



On-Board[®] W Module (Sublime)
Programming and
Operation Instructions

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Table of Contents

Section 1 - Common On-Board Module Information

Introduction	1-1
Microprocessor Control System	1-1
Keypad/Display	1-1
Remote Keypad/Display	1-1
Host Computer (or RS-232)	1-1
Network Terminal	1-1
Keypad/Display Control Description	1-2
Alphanumeric Display	1-2
Horizontal Scroll Display Keys	1-2
Vertical Scroll Display Keys (Last, Next)	1-3
Clear Display Key	1-3
Numeric Keypad	1-3
Enter Command Key	1-3
Function Keys	1-3
On-line Help	1-3
Software Version Identification	1-4

Section 2 - System Power

Before You Start	2-1
On-Board Waterpump Configurations	2-1
On-Board Waterpump Start-up	2-2
On-Board Waterpump Shutdown	2-2

Section 3 - Programming and Operation

Introduction	3-1
Normal Operation	3-1
MONITOR Function	3-1
ON/OFF Status and Refrigerator Temperature	3-3
Refrigerator Temperature and Thermocouple Gauge Pressure	3-3
Thermocouple Gauge Pressure	3-4
Auxiliary Thermocouple Gauge Pressure	3-4
Relay 1 ON/OFF and Auto/Manual Control	3-5
Relay 2 ON/OFF and Auto/Manual Control	3-5
Accumulated Exposure Time	3-5
MONITOR Function Operation	3-6
REGEN Function	3-7
REGEN Start	3-12
Delay Start	3-13
Extended Purge	3-13

Table of Contents (continued)

Cooldown Mode	3-14
Sublime Temperature	3-14
Sublime Time	3-15
Rough Valve Interlock	3-15
Power Fail Recovery	3-16
Power Fail Recovery Temperature	3-18
REGEN Setup	3-18
REGEN Cycle Start/Abort	3-19
REGEN Start for Sublime	3-19
REGEN Start for Warm-Up	3-19
Abort REGEN	3-19
REGEN Function Programming	3-20
Delay Start	3-20
Extended Purge	3-20
Cooldown Mode	3-21
Sublime Temperature	3-21
Sublime Time	3-21
Rough Valve Interlock	3-22
Power Failure Recovery	3-23
Power Failure Recovery Temperature	3-23
REGEN Setup	3-24
SERVICE Function	3-24
Serial Number and Software Version	3-26
Network Identification Number	3-27
Elapsed Pump Time	3-28
Time Since Last REGEN	3-28
Password	3-29
Lock Mode	3-29
Parameter Lock	3-30
Zero On-Board Waterpump Thermocouple	3-30
Zero Auxiliary Thermocouple	3-31
On-Board Waterpump Temperature Control	3-31
Exposure Temperature	3-32
Exposure Time	3-32
SERVICE Function Operation	3-33
Serial Number and Software Version	3-33
Net Identification	3-33
Elapsed Pump Time	3-34
Time Since Last REGEN	3-34
Password	3-34
Lock Mode	3-35
Parameter Lock	3-35

Table of Contents (continued)

Zero On-Board Waterpump Thermocouple Gauge	3-35
Zero Auxiliary Thermocouple Gauge	3-36
On-Board Waterpump Refrigerator Temperature Control	3-36
Exposure Temperature	3-37
Exposure Time	3-37
CONTROL Function	3-38
On-Board Waterpump ON/OFF and Refrigerator Temperature	3-40
Aux TC ON/OFF and TC Pressure	3-41
Rough Valve Open/Closed	3-41
Purge Valve Open/Closed	3-42
Relay 1 ON/OFF and Auto/Manual Control	3-42
Relay 2 ON/OFF and Auto/Manual Control	3-43
CONTROL Function Operation	3-43
On-Board Waterpump ON/OFF and Temperature	3-43
Aux TC ON/OFF and TC Pressure	3-44
Rough Valve Open/Closed	3-44
Purge Valve Open/Closed	3-44
Relay 1 ON/OFF and Auto/Manual Control	3-45
Relay 2 ON/OFF and Auto/Manual Control	3-45
RELAYS Function	3-46
Select Relay 1 or 2	3-48
Current State of Relay ON/OFF, Auto/Manual	3-49
Current Program for Automatic Control	3-49
Refrigerator Temperature Limits	3-50
On-Board Waterpump TC Gauge Pressure Limits	3-51
Auxiliary TC Gauge Pressure Limits	3-51
On-Board Waterpump Status	3-52
REGEN	3-52
Roughing Valve	3-53
Purge Valve	3-53
Panel Full	3-54
Delay Activation of Relay	3-54
RELAYS Function Operation	3-55
Programming Panel Temperature Limits	3-55
Programming On-Board Waterpump TC Gauge Pressure Limits	3-56
Programming Auxiliary TC Gauge Pressure Limits	3-56
On-Board Waterpump	3-57
REGEN Track	3-57
Rough Valve	3-58
Purge Valve	3-58
Panel Full	3-59
Time Delay	3-59

Table of Contents (continued)

W Module Software Function Parameters	3-59
 Section 4 - On-Board Module Replacement	
Module Ordering Information	4-1
Module Replacement	4-1
 Appendix A - Customer Support Information	
 Appendix B - On-Board Module RS-232 Interface Protocol Format	
 Appendix C - RS-232 REGEN Responses	
 Appendix D - RS-232 Power Failure Recovery Messages	
 Appendix E - On-Board Pump Fault Messages	
 Appendix F - On-Board Keypad/Display Error Messages	
 Appendix G - REGEN Cycle Operation Examples	

Figures

Figure 1-1: On-Board Keypad/Display	1-2
Figure 1-2: On-line Help Message Example	1-4
Figure 3-1: MONITOR Function Flowchart	3-2
Figure 3-2: ON/OFF Status and Refrigerator Temperature	3-3
Figure 3-3: Refrigerator Temperature and Thermocouple Gauge Pressure	3-3
Figure 3-4: Thermocouple Gauge Pressure	3-4
Figure 3-5: Auxiliary Thermocouple Gauge Pressure	3-4
Figure 3-6: Relay 1 Automatic or Manual Control	3-5
Figure 3-7: Relay 2 Automatic or Manual Control	3-5
Figure 3-8: Accumulated Exposure Time Display	3-6
Figure 3-9: REGEN Warm-Up Setup Flowchart	3-9

Table of Contents (continued)

Figure 3-10: REGEN Sublime Setup Flowchart	3-10
Figure 3-11: REGEN Start Display	3-12
Figure 3-12: Delay Start of REGEN Display	3-13
Figure 3-13: Extended Purge Display	3-13
Figure 3-14: Cooldown Mode Display	3-14
Figure 3-15: Sublime Temperature Display	3-14
Figure 3-16: Sublime Time Display	3-15
Figure 3-17: Rough Valve Interlock Display	3-16
Figure 3-18: Power Fail Recovery Display	3-16
Figure 3-19: Power Fail Recovery Temperature Display	3-18
Figure 3-20: REGEN Setup Display	3-18
Figure 3-21: SERVICE Function Flowchart	3-25
Figure 3-22: On-Board Waterpump Serial Number and Software Version Display	3-27
Figure 3-23: Network Identification Number Screen and Network Rotary Switch Location	3-27
Figure 3-24: Elapsed Pump Time Display	3-28
Figure 3-25: Time Since Last REGEN Display	3-28
Figure 3-26: Password Screen Display	3-29
Figure 3-27: Lock Mode OFF Display	3-29
Figure 3-28: Parameter Lock ON Display	3-30
Figure 3-29: Zero On-Board Waterpump Thermocouple Gauge Display ...	3-30
Figure 3-30: Zero Auxiliary Thermocouple Display	3-31
Figure 3-31: Refrigerator Control	3-31
Figure 3-32: Exposure Temperature Display	3-32
Figure 3-33: Exposure Time Display	3-33
Figure 3-34: CONTROL Function Flowchart	3-39
Figure 3-35: On-Board Waterpump ON/OFF and Refrigerator Temperature Display	3-40
Figure 3-36: Aux TC ON/OFF and TC Pressure Display	3-41
Figure 3-37: Rough Valve Open/Closed Display	3-41
Figure 3-38: Purge Valve Open/Closed Display	3-42
Figure 3-39: Relay 1 ON/OFF and Auto/Manual Control Display	3-42
Figure 3-40: Relay 2 ON/OFF and Auto/Manual Control Display	3-43
Figure 3-41: RELAYS Function Flowchart	3-47
Figure 3-42: Select Relay 1 or 2 Display	3-48
Figure 3-43: Current State of Relay ON/OFF, Auto/Manual	3-49
Figure 3-44: Current Program for Automatic Control Display	3-49
Figure 3-45: Temperature Limits Display	3-50
Figure 3-46: On-Board Waterpump TC Gauge Pressure Limits Display ...	3-51
Figure 3-47: Auxiliary TC Gauge Pressure Limits Display	3-51
Figure 3-48: On-Board Waterpump Display	3-52

Table of Contents (continued)

Figure 3-49: REGEN Display	3-52
Figure 3-50: Roughing Valve Display	3-53
Figure 3-51: Purge Valve Display	3-53
Figure 3-52: Panel Full Display	3-54
Figure 3-53: Delay Activation of Relay Display	3-54
Figure 4-1: On-Board Module Component Location	4-2
Figure B-1: RS-232 Cable Connections	B-5
Figure G-1: On-Board Waterpump REGEN Sublime Cycle	G-1
Figure G-2: On-Board Waterpump REGEN Warm-Up Cycle	G-3

Tables

Table 3-1: REGEN Warm-Up Function Parameters	3-11
Table 3-2: REGEN Sublime Function Parameters	3-11
Table 3-3: Power Failure Recovery Modes of Operation	3-17
Table 3-4: SERVICE Function Parameters	3-26
Table 3-5: CONTROL Function Parameters	3-40
Table 3-6: RELAYS Function Parameters	3-48
Table 3-7: W Module Software Function Parameters (Warm-up Routine) ...	3-60
Table 3-8: W Module Software Function Parameters (Sublime Routine) ...	3-61
Table B-1: On-Board Module RS-232 Commands	B-6
Table C-1: RS-232 REGEN Responses and Descriptions	C-2
Table D-1: Power Failure Recovery Messages	D-1
Table E-1: Host Commands and Fault Messages	E-1
Table F-1: Keypad/Display Error Message Description	F-1

Section 1 - Common On-Board Module Information

Introduction

Section 1 describes the following information which is common to all On-Board Modules: microprocessor control, keypad/display, on-line help, and software version verification.

Microprocessor Control System

The On-Board Waterpump is equipped with a state-of-the-art microprocessor controlled W Module which allows the user to monitor, program, and operate a wide range of important vacuum system functions.

The On-Board Module communicates with the On-Board Waterpump via one of the following:

Keypad/Display

A pivoting keypad/display can be mechanically attached to the On-Board Waterpump. The user can operate the keypad/display by merely pushing an easily learned sequence of keys.

Remote Keypad/Display

A remote keypad/display can be installed in a standard 19 inch electronics rack or in another convenient location. The remote keypad/display provides the same functionality as the keypad/display device which is attached to the On-Board Waterpump.

Host Computer (or RS-232)

The On-Board Module is capable of being controlled from a personal or host computer via the RS-232 port on the rear panel. The RS-232 port is standard equipment. Refer to Appendix B for more information.

Network Terminal

The On-Board Module can also be controlled via an On-Board Network Terminal using the network connectors located on the rear panel.

Keypad/Display Control Description

The On-Board Keypad/Display, shown in Figure 1-1, provides a user interface to the On-Board system for programming and operating all On-Board Waterpump functions. Figure 1-1 shows the location of all function keys and the alphanumeric display. The paragraphs that follow explain the purpose of each keypad/display function.

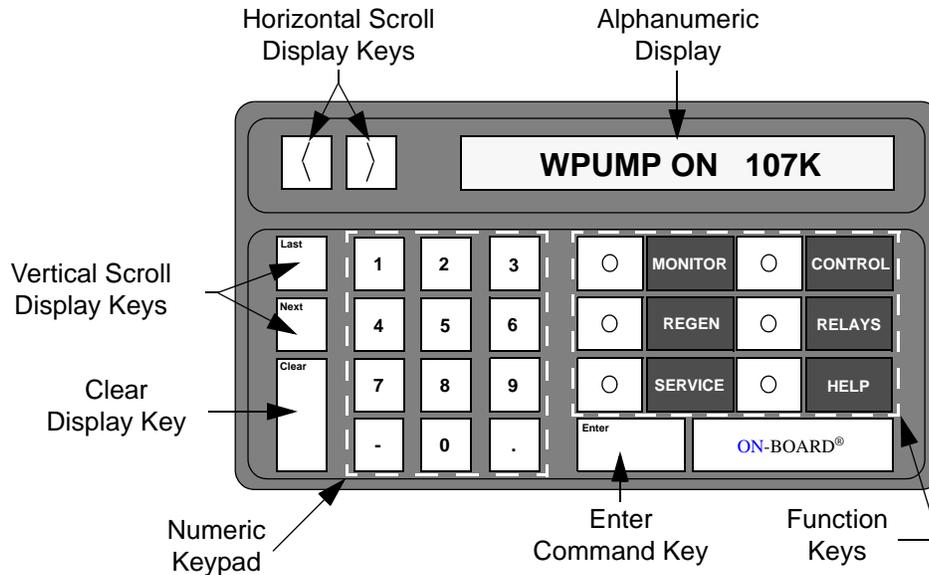


Figure 1-1: On-Board Keypad/Display

Alphanumeric Display

The alphanumeric display shows up to 16 alphanumeric characters of data entry. Messages longer than 16 characters can be viewed by using the horizontal scroll display key.

Horizontal Scroll Display Keys

The horizontal scroll display keys move the message to the left or right on the alphanumeric display when pressed. These keys are typically used to display a message which is longer than the 16 character width of the display.

Vertical Scroll Display Keys (Last, Next)

The Last and Next keys allow the user to display the preceding or proceeding messages of the selected function.

Clear Display Key

The Clear key is used to remove user entered information during On-Board Module programming or device selection.

NOTE: The Clear key must be pressed before the Enter key is pressed to remove the desired information.

Numeric Keypad

The numeric keypad is used to enter numeric values for On-Board Module programming and operation.

Enter Command Key

The Enter key is used to accept numeric information which the user has entered via the numeric keypad.

Function Keys

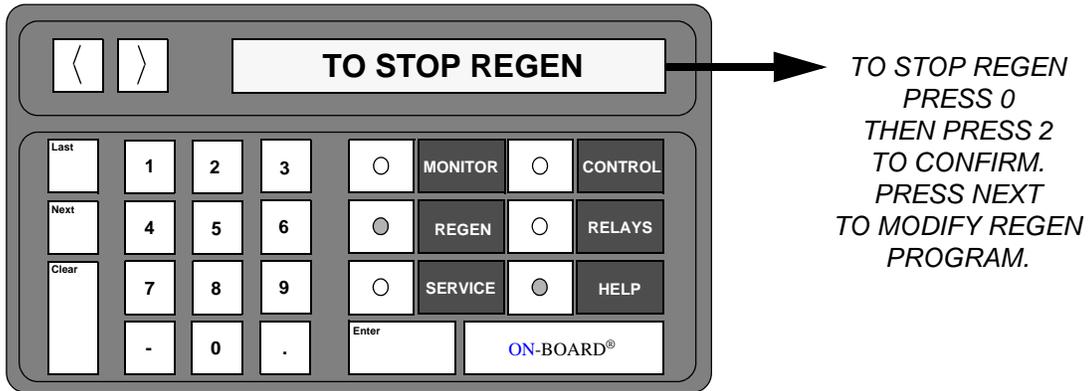
The function keys allow the user to select the software function in which programming or operation is desired. Refer to **Section 3 - Programming and Operation** for a complete description of programming and operation information of each On-Board W Module function.

On-line Help

The on-line HELP function provides the user with additional information when used in conjunction with the MONITOR, REGEN, SERVICE, CONTROL, and RELAYS function keys.

Ranges of programmable values are displayed when the HELP key is pressed after the Enter key has been pressed. ON/OFF values are also displayed at appropriate times.

Instructions are also displayed for certain messages that appear on the screen. Figure 1-2 shows a help message that might be displayed, line by line, in the keypad/display when the HELP key is pressed during warm-up in the REGEN cycle.



NOTE: After pressing the HELP key, press the Next key to display the help message line by line.

Figure 1-2: On-line Help Message Example

Software Version Identification

Refer to the SERVICE Function within **Section 3 - Programming and Operation** of this manual to identify the On-Board Module serial number and the software version.

Section 2 - System Power

Before You Start

Make sure the On-Board Waterpump has been installed according to the directions found in the **On-Board Waterpump Installation and Service Instructions** manual, CTI-CRYOGENICS P/N 8040364.

On-Board Waterpump Configurations

On-Board Waterpumps are available in the following three standard configurations:

- **In Situ (Cryopanel) Configuration** - for installation in transfer chambers, load-locks, or PVD process chambers. The cryopanel is located in the chamber to provide maximum water speed.
- **Inline Configuration** - For installation *in series* with a turbopump or other high vacuum pump. The cylindrical cryopanel maximizes the conductance from the chamber to the high vacuum pump so that the pumping speed of the high vacuum pump is not impaired.
- **Appendage Configuration** - For installation in a spare port on the tool.

A standard On-Board Waterpump is equipped with a thermocouple (TC) gauge. Depending upon the specific design, the On-Board Waterpump may also be equipped with a purge valve and/or a roughing valve.

When a user receives an On-Board Waterpump, the On-Board W Module has already been programmed for the particular type of pump and REGEN routine. The user can however, reprogram the module at any time. Refer to **Section 3 - Programming and Operation** for more information on the REGEN function.

On-Board Waterpump Start-up

An On-Board Waterpump can be started using the following procedure:

1. Turn the On-Board ON/OFF switch, located on the compressor, to the ON position.
2. Turn the compressor ON/OFF switch to the ON position.

If applicable, perform steps 3 - 5, otherwise proceed with step 6.

3. Turn the roughing pump ON.
4. Ensure that the nitrogen or air supply to the roughing valve is between 60 - 80 psig.

NOTE: Do not exceed 80 psig when performing step 5.

5. Ensure that the nitrogen supply to the purge valve is between 40 - 80 psig.
6. Press the **CONTROL** button on the keypad/display.
7. Press **1** to start the On-Board Waterpump.

On-Board Waterpump Shutdown

An On-Board Waterpump can be shutdown using the following procedure:

If applicable, perform steps 1 - 2, otherwise proceed with step 3.

1. Close the hi-vac valve located between the On-Board Waterpump and the vacuum system.
2. Turn the turbo or other high vacuum pump OFF.
3. Press the **CONTROL** key on the keypad/display.
4. Press **0** to turn the On-Board Waterpump OFF.

Section 3 - Programming and Operation

Introduction

Section 3 provides the user with a description of programming and operation information for On-Board W (Water) Module software. Refer to Tables 3-7 and 3-8 at the end of this section for a complete list of all On-Board W Module software parameters.

Normal Operation

The On-Board Waterpump has been designed to operate without user assistance. Make sure the compressor helium gauge reading is within the specified range as discussed in the appropriate compressor manual.

CAUTION

Refer to **Appendix A** and contact the local customer support center location if the helium supply gauge reading is not within the specified range.

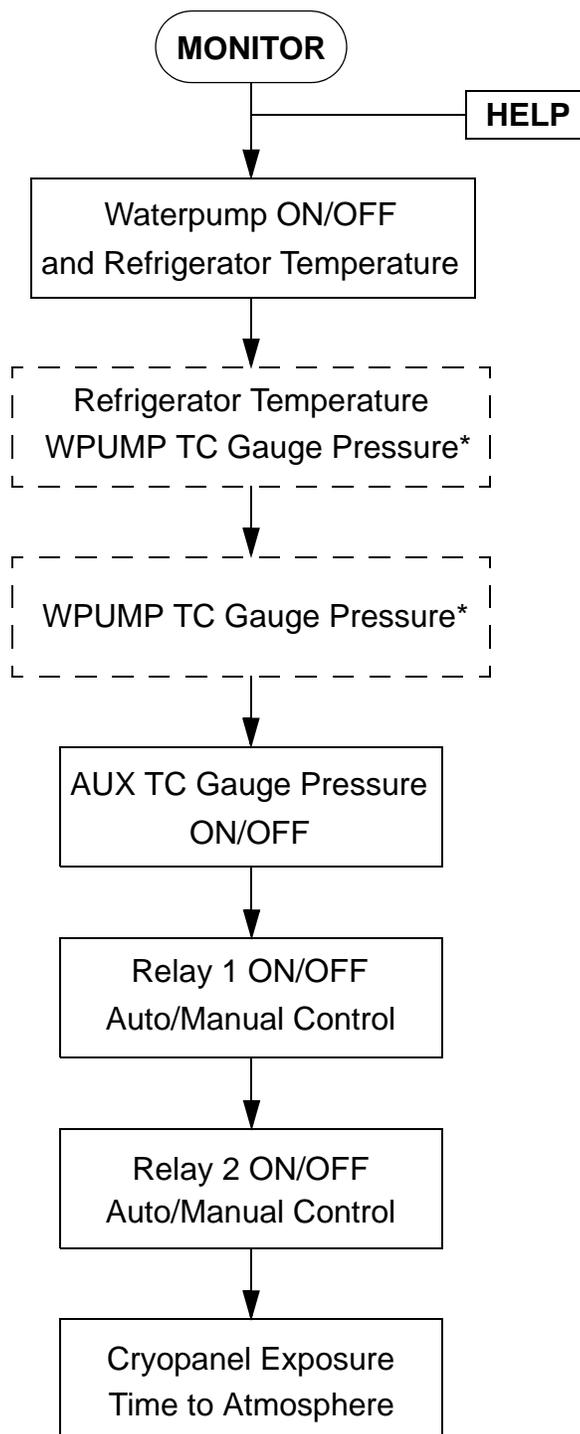
MONITOR Function

The MONITOR function allows the user to observe the following On-Board Waterpump system data:

- ON/OFF status of the On-Board Waterpump
- On-Board Waterpump refrigerator temperature
- On-Board Waterpump thermocouple and auxiliary thermocouple gauge (TC) pressures
- ON/OFF status of both programmable relays
- Exposure Time Information

NOTE: The MONITOR function only displays data.

Data that is displayed using the MONITOR function is useful in determining the operating status of the On-Board Waterpump. The flowchart in Figure 3-1 displays all W Module MONITOR software functions.



* Only visible when waterpump is setup with a TC gauge.

Figure 3-1: MONITOR Function Flowchart

ON/OFF Status and Refrigerator Temperature

The first parameter within the MONITOR function displays the On-Board Waterpump ON/OFF status and refrigerator temperature (degrees Kelvin) as shown in Figure 3-2.

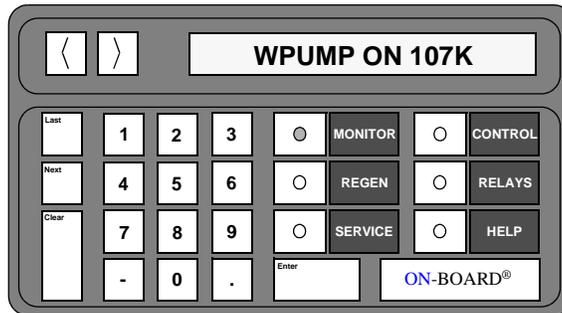


Figure 3-2: ON/OFF Status and Refrigerator Temperature

NOTE: Refer to Appendix A and contact the local CTI-CRYOGENICS customer support center if the letters SHO or OPN are displayed.

Refrigerator Temperature and Thermocouple Gauge Pressure

The second parameter of the MONITOR function displays the On-Board Waterpump refrigerator temperature (degrees Kelvin) and the thermocouple gauge pressure (microns) if the waterpump is equipped with a TC gauge. Refer to Figure 3-3. The display will indicate pressures between 0 - 999 microns.

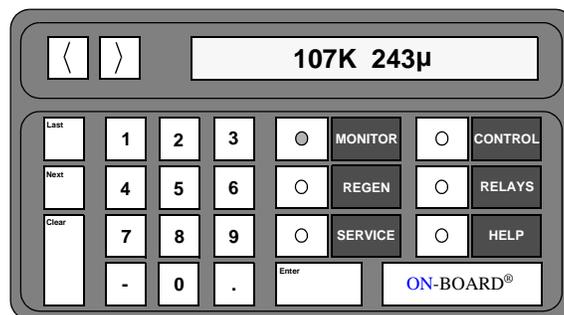


Figure 3-3: Refrigerator Temperature and Thermocouple Gauge Pressure

Thermocouple Gauge Pressure

The third parameter of the MONITOR function displays the On-Board Waterpump thermocouple gauge pressure (in microns) if the waterpump is equipped with a TC gauge. Refer to Figure 3-4. The display indicates pressures between 0 - 999 microns.

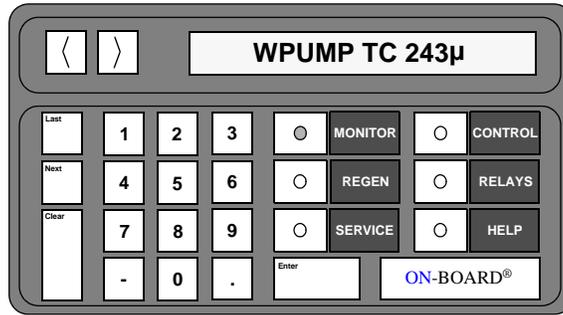


Figure 3-4: Thermocouple Gauge Pressure

Auxiliary Thermocouple Gauge Pressure

The fourth parameter of the MONITOR function displays the auxiliary thermocouple gauge pressure (in microns). Refer to Figure 3-5. The display indicates pressures between 0 - 999 microns or OFF when the auxiliary thermocouple gauge is turned OFF.

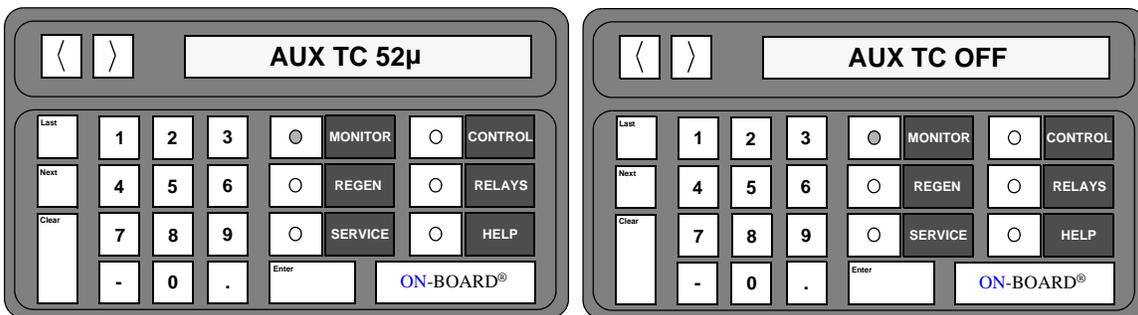


Figure 3-5: Auxiliary Thermocouple Gauge Pressure

Relay 1 ON/OFF and Auto/Manual Control

The fifth parameter of the MONITOR function displays the ON/OFF status of Relay 1 and whether Relay 1 is in automatic or manual control. Refer to Figure 3-6.

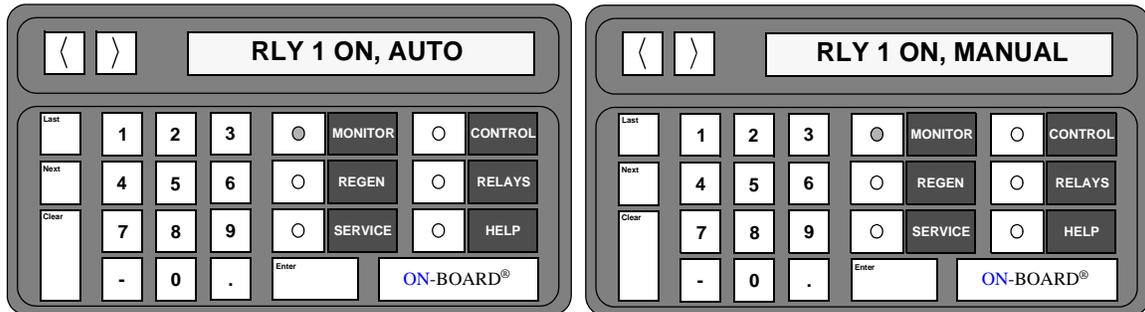


Figure 3-6: Relay 1 Automatic or Manual Control

Relay 2 ON/OFF and Auto/Manual Control

The sixth parameter of the MONITOR function displays the ON/OFF status of Relay 2 and whether Relay 2 is in automatic or manual control. Refer to Figure 3-7.

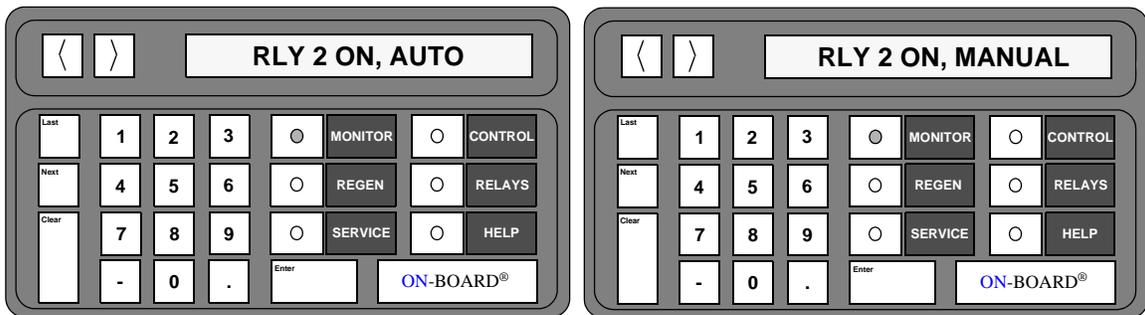


Figure 3-7: Relay 2 Automatic or Manual Control

Accumulated Exposure Time

The seventh parameter of the MONITOR function displays the total amount of time the cryopanel has been exposed to temperatures greater than the exposure temperature setpoint. The total accumulated exposure time and the maximum allowable time before a REGEN cycle is recommended are displayed in minutes as shown in Figure 3-8.

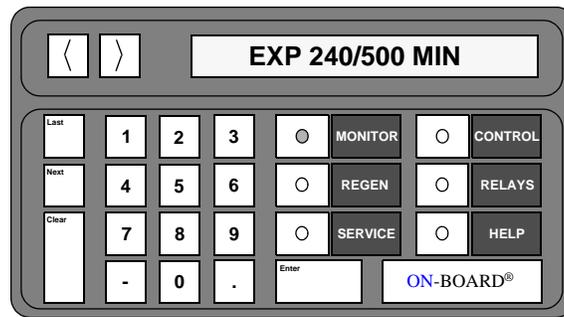


Figure 3-8: Accumulated Exposure Time Display

MONITOR Function Operation

Use the following procedure to observe the MONITOR function parameters of the On-Board W Module.

NOTE: The On-Line HELP function is always available for use during the operation of the MONITOR function. Refer to **Section 1 - Common On-Board Module Information** for more information.

1. Press the **MONITOR** key on the keypad/display. The MONITOR key illuminates, the On-Board Waterpump ON/OFF status and refrigerator temperature are displayed.

NOTE: Refer to Appendix A and contact the local CTI-CRYOGENICS customer support center if the letters SHO or OPN are displayed.

2. Press the **Next** key. If the waterpump is equipped with a TC gauge, the refrigerator temperature is displayed in degrees Kelvin and the On-Board Waterpump thermocouple gauge pressure is displayed in microns.
3. Press the **Next** key. If the waterpump is equipped with a TC gauge, the On-Board Waterpump thermocouple gauge pressure is displayed in microns.
4. Press the **Next** key. The auxiliary thermocouple gauge pressure is displayed in microns.
5. Press the **Next** key. The ON/OFF status of Relay 1 is displayed along with the automatic or manual mode indicator.
6. Press the **Next** key. The ON/OFF status of Relay 2 is displayed along with the automatic or manual mode indicator.
7. Press the **Next** key. The accumulated exposure time display is displayed in minutes.
8. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

REGEN Function

The REGEN function within the On-Board W Module allows the user to start a REGEN cycle. A REGEN cycle begins by allowing the On-Board Waterpump to warm so that water vapor collected on the cryopanel can be purged from the pump. The recommended REGEN parameters for your particular waterpump application have been pre-programmed by CTI-CRYOGENICS, but if desired, the user can reset the REGEN parameters by pressing the REGEN key and stepping through the REGEN menus as shown in Figures 3-9 and 3-10.

There are two different REGEN routines programmed into the On-Board W Module. The *warm-up* routine removes collected frost by liquefying it. The *sublime* routine removes collected frost by changing it to a vapor and removing it from the chamber by a rough or high vacuum pump. If this is an In-Line Waterpump, the vapor phase should be removed using both the rough pump and the high-vacuum pump.

There are two programming options within the *warm-up* routine. The first option allows the On-Board Waterpump to warm to room temperature and shut OFF. The second option cools the On-Board Waterpump back down after attaining room temperature. This second option provides the operator enough time (approximately 10 - 15 minutes) to wipe off the cryopanel prior to the On-Board Waterpump getting cold.

NOTE: *The cryopanel can be wiped off at temperatures greater than 285K.*

There are two programming options within the *sublime* routine. These options are based on *pressure* and *time*. These two sublime routines can be thought of as *full (pressure)* and *partial (time)* REGEN cycles. Sublime based on *pressure* utilizes a TC gauge to determine when all water is removed from the cryopanel. Sublime based on *time* allows you to select an amount of time you can afford to operate a REGEN cycle. This latter routine will help extend the time between full REGEN cycles and allows the On-Board Waterpump to dwell at the preset sublime temperature but does not include refrigerator warm-up or cool down time. The sublime routine based on *time* may not remove all the water from the cryopanel. However, the sublime routine based on *pressure* will remove all water from the cryopanel.

NOTE: *CTI-CRYOGENICS can provide REGEN cycle time estimates. However, each REGEN cycle time should be measured on your system because cycle time is application specific.*

The On-Board W Module has been pre-programmed to run the appropriate REGEN routine prior to leaving the factory, though it can be re-programmed at anytime by running REGEN Setup.

Examples on the operation of the warm-up and sublime routines are described in **Appendix G**.

The REGEN function incorporates a number of parameters which are preset at the factory. The REGEN parameters are shown in Tables 3-1 and 3-2 along with their default settings and acceptable range of values. Each of the REGEN parameters are described on the following pages.

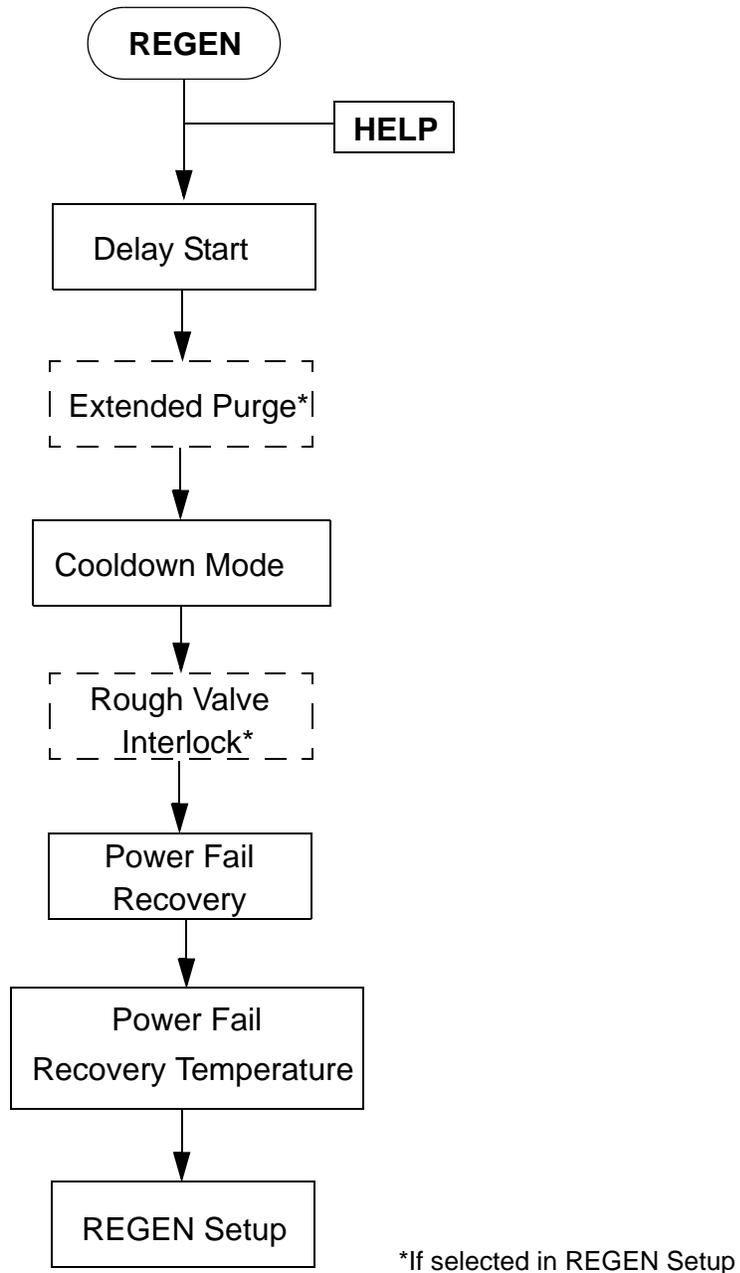
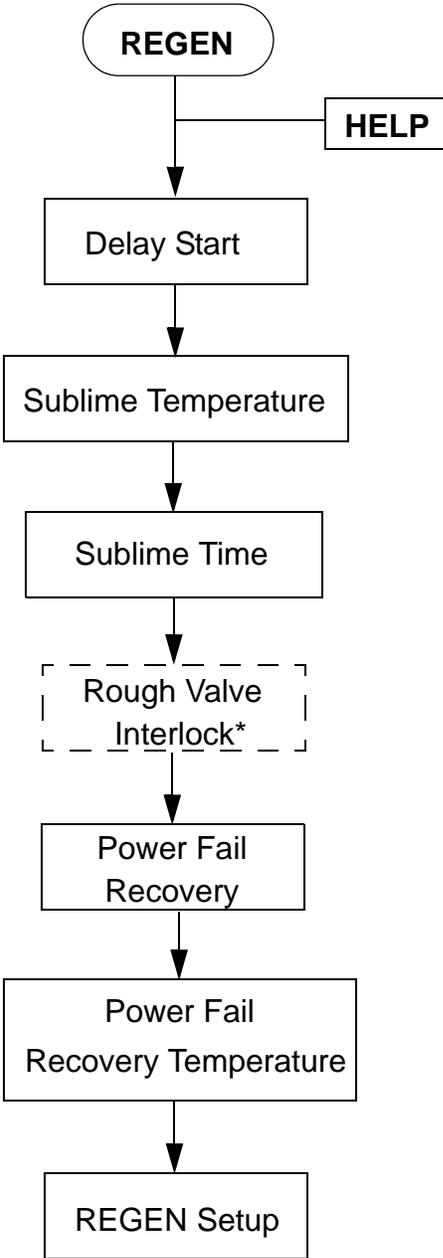


Figure 3-9: REGEN Warm-Up Setup Flowchart



*If selected in REGEN Setup

Figure 3-10: REGEN Sublime Setup Flowchart

Table 3-1: REGEN Warm-Up Function Parameters

REGEN Parameter	Default Value	Range of Values
Delay Start	0	0 - 500.0 hours
Extended Purge*	10 minutes	0 -999 minutes
Cooldown Mode	OFF	ON/OFF
Rough Valve Interlock*	OFF	ON/OFF
Power Fail Recovery	OFF	ON/OFF
Power Fail Recovery Temperature	260K	110 - 260K
REGEN Setup	-	TC Gauge: YES/NO REGEN Type: warm-up/sublime Purge Valve: YES/NO Rough Valve: YES/NO
*If selected in REGEN Setup		

Table 3-2: REGEN Sublime Function Parameters

REGEN Parameter	Default Value	Range of Values
Delay Start	0	0 - 500.0 hours
Sublime Temperature	230K	110 - 250K
Sublime Time	30 minutes	10 - 600 minutes
Rough Valve Interlock*	OFF	ON/OFF
Power Fail Recovery	OFF	ON/OFF
Power Fail Recovery Temperature	260K	110 - 260K
REGEN Setup	-	TC Gauge: YES/NO REGEN Type: warm-up/sublime Purge Valve: YES/NO Rough Valve: YES/NO
*If selected in REGEN Setup		

REGEN Start

When the REGEN button is initially pushed, the current REGEN cycle status is displayed.

NOTE: The REGEN cycle status displayed depends upon the REGEN cycle (warm-up or sublime) selected during REGEN Setup.

If a warm-up REGEN cycle was selected, the user presses the 1 key to start and the 2 key to confirm the start of a warm-up cycle.

If a sublime REGEN cycle was selected, the user presses:

- 1 to start
- 2 to confirm the start of a pressure sublime REGEN cycle
- 3 to confirm the start of a timed sublime REGEN cycle.

The time to complete a REGEN cycle is dependent upon the On-Board Waterpump design and application. An example of the keypad/display messages are shown in Figure 3-11.

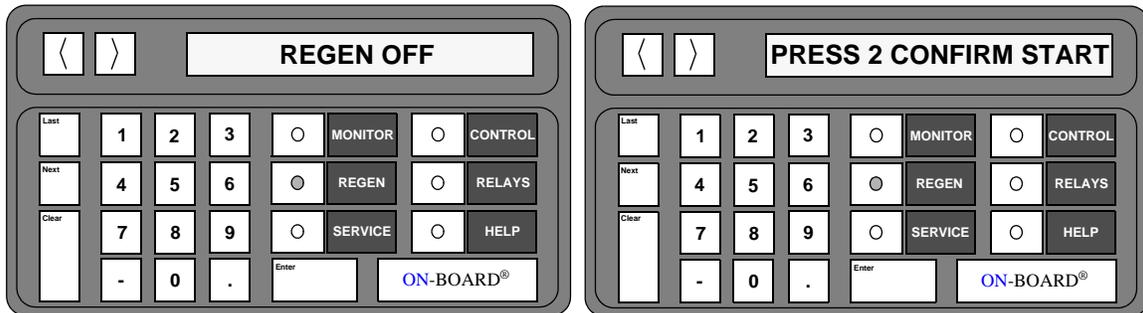


Figure 3-11: REGEN Start Display

Delay Start

The Delay Start parameter of the REGEN function allows the user to set the amount of time that the start of a REGEN cycle will be delayed. The On-Board Waterpump waits that amount of time before starting the REGEN cycle. The keypad/display message is shown in Figure 3-12.

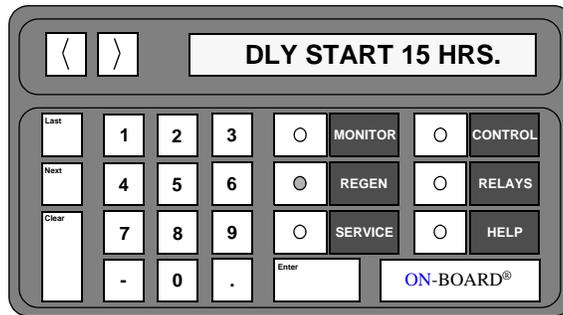


Figure 3-12: Delay Start of REGEN Display

Extended Purge

The Extended Purge parameter is only available if the REGEN function is programmed for the *warm-up routine* and the On-Board Waterpump is equipped with a *purge valve*. This parameter allows the user to set the amount of time that purge gas will flow into the system after the On-Board Waterpump has warmed up. The keypad/display message is shown in Figure 3-13.

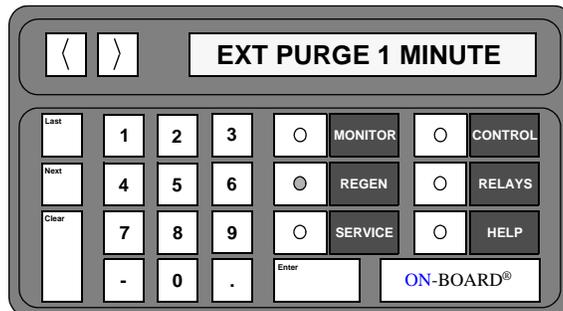


Figure 3-13: Extended Purge Display

Cooldown Mode

The Cooldown Mode parameter is only available if the REGEN function is programmed for the *warm-up routine*. This parameter allows the user to choose either a *cold to cold* REGEN cycle or a *cold to warm* REGEN cycle.

When Cooldown mode is ON, the On-Board Waterpump will cool down after it has warmed up to the preprogrammed temperature set point. When Cooldown mode is OFF, the On-Board Waterpump will warm up to the maximum temperature set point, the REGEN cycle will be complete, and the On-Board Waterpump will remain OFF. The ON COOLDOWN MODE message is displayed as shown in Figure 3-14.

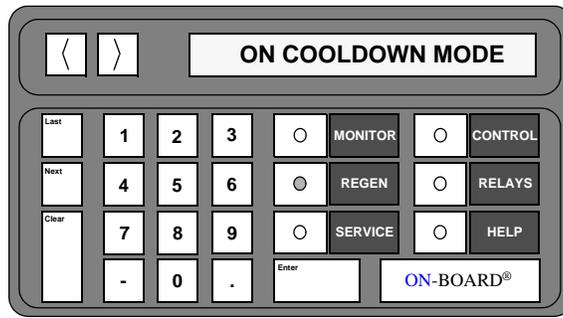


Figure 3-14: Cooldown Mode Display

Sublime Temperature

The Sublime Temperature parameter is only available if the REGEN function is programmed for the *sublime routine*. This parameter allows the user to set the temperature which the On-Board Waterpump will rise to during a sublime REGEN cycle. The keypad/display message is shown in Figure 3-15.

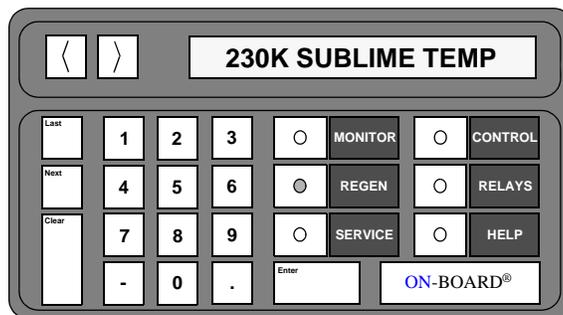


Figure 3-15: Sublime Temperature Display

Sublime Time

The Sublime Time parameter is only available if the REGEN function is programmed for the *sublime routine*, and is only used when running time sublimes. This parameter allows the user to set the amount of time the On-Board Waterpump will dwell at the sublime temperature.

NOTE: This parameter does not include the time taken to warm-up or cool-down the On-Board Waterpump.

The keypad/display message is shown in Figure 3-16.

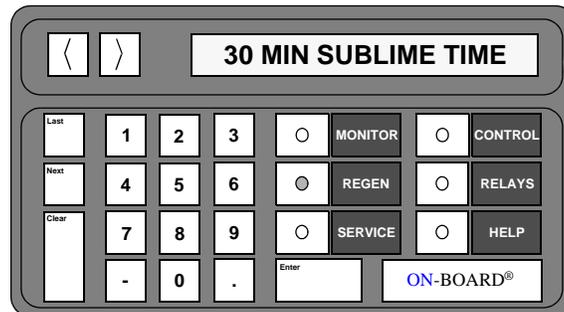


Figure 3-16: Sublime Time Display

Rough Valve Interlock

NOTE: The rough valve interlock must be OFF when an On-Board Waterpump is not being operated within a **rough valve group**. Otherwise, the rough valve will never open and the On-Board Waterpump will remain in the **rough share wait mode**.

The Rough Valve Interlock parameter of the REGEN function is only available if the On-Board Waterpump is equipped with a *roughing valve*. This parameter allows the user to control the operation of the On-Board Waterpump roughing valve. The rough valve interlock is typically used in a network configuration when multiple On-Board Waterpumps share a single roughing pump to allow only one On-Board Waterpump to access the roughing pump.

When the Rough Valve Interlock is set to OFF (0), the On-Board Waterpump roughing valve operates independent of the system rough valve grouping. When the Rough Valve Interlock is ON (1), the rough valve will open when permission is received from the Network Terminal. Having the Rough Valve Interlock ON prevents rough pump overload when two or more On-Board Waterpumps are being regenerated simultaneously. The Rough Valve Interlock display is shown in Figure 3-17.

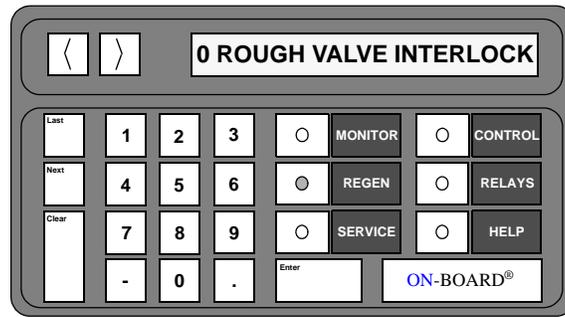


Figure 3-17: Rough Valve Interlock Display

Power Fail Recovery

The Power Fail Recovery of the REGEN function allows the user to choose whether the On-Board Waterpump will automatically perform a REGEN cycle or cool down if below the power failure recovery temperature, after a power failure has occurred. There are three settings available to the user:

- 0 - Power Fail OFF
- 1 - Power Fail ON
- 2 - Power Fail Cool

***NOTE:** If Power Fail Cool is selected, and the power failure occurs while the On-Board Waterpump is ON, the On-Board Waterpump will only cool down if it is below the power fail recovery temperature set point. If the On-Board Waterpump temperature is above the set point, the On-Board Waterpump will remain OFF. The keypad/display messages are shown in Figure 3-18.*

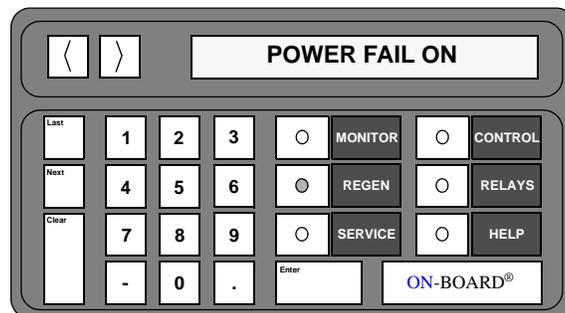


Figure 3-18: Power Fail Recovery Display

The information in Table 3-3 provides an explanation of the different modes of On-Board Waterpump operation during the power failure recovery modes.

Table 3-3: Power Failure Recovery Modes of Operation

On-Board Waterpump Operating Status (ON/OFF/REGEN)	Power Fail Recovery (ON/OFF/Cool)	Setpoint (Above/Below)	REGEN Type (warm-up/sublime)	Result
ON/OFF/REGEN	OFF	Above or Below	warm-up or sublime	Pump stays OFF
ON ON	ON ON	Below Above	- -	Pump turns ON Pump turns ON
ON ON	Cool Cool	Below Above	- -	Pump turns ON Pump stays OFF
OFF	ON/OFF/Cool	Above or Below	-	Pump stays OFF
REGEN REGEN	ON or Cool ON or Cool	Above Below	sublime sublime	Pump stays OFF* Continue sublime
REGEN	ON or Cool	Above or Below	warm-up	Continue warm-up
* sublime routine aborted				

Power Fail Recovery Temperature

The Power Fail Recovery Temperature parameter of the REGEN function allows the user to establish a temperature set point which the On-Board Waterpump uses to decide whether to perform a power fail recovery routine. The keypad/display message is shown in Figure 3-19. This setpoint temperature is the temperature of the refrigerator. Temperature gradient considerations must be given to On-Board Waterpump designs using cold links and large cryopanel.

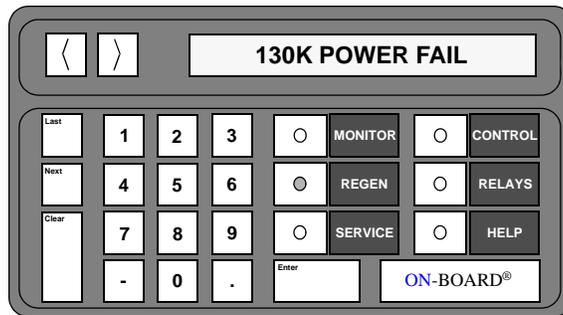


Figure 3-19: Power Fail Recovery Temperature Display

REGEN Setup

The REGEN Setup parameter first queries the user to determine whether the On-Board Waterpump has a TC gauge. If the waterpump does not have a TC gauge, the system will only allow warm-up regeneration cycles to be run. If the waterpump does have a TC gauge, the user can program the waterpump to perform either the warm-up routine (where the frost turns to a liquid) or sublime routine (where the frost turns into a vapor). It also allows the user to establish whether the On-Board Waterpump controls a purge valve and/or rough valve. The keypad/display message is shown in Figure 3-20.

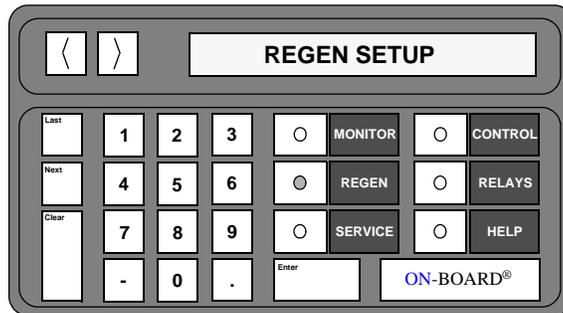


Figure 3-20: REGEN Setup Display

REGEN Cycle Start/Abort

Use the following procedures to start a sublime or warm-up REGEN cycle, or to abort a REGEN cycle.

***NOTE:** Make sure the correct REGEN routine (warm-up or sublime) has been selected before starting a REGEN cycle. Refer to **REGEN Setup** for more information.*

REGEN Start for Sublime

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press **1** to initiate a sublimation routine.
3. Press **2** to confirm the start of a pressure sublime cycle or press **3** to confirm the start of a timed sublime cycle.

REGEN Start for Warm-Up

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press **1** to initiate a warm-up cycle.
3. Press **2** to confirm the start of a warm-up cycle.

Abort REGEN

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press **0** to abort the REGEN cycle.
3. Press **2** to confirm the end of a REGEN cycle. REGEN has been aborted.

REGEN Function Programming

Use the following procedures to program the REGEN function parameters of the On-Board W Module.

Delay Start

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key. The current delay start time value is displayed in hours.
3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys for the desired delay time. For example: **1, 5** for 1.5, or **1, 5, and 0** for 15.0. The range of values is 0 - 500.0 hours.

NOTE: The Clear key may be pressed if incorrect data has been entered. The On-Board module allows the user to enter the new value.

5. Press the **Enter** key. Delay start programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Extended Purge

*NOTE: This parameter is only available for use when **purge valve** and **warm-up** have been selected in REGEN Setup.*

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key until **XXX MIN EXT D PUR** is displayed.
3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys to enter the desired extended purge time. For example: **1, 5, and 0** for 150. The range of values is 0-999 minutes.

NOTE: The Clear key may be pressed if incorrect data has been entered. The On-Board module allows the user to enter the new value.

5. Press the **Enter** key. Extended purge programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Cooldown Mode

***NOTE:** This parameter is only available for use when **warm-up** has been selected in REGEN Setup.*

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key until the current status is displayed for cooldown mode.
3. Press **1** to turn cooldown mode ON or **0** to turn cooldown mode OFF. Cooldown mode programming is complete.
4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Sublime Temperature

***NOTE:** This parameter is only available for use when **sublime** has been selected in REGEN Setup.*

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press **Next** until XXXK **SUBLIME TEM** is displayed.
3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys for the desired sublime temperature. For example: **1**, **5**, and **0** for 150. The range of values is 110K - 250K.

***NOTE:** The Clear key may be pressed if incorrect data has been entered. The On-Board module allows the user to enter the new value.*

5. Press the **Enter** key. Sublime temperature programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Sublime Time

***NOTE:** This parameter is only available for use when **sublime** has been selected in REGEN Setup.*

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press **Next** until XXX **MIN SUBLIME** is displayed.

3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys for the desired sublime time. For example: **1**, **5**, and **0** for 150. The range of values is 10 - 600 minutes.

***NOTE:** The Clear key may be pressed if incorrect data has been entered. The On-Board module allows the user to enter the new value.*

5. Press the **Enter** key. Sublime time programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Rough Valve Interlock

***NOTE:** This parameter is only available for use when **rough valve** has been selected in **REGEN Setup**.*

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key until the current state for rough valve interlock is displayed.

***NOTE:** The rough valve interlock must be **OFF** when an On-Board Waterpump is not being operated within a rough valve group. Otherwise, the rough valve will never open and the On-Board Waterpump will remain in the rough share wait mode.*

3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys to turn the rough valve interlock ON or OFF. The range of values is 1 (ON) or 0 (OFF).
5. Press the **Enter** key. Sublime time programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Power Failure Recovery

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key until the current mode for power failure recovery is displayed.
3. Press the desired numeral key to set power failure recovery to the desired mode. The range of values is 0 (OFF), 1 (ON), or 2 (Cool).
4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Power Failure Recovery Temperature

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Next** key until the current power failure recovery temperature is displayed.
3. Press the **Enter** key. The current value is underlined and ready to accept a new value.
4. Press the numeral keys for the desired recovery temperature. For example: **1**, **5**, and **0** for 150. The range of values is 110K - 260K.

***NOTE:** The Clear key may be pressed if incorrect data has been entered. The On-Board module allows the user to enter the new value.*

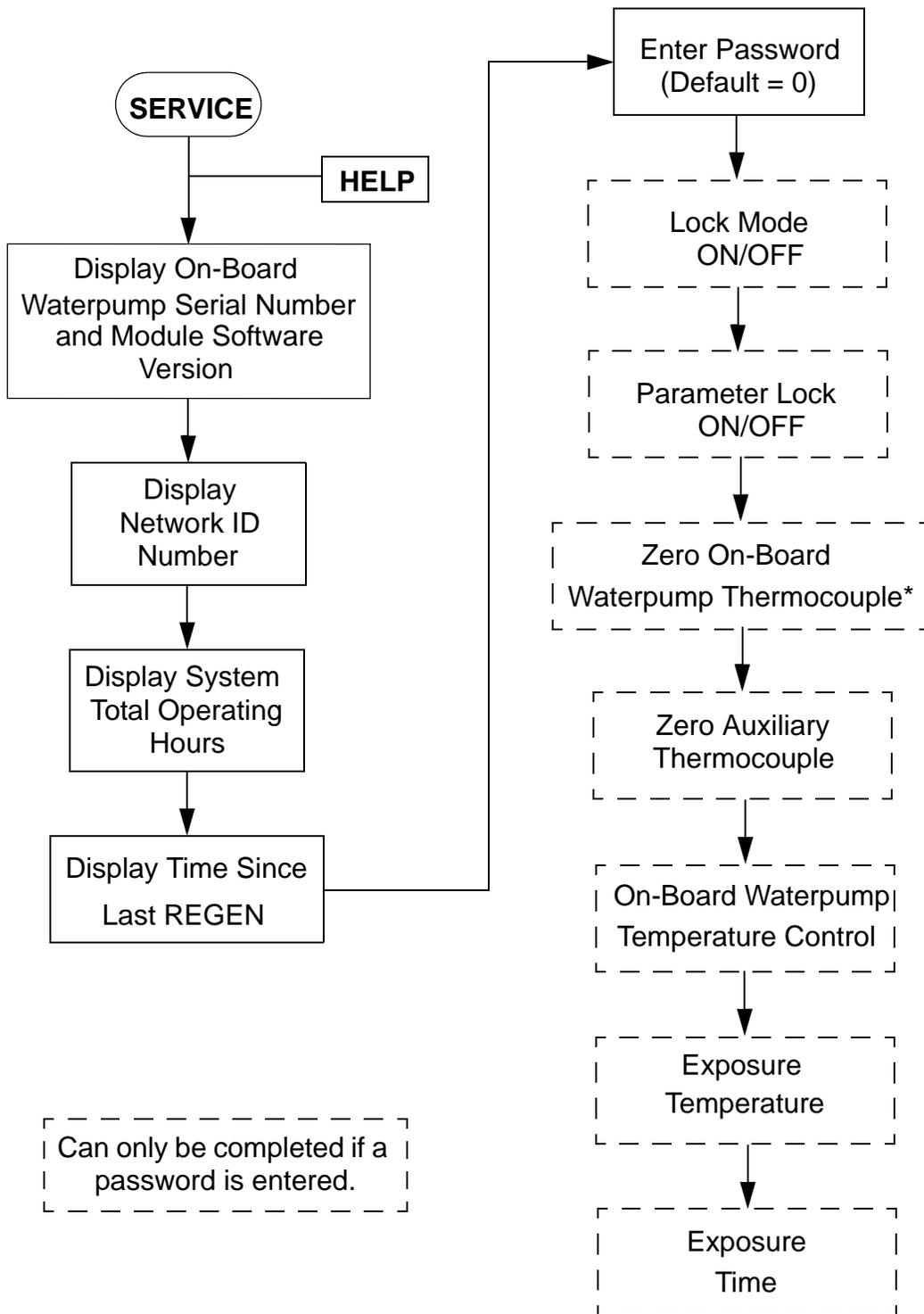
5. Press the **Enter** key. Power failure recovery temperature programming is complete.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

REGEN Setup

1. Press the **REGEN** key on the keypad/display. The current REGEN status is displayed.
2. Press the **Last** key until *REGEN SETUP TO SELECT TYPE PRESS ENTER* is displayed.
3. Press the **Enter** key. The question: *IS THERE A TC GAUGE?* appears. Press **0** for No or press **1** for Yes.
4. If queried, press **0** for warm-up or press **1** for sublime.
5. The question *IS THERE A PURGE VALVE?* may appear. Press **0** for No or press **1** for Yes.
6. The question *IS THERE A ROUGH VALVE?* appears. Press **0** for No or press **1** for Yes.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

SERVICE Function

The On-Board W Module SERVICE function allows the user to access On-Board Waterpump identification information, elapsed operating time, and establish password protection as shown in Figure 3-21. The default and range of SERVICE function parameters are listed in Table 3-4. An explanation of each parameter is provided on the following pages.



* Only available when thermocouple gauge is selected in REGEN set-up.

Figure 3-21: SERVICE Function Flowchart

Table 3-4: SERVICE Function Parameters

SERVICE Parameter	Default Value	Range of Values
Serial Number/Software Version	-	-
Net ID	0	0 - 9
Elapsed Pump Time	-	-
Time Since Last REGEN	-	-
Password	0	0 - 32,767
Lock Mode	OFF	1 (ON)/ 0 (OFF)
Parameter Lock	OFF	1 (ON)/ 0 (OFF)
Zero Waterpump Thermocouple	-	-
Zero Auxiliary Thermocouple	-	-
Refrigerator Temperature	107K	0K - 320K
Exposure Temperature	130K	90K - 250K
Exposure Time	500	0 - 9999 minutes

Serial Number and Software Version

The first parameter of the SERVICE function allows the user to display the On-Board Waterpump serial number and current module software version as shown in Figure 3-22.

The serial number is used to identify the On-Board Waterpump. The software version number identifies the software which is running in the On-Board W Module.

NOTE: Press the > key to display the entire software version number.

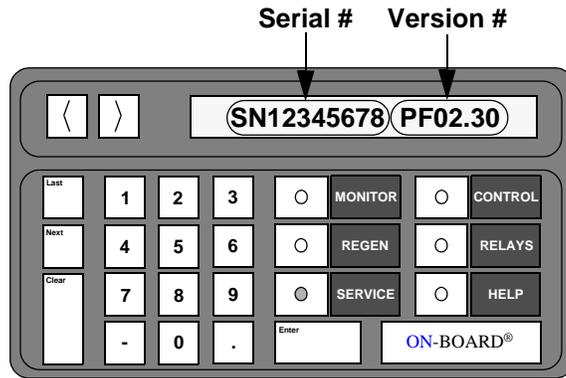


Figure 3-22: On-Board Waterpump Serial Number and Software Version Display

Network Identification Number

The second parameter of the SERVICE function indicates the position of the network rotary switch on the rear panel of the On-Board W Module. The position of the rotary switch identifies the network address of the On-Board Waterpump. The Net Identification screen and rotary switch location, shown in Figure 3-23, indicate that the network rotary switch is set to position 3.

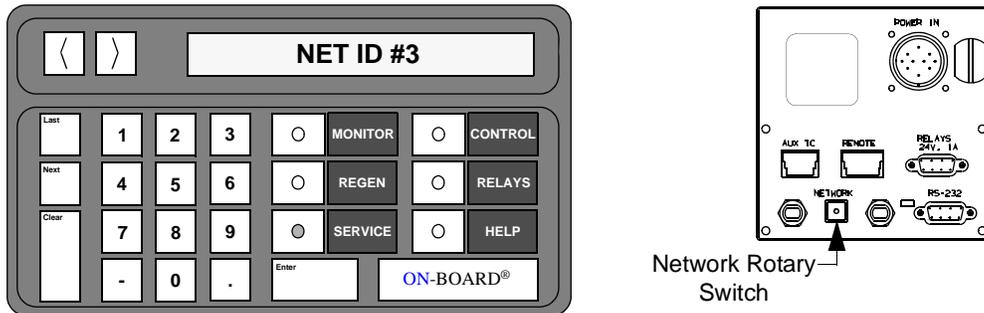


Figure 3-23: Network Identification Number Screen and Network Rotary Switch Location

Elapsed Pump Time

The third parameter of the SERVICE function allows the user to display the total number of On-Board Waterpump operating hours as shown in Figure 3-24.

NOTE: The clock cannot be reset.

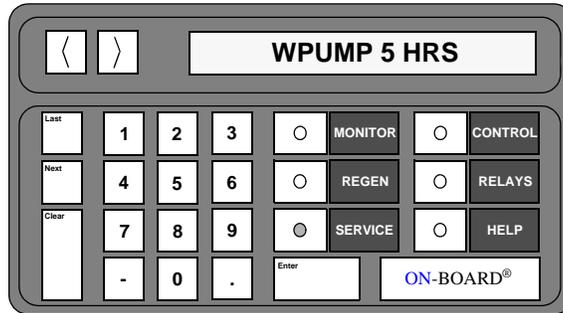


Figure 3-24: Elapsed Pump Time Display

Time Since Last REGEN

The fourth parameter of the SERVICE function allows the user to display the total number of hours since the last REGEN was performed as shown in Figure 3-25. The clock is automatically reset to zero upon the completion of the last REGEN cycle.

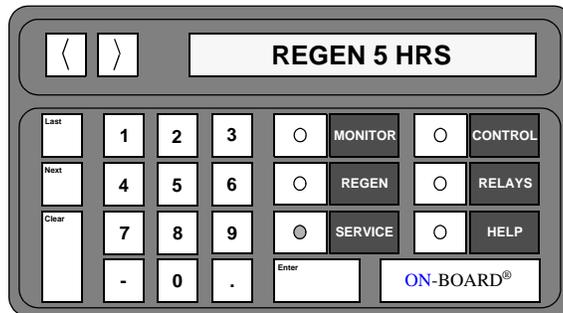


Figure 3-25: Time Since Last REGEN Display

Password

The fifth parameter of the SERVICE function allows the user to create or display a password. A password allows a level of system security to prevent unauthorized users from accessing SERVICE functions. The password display screen is shown in Figure 3-26. The default password is 0.

NOTE: Refer to **Appendix A** and contact the local customer support center if the password is forgotten. A master password can be used to clear the original password.

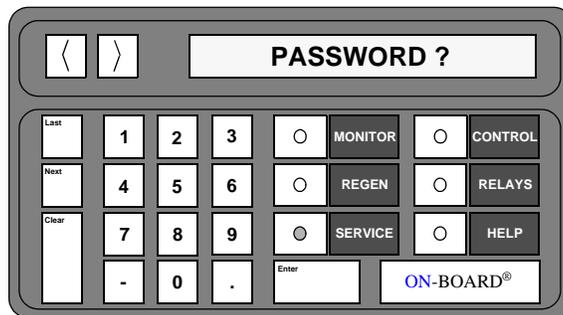


Figure 3-26: Password Screen Display

Lock Mode

The sixth parameter of the SERVICE function prevents an unauthorized user from accessing the REGEN, CONTROL, or RELAYS functions when lock mode is ON. A **LOCKED OUT** message is displayed when the REGEN, CONTROL, or RELAYS keys are pressed. The Lock Mode OFF screen is shown in Figure 3-27.

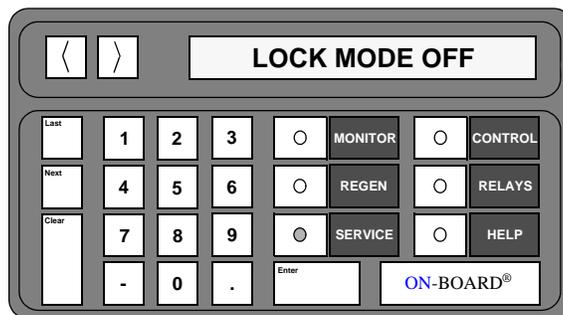


Figure 3-27: Lock Mode OFF Display

Parameter Lock

The seventh parameter of the SERVICE function prevents the user from accessing all programmable REGEN parameters and relay setpoints. When an attempt is made to change a programmable setpoint with Parameter Lock ON, the *CHANGES LOCKED* message is displayed as shown in Figure 3-28.

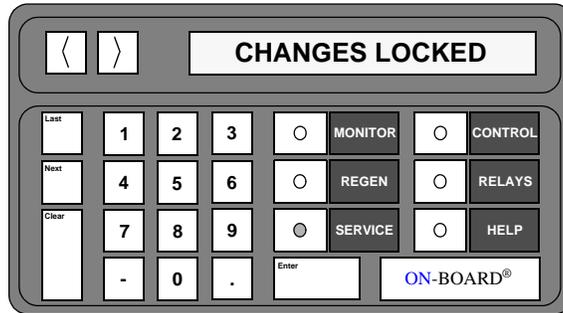


Figure 3-28: Parameter Lock ON Display

Zero On-Board Waterpump Thermocouple

The eighth parameter of the SERVICE function resets the On-Board Waterpump thermocouple gauge to zero if the waterpump is set-up with a thermocouple gauge. The thermocouple gauge reading is displayed until the gauge is set to zero. Refer to Figure 3-29.

NOTE: The On-Board Waterpump thermocouple gauge should not be set to zero above a pressure of 1 micron.

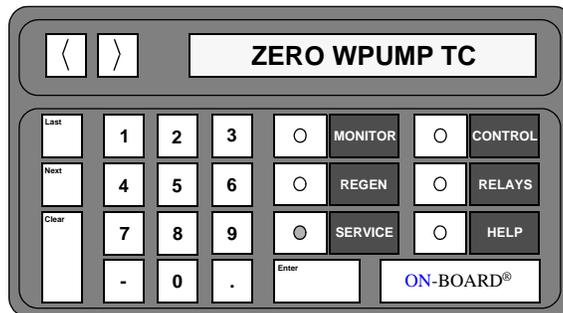


Figure 3-29: Zero On-Board Waterpump Thermocouple Gauge Display

Zero Auxiliary Thermocouple

The ninth parameter of the SERVICE function, as shown in Figure 3-30, resets the auxiliary thermocouple gauge to zero. The auxiliary thermocouple gauge reading is displayed until the gauge is set to zero.

NOTE: The auxiliary thermocouple gauge should not be set to zero above a pressure of 1 micron.

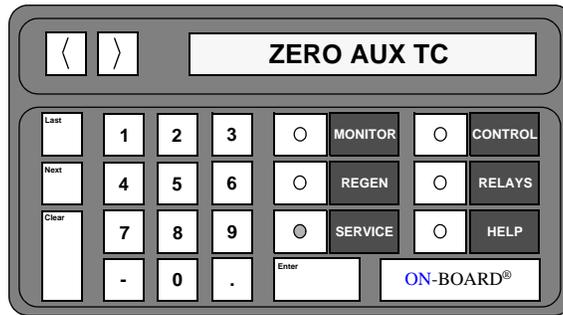


Figure 3-30: Zero Auxiliary Thermocouple Display

On-Board Waterpump Temperature Control

The tenth parameter of the SERVICE function allows the On-Board Waterpump to be set to a user defined temperature between 0K - 320K. A value of zero sets temperature control OFF. The temperature setting is displayed as shown in Figure 3-31.

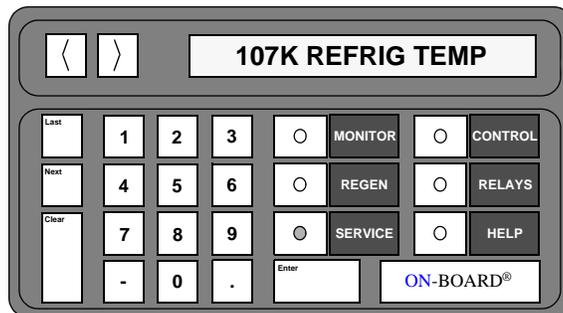


Figure 3-31: Refrigerator Control

Exposure Temperature

NOTE: This parameter is only useful for On-Board Waterpumps that are exposed to atmosphere.

The eleventh parameter of the SERVICE function allows the user to set the exposure temperature. During exposure to atmosphere, the temperature of the On-Board Waterpump warms up slightly dependent upon the sizes of the refrigerator and cryopanel.

When the On-Board Waterpump temperature reaches the exposure temperature, the accumulative exposure time counter will start. When the exposure temperature falls back to the setpoint, the counter will stop. This parameter is utilized in conjunction with exposure time to determine when a REGEN cycle is required. The exposure temperature can be set between 90K and 250K. This exposure temperature setting is displayed as shown in Figure 3-32 and has been pre-programmed at CTI-CRYOGENICS for your application.

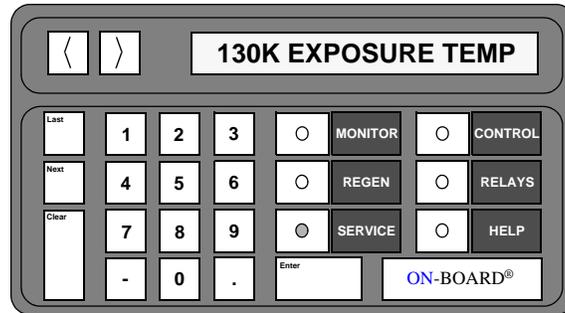


Figure 3-32: Exposure Temperature Display

Exposure Time

The twelfth and final parameter of the SERVICE function allows the user to set the exposure time limit. When the exposure time counter exceeds 75% of the exposure time limit, the *PANEL 75% FULL* warning appears on the keypad notifying the user that the On-Board Waterpump cryopanel is 75% full and will soon be in need of a warm-up or sublime REGEN cycle.

When the exposure time counter reaches the exposure time limit, the *PANEL FULL* warning appears on the keypad notifying the user that the On-Board Waterpump cryopanel has exceeded 100% of the maximum allowable exposure time and is in need of a warm-up or sublime REGEN cycle.

The exposure time counter is accumulative and will only reset after a warm-up or pressure sublimation cycle has been completed. The exposure time setting is displayed as shown in Figure 3-33.

NOTE: The exposure time timer does not reset to zero following the completion of a time sublimation.

NOTE: Refer to **REGEN Function** within this section for more information on REGEN cycles.

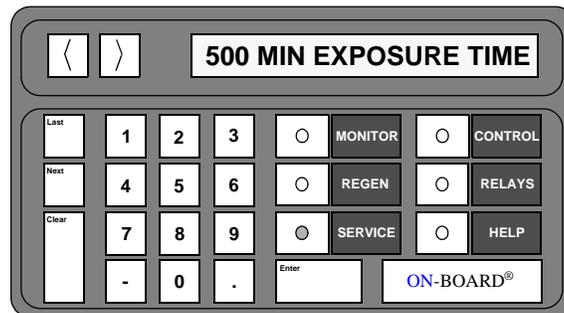


Figure 3-33: Exposure Time Display

SERVICE Function Operation

Use the following procedures to operate the SERVICE function parameters of the On-Board W Module.

Serial Number and Software Version

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Net Identification

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key. The *Net ID* number is displayed.
3. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Elapsed Pump Time

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Pump Hours* are displayed.
3. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Time Since Last REGEN

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *REGEN Hours* are displayed.
3. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Password

NOTE: The default password is 0.

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password* prompt is displayed.
3. Press the **Enter** key. *0 = Password* is displayed.
4. Press the **Enter** key again. The current value (0) is underlined and ready to accept a new value if desired.
5. Press the numeral keys for the desired password. The range of values is 0 - 32767.
6. Press the **Enter** button.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

*NOTE: Refer to **Appendix A** and contact the local customer support center if the password is forgotten. A master password can be used to access the original password.*

Lock Mode

***NOTE:** The Lock Mode parameter cannot be accessed unless a password has been entered. The default password is 0.*

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until the current status of *Lock Mode* is displayed.
5. Press **1** to enable or press **0** to disable lock mode.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Parameter Lock

***NOTE:** The Parameter Lock parameter cannot be accessed unless a password has been entered. The default password is 0.*

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until the current status of *Param Lock* is displayed.
5. Press **1** to enable or press **0** to disable parameter lock mode.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Zero On-Board Waterpump Thermocouple Gauge

***NOTE:** This parameter is only available when the waterpump is set-up with a thermocouple gauge. The Zero On-Board Waterpump Thermocouple parameter cannot be accessed unless a password has been entered. The default password is 0.*

***NOTE:** The auxiliary thermocouple gauge must be turned ON and under a vacuum of less than 10^{-4} torr (less than 1 micron) before this parameter can be used.*

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until *Zero WPUMP TC* is displayed.
5. Press **Enter**. The question *IS YOUR VACUUM BELOW 1 MICRON?* is displayed. Press **1** for YES, the TC gauge will be calibrated. Press **0** for NO, calibration failure will occur.
6. Press the **Enter** key. The On-Board Waterpump thermocouple pressure is displayed until calibration is complete.

Zero Auxiliary Thermocouple Gauge

NOTE: The Zero Auxiliary Thermocouple parameter cannot be accessed unless a password has been entered. The default password is 0.

NOTE: The auxiliary thermocouple gauge must be turned ON and under a vacuum of less than 10^{-4} torr (less than 1 micron) before this parameter can be used.

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until *Zero AUX TC* is displayed.
5. Press the **Enter** key. If the AUX TC is on, the question: *IS YOUR VACUUM BELOW 1 MICRON?* appears. Press **1** for Yes. The TC gauge will be calibrated. Press **0** for No. Calibration failure will occur.
6. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

On-Board Waterpump Refrigerator Temperature Control

NOTE: The On-Board Waterpump Refrigerator Temperature Control parameter cannot be accessed unless a password has been entered. The default password is 0.

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.

3. Enter the password and press **Enter**.
4. Press the **Next** key until *REFRIG TEMP* is displayed.
5. Press the **Enter** key. Press the numeral keys for the desired temperature setpoint. The range of values is 0K - 320K.

NOTE: A value of 0 indicates that temperature control is turned OFF.

6. Press the **Enter** button.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Exposure Temperature

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until *EXPOSURE TEMP* is displayed.
5. Press the **Enter** key. Press the numeral keys for the desired exposure temperature. The range of values is 90K - 250K.
6. Press the **Enter** button.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

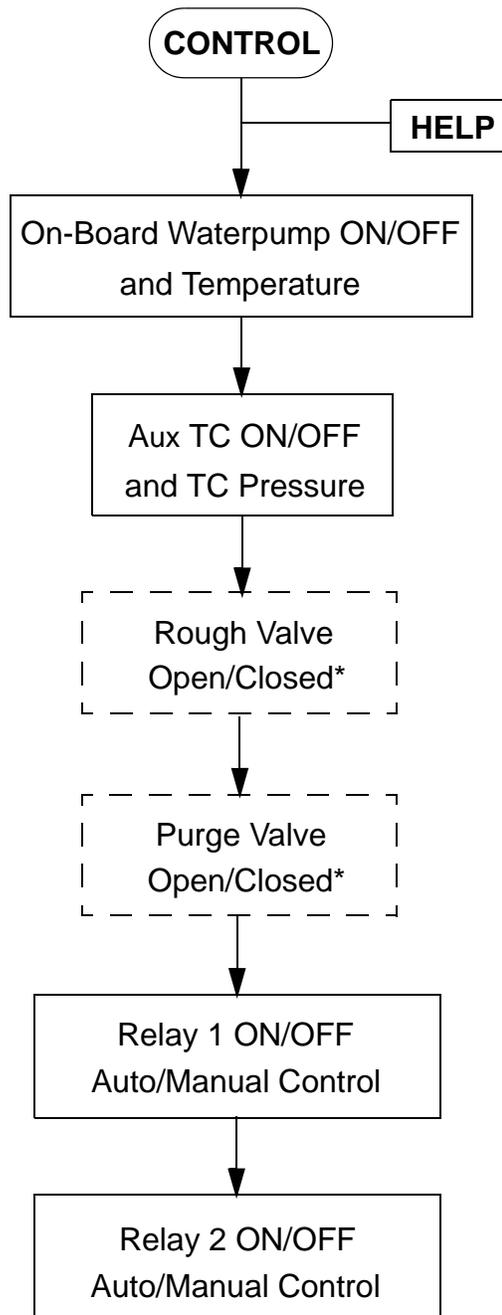
Exposure Time

1. Press the **SERVICE** key on the keypad/display. The serial number and software version information are displayed.
2. Press the **Next** key until the *Password?* prompt is displayed.
3. Enter the password and press **Enter**.
4. Press the **Next** key until *EXPOSURE TIME* is displayed.
5. Press the **Enter** key. Press the numeral keys for the desired exposure time. The range of values is 0 - 9999 minutes.
6. Press the **Enter** button.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

CONTROL Function

The CONTROL function within the On-Board W Module allows the user to turn the On-Board Waterpump, plus selected gauges, valves, and relays ON or OFF. These functions can be used during manual regeneration cycles and to manually operate the On-Board Waterpump.

The CONTROL function parameters are shown in Figure 3-34 and described on the following pages. The default setting and range of CONTROL parameters are provided in Table 3-5.



* Only appears if selected in REGEN setup.

Figure 3-34: CONTROL Function Flowchart

Table 3-5: CONTROL Function Parameters

CONTROL Parameter	Default Value	Range of Values
Waterpump ON/OFF	OFF	ON/OFF
Aux TC ON/OFF	OFF	ON/OFF
Rough Valve Open/Closed*	Closed	Open/Closed
Purge Valve Open/Closed*	Closed	Open/Closed
Relay 1 ON/OFF and Auto/Manual Control	OFF, Manual	ON/OFF (Auto/Manual)
Relay 2 ON/OFF and Auto/Manual Control	OFF, Manual	ON/OFF (Auto/Manual)
* If selected in REGEN setup		

On-Board Waterpump ON/OFF and Refrigerator Temperature

The first parameter of the CONTROL function allows the user to turn the On-Board Waterpump ON or OFF. The keypad/display shows the ON/OFF status as shown in Figure 3-35.

***NOTE:** Check the power connections, fuses, and switches on the On-Board compressor if the NO CRYO POWER1 or NO CRYO POWER2 message appears in the display.*

***NOTE:** The heater is turned ON or OFF when the On-Board Waterpump is turned ON or OFF.*

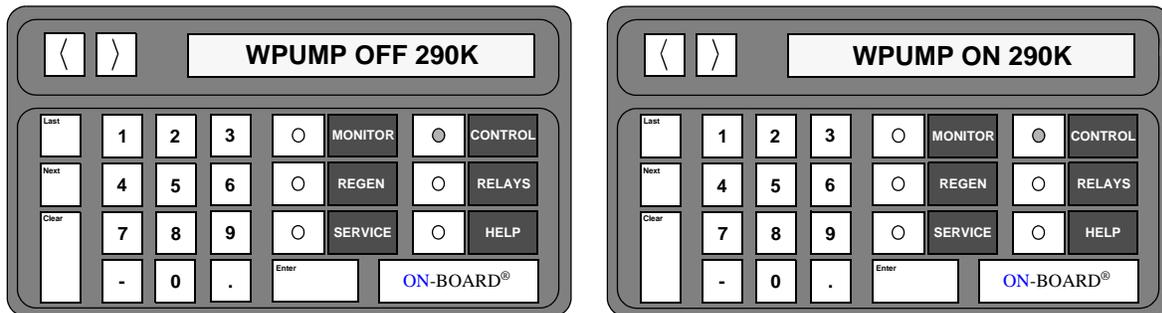


Figure 3-35: On-Board Waterpump ON/OFF and Refrigerator Temperature Display

Aux TC ON/OFF and TC Pressure

The second parameter of the CONTROL function allows the user to turn the auxiliary thermocouple gauge ON or OFF. The keypad/display shows the ON/OFF status of the thermocouple pressure as shown in Figure 3-36.

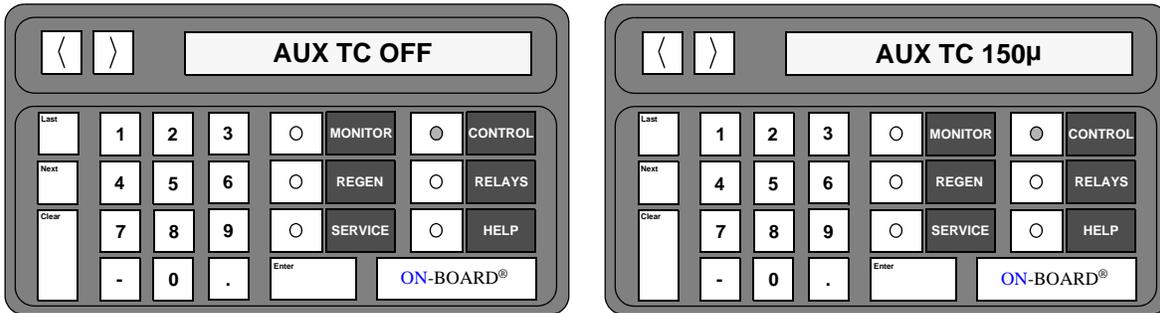


Figure 3-36: Aux TC ON/OFF and TC Pressure Display

Rough Valve Open/Closed

NOTE: This parameter only appears if a rough valve has been selected in the REGEN setup.

The third parameter of the CONTROL function allows the user to open or close the rough valve as shown in Figure 3-37.

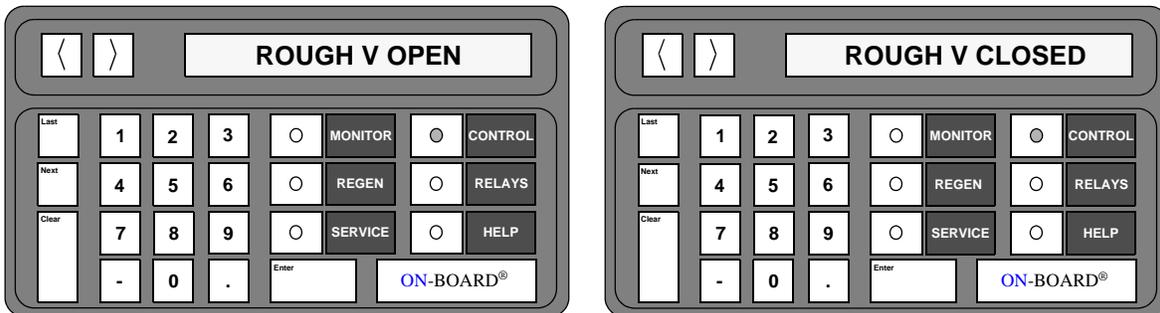


Figure 3-37: Rough Valve Open/Closed Display

CAUTION

Opening the rough valve when the On-Board Waterpump is turned ON may cause oil from the roughing pump to backstream into the vacuum chamber. A message is displayed on the keypad/display warning the user about this potential problem.

Purge Valve Open/Closed

NOTE: This parameter only appears if a purge valve has been selected in the REGEN setup.

The fourth parameter of the CONTROL function allows the user to open or close the purge valve as shown in Figure 3-38.

NOTE: The purge valve cannot be opened during a sublime REGEN cycle.

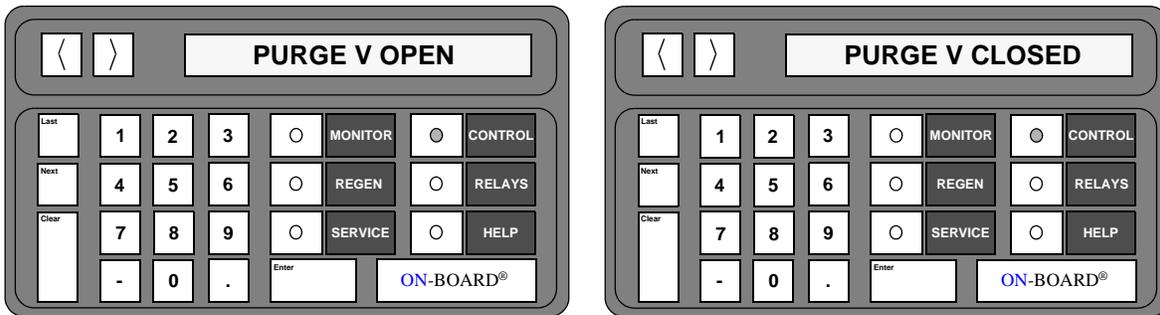


Figure 3-38: Purge Valve Open/Closed Display

Relay 1 ON/OFF and Auto/Manual Control

The fifth parameter of the CONTROL function allows the user to turn relay 1 ON or OFF and select between automatic or manual control as shown in Figure 3-39. Manual control is typically used during system diagnosis when manual activation of relay 1 is required.

Automatic control is used to automatically turn relay 1 ON or OFF depending upon user specified relay programming. The user cannot turn relay 1 ON or OFF when it is in automatic control.

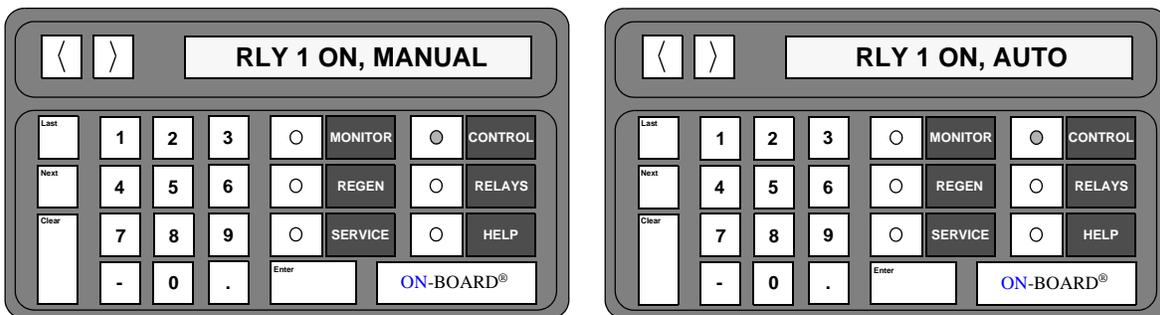


Figure 3-39: Relay 1 ON/OFF and Auto/Manual Control Display

Relay 2 ON/OFF and Auto/Manual Control

The sixth parameter of the CONTROL function allows the user to turn relay 2 ON or OFF and select between automatic or manual control as shown in Figure 3-40. Manual control is typically used during system diagnosis when manual activation of relay 2 is required.

Automatic control is used to automatically turn relay 2 ON or OFF depending upon user specified relay programming. The user cannot turn relay 2 ON or OFF when it is in automatic control.

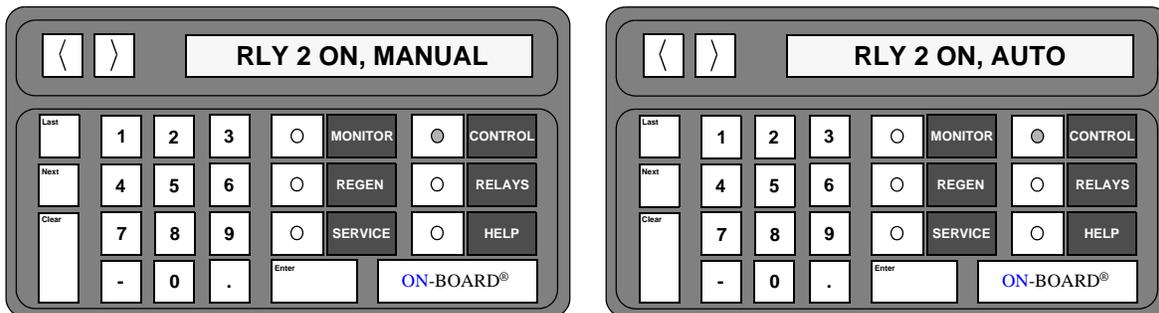


Figure 3-40: Relay 2 ON/OFF and Auto/Manual Control Display

CONTROL Function Operation

Use the following procedures to operate the CONTROL parameters of the On-Board W Module.

On-Board Waterpump ON/OFF and Temperature

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.

NOTE: Refer to **Appendix A** and contact the local **CTI-CRYOGENICS** customer support center if the letters **SHO** or **OPN** are displayed.

2. Press **1** to turn the On-Board Waterpump ON, or press **0** to turn the On-Board Waterpump OFF.
3. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Aux TC ON/OFF and TC Pressure

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.
2. Press the **Next** key. The current *Aux TC* status is displayed.
3. Press **1** to turn the Aux TC ON, or press **0** to turn the Aux TC OFF.
4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Rough Valve Open/Closed

NOTE: This parameter only appears if a rough valve has been selected in the REGEN setup.

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.
2. Press the **Next** key until the current rough valve status is displayed.
3. Press **1** to open the rough valve, or press **0** to close the rough valve.
4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Purge Valve Open/Closed

NOTE: This parameter only appears if a purge valve has been selected in the REGEN setup.

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.
2. Press the **Next** key until the current purge valve status is displayed.
3. Press **1** to open the purge valve, or press **0** to close the purge valve.
4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Relay 1 ON/OFF and Auto/Manual Control

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.
2. Press the **Next** key until the current status and mode for relay 1 are displayed.
3. Press one of the following number keys for the desired relay activity:
 - 1** to turn relay 1 ON
 - 0** to turn relay 1 OFF

NOTE: Keys 7 and 9 can only be used if the relay was setup using the RELAYS function.

- 7** to turn automatic mode ON
- 9** to turn manual mode ON

4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Relay 2 ON/OFF and Auto/Manual Control

1. Press the **CONTROL** key on the keypad/display. The ON/OFF status and the temperature of the On-Board Waterpump are displayed.
2. Press the **Next** key until the current status and mode for relay 2 are displayed.
3. Press one of the following number keys for the desired relay activity:
 - 1** to turn relay 2 ON
 - 0** to turn relay 2 OFF

NOTE: Keys 7 and 9 can only be used if the relay was setup using the RELAYS function.

- 7** to turn automatic mode ON
- 9** to turn manual mode ON

4. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

RELAYS Function

The RELAYS function within the On-Board W Module allows the user to program the setpoint relays to open or close when a vacuum system function occurs.

***NOTE:** Relay activation/deactivation is dependent upon the manner in which the relays are wired, normally open or normally closed.*

The RELAYS function parameters are shown in Figure 3-41. Relay parameters and their ranges are provided in Table 3-6 and are described on the following pages.

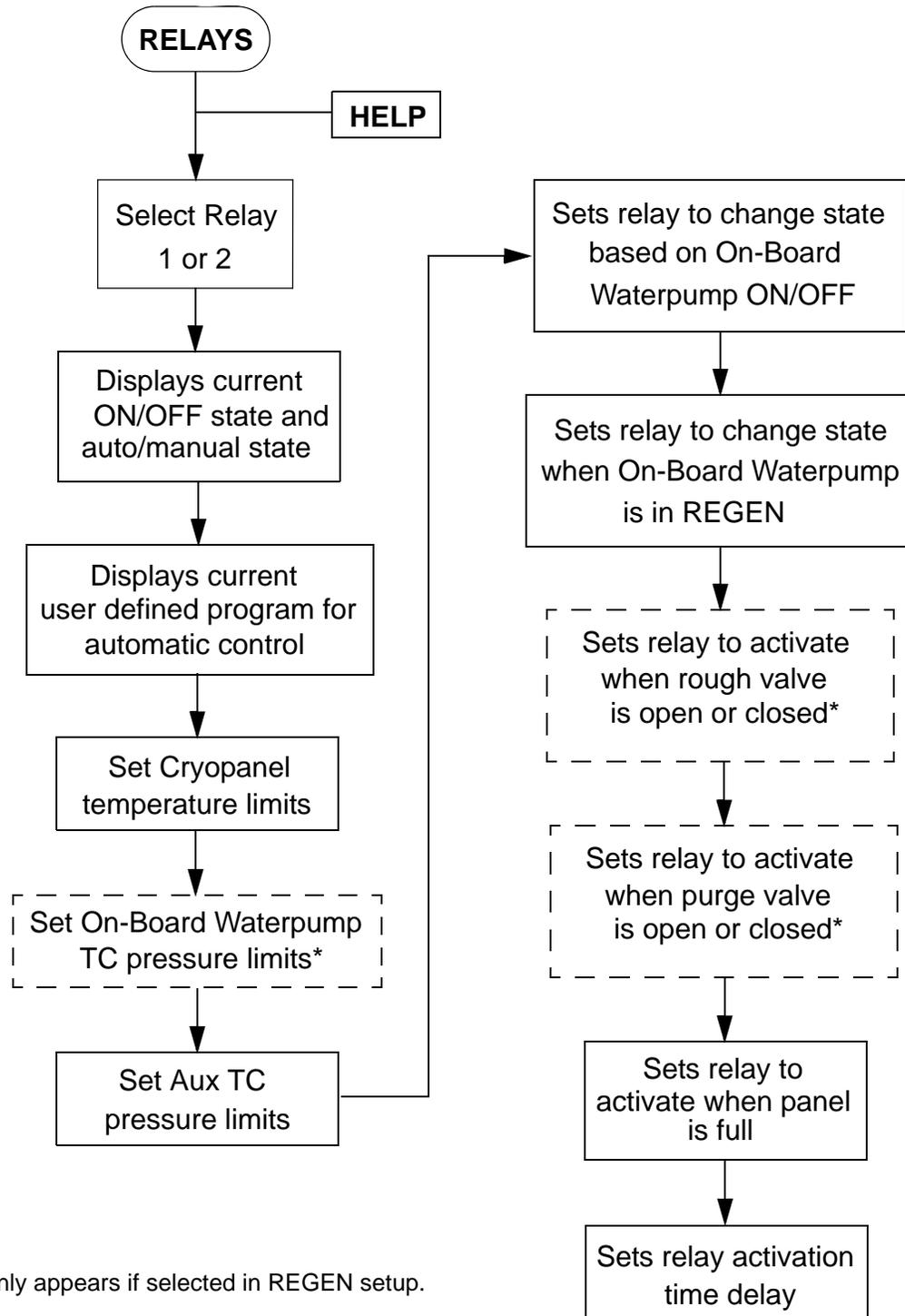


Figure 3-41: RELAYS Function Flowchart

Table 3-6: RELAYS Function Parameters

RELAYS Parameter	Range of Values
Relay 1 or 2	1 - 2
Relay ON/OFF, Auto/Manual	ON/OFF Auto/Manual
Panel Temperature	0K - 320K
On-Board Waterpump TC Pressure*	1 - 999 microns
Aux TC Pressure	1 - 999 microns
On-Board Waterpump	ON/OFF
REGEN Track	ON/OFF
Rough Valve*	ON/OFF
Purge Valve*	ON/OFF
Panel Exposure	ON/OFF
Time Delay	0 - 99 seconds
*Only appears if selected in REGEN setup.	

Select Relay 1 or 2

The first parameter of the RELAYS function allows the user to select setpoint relay 1 or 2 to be programmed as shown in Figure 3-42.

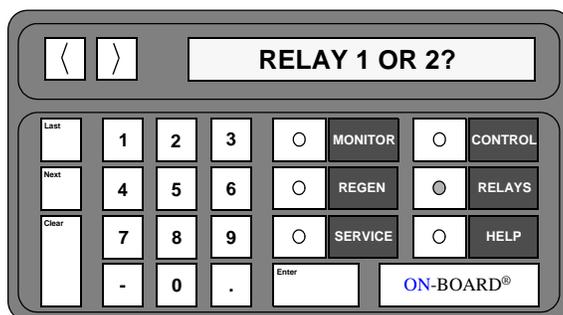


Figure 3-42: Select Relay 1 or 2 Display

Current State of Relay ON/OFF, Auto/Manual

The second parameter of the RELAYS function allows the user to determine whether the relay is ON or OFF and in automatic or manual mode shown in Figure 3-43. If in automatic mode, the relay is programmed to change state (ON/OFF) based upon a programmed function as listed.

NOTE: Relay activation is controlled in the CONTROL function if in manual mode.

Automatic control is used to turn the setpoint relay ON or OFF based upon user specified programming. The user cannot manually turn the setpoint relay ON or OFF when in automatic control. Manual control is typically used during system diagnosis when manual activation of a setpoint relay is required.

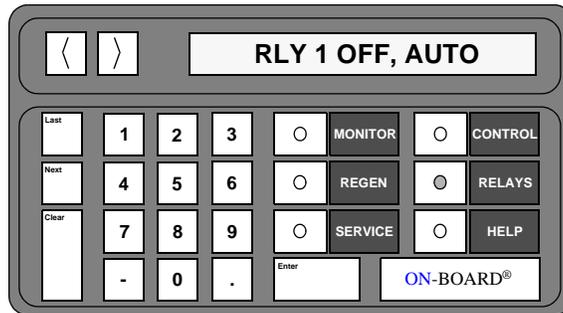


Figure 3-43: Current State of Relay ON/OFF, Auto/Manual

Current Program for Automatic Control

The third parameter of the RELAYS function displays the current user defined program which was selected for automatic control of the setpoint relays. The message shown in Figure 3-44 for example, means that the relay is activated based upon the On-Board Waterpump being turned ON or OFF.

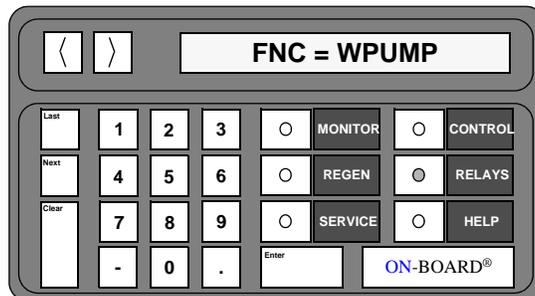


Figure 3-44: Current Program for Automatic Control Display

Refrigerator Temperature Limits

The fourth parameter of the RELAYS function allows the user to establish the upper and lower temperature limits of the On-Board Waterpump refrigerator as shown in Figure 3-45. The upper limit is designated as *UL* and the lower limit is designated as *LL*. The temperature range is 0K - 320K.

Upper and lower limits were designed to prevent relay *chatter*. The limit example in Figure 3-45 indicates the relay will not be activated until the On-Board Waterpump refrigerator reaches a temperature of 107K. Once activated, the relay will not deactivate until the On-Board Waterpump refrigerator reaches a temperature of 130K. For example, if the On-Board Waterpump refrigerator temperature goes from 300K to 105K and back to 107K, the relay state will not have changed.

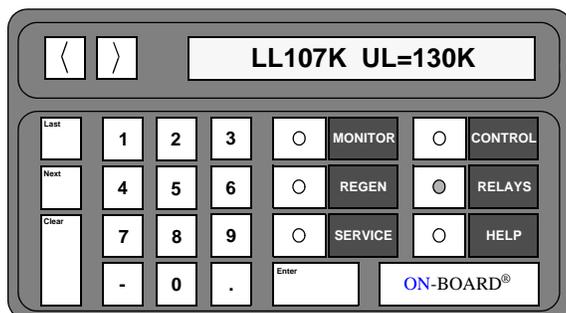


Figure 3-45: Temperature Limits Display

On-Board Waterpump TC Gauge Pressure Limits

NOTE: This parameter only appears if a TC gauge has been selected in the REGEN set-up.

The fifth parameter of the RELAYS function allows the user to establish the upper and lower On-Board Waterpump thermocouple gauge limits as shown in Figure 3-46. The pressure range is 1 - 999 microns.

Upper and lower limits were designed to prevent relay *chatter*. The limit example in Figure 3-46 indicates the relay will not be activated until the On-Board Waterpump TC gauge reaches a pressure of 107 microns. Once activated, the relay will not deactivate until the On-Board Waterpump TC gauge reaches a pressure of 110 microns. For example, if the On-Board Waterpump TC gauge pressure goes from 308 microns to 108 microns and back to 310 microns, the relay state will not have changed.

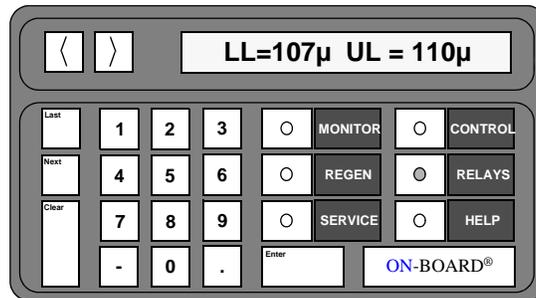


Figure 3-46: On-Board Waterpump TC Gauge Pressure Limits Display

Auxiliary TC Gauge Pressure Limits

The sixth parameter of the RELAYS function allows the user to establish the upper and lower auxiliary thermocouple gauge limits of the On-Board Waterpump as shown in Figure 3-47. The pressure range is 1 - 999 microns.

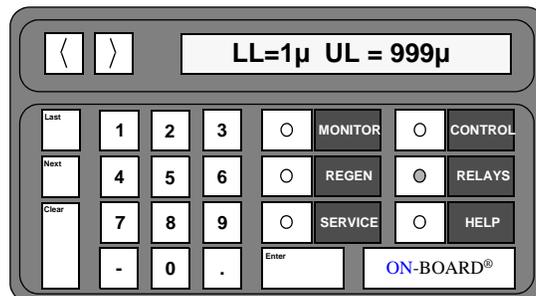


Figure 3-47: Auxiliary TC Gauge Pressure Limits Display

On-Board Waterpump Status

The seventh parameter of the RELAYS function allows the user to program the setpoint relay to change state when the On-Board Waterpump is turned ON and deactivate when the On-Board Waterpump motor is turned OFF as shown in Figure 3-48.

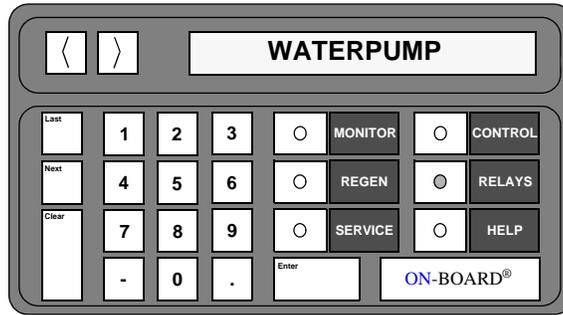


Figure 3-48: On-Board Waterpump Display

REGEN

The eighth parameter of the RELAYS function allows the user to program the setpoint relay to change state when the On-Board Waterpump is in REGEN mode as shown in Figure 3-49.

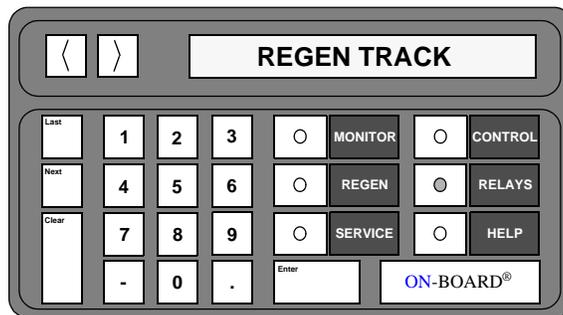


Figure 3-49: REGEN Display

Roughing Valve

NOTE: This parameter only appears if a roughing valve has been selected in the REGEN setup.

The ninth parameter of the RELAYS function allows the user to program the setpoint relay to change state when the rough valve is opened and deactivate when the rough valve is closed as shown in Figure 3-50.

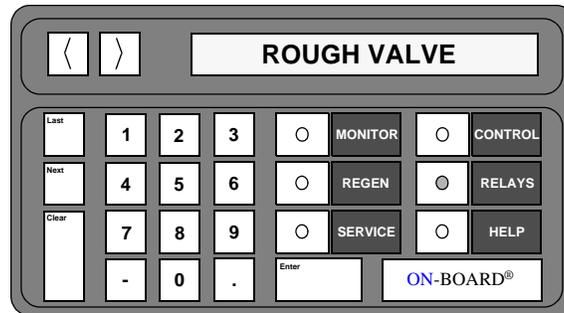


Figure 3-50: Roughing Valve Display

Purge Valve

NOTE: This parameter only appears if a purge valve has been selected in the REGEN setup.

The tenth parameter of the RELAYS function allows the user to program the setpoint relay to change state when the purge valve is opened and deactivate when the purge valve is closed as shown in Figure 3-51.

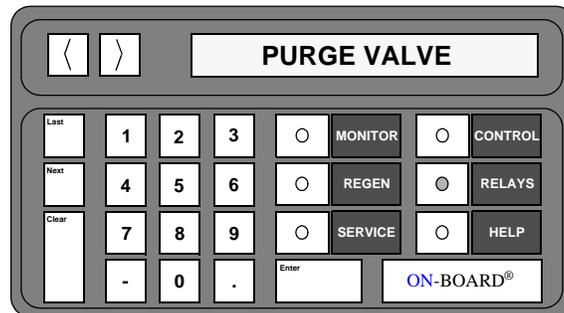


Figure 3-51: Purge Valve Display

Panel Full

The eleventh parameter of the RELAYS function allows the user to program the setpoint relay to change state when the cryopanel is full of water vapor as shown in Figure 3-52.

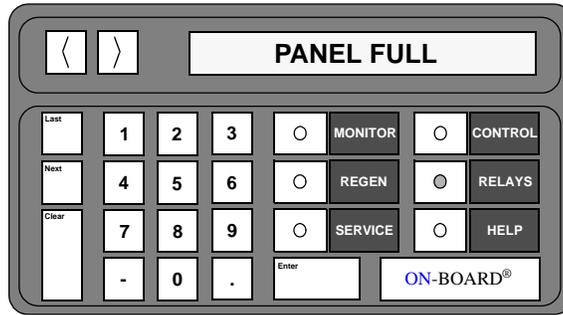


Figure 3-52: Panel Full Display

Delay Activation of Relay

The twelfth parameter of the RELAYS function allows the user to establish a delay time (in seconds) during which the user selected relay waits before operating as shown in Figure 3-53. This parameter will delay both activation and deactivation of the relays.

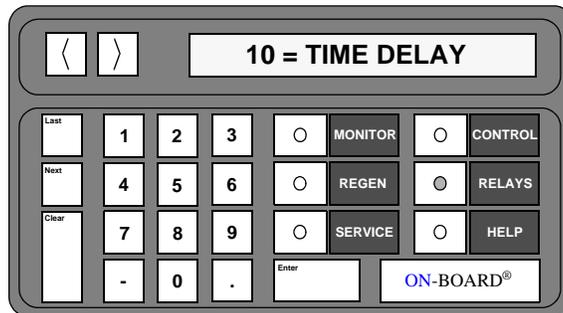


Figure 3-53: Delay Activation of Relay Display

RELAYS Function Operation

Only one relay parameter can be in control of the relay at anytime. Once a relay parameter has been programmed, the user selected relay will be placed in automatic mode as indicated by the *FNC = WATERPUMP* message. FNC is an abbreviation for *Function* and the message indicates the relay will be activated when the On-Board Waterpump is turned ON. The previously programmed relay parameter (if one exists) will be cancelled. The *FNC = MANUAL OFF* message indicates that none of the relay parameters have been programmed.

Use the following procedures to program the Relay parameters of the On-Board W Module.

NOTE: *Relay activation/deactivation is dependent upon the manner in which the relays are wired, normally open or normally closed.*

Programming Panel Temperature Limits

This procedure programs relay 1 or 2 to change state when either of the On-Board Waterpump cryopanel temperature limits are reached.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until the *PANEL TEMP* is displayed.
4. Press the **Enter** key. The cursor is placed under the current lower limit (LL) value.

NOTE: *If a number which is not in the proper range is entered, LL-???K or UL-???K will be displayed. Press the Clear button to continue.*

5. Using the keypad, enter the new lower limit value.
6. Press the **Enter** key. The cursor is placed under the current upper limit (UL) value.
7. Using the keypad, enter the new upper limit value.
8. Press the **Enter** key. The limit values are programmed.
9. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Programming On-Board Waterpump TC Gauge Pressure Limits

***NOTE:** This parameter only appears if a TC gauge has been selected in the REGEN set-up.*

This procedure programs relay 1 or 2 to change state when either of the On-Board Waterpump thermocouple gauge pressure limits are reached.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until *WPUMP TC* appears in the display.
4. Press the **Enter** key. The cursor is placed under the current lower limit (LL) value.

***NOTE:** If a number which is not in the proper range is entered, LL-??? μ or UL-??? μ will be displayed. Press the Clear button to continue.*

5. Using the keypad, enter the new lower limit value.
6. Press the **Enter** key. The cursor is placed under the current upper limit (UL) value.
7. Using the keypad, enter the new upper limit value.
8. Press the **Enter** key. The limit values are programmed.
9. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Programming Auxiliary TC Gauge Pressure Limits

This procedure programs relay 1 or 2 to change state when either of the auxiliary thermocouple pressure limits are reached.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until *AUX TC* appears in the display.
4. Press the **Enter** key. The cursor is placed under the current lower limit (LL) value.

***NOTE:** If a number which is not in the proper range is entered, LL-??? μ or UL-??? μ will be displayed. Press the Clear button to continue.*

5. Using the keypad, enter the new lower limit value.

6. Press the **Enter** key. The cursor is placed under the current upper limit (UL) value.
7. Using the keypad, enter the new upper limit value.
8. Press the **Enter** key. The limit values are programmed.
9. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

On-Board Waterpump

This procedure programs relay 1 or 2 to change state when the On-Board Waterpump is turned ON or OFF.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until *WATERPUMP* appears in the display.
4. Press the **Enter** key. *FNC=WATERPUMP* will be displayed. The relay is programmed.
5. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

REGEN Track

This procedure programs relay 1 or 2 to change state when the On-Board Waterpump begins or completes a REGEN cycle.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until *REGEN TRACK* appears in the display.
4. Press the **Enter** key. *FNC=REGEN TRACK* will be displayed. The relay is programmed.
5. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Rough Valve

***NOTE:** This parameter only appears if a roughing valve has been selected in the REGEN setup.*

This procedure programs relay 1 or 2 to change state when the rough valve opens/closes.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number and the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** button until *ROUGH VALVE* appears in the display.
4. Press the **Enter** key. *FNC = ROUGH VALVE* is displayed. The relay is programmed.
5. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Purge Valve

***NOTE:** This parameter only appears if a purge valve has been selected in the REGEN setup.*

This procedure programs relay 1 or 2 to change state when the purge valve opens/closes.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number and the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** button until *PURGE VALVE* appears in the display.
4. Press the **Enter** key. *FNC = PURGE VALVE* is displayed. The relay is programmed.
5. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Panel Full

This procedure programs relay 1 or 2 to change state when the On-Board Waterpump cryopanel is 100% full.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until *PANEL FULL* appears in the display.
4. Press the **Enter** key. *FNC=PANEL FULL* will be displayed. The relay is programmed.
5. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

Time Delay

This procedure programs relay 1 or 2 to delay activation/deactivation by a user determined amount of time.

1. Press the **RELAYS** key on the keypad/display.
2. Press **1** or **2** depending upon which relay is being selected. The selected relay number along with the ON/OFF and Auto/Manual status are displayed.
3. Press the **Next** key until the current *TIME DELAY* value appears in the display.
4. Press the **Enter** key.
5. Using the keypad, enter the desired amount of delay time (in seconds).
6. Press the **Enter** key. The new time delay value is programmed.
7. Press the **MONITOR** key. The On-Board microprocessor will monitor system operation.

W Module Software Function Parameters

Table 3-7 provides the user with a complete listing of all W Module Software parameters. This table can be used as a quick reference to locate parameters within the MONITOR, REGEN, SERVICE, CONTROL, and RELAYS functions.

Table 3-7: W Module Software Function Parameters (Warm-up Routine)

MONITOR	REGEN	SERVICE	CONTROL	RELAYS
ON/OFF Status and Refrigerator Temperature	Delay Start	Serial Number/ Software Version	On-Board Waterpump ON/OFF and Temperature	Relay 1 or 2
Refrigerator Temperature, WPUMP TC Gauge Pressure*	Extended Purge*	Net Identification Number	Aux TC ON/OFF and TC Pressure	Relay ON/OFF, Auto/Manual
Waterpump TC Gauge Pressure*	Cooldown Mode	Elapsed Pump Time	Rough Valve Open/Closed*	Current Program
Aux TC Gauge Pressure ON/OFF	Rough Valve Interlock*	Time Since Last REGEN	Purge Valve Open/Closed*	Refrigerator Temperature
Relay 1 ON/OFF and Auto/Manual Control	Power Failure Recovery	Password	Relay 1 ON/OFF and Auto/Manual Control	Waterpump TC Gauge Pressure*
Relay 2 ON/OFF and Auto/Manual Control	Power Failure Recovery Temperature	Lock Mode	Relay 2 ON/OFF and Auto/Manual Control	Aux TC Gauge Pressure
Exposure Time	REGEN Setup	Parameter Lock		Waterpump
		Zero On-Board Waterpump TC Gauge*		REGEN Track
		Zero Auxiliary TC Gauge		Rough Valve*
		Refrigerator Temperature Control		Purge Valve*
		Exposure Temperature		Panel Full
		Exposure Time		Time Delay
* Only appears if selected in REGEN setup				

Table 3-8: W Module Software Function Parameters (Sublime Routine)

MONITOR	REGEN	SERVICE	CONTROL	RELAYS
ON/OFF Status and Refrigerator Temperature	Delay Start	Serial Number/ Software Version	On-Board Waterpump ON/OFF and Temperature	Relay 1 or 2
Refrigerator Temperature WPUMP TC Gauge Pressure	Sublime Temperature	Net Identification Number	Aux TC ON/OFF and TC Pressure	Relay ON/OFF, Auto/Manual
Waterpump TC Gauge Pressure*	Sublime Time	Elapsed Pump Time	Rough Valve Open/Closed*	Current Program
Aux TC Gauge Pressure ON/OFF	Rough Valve Interlock*	Time Since Last REGEN	Purge Valve Open/Closed*	Refrigerator Temperature
Relay 1 ON/OFF and Auto/ Manual Control	Power Failure Recovery	Password	Relay 1 ON/OFF and Auto/ Manual Control	Waterpump TC Gauge Pressure*
Relay 2 ON/OFF and Auto/ Manual Control	Power Failure Recovery Temperature	Lock Mode	Relay 2 ON/OFF and Auto/ Manual Control	Aux TC Gauge Pressure
Exposure Time	REGEN Setup	Parameter Lock		Waterpump
		Zero On-Board Waterpump TC Gauge*		REGEN Track
		Zero Auxiliary TC Gauge		Rough Valve*
		Refrigerator Temperature Control		Purge Valve*
		Exposure Temperature		Panel Full
		Exposure Time		Time Delay
* Only appears if selected in REGEN setup				

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Section 4 - On-Board Module Replacement

Module Ordering Information

The serial numbers of the On-Board Pump and On-Board Module must match to ensure module/pump calibration. Refer to **Appendix A** and be prepared to provide the CTI-CRYOGENICS Service Representative with the following information when requesting a replacement On-Board Module:

- Pump Serial Number
- On-Board Module Part Number and Serial Number
- Number of Hours on Pump

CTI-CRYOGENICS will ensure that the existing module serial number is programmed into the replacement module to maintain the calibration integrity of the On-Board system.

Module Replacement

***NOTE:** The existing On-Board Module may be programmed to specific user defined process parameters. The replacement module must be programmed to restore the user defined parameters once installed.*

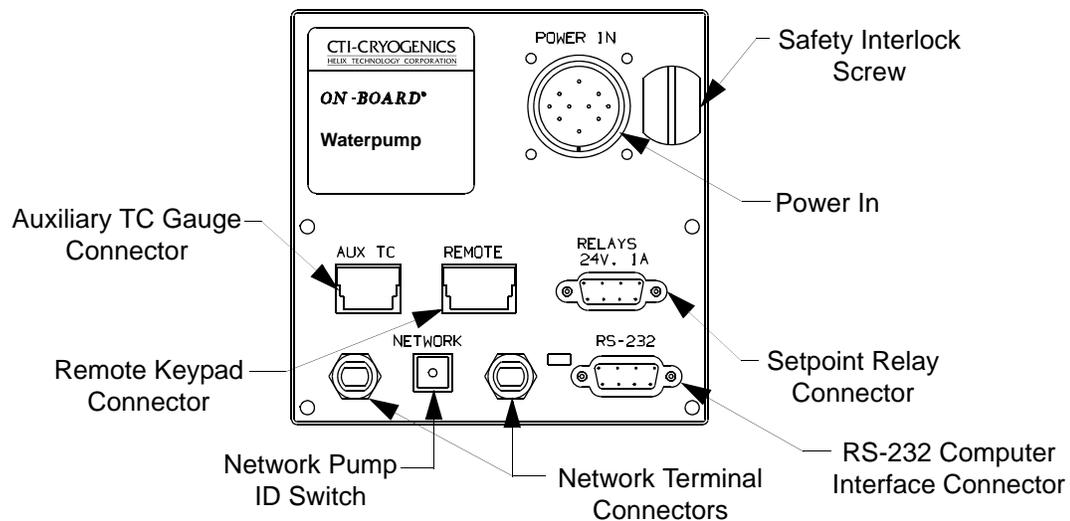
1. Set the On-Board power switch located on the compressor or compressor controller to the OFF position.
2. Remove all cables from the *Power In, AUX TC, Remote, Relays, Network,* and *RS-232* connectors as shown in Figure 4-1.
3. Using a straight blade screwdriver, loosen the safety interlock screw until the On-Board Module is released from the module housing. Slide the On-Board Module out of the housing.

***NOTE:** Make sure the safety interlock screw is completely tightened during step 4 to ensure that the module circuit board is inserted into the housing connector.*

4. Insert the new On-Board Module into the module housing and tighten the safety interlock screw.

NOTE: The safety interlock screw must be in the vertical position before the Power In cable can be connected. If necessary, turn the screw out 1/4 turn to set the screw in a vertical position as shown in Figure 4-1.

5. Connect the cables removed during Step 2.
6. Set the On-Board power switch, located on the compressor, to the ON position.
7. Refer to **Section 3 - Programming and Operation** to program the new On-Board module.



TP-3650401

Figure 4-1: On-Board Module Component Location

Appendix A - Customer Support Information

Customer Support Center Locations

To locate a Customer Support Center near you, please visit our website www.helixtechnology.com on the world wide web and select *CONTACT* on the home page.

Guaranteed Up-Time Support (GUTS)

For 24 hour, 7 day per week Guaranteed Up-Time Support (GUTS) dial:

800-367-4887 - Inside the United States of America

508-337-5599 - Outside the United States of America

Product Information

Please have the following information available when calling so that we may assist you:

- Product Part Number
- Product Serial Number
- Product Application
- Specific Problem Area
- Hours of Operation
- Equipment Type
- Vacuum System Brand/Model/Date of Manufacture

E-mail

For your convenience, you may also e-mail us at:

techsupport@helixtechnology.com

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Appendix B - On-Board Module RS-232 Interface Protocol Format

The format of RS-232 messages between a computer device (the HOST) and the On-Board Module (slave) is the same for both directions of message flow (HOST transmitted or slave transmitted). Each message consists of a series of ASCII characters transmitted via a standard RS-232 asynchronous framing convention of one (1) start bit, seven (7) data bits, a parity bit generated for even parity, and one (1) stop bit; at a transmission rate of 2400 baud.

The message packet is composed of a starting flag character (the \$ character, hex 24), followed by a message dependent data field, followed by a message checksum character, terminated by an ASCII carriage return code (hex 0D). The starting flag character serves the unique purpose of synchronizing the receiver to the transmitter, by signaling the start of the message packet. This '\$' code is not contained in the set of characters used to construct the data field or the checksum character, and therefore establishes a fixed reference point to sync up data flow. Whenever either receiver (HOST or slave) receives a '\$' character, all history and status of previous partial packet data (if any) is aborted and lost, and a packet message is started anew.

The data field consists of from one (1) to a maximum of fourteen (14) ASCII characters, the meaning of which is defined in the Pump Command List for commands and responses. All characters with the exception of '\$' and Carriage-Return (0D hex) may be employed in the data field, if suitable.

The message checksum character is employed to guard against garbled or incorrect messages being received and acted upon, causing undesirable or damaging results. Only messages which are conveyed accurately and intact from the master to slave (or visa versa) are accepted and acted upon. The checksum character which follows the data field is computed by a modified binary sum technique (described later) over the characters composing the data field. The transmitting On-Board Module generates this sum based on the characters it used to produce the data field, and appends it after the field just prior to the CR code terminator.

The receiving unit performs the same checksum algorithm on all characters which it receives between the '\$' character and the character just prior to the CR terminator (non-inclusive). If this sum matches the final character preceding the CR terminator, then the message is validated and processed by the receiver. If not, then an error has occurred and the action taken depends on whether the receiver is the HOST or slave unit. The checksum algorithm generates a character between ASCII '0' and 'o' (30 hex to 6F hex) inclusive.

Message traffic is always originated by the HOST unit. This message is referred to as a command or query. Commands cause specific actions to occur in the On-Board Module. Queries request that the On-Board Module reply with status or other parametric information. The On-Board Module responds to all such correctly received messages with a response message. The pairing of these command-response or query-response message sets defines a transaction or exchange. If a faulty message is received by the On-Board Module (due to improper production in the host, or transmission media failure), the message is discarded and no response is sent back to the host as a reply. The host must be able to detect that either no response or an invalid response was received from the slave (through time-out and checksum detection), and if desired, repeat the message to the slave in an attempt to secure a valid transaction.

All communications between a host computer and the On-Board Module will occur within this message transaction framework. Software operating on the host computer must generate and interpret the message-response pairs to properly execute and control remote operation and data-logging of the On-Board Module. Software within the On-Board Module interprets these valid messages and returns appropriate replies, as documented in Table B-1. Error code messages may be returned by the On-Board Module if a valid message packet is received but the data field contents are not correct and cannot be interpreted. This is not a communications error, but a software error. Invalid commands, improper parameter ranges, or requests to perform operations which are disallowed for some reason all result in an error message response. There are three categories of response messages:

1. The normal response for an understandable and executable message is A. If this inquiry is the first since a power failure, the message is B.
2. If a command is sent that cannot be executed under any conditions, the error message is E. If this inquiry is the first since a power failure, the message is F.

3. If a command is sent that cannot be executed because of certain conditions, due to interlocks, the return message is G. If this inquiry is the first since a power failure, the message is H.

***NOTE:** If using a Network Terminal or On-Board Central Control software, the only reply you will see will be "A". This reply occurs because the error messages will have been cleared by the Network Terminal or On-Board Central Control software. If your system utilizes a Network Terminal or On-Board Central Control software, you should use the lower case *t* command as described in Table B-1 (within this appendix) and Appendix D if you wish to have your system controller recognize a power failure signal which is recorded in the pump.*

Each category has two possible responses. The first is a response under normal conditions. The second is a response message that also signals a recent power loss. If a power loss signal is received, this flag can be reset by using the S command as shown in Table B-1.

Between the time that the host sends a command/query and the slave returns a response message, further characters sent from the host to the slave are ignored. The slave will respond to any verified message packet it receives within 200 milli-seconds. A time-out period in excess of this within host can be used to detect a failure and need to re-try. Once a response to a message has been received by the host, new command/query messages may be immediately sent out. In this way, the message traffic is self synchronizing.

The following is an example of a typical exchange:

Host sends query to get back On-Board Module version information

	Flag	Data Field	Checksum	Terminator
ASCII	[\$]	[@]	[1]	[CR]
Hex	[24]	[40]	[31]	[0D]

Checksum of hex 40 data field:

```

Bits 76543210
Sum = 40 = 01000000
Bits 7 and 6
aligned for
XOR      00000001
XOR result 01000001
Mask D5,D0 00000001
Addend "0" 00110000
    
```



Final Chk 00110001 Hex 31, ASCII "1"

Slave sends replay of AP A2.01, meaning no error, pump version A2.01.

	<i>Flag</i>	<i>Data Field</i>	<i>Checksum</i>	<i>Terminator</i>
<i>ASCII</i>	<i>[\$]</i>	<i>[A] [P] [] [A] [2] [.] [0] [1]</i>	<i>[a]</i>	<i>[CR]</i>
<i>Hex</i>	<i>[24]</i>	<i>[41] [50] [20] [41] [32] [2E] [30] [31]</i>	<i>[61]</i>	<i>[0D]</i>

Checksum of hex data field:

Bits 76543210

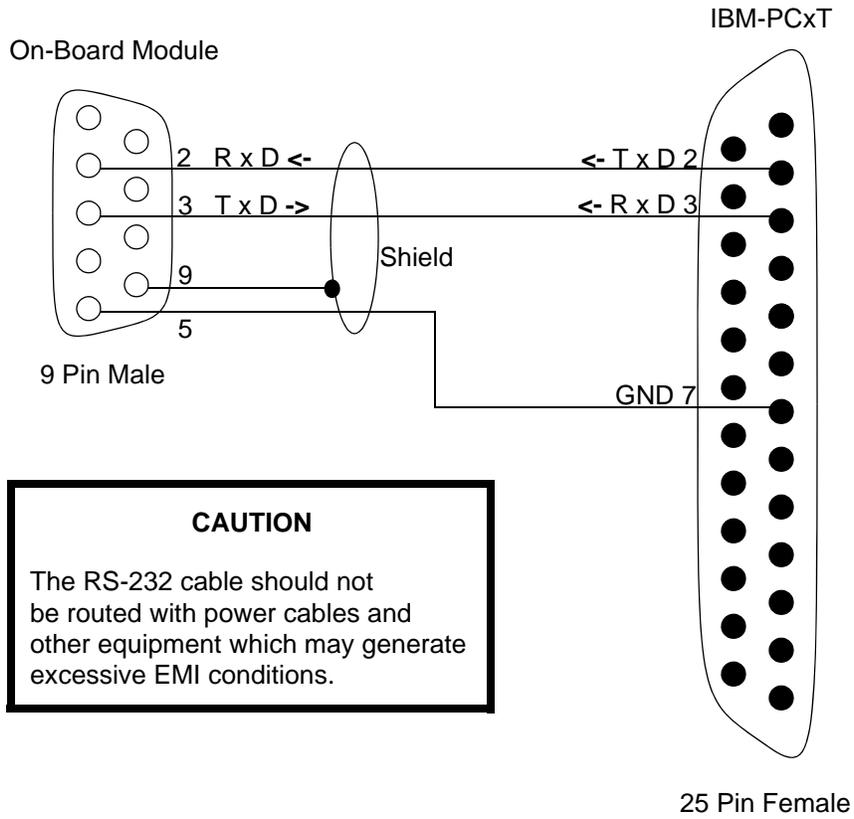
Sum of

*41 01000001
50 01010000
20 00100000
41 01000001
32 00110010
2E 00101110
30 00110000
31 00110001*

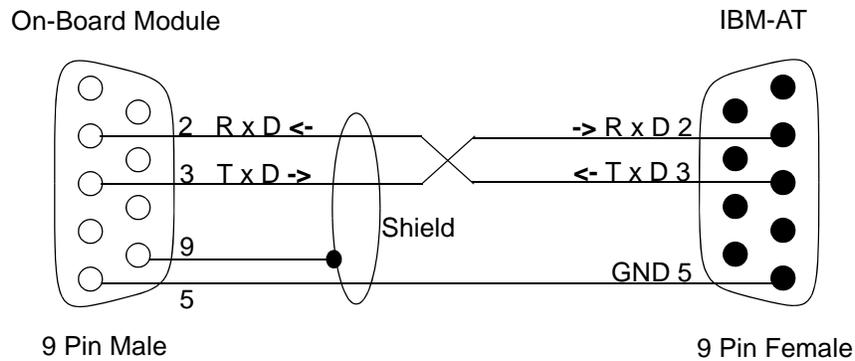
equals 10110011 or hex B3 modulo 256.

*Bits 7 and 6
aligned for*

*XOR 00000010
XOR result 10110001 or B1
Mask D5,D0 00110001
Addend "0" 00110000
Final Chk 01100001 Hex 61, ASCII "a"*



On-Board Module to IBM-PCxT



On-Board Module to IBM-AT

NOTE: Connectors should be of a metal case type and cable lengths should not exceed 40 feet.

Figure B-1: RS-232 Cable Connections

Table B-1: On-Board Module RS-232 Commands

Command	Parameter	Description
A	[0 - 1] [?]	Turns the pump ON and OFF and provides status: 0 - Turns pump OFF 1 - Turns pump ON ? - Provides pump status
C	[0 - 1] [?]	Turns the AUX TC ON and OFF. 0 - Turns PUMP AUX TC OFF 1 - Turns PUMP AUX TC ON ? - Provides AUX TC status
D	[0 - 1] [?]	Opens or closes the rough valve and provides status. 0 - Closes rough valve 1 - Opens rough valve ? - Provides rough valve status
E	[0 - 1] [?]	Opens or closes the purge valve and provides status. 0 - Closes purge valve 1 - Opens purge valve ? - Provides purge valve status
H	[0-320] [?]	Sets temperature control of the waterpump. Temperature control is turned OFF if set to "0". A "?" reads back the current value of 0-320.
J	None	Sends back the waterpump temperature.
L	None	Sends back the pump TC pressure.
M	None	Sends back the AUX TC pressure.
N	[0 - 1]	Starts or aborts a warm-up REGEN cycle. 0 - Aborts warm-up REGEN 1 - Starts warm-up REGEN
	[0-2]	Starts or aborts a sublime REGEN cycle. 0 - Aborts sublimation 1 - Starts pressure sublimation 2 - Starts time sublimation
O	None	Sends back the current REGEN step. Refer to Appendix C.



Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
P	[1, 6, A, W, e...t] [5 digit number] [?]	<p>Reads/Sets a REGEN parameter.</p> <p>1 = Extended purge time (minutes) range - 0-999/10 6 = Start-up temp. (after power failure) range = 110-260/260 A = Clear/set rough valve interlock range = 0 - 1 W= On-Board Waterpump REGEN mode range 16-17,20-21, 24,32-35,48-55 Bit weighted as follows: 01H - Has purge valve installed 02H - Has rough valve installed 04H - Desired cooldown within warm REGEN. Only has meaning when 16 set below. 08H - Default, works same as 0 value, forces setup menu 16H - Set to select warm mode, default is sublimation 32H - Has TC gauge installed</p> <p>e = Sublime temperature range 110-250/230K f = Rough time for sublimation range 10-600/300 min n = Exposure Time above exposure temperature before REGEN needed range 0-9999/500 min o = Exposure temperature range 90-250/130K</p>
Q	[None] [?]	<p>Rough valve interlock. The valve token is given to the pump if no parameter is specified. Once the pump has the token, it keeps it until it is finished with the rough valve. During the query (?), a bit 0 ON (1) indicates that the pump has the token. A bit 1 ON (2) indicates the pump needs the valve token for REGEN. A bit 2 ON (4) indicates the pump is ON (PUMP ON is True). Valid returns are "0 - 7". A 0 or 4 means that the pump has given the flag back.</p>

Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
S	1 - 3	<p>Send back various status indicators.</p> <p>Status 1 01H = Pump ON 02H = Rough valve ON 04H = Purge valve ON 08H = TC1 ON 10H = TC2 ON 20H = A result of 0 means that there was a power failure. The bit is reset to 1 after this query.</p> <p>Status 2 01H = Setpoint 1 ON 08H = Temperature control ON</p> <p>Status 3 01H = Pump phase 1 check 02H = Pump phase 2 check</p>

Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
T	[1-2] {0-8,ABCF} [4 digit number] { {[?] [0,1,2,8]}	<p>This command programs the setpoint relays. The first parameter tells the relay number (1 or 2). The second parameter is one of two forms. The first, used for setting the item to be programmed, consists of a selector (0,1,4-8). This form is followed by a third parameter, a 4 four digit number, if the selector is 0 - 8. The A - F selectors do not require a following numeric parameter, as they are logical function settings.</p> <p>The second form is used to query the settings and consists of the "?" command element followed by a selector (0-2, 8) to indicate what data is being queried.</p> <p>Selector meaning for first form: 0 = Set waterpump LL (deg Kelvin) 1 = Set waterpump UL 4 = Set Pump TC LL (microns) 5 = Set Pump TC UL 6 = Set AUX TC LL (microns) 7 = Set AUX TC UL 8 = Set time relay (0-9999 seconds) A = Set unconditional ON B = Set unconditional OFF C = Set as REGEN status tracking relay D = Set as rough valve tracking relay E = Set as purge valve tracking relay F = Set as pump motor ON/OFF status tracking relay G = Set as exposure panel alert 100% full tracking relay</p> <p>Selector meaning for second form: 0:=Query previously set LL (meaning depends upon previous use) 1:=Query previously set UL (meaning depends upon previous use) 2:=Query last sent first form selector (0,1,4-8, A...G) used to establish particular relay function 8:=Query relay time delay (0-9999 seconds)</p> <p>Example: "\$T 1 8 30" /*Set relay time delay to 30 seconds*/</p>
VA	[?]	Read pump serial number.
Y	?	Read elapsed time. The units are in hours and expressed as an integer. The range is up to 65,000 hours.
Z	[?]	Read the number of REGEN cycles that have been completed.

Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
@	None	Returns an identifier string indicating module type and software revision level.
a	None, 2	Read back how long it has been since the last REGEN cycle. None for time since last complete REGEN. 2 for time since last partial REGEN. The units are in hours.
e	None	Read error code result of REGEN operation. Returns one of eight characters as defined in Appendix C, should only be used when REGEN response V is returned.
g	None	Requests the auto calibration of the pump TC gauge. Returns a "G" or "H" error code if conditions are not valid to perform the auto zero calibrate, such as TC not turned ON or the pressure is too high.
h	None	Requests the auto calibration of the AUX TC gauge. Returns a "G" or "H" error code if conditions are not valid to perform the auto zero calibrate, such as TC not turned ON or the pressure is too high.
i	[0,1,2,?]	Set/Clear/Query the power fail recovery flag. 0 - Power Fail Recovery turned OFF 1 - Power Fail Recovery turned ON 2 - Power Fail Recovery if below power failure temperature limit ? - Provides Power Fail Recovery status
j	[0..30000, ?]	Pump delay to start of REGEN cycle (minutes).
k	None	Returns an internal interval timer value in minutes. When in the appropriate phase, this value represents the time remaining in the phase (delay start, cryo restart, purge time). Times from 1 to 60 seconds return as 1 minute. Times from 61 seconds to 120 seconds return as 2 minutes. Zero returns as 0 minutes.

Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
r	P X, form is rP or rX	<p>Polls an event count value which specifies the completion of either the pump (P) or AUX (X) TC auto zero sequence. This value is used by a remote computer to tell when an initiated auto zero is complete.</p> <p>Returns a modulo 256 (0-255) numeric value which is incremented each time the auto zero operation completes. The remote unit can detect the completion of the event by a change in value.</p>
s	None	Polls an event count modulo 256 (0-255) which is incremented each time a REGEN cycle is performed. Used to indicate whether the REGEN idle message should be REGEN COMPLETE or REGEN OFF.
t	? =, form is t? or t=	Command to either inquire (t?) or acknowledge and clear (t=) the power recovery flag. A response of 1 is COOLDOWN, 2 is REGEN, 3 is IN PROCESS, 4 is RECOVERED, 5 is CHECK PUMP TEMP, 6 is PUMP OFF, 7 is TOO WARM TO SUB-LIME. Clear the flag with the (t=) command after inquiring on the flag value.
u	None	Inquires pump for information in byte fail_cause of pump, which contains 0 if AC to pump OK, else bits 4,5 set for fail of each phase. Codes are @, P,p. Used to display of power phase information of pump. OFF, ON, ERR1, and ERR2.
v	None	<p>Inquires pump for several flag conditions combined as bits in one response. The bits are biased by @ for ASCII printable results. The bit weights are:</p> <p>01H - Waiting for rough valve. 02H - Purge gas fail detected in REGEN. 04H - Heater failure detected in REGEN.</p>
z	[0,1, ?]	Set/Clear/Query the user keypad access lockout state. When True, the user is limited to the use of the MONITOR and SERVICE functions on the keypad/display.
[B	1 - 2	Restore relay 1 or 2 to automatic settings from manual mode.

Table B-1: On-Board Module RS-232 Commands (Continued)

Command	Parameter	Description
[L	? 1...195	<p>Query and clear the On-Board Waterpump warnings. The returned value is a number from 0 to 195, and is comprised of the sum of binary bit weights for each of the warnings that are present.</p> <p>0 - No warnings 1 - Diode error warnings 64 - 100% panel full warning 128 - 75% panel full warning</p> <p>To clear a warning, use the [L command with the warning number. For example, use [L1 to clear a diode warning.</p>
[M	?	Query the On-Board Waterpump panel exposure counter. The values are in minutes.

Appendix C - RS-232 REGEN Responses

Introduction

Appendix C describes the On-Board pump REGEN responses which are requested by host computer O status command. The REGEN responses inform the host computer of the REGEN cycle status of the On-Board pump.

NOTE: In some cases there are several responses which mean the same thing.

REGEN Response Description

Refer to Table C-1 for a complete description of the REGEN responses.

Responses to the O command are A z (equal to numeric codes 0....57) and 58N. The numeric return information is preceded by the plus sign (+).

Table C-1: RS-232 REGEN Responses and Descriptions

REGEN Response	Description
68, \	Begin REGEN
A, E, 92	<p>WARM-UP - During warm-up, the actual temperature and the target temperature are displayed.</p> <p>Example: WARM-UP 220K/290K</p> <p>290K is the target temperature and 220K is the response from the command J.</p>
D	<p>REDUCED WARM-UP - During warm-up, the actual temperature and the temperature it is attempting to reach are displayed. The reduced temperature of 274K represents a failure of the pump to reach 290K in 60 minutes.</p> <p>Example: WARM-UP 260K/274K 274 is the desired temperature and 260 is the response from the command J.</p>
84, 85	<p>WARM-UP - During warm-up the actual temperature and the temperature it is attempting to reach are displayed.</p> <p>Example: WARM-UP 220K/230K 230K is the desired temperature and the 220 is the response from the command J.</p>
H	<p>EXTENDED PURGE</p> <p>An H response means that the pump has reached its warm-up temperature and the purge is being extended for some amount of time. The time is determined when the REGEN parameters are programmed. The time remaining in minutes is command k.</p> <p>Example: EXTENDED PURGE 10 MIN</p>
86...89	<p>WARM WAIT</p> <p>The On-Board Waterpump has reached its sublime temperature and waits for the ice to begin vaporizing.</p>

Table C-1: RS-232 REGEN Responses and Descriptions (Continued)

REGEN Response	Description
M,N, 63, 64, 66, 67, 73...76	<p>COOLDOWN</p> <p>This display shows the actual temperature and the target temperature which is always 130K.</p> <p>Example: COOLDOWN 155K/130K</p> <p>155K is the response from the J command.</p>
P, 77	REGEN complete
q	<p>WARM-UP COMPLETE</p> <p>This message indicates that a REGEN cycle was performed while the cooldown mode was turned OFF. The pump has warmed up to 290K and REGEN cycle is complete. This message is quickly replaced by P.</p>
65, 79...81, 90	<p>SHARE WAIT</p> <p>The On-Board Waterpump is waiting for permission to use the rough valve.</p>
69, 70	<p>PRESSURE SUBLIME</p> <p>The On-Board Waterpump is at sublime temperature.</p>
82...83	<p>TIME SUBLIME</p> <p>The On-Board Waterpump is at sublime temperature and will sublime for a programmed time.</p>

Table C-1: RS-232 REGEN Responses and Descriptions (Continued)

REGEN Response	Description
V	<p>REGEN ABORTED</p> <p>Command e displays the reasons for REGEN abort. The messages are as follows:</p> <p>@ - No error</p> <p>F - Manual abort - someone manually gave the command to stop REGEN.</p> <p>K - Power Fail Aborted Sublime REGEN - The On-Board Waterpump was running a sublime REGEN prior to power failure and now the cryopanel temperature is too warm to sublime.</p> <p>L - Pressure Test Failure - During a cooldown, the On-Board Water pump was unable to create vacuum.</p> <p>M - Temperature Test Failure - The On-Board Waterpump was unable to cool down.</p> <p>N - Cooldown Timeout - The On-Board Waterpump did not cooldown to 130K within 5 hours.</p> <p>O - Warm-up Timeout - The On-Board Waterpump did not warm up to the sublime temperature within 2 hours.</p>
X, 71, 72	<p>POWER FAILURE</p> <p>There was a power failure during the REGEN cycle and the pump will make a decision to cooldown or REGEN. This display should last for no longer than one second.</p>
Y	<p>POWER FAILURE COOLDOWN</p> <p>There was a power failure during REGEN but the pump is continuing to cool down. Refer to Appendix D - Power Failure Messages.</p>
Z, 78	<p>DELAY START</p> <p>The start of REGEN will be delayed for some time. The time of this delay is the command k. This will give the time in minutes. Display it in hours.</p>

Appendix D - RS-232 Power Failure Recovery Messages

Introduction

Appendix D describes the On-Board pump power failure recovery messages which are requested by host computer commands. Power failure recovery messages inform the host computer of the power failure recovery status of the On-Board pump.

Table D-1: Power Failure Recovery Messages

Host Command	Response
t?	0 - No power failure has occurred. 1 - On-Board Waterpump was in REGEN and is continuing to cool down. 2 - On-Board Waterpump is in REGEN. 3 - On-Board Waterpump is ON and attempting to recover to 130K. 4 - On-Board Waterpump has recovered from the power failure. 5 - On-Board Waterpump did not recover to 130K. Check the temperature. 6 - On-Board Waterpump is above power failure temperature setpoint limit and is programmed to remain OFF. 7 - On-Board Waterpump was in a sublime REGEN and the cryopanel temperature is now too warm to sublime. On-Board Waterpump remains OFF.
t=	Clears the power failure flag.

NOTE: If using a Network Terminal or On-Board Central Control software, you may not see a power reset flag such as a B prefix to the return string. This reply occurs because the error messages will have been cleared by the Network Terminal or On-Board Central Control software. If your system utilizes a Network Terminal or On-Board Central Control software, you should use the lower case **t** command as described in **Appendix B** and **Appendix E** if you wish to have your system controller recognize a power failure signal which is recorded in the pump.

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Appendix E - On-Board Pump Fault Messages

Introduction

Appendix E describes the On-Board pump fault messages which are requested by host computer commands. The fault message indicates that a problem exists within the pump.

Table E-1: Host Commands and Fault Messages

Host Command	Action	Description
S3	Logical AND the response with 01H	A result of 1 means one phase of pump power is missing.
S3	Logical AND the response with 02H	A result of 1 means both phases of pump power are missing.
v	Logical AND the response with 04H	When TRUE, a heater failure has been detected and the warm-up temperature is reduced to 285K.
v	Logical AND the response with 01H	When TRUE, there is a contention for the roughing valve.

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Appendix F - On-Board Keypad/Display Error Messages

Introduction

Appendix F describes the fault messages that can be tested for in the On-Board Module. Currently, each module must be polled for this information. The module does not automatically send an error message.

Table F-1: Keypad/Display Error Message Description

Error Message	Condition	Solution
No Wpump Power	One phase of power is missing.	Refer to the appropriate compressor manual for more information.
REGEN Abort: Warmup Timeout Heater Failure	The On-Board Waterpump timed out during a warmup and aborted the REGEN cycle. Possible heater or diode failure.	Refer to Appendix A and contact your customer support center for assistance.
REGEN Alert: Cooldown Timeout	The On-Board Waterpump could not cool down to the desired operating temperature in the supplied time duration. The pump remains ON.	Check for proper chamber vacuum Check dynamic helium pressure in compressor
REGEN Alert: Slow Cooldown	The On-Board Waterpump's rate of temperature decrease during a cool down is slower than usual. Cooldown will continue.	Check for proper chamber vacuum Check dynamic helium pressure in compressor
REGEN Abort: Poor Rough Vacuum	During cooldown and rough out, the On-Board Waterpump did not register a pressure decrease. Possible chamber leak or rough valve blockage/failure. The pump will turn OFF.	Close all chamber ports and doors Check for proper chamber vacuum

Table F-1: Keypad/Display Error Message Description

Error Message	Condition	Solution
Partial REGEN: Rough Timeout	The On-Board Waterpump timed out during a pressure sublimation. The cryopanel was not completely regenerated. The pump will cool down.	Check sublime temperature and timeout values. Refer to Section 3 of this manual. Heavy frost layer on cryopanel - more frequent regeneration cycles should be performed. Refer to Appendix A and contact your customer support center for assistance.
Heater Failure	Refrigerator temperature is less than setpoint temperature warm-up time-out.	Refer to Appendix A and contact your customer support center for assistance.

Appendix G - REGEN Cycle Operation Examples

The flowcharts in Figures G-1 and G-2 provide the user with examples of typical REGEN cycle programs for On-Board Waterpumps.

NOTE: The values in these programs are for discussion purposes only.

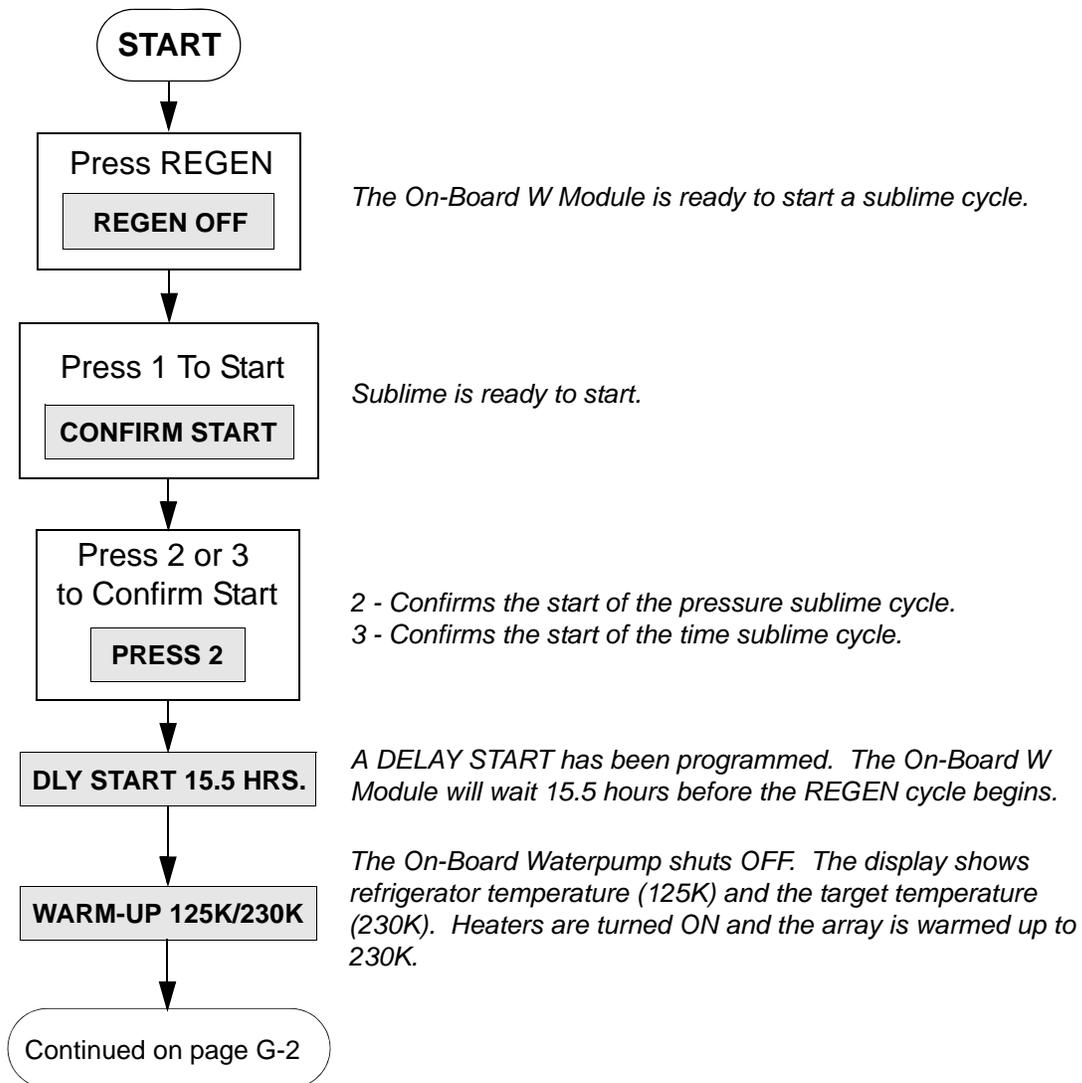


Figure G-1: On-Board Waterpump REGEN Sublime Cycle

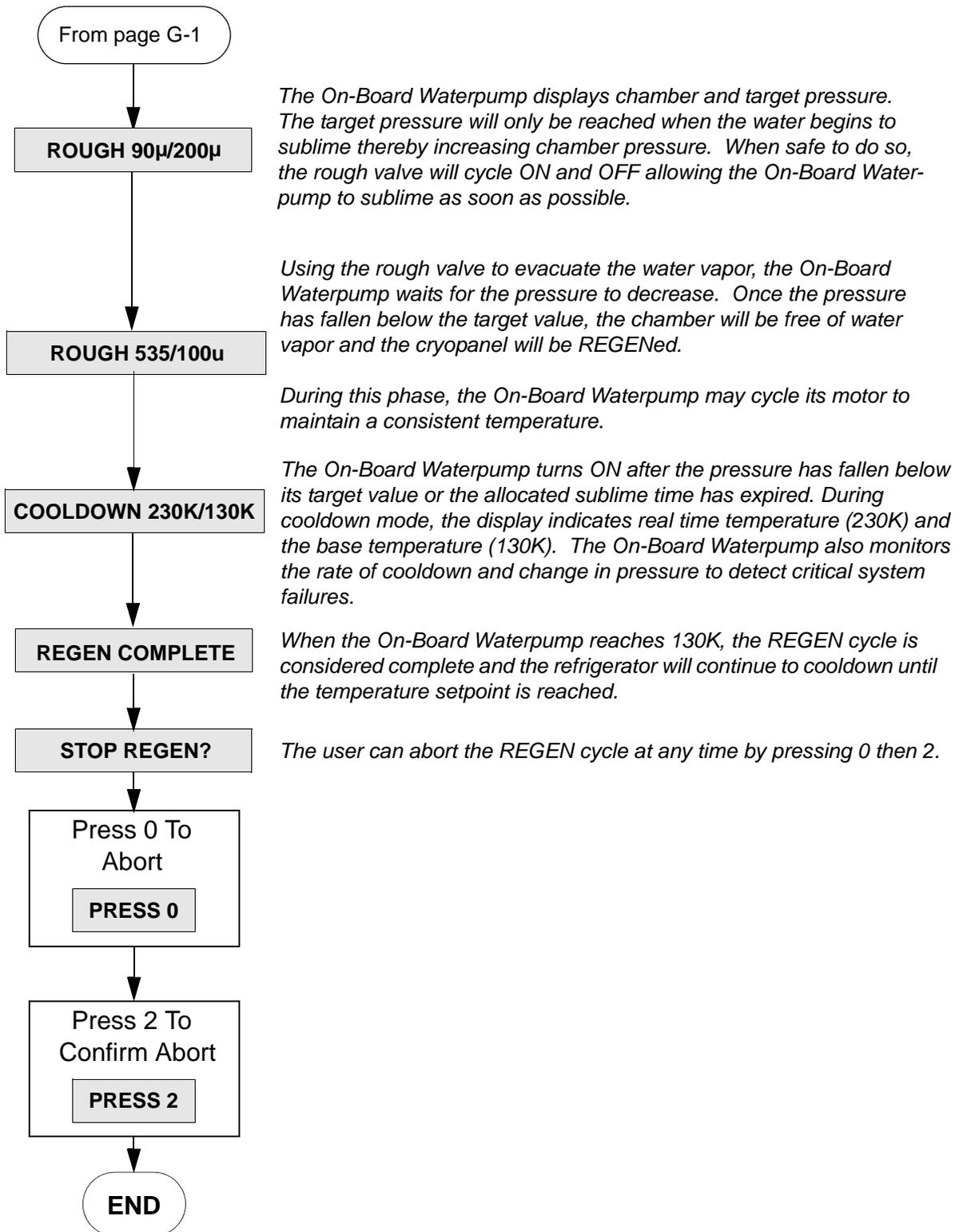


Figure G-1: On-Board Waterpump REGEN Sublime Cycle (continued)

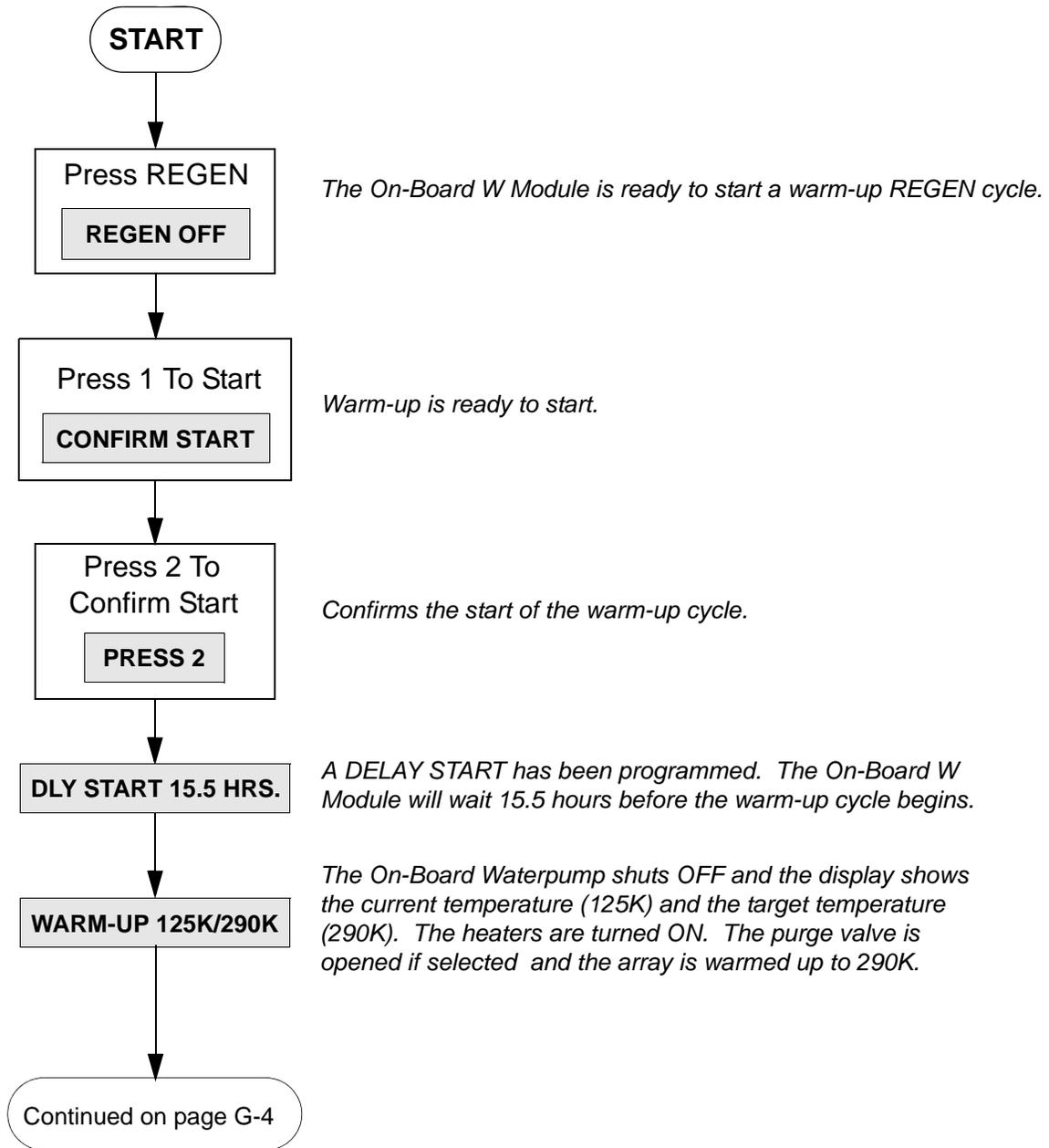


Figure G-2: On-Board Waterpump REGEN Warm-Up Cycle

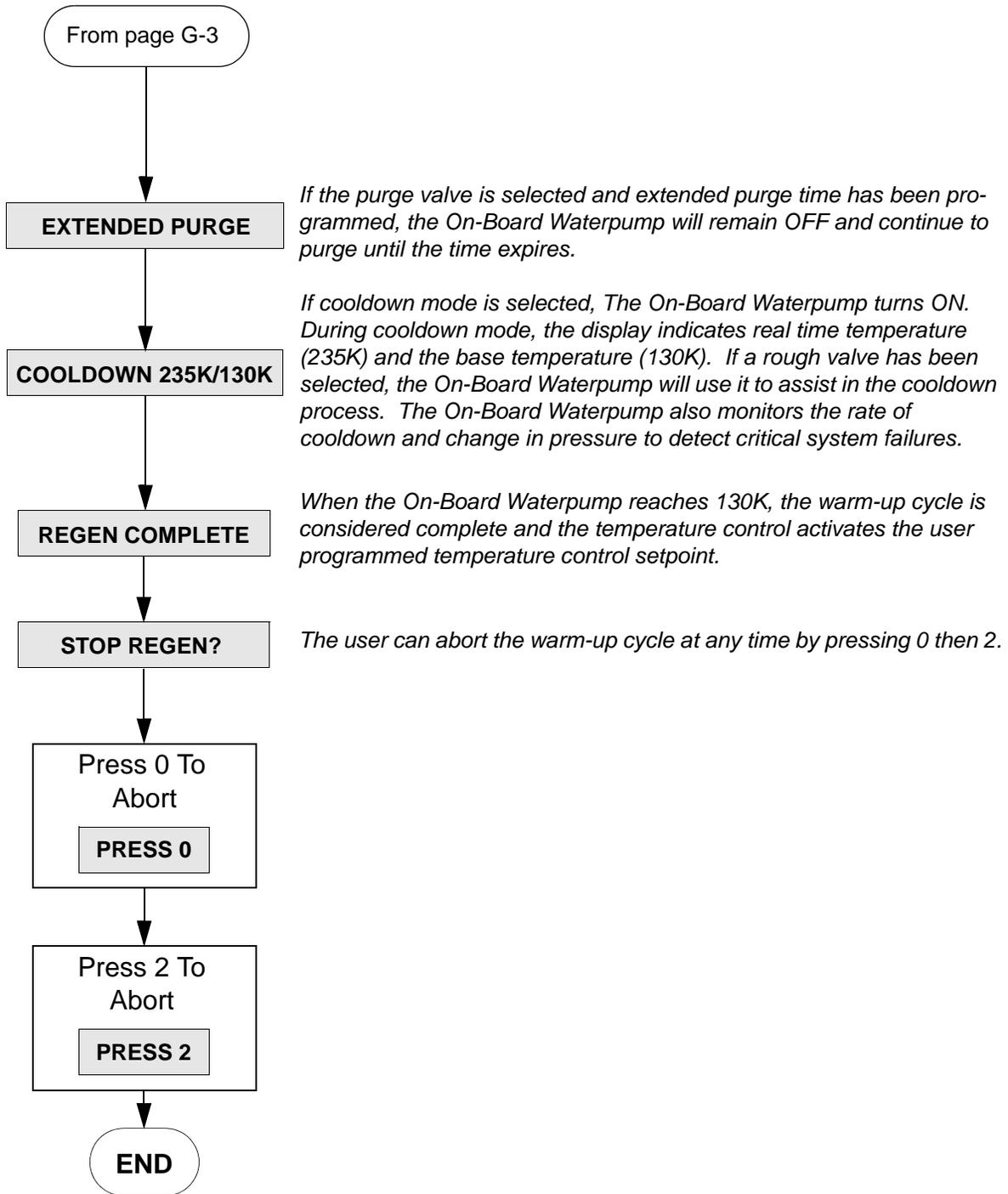


Figure G-2: On-Board Waterpump REGEN Warm-Up Cycle (continued)