant used is not DI water based.	On	On
< Or >	Warning	Process temp is outside of user set limits (ALRM+/-). This is normal if the chiller has just been turned on or if changing set points. If this occurs during normal operations, check that the PCW flow is at least 6 gpm (23 lpm).	On	On
Pump Flow Low	Alarm	The pump failed to prime at start-up or the flow of coolant has fallen below the minimum required for normal pump operation. Check that there are no kinks in the hoses or valves closed. If this occurs at start-up, the pump has failed to prime after 10 attempts. Cycle the power and restart (waiting 30 seconds prior to turning the chiller back on). If the Pump Flow Low occurs again, contact technical support.	Off	Off
PCW Flow Low	Alarm	The flow of plant cooling water is too low. Check external PCW plumbing. Set the flow to 6 gpm (23 lpm) or greater.	Off	On
ERR TOOL INTFC	Alarm	An internal communications fault has occurred with the tool interface card. Cycle AC power to clear and restart (waiting 30 seconds prior to turning the chiller back on). If this error returns the tool interface card must be replaced.	Off	On
VFD Not Ready	Alarm	The pumps variable frequency drive has turned off the pump and issued an alarm. Note: This alarm will occur if you cycle the AC power of the chiller off/on too quickly. Always leave the chiller off for 30 seconds before turning back on. Other causes for the fault are listed below. Contact technical support for assistance.	Off	Off

THE ALARMS BELOW CAN BE FOUND ON THE VFD DISPLAY. THE VFD IS LOCATED INSIDE THE FRONT PANEL ON THE RIGHT SIDE. REMOVE THE RIGHT SIDE PANEL TO ACCESS.				
VFD Flt #2	Alarm	Auxiliary Input – not used	Off	Off
VFD Flt # 3	Alarm	Pump Variable Frequency Drive detects a Power Loss	Off	Off
VFD Flt #4	Alarm	Pump Variable Frequency Drive detects an Under voltage	Off	Off
VFD Flt#5	Alarm	Pump Variable Frequency Drive detects an Overvoltage	Off	Off
VFD Flt #6	Alarm	Pump Variable Frequency Drive detects a Motor Stalled	Off	Off
VFD Flt #7	Alarm	Pump Variable Frequency Drive detects a Motor Current Overload	Off	Off
VFD Flt # 8	Alarm	Pump Variable Frequency Drive detects a Heat sink Over temperature	Off	Off
VFD Flt # 12	Alarm	Pump Variable Frequency Drive detects a HW Current (300%)	Off	Off
VFD Flt # 13	Alarm	Pump Variable Frequency Drive detects a Ground Fault	Off	Off
VFD Flt # 29	Alarm	Pump Variable Frequency Drive detects a Analog Input Loss	Off	Off
VFD Flt # 33	Alarm	Pump Variable Frequency Drive detects a Auto Restart Tries	Off	Off
VFD Flt # 39	Alarm	Pump Variable Frequency Drive detects a Phase V to Ground Short	Off	Off
VFD Flt # 40	Alarm	Pump Variable Frequency Drive detects a Phase W to Ground Short	Off	Off
VFD Flt # 41	Alarm	Pump Variable Frequency Drive detects a Phase UV Short	Off	Off
VFD Flt # 42	Alarm	Pump Variable Frequency Drive detects a Phase UW Short	Off	Off
VFD Flt # 43	Alarm	Pump Variable Frequency Drive detects a Phase VW Short	Off	Off
VFD Flt # 63	Alarm	Pump Variable Frequency Drive detects a Software Over current	Off	Off
VFD Flt # 64	Alarm	Pump Variable Frequency Drive detects a Drive Overload	Off	Off
VFD Flt # 70	Alarm	Pump Variable Frequency Drive detects a Power Unit Fail	Off	Off
VFD Flt # 80	Alarm	Pump Variable Frequency Drive detects a Auto Tune Fail	Off	Off
VFD Flt # 81	Alarm	Pump Variable Frequency Drive detects a Communication Loss	Off	Off
VFD Flt # 100	Alarm	Pump Variable Frequency Drive detects a Parameter Checksum Error	Off	Off
VFD Flt # 122	Alarm	Pump Variable Frequency Drive detects a I/O Board Fail	Off	Off

11.0 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

12.0 SAFETY DATA SHEETS

12.1 3M™ FLUORINERT™ FC-3283 ELECTRONIC LIQUID SDS

SAFETY DATA SHEET

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Document Group:	06-4521-8	**Version Number:**	31.06
Issue Date:	01/18/18	**Supercedes 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	Condition
Carbon monoxide	During Combustion
Carbon dioxide	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	*No Data Available*
pH	*Not Applicable*
Melting point	*Not Applicable*
Boiling Point	123 - 133 ºC
Flash Point	No flash point
Evaporation rate	< 1 [*Ref Std:*BUOAC=1]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	14 mmHg [@ 23 ºC]
Vapor Density	18 [@ 23 ºC] [*Ref Std:*AIR=1]
Density	1.8 g/ml
Specific Gravity	1.8 [*Ref Std:*WATER=1]
Solubility in Water	Nil
Solubility- non-water	*No Data Available*
Partition coefficient: n-octanol/ water	*No Data Available*
Autoignition temperature	*No Data Available*
Decomposition temperature	*Not Applicable*
Viscosity	0.7 centistoke [@ 25 ºC]
Molecular weight	*No Data Available*
Volatile Organic Compounds	[*Details:*Exempt]
Percent volatile	100 %
VOC Less H2O & Exempt Solvents	[*Details:*Exempt]

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	Condition
Hydrogen Fluoride	At Elevated Temperatures - greater than 200 ºC
Perfluoroisobutylene (PFIB)	At Elevated Temperatures - greater than 200 ºC

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	Inhalation	heart | endocrine	Not classified	Rat	NOAEL	13 weeks
COMPOUNDS, C5-18		system | bone, teeth, nails, and/or hair | hematopoietic system | liver | immune system | nervous system | eyes | kidney and/or bladder | respiratory system			49,821 ppm	
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	**Supercedes 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,3Mmakes 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

12.2 3M™ NOVEC™ 7100 ENGINEERED FLUID SDS

3M

SAFETY DATA SHEET

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Document Group:	07-6378-9	**Version Number:**	69.03
Issue Date:	01/18/18	**Supercedes 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	Condition
Carbon monoxide	During Combustion
Carbon dioxide	During Combustion
Hydrogen Fluoride	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
CEIL: 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	*No Data Available*
pH	*Not Applicable*
Melting point	-135 ºC
Boiling Point	61 ºC [@ 760 mmHg]
Flash Point	No flash point
Evaporation rate	49 [*Ref Std:*BUOAC=1]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	202 mmHg [@ 25 ºC]
Vapor Density	8.6 [*Ref Std:*AIR=1]
Density	1.5 g/ml
Specific Gravity	1.5 [*Ref Std:*WATER=1]
Solubility in Water	, 12 ppm
Solubility- non-water	*No Data Available*
Partition coefficient: n-octanol/ water	3.9 [*Details*:30 °C]
Autoignition temperature	405 ºC [*Details*:(ASTM E659-84)]
Decomposition temperature	*Not Applicable*
Viscosity	0.6 centistoke [@ 23 ºC]
Molecular weight	*No Data Available*
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

Substance	**Condition**
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
Issue Date:	01/18/18	**Supercedes Date:**	09/06/16

Reason for Reissue
Conversion to GHS format SDS.

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End of SDS

12.3 SOLVAY GALDEN® HT SDS

SOLVAY

SAFETY DATA SHEET

Revision Date 25.02.2014

SECTION 1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

- Product name	:	**GALDEN® HT LOW-BOILING (2)**
- Product grade(s)	:	HT80; HT110; HT135
- Chemical characterization	:	Perfluorinated polyethers

1.2. Relevant identified uses of the substance or mixture and uses advised against

- Identified uses	:	- Heat transfer medium
	:	- For industrial use only.

1.3. Details of the supplier of the safety data sheet

- Company	:	SOLVAY
	:	SPECIALTY POLYMERS JAPAN K.K.
- Address	:	7TH FL,ATAGO GREEN HILLS MORI TOWER ATAGO 2-5-1, MINATO-KU J- 105-6207 TOKYO
- Telephone	:	+81354254330/4300
- Fax	:	+81354254321
- E-mail address	:	sds.solvay@solvay.com

1.4. Emergency telephone number

- Emergency telephone number **+44(0)1235 239 670 [CareChem 24] (Europe)**

SECTION 2. HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

2.1.1. European regulation (EC) 1272/2008, as amended

Not classified as hazardous according to the European regulation (EC) 1272/2008, as amended

2.1.2. European Directive 67/548/EEC or 1999/45/EC, as amended

Not classified as hazardous according to European Directive 67/548/EEC or 1999/45/EC, as amended

2.2. Label elements

No labelling

2.3. Other hazards

- Thermal decomposition can lead to release of toxic and corrosive gases.

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. CAS-No.: 69991-67-9 / EC-No.: - / Index-No.:-	> 99.9 %

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
CHEMTRECÒ, Inside the USA: 800-424-9300
CHEMTRECÒ, 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.

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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Creation Date 02-Feb-2010
Revision Date 17-Jan-2018
Print Date 17-Jan-2018
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

WARRANTY

This Solid State Cooling Systems Product is covered under a two-year parts and labor warranty from the date of shipment, assuming proper use and maintenance of the unit. All warranty work shall be performed at Solid State Cooling Systems' facility, currently located in Wappingers Falls, NY, USA and requires pre-authorization by SSCS. 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 Systems' 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 the product.
- Changing any components of the product.
- Subjecting the product to temperatures below the freezing point of the coolant used.
- 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 SSCS's factory, within 30 days or the reporting date will be moved ahead 30 days and a new 30-day waiting period will begin. Customers shall pay shipping cost of returning any unit to SSCS and SSCS shall pay shipping cost of returning any unit repaired under warranty to the customer.

All out of warranty returned goods will require an evaluation purchase order prior to receipt at Solid State Cooling Systems. The evaluation costs will depend on product model and will be deducted from the cost of any repairs required.