ThermoForma

Cryomed
Model 1010/1011

Programmable Freezing System

Operating and Maintenance Manual

Manual No: 7001010 Rev. 3

Read This Instruction Manual.

Failure to read, understand and follow the instructions in this manual may result in damage to the unit, injury to operating personnel, and poor equipment performance.

CAUTION! All internal adjustments and maintenance must be performed by qualified service personnel.

Refer to the serial tag on the back of this manual.

MANUAL NUMBER 7001010

REV	ECR/ECN	DATE	DESCRIPTION	By
3	--	2/5/01	Updated format to Quark	ccs
2	19303/FR-1913	6/14/00	Removed calibration section	ccs
--	16847	10/3/97	Corrected error setpoint limits	heg
--	FR-1094	3/26/97	Added printer cable and DIP settings	heg
1	FR-167	12/13/96	Revised calibration procedures	heg
0	--	8/93	Original manual	

Important operating and/or maintenance instructions. Read the accompanying text carefully.

Ce symbole attire l'attention de l'utilisateur sur des instructions importantes de fonctionnement et/ou d'entretien. Il peut être utilisé seul ou avec d'autres symboles de sécurité. Lire attentivement le texte d'accompagnement.

Wichtige Betriebs- und/oder Wartungshinweise. Lesen Sie den nachfolgenden Text sorgfältig.

Importante instruccions de operacion y/o mantenimiento. Lea el texto acompanante cuidadosamente.

Potential electrical hazards. Only qualified persons should perform procedures associated with this symbol.

Ce symbole attire l'attention de l'utilisateur sur des risques électriques potentiels. Seules des personnes qualifiées doivent appliquer les instructions et les procédures associées à ce symbole.

Gefahr von Stromschlägen. Nur qualifizierte Personen sollten die Tätigkeiten ausführen, die mit diesem Symbol bezeichnet sind.

Potencial de riesgos electricos. Solo personas das capacitadadas deben ejecutar los procedimientos asociadas con este simbulo.

Equipment being maintained or serviced must be turned off and locked off to prevent possible injury.

Risques potentiels liés à l'énergie. L'équipement en entretien ou en maintenance doit être éteint et mis sous clé pour éviter des blessures possibles.

Geräte, an denen Wartungs- oder Servicearbeiten durchgeführt werden, müssen abgeschaltet und abgeschlossen werden, um Verletzungen zu vermeiden.

El equipo recibiendo servicio o mantenimiento debe ser apagado y segurado para prevenir danos.

Hot surface(s) present which may cause burns to unprotected skin, or to materials which may be damaged by elevated temperatures.

Présence de surface(s) chaude(s) pouvant causer des brûlures sur la peau non protégée, ou sur des matières pouvant être endommagées par des températures élevées.

Heiße Oberfläche(n) können ungeschützter Haut Verbrennungen zufügen oder Schäden an Materialien verursachen, die nicht hitzebeständig sind.

Superficias calientes que pueden causar quemaduras a piel sin proteccion o a materiales que pueden estar danados por elevadas temperaturas.

√ Always use the proper protective equipment (clothing, gloves, goggles, etc.)
√ Always dissipate extreme cold or heat and wear protective clothing.
√ Always follow good hygiene practices.
√ Each individual is responsible for his or her own safety.

Do You Need Information or Assistance on Thermo Forma Products?

If you do, please contact us 8:00 a.m. to 7:00 p.m. (Eastern Time) at:

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Our **Sales Support** staff can provide information on pricing and give you quotations. We can take your order and provide delivery information on major equipment items or make arrangements to have your local sales representative contact you. Our products are listed on the Internet and we can be contacted through our Internet home page.

Our **Service Support** staff can supply technical information about proper setup, operation or troubleshooting of your equipment. We can fill your needs for spare or replacement parts or provide you with on-site service. We can also provide you with a quotation on our Extended Warranty for your Thermo Forma products.

Whatever Thermo Forma products you need or use, we will be happy to discuss your applications. If you are experiencing technical problems, working together, we will help you locate the problem and, chances are, correct it yourself...over the telephone without a service call.

When more extensive service is necessary, we will assist you with direct factory trained technicians or a qualified service organization for on-the-spot repair. If your service need is covered by the warranty, we will arrange for the unit to be repaired at our expense and to your satisfaction.

Regardless of your needs, our professional telephone technicians are available to assist you Monday through Friday from 8:00 a.m. to 7:00 p.m. Eastern Time. Please contact us by telephone or fax. If you wish to write, our mailing address is:

Thermo Forma
Millcreek Road, PO Box 649
Marietta, OH 45750

International customers please contact your local Thermo Forma distributor.

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Section 1 - Receiving

1.1 Preliminary Inspection

This item was thoroughly inspected and carefully packed prior to shipment and all necessary precautions were taken to ensure safe arrival. Immediately upon receipt, before the unit is moved from the receiving area, carefully examine the shipment for loss or damage. Unpack the shipment and inspect both interior and exterior for any in-transit damage.

1.2 Visible Loss or Damage

If any loss or damage is discovered, note any discrepancies on the delivery receipt and call the delivering carrier and request that their representative perform an inspection. Do not discard any of the packing material and do not move the shipment from the receiving area.

1.3 Responsibility for Shipping Damage

For products shipped F.O.B. Marietta, Ohio, the responsibility of Thermo Forma ends when the merchandise is loaded onto the carrier's vehicle.

On F.O.B. Destination shipments, Thermo Forma's and the carrier's responsibility ends when your Receiving Department personnel sign a free and clear delivery receipt.

Whenever possible, Thermo Forma will assist in settling claims for loss or in-transit damage.

Section 2 - Introduction

2.1 Standard Features

The Model 1010 Freezing System consists of a Model 8018 Programmable Controller, a Countertop Freezing Chamber and a Strip Chart Temperature Recorder.

a. Model 8018 Programmable Controller

The Model 8018 is a microprocessor based programmable controller, that provides precise automatic temperature control for a choice of freezing chambers.

Six standard factory-set programs provide ease of operation for common freezing operations. Additionally, nine programs that may be operator programmed, are available to address the user's specific freezing applications. Each program consists of nine sections, for continuous temperature programming. A "jump and loop" programming feature permits the user to automatically advance to subsequent steps, or return to a previous step, as needed.

A three-digit access code provides system security, as well as protection against inadvertent program erasure. The access code may be used to manually override a program in "run" mode, but on the factory-set programs the controller will not retain in memory the value entered, and will revert back to the factory-set program.

An audible alarm system alerts the operator of any deviation from setpoint, by comparing the current chamber temperature with setpoint temperature. If the two values differ by more than the factory-set time and temperature limits, an audible alarm is activated, and a tracking error is logged on the strip-chart recorder printout. The audible alarm also signals completion of the program cycle.

Note: The Tracking Error Limit setpoints were entered at the factory for one minute, at ±5°C.

Built-in self diagnostics provide service quality assurance, in that any test error is visually displayed in conjunction with an audible alarm.

b. Countertop Freezing Chamber

The Model 8022, 8024 and 8026 Freezing Chamber is a well insulated, top or front loading unit, of stainless steel construction. It is sufficiently compact to be placed on a laboratory table, yet has the capacity to house several stacked freezing racks.

All freezing chamber space is usable. An electric blower, mounted on the outside of the chamber, circulates gaseous nitrogen between specimens, to assure uniform cooling. Thermocouple temperature probes provide the programmable freezing controller with sample, and chamber temperature information. Keyed electrical connectors assure proper mating configuration.

All chambers have a heating element to warm the freezing chamber to +25°C, after the specimen has been removed, at the completion of each freezing run.

Gaseous nitrogen used in the cooling process, escapes from the freezing chamber to the atmosphere through a vent, located at the rear of the chamber. A liquid nitrogen transfer hose and pressure relief, set at 60 PSIG, connect to the solenoid valve to supply coolant to the freezing chamber. Electrical connectors, consisting of thermocouple signal leads, and control lines for the electric blower, heater, and solenoid valve(s) are supplied.

c. Strip Chart Temperature Recorder

The LINSEIS flatbed recorders are x=f(t) recorders that operate according to the compensation principle.

The recording follows the formula x=f(t) in a rectangular coordinate system, the pen moves in an x-direction compensating for the supplied measurement voltage.

The resulting diagram represents an accurate recording of the measured signal during the measured time.

The paper is moved in a vertical y-direction by a crystal controlled stepper motor.

The mechanical construction of the flatbed recorders is based on modules. Thus, amplifiers, stepper motor, printed circuit assembly and input modules are easy to add and easy to change.

The printer is configured for: 0-10 Volt scale (fixed)

Chart Speed: 1/2” per minute (fixed)

The solid mechanical construction allows the use of this recorder for all applications in scientific measurement. This instrument can also be used for measuring and recording in research and development, and process applications.

d. Thermal Printer (Optional)

The DPU-411 is a thermal serial dot printer unit, for printing character or graphic data, from computers and other equipment. The printer has eight international character sets and handles many types of printing. The printing types include 40 columns of ordinary characters, 80 columns of condensed characters, 20 columns of double-width characters, bold, and double-strike characters.

Bi-directional logical-seeking increases the printer’s speed; and the printer features a built-in Ni-cad battery that enables the printing of approximately 1500 character lines, without connection to the AC adapter. Centronics 8-bit parallel or RS-232 serial interface is an available feature.

The following accessories are included with each printer:

1. A thermal paper roll (loaded in the printer)
2. An AC adapter
3. An instruction manual

e. DIP Switch Settings

DIP Switch #1		DIP Switch #2	
SW 1	OFF	SW1	ON
SW2	OFF	SW2	ON
SW3	ON	SW3	ON
SW4	ON	SW4	OFF
SW5	ON	SW5	OFF
SW6	OFF	SW6	OFF
SW7	ON		
SW8	ON		

f. Printer Interface Cable

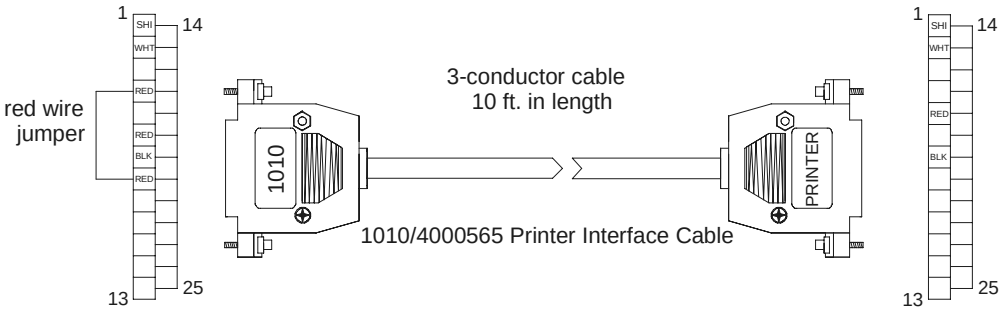


Figure 2-1

Section 3 - Installation

3.1 Unpacking List

ITEMS SUPPLIED

The Model 1010 Freezing System consists of a controller, freezing chamber and recorder. All other components required for normal operation of the unit are supplied and include the following:

1. Four foot nitrogen transfer hose with swivel end and fittings

Note: A 6' long hose with swivel is available as an option. The use of a transfer hose longer than six feet is not recommended and may degrade system performance. Contact Thermo Forma if extended transfer hose length is required.

2. Chart paper and recorder pen
3. Power cords
4. Sample thermocouple

Note: The chamber thermocouple has been permanently mounted behind the fan guard to assure accurate chamber temperature output to the controller.

5. Stabilizing corks for securing the sample thermocouple inside the control ampule.

REQUIRED BUT NOT SUPPLIED

In addition to the above furnished items, a low pressure (22 PSI) liquid nitrogen supply is required.

3.2 Location

The Model 1010 Freezing System should be located in a well ventilated area of the laboratory, on a bench top with adequate work space available. Allow for adequate clearance of chamber door swing and door latch, since such precautions are essential to safe specimen handling.

The chamber should be located adjacent to the liquid nitrogen supply, and a suitable electrical outlet. If a nitrogen supply tank is to be used, space must be allocated for tank replacement.

Caution! The freezing chamber must not be positioned above the controller or recorder. Such positioning will result in condensate dripping into the electronics and will cause serious damage to the internal circuitry.

Caution! The gaseous nitrogen vent, located at the rear of the chamber must not be obstructed. obstruction of the vent will seriously interfere with normal system operation.

Caution! The area surrounding the gaseous nitrogen vent is subject to low temperatures. items adversely affected by extreme cold should be kept away from the vent.

Arrangements should be made to collect the condensate from the transfer hose and at the freezing chamber exhaust.

3.3 Electrical Connections

Interconnect the controller and the strip chart recorder with the freezing chamber.

Caution! Do not force the connectors together. If connectors do not join freely, check the pin and socket orientation of the plug and receptacle. Thermocouple leads are color-coded to assure proper mating. Failure to follow these cautions may result in permanent connector damage.

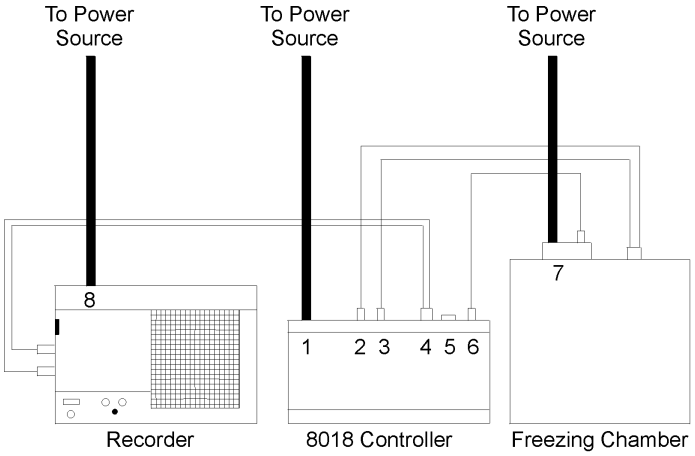


Figure 3-1

Make the following connections:

Note: Refer to the electrical schematic, or the serial tag on the rear of the controller, for specific electrical requirements.

1. Power to the controller: With the controller power switch set to the "OFF" position, connect the controller power cord to a grounded power source.
2. Chamber thermocouple input: Provides chamber thermocouple signal to controller from freezing chamber.

3. Sample thermocouple input: Provides sample thermocouple signal to controller.
4. Recorder output: Provides chamber and/or sample temperature information to recorder for hard copy graphs.
5. RS232 Port: Computers/printers interface
6. Chamber output: Provides signal from controller to control fan, cool and cool + solenoid valves, and heater.
7. Power to freezing chamber: Provides power for fan, cool and cool+, solenoid valves and heater.
8. Power to recorder: Connect to a power supply.

Note: Before beginning a program run, turn the recorder power "ON", the chart drive power "ON" and lower the pen to the chart paper, using the pen lever arm. For details on recorder operation, refer to the supplemental recorder manual.

3.4 Connecting the Liquid Nitrogen Transfer Hose

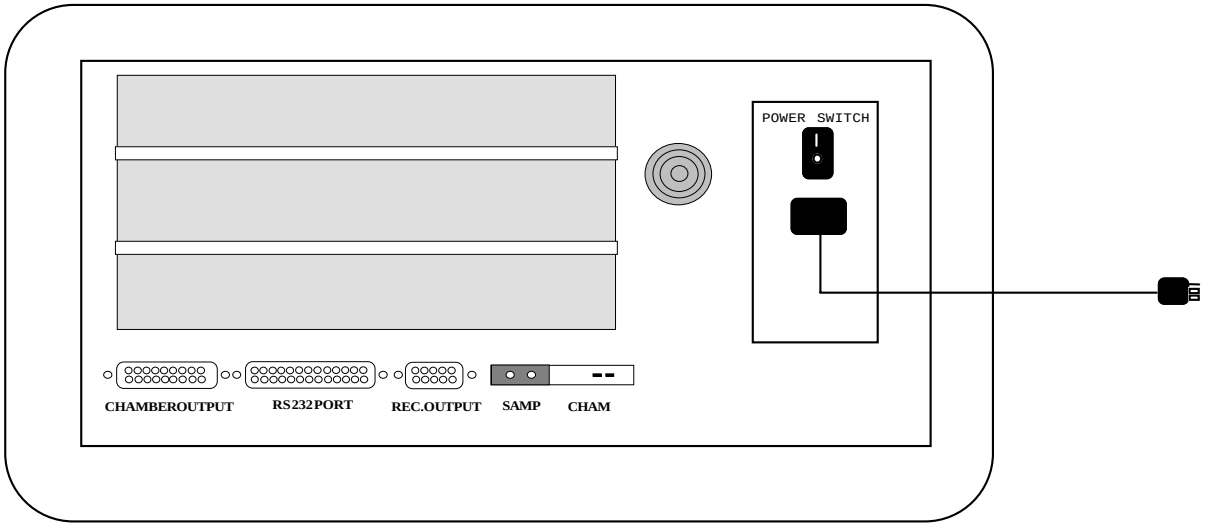
Warning! Some liquid nitrogen supply tanks contain a pressure capable of supplying liquid, or gaseous nitrogen at up to 235 PSIG. Under such conditions, change the supply tank to one with a 22 PSIG setting to provide compatibility.

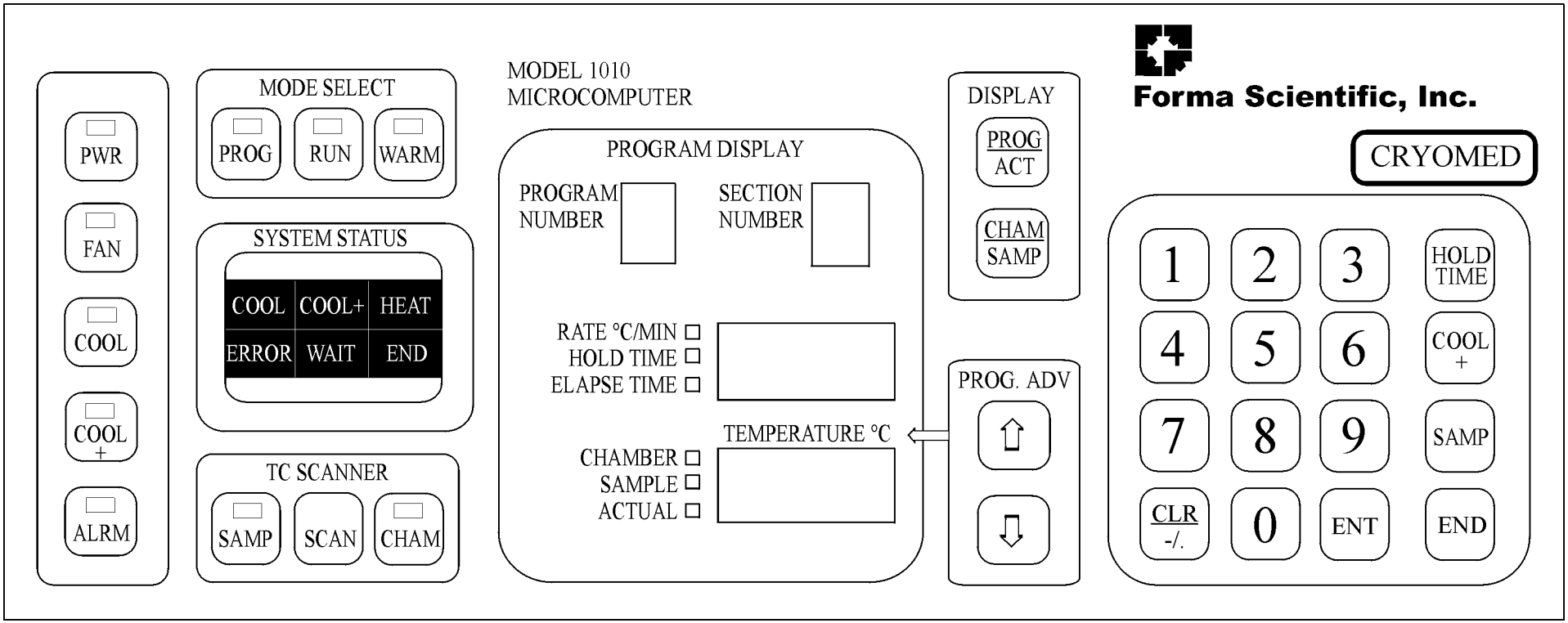
Using a 7/8" open end or an adjustable wrench, connect the transfer hose:

1. Connect hose to input flare fitting on back of chamber.
2. Connect other end of hose to the LIQUID side of the LN_2 tank.

Important! The supply tank has a liquid fitting and a vent fitting. Be sure to connect the nitrogen transfer hose to the liquid fitting.

Figure 3-2





1. Control alarm, fan and cooling mode operation.
2. Used to select four specific operating modes of the controller: Program, Run, Warm or Idle.

Note: Unit is in Idle Mode if no displays are illuminated.

3. Six LED modules display the system status of the unit during a program cycle.
4. Three keys control thermocouple scanner operation for sample only, chamber only, or sample and chamber alternately and relay temperature information to strip chart recorder.
5. Digital LED display of selected program, section number, hold time, elapse time and setpoint temperatures.
6. Four indicators allow user to toggle display of programmed/actual chamber or sample temperature.
7. Up and down arrow keys allow user to advance or retreat through the programs to subsequent or previous sections.
8. Used to select and enter numerical values and functions.

Section 4 - Operation

4.1 Control Panel Operation

The controller face plate is composed of a sealed membrane keyboard, with small indicating LED's and digital displays. The keyboard is arranged in sections, separated into groups of outlined keys by function.

a. Control Section

The function of this set of keys on the control panel is the alarm, fan and cooling mode operation.

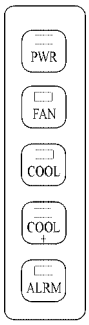


Figure 4-1

CONTROL NAME	FUNCTION
PWR (Indicator)	Indicator illuminates when the unit is turned "on".

Note: The power switch is located on the rear of the unit, directly above the power cord.

ALRM	Controls power to the audible alarm circuit, when controller is in IDLE mode. Red LED indicates alarm is enabled. Will silence audible alarm.

Note: Alarm sounds at cycle end (freezing run and warming run) and when error conditions occur.

FAN *	Controls power to the fan circuit in the freezing chamber, when con troller is in IDLE mode. Red LED illuminates only when fan is actually energized.

*It is not necessary to turn the fan "on" before each run. It will automatically function when the unit is in Run Mode.

COOL	Controls the liquid nitrogen solenoid valve circuit, in both automatic and manual modes, as follows:

Automatic Operation: Enables COOL circuit when controller is in IDLE mode. This will always be enabled.

The red LED illuminates to indicate that the COOL circuit is enabled.

Manual Operation: Opens the Cool liquid nitrogen solenoid valve, when depressed, and closes it when released; under the following conditions:

- The COOL circuit has been enabled (while running in the "unlimited access mode").
- The controller is running a program, or is in the "IDLE" mode.

Note: After the COOL keypad is released, automatic controller operation will resume.

CONTROL NAME	FUNCTION
COOL+	Controls the liquid nitrogen solenoid valve circuit, for the injection of additional LN2 (for accelerated freezing rates) as follows:

Automatic Operation: Enables COOL + circuit when controller is in IDLE mode. This will be enabled only if it has been programmed into the section being viewed.

The red LED illuminates to indicate that the COOL + circuit is enabled. This must be programmed into the memory in order to be enabled.

Important: The COOL+ circuit must be programmed in, for the computer to energize the COOL+ liquid nitrogen solenoid valve.

Manual Operation: Opens the COOL+ liquid nitrogen solenoid valve, when depressed, and closes it when released; under the following conditions:

- When the COOL+ circuit has been enabled (while running in the "unlimited access mode").
- When the controller is running a program, or is in the "IDLE" mode.

Note: After the COOL+ keypad is released, automatic controller operation will resume.

b. Mode Select

This set of keys is used to select specific operating modes of the controller: Program, Run, Waarm, Full Access run.

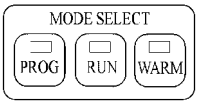


Figure 4-2

Note: Unit is in Idle Mode if no displays are illuminated.

CONTROL NAME	FUNCTION
PROG	Selects the programming mode. Use when operator wishes to change any internal program memory.
RUN	Press the RUN key to start a program; Press also to resume the program, during a WAIT program section.

Note: Program will not proceed during a WAIT section, until the RUN key is pressed.

WARM	Starts the automatic WARM cycle. Causes freezing chamber to warm to +25°C.

Note: The PROGRAM NUMBER and SECTION NUMBER will display 0.0. When the freezing chamber reaches +25°C, the controller will hold the temperature at +25°C. It will cycle LN2 if it is supplied.

CONTROL NAME FUNCTION

Note: Pressing a keypad whose LED's is already illuminated, will cause the computer to exit from that mode with the exception of the "RUN" mode.

(IDLE Mode) This action will return the controller to the IDLE mode (no displays in Mode Select section are illuminated).

The term IDLE MODE will be used during installation and troubleshooting of the unit.

c. System Status

Six LED modules display the system status of the unit during a program cycle.

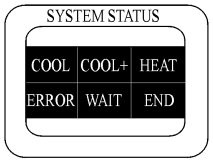


Figure 4-3

INDICATOR NAME FUNCTION

COOL — Indicator illuminates to indicate when the COOL solenoid valve is open, injecting liquid nitrogen into the freezing chamber.

COOL + — Indicator illuminates to indicate when the COOL + solenoid valve is open, injecting additional liquid nitrogen into the freezing chamber.

HEAT — Illuminates when heating circuit is energized.

WAIT — Illuminates when the program is being run, indexing through, or being edited contains a WAIT section.

ERROR — Illuminates when the controller senses the presence of an error condition.

END — Illuminates when the program is being run, indexing through, or being edited contains a END section.

d. TC Scanner

Three keys control thermocouple scanner operation for sample only, chamber only, or sample and chamber alternately. This temperature information is then relayed to the strip chart recorder.

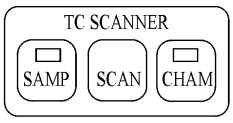


Figure 4-4

CONTROL NAME FUNCTION

SAMP — Selects the Sample thermocouple as the temperature to be sent to the recorder. The red LED illuminates when the controller is sending out Sample temperature to recorder.

CHAM — Selects the Chamber thermocouple as the temperature to be sent out to the recorder. The red LED illuminates when the controller sending out chamber temperature to the recorder.

SCAN — Tells computer to scan both thermocouples at fixed rate (two seconds for the chamber thermocouple, followed by ten seconds for the sample thermocouple) and outputs the information to the recorder.

Note: The SAMP and CHAM LEDs will alternately illuminate during scanning to indicate the thermocouple being scanned at that moment.

Note: The SCAN keypad does not have a LED indicator.

e. Program Display

The digital LED display of the selected program, section number, rate, hold time, elapse time, and setpoint temperatures.

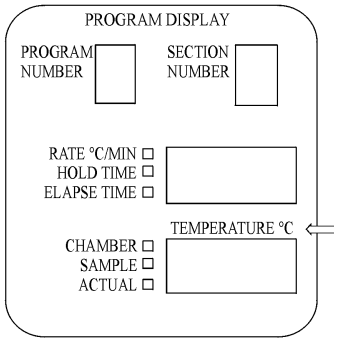


Figure 4-5

f. Display

Four indicators permit the operator to toggle the display of the programmed/actual chamber or chamber/sample temperature.

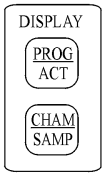


Figure 4-6

CONTROL NAME FUNCTION

PROG/ACT — Manually toggles the display section between the programmed, or actual temperature value.

Note: When in PROG mode, automatically toggles between programmed temperature and target temperature for that programmed section.

CHAM/SAMP — Must be in ACT, manually switches the display section between the CHAM and SAMP value.

g. Prog. Adv.

The up and down arrow keys allow the user to scroll through the programs.

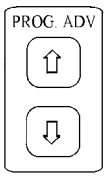


Figure 4-7

CONTROL NAME	FUNCTION
UP ARROW	Increments through the program to the next section; repeats approximately three times per second if held depressed.
DOWN ARROW	Decrements through the program to the previous section; repeats approximately three times per second if held depressed.

Note: In full access mode, these arrow keys raise or lower the setpoint.

h. Numerical and Special Functions

This keypad is used to select and enter numerical values and functions when programming the controller.

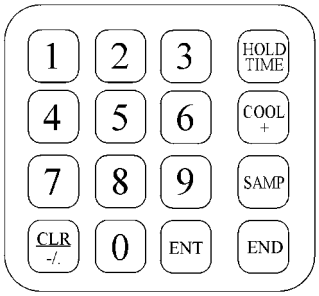


Figure 4-8

CONTROL NAME	FUNCTION
NUMERIC KEYS	Represent numerical values, zero through nine.
HOLD TIME	Used when programming to enter a specific amount of time (in minutes) that the temperature, within a cycle, is to be held.
COOL +	Used when programming to select a COOL+ function, for rapid cooling.

Important: Should be used on all low temperature programs.

SAMP	Used when programming to enter a setpoint value, corresponding to the SAMPLE temperature. When used with “HOLD”, permits seconds to be programmed.
ENT	Used to enter and store values and parameters, previously keyed into the computer memory (active only when in Program mode).
END	Used to program a “label” the end or last section of a program (active only when in the PROG position).
CLR -/.	Used when programming to remove and entry (active only when in the PROG position).
	Used when programming a negative number.
	Used to enter a decimal point when entering a program number in the user-definable half of memory.

4.3 System Operation

The Model 8018 Programmable Controller regulates the flow of liquid nitrogen to the freezing chamber. Additionally, it supplies temperature information to the strip chart recorder.

The freezing cycle consists of the following steps and operations:

Note: Typically the biological sample is mixed with a solution of cryoprotective agent and placed in a plastic cryoampule.

1. STARTING TEMPERATURE. Sample temperature prior to being loaded into the freezing chamber. The sample is usually at room temperature (+22C) or ice bath temperature (+4C).
2. LIQUID PHASE COOLING. The rate at which the liquid sample is cooled. A typical rate of cooling is 1°C/min.

Note: A regulated flow of LN2 into the freezing chamber is circulated by an internal electric fan. This assures even sample cooling.

3. SUPER COOLING. The temperature drop achieved just prior to liquid-to-solid phase change. It is generally three to four degrees centigrade below the freezing point.
4. PHASE CHANGE. The beginning of the liquid-to-solid phase change process, characterized by a rapid increase in temperature, from super cooled temperature to freezing temperature. To minimize temperature rise during phase change, chamber temperature is rapidly dropped. This rapid cooling absorbs latent heat of fusion, minimizing any temperature rise above the freezing point.

Note: Refer to the chart (Figure 4-1) at the end of this section for the freezing point temperature of the biological sample corresponding to the percentage of cryoprotective agent added to the sample.

5. SOLID PHASE I FREEZING. The freezing rate selected for solid phase cooling is independent of liquid phase cooling rate. This rate is determined by the operator, as required, and is typically the same as liquid phase cooling rate of 1°C/min.

6. END SOLID PHASE I FREEZING. The final temperature achieved in Solid Phase I freezing cycle. It is typically set between -30°C and -50°C, as required by the operator.
7. SOLID PHASE II FREEZING. The freezing rate is independent of the Solid Phase I freezing rate. At -30°C to -50°C, the sample is considered safe. This permits the temperature to be dropped at a much faster rate, such as 10°C to 20°C per minute.

Note: Researchers generally find that a Liquid Phase cooling rate of 1°C/min, a solid Phase I freezing rate of 1°C/min, and a Solid Phase II rate of 10°C/min will provide maximum recovery of viable cells, while minimizing freezing cycle time.

8. END FREEZE TEMPERATURE. The final temperature achieved at Solid Phase II freezing cycle. It is typically set at -90°C, and maintains freezing chamber temperature until sample is ready to be transferred to long term storage.

The following chart shows the relationship between the freezing point temperature of biological samples and the percentage of cryoprotective agent added.

Chart 4-1

% Cryoprotective Agent (DMSO, Glycerol, Etc.)	Freezing Point Temperature
0	0°C
5%	-2°C
7.5%	-3°C
10%	-4°C
12.5%	-5°C
15%	-6°C
20%	-8°C
30%	-12°C

4.4 Initiating a Freezing Run

After the freezing system has been connected as illustrated in Figure 3-1, proceed as follows:

1. Turn on the controller.

Note: Upon start-up, the controller will run through a complete lamp test, and return to the "Idle Mode" (no lights are illuminated in the "Mode Select" section of the front panel).

2. Press the power switch on the strip chart recorder, and permit the system to warm-up for 20 minutes.
3. Uncap and lower the pen to the graph paper.
4. Calibrate the recorder as follows:
   a. Press "CHAM" in the TC Scanner section of the controller. The recorder pen should move to zero on the strip chart recorder. If it does not, dial it to zero, using the black knob on the recorder.
   b. Press "SAMP" in the TC Scanner section of the controller. The recorder pen should move to -180°C. If it is out of calibration, adjust using the set screw adjacent to the zero knob until the pen reaches -180°C.
   c. Recheck zero calibration as directed in step 4A.
5. To select program:

   User Program - Press the program number, the decimal point, (and section number, if required).

   Factory-set Program - Press the program number (and section number, if required).

Note: Program and Section of desired program may be selected by using the up/down arrow keys to locate the program number and section number that you wish to run. (Up arrow means increase in numbers; down arrow means decrease in numbers.)

6. Depress "RUN" to start.

4.5 Factory Pre-set Programs

PROGRAM #1
Standard 1.2/2.0ml w/7% to 12% Cryoprotectant Agent

Section 1	Wait @ 4° Cool+
Section 2	1 degree/minute to -4° Sample
Section 3	25 degrees/minute to -40° Cool+
Section 4	15 degrees/minute to -12° Cool+
Section 5	1 degree/minute to -40° Cool+
Section 6	10 degrees/minute to -90° Cool+
Section 7	End

PROGRAM #2 Standard Microtest Tray Freeze

Section 1	Wait @ 4° Cool+
Section 2	1 degree/minute to -40° Sample
Section 3	10 degrees/minute to -90° Cool+
Section 4	End

PROGRAM #3 Standard Embryo Freeze (0.25 to 0.50ml straw)

Section 1	Wait @ +20° Cool+
Section 2	1 degree/minute to -4°
Section 3	0.5 degree/minute to -7°
Section 4	5 minute hold time at -7°
Section 5	0.3 degrees/minute to -35°
Section 6	0.1 degrees/minute to -37°
Section 7	End

PROGRAM #4 Standard Blood Bag/Bone Marrow 75-150ml, w/7% to 10% Cryoprotectant Agent

Section 1	Wait @ 20° Cool+
Section 2	1 degree/minute to -6° Sample
Section 3	25 degrees/minute to -50° Cool+
Section 4	15 degrees/minute to -14° Cool+
Section 5	1 degree/minute to -45° Cool+
Section 6	10 degrees/minute to -90° Cool+
Section 7	End

PROGRAM #5 Skin Packet 4" x 6" w/10% Cryoprotectant Agent

Section 1	Wait @ +4° Cool+
Section 2	1 degree/minute to -5° Sample
Section 3	20 degrees/minute to -40° Cool+
Section 4	10 degrees/minute to -10° Cool+
Section 5	1 degree/minute to -35° Cool+
Section 6	10 degrees/minute to -90° Cool+
Section 7	End

PROGRAM #6 2ml Sample w/7%-12% Cryoprotectant Agent

Section 1	Wait @ +4° Cool+
Section 2	1 degree/minute to -4° Sample
Section 3	20 degrees/minute to -45° Cool+
Section 4	15 degrees/minute to -10° Cool+
Section 5	0.5 degree/minute to -20° Cool+
Section 6	1 degree/minute to -80° Sample
Section 7	End

4.6 Programming the Controller

The Model 8018 Programmable Controller permits the operator to create freezing programs suited to a specific need. The operator may enter, by touching the appropriate keypads, a sequence of operating command, and parameters into the computer memory. The memory is retained even when a power loss occurs, and is available upon power-up at the touch of a few keys.

A "lock-out" feature, requiring an access code protects the programs from unauthorized tampering, or accidental change.

Note: The user programmable section of memory is identified as "Program Number" (1-9), decimal point, followed by "Section Number" (1-9), as shown at the right.

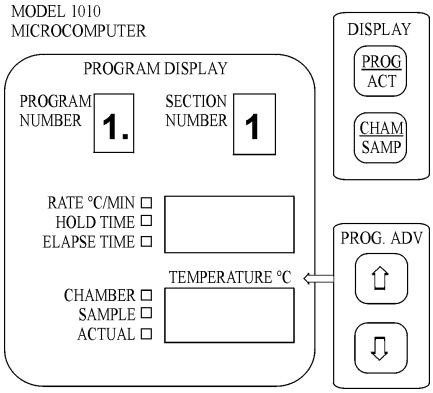


Figure 4-9

Nine programs, each consisting of nine sections, are user programmable. Each memory section is designed to hold information necessary to perform a single task. Each freezing task can consist of only one of the following:

1. A "HOLD" time, while maintaining a chamber temperature setpoint.
2. A "WAIT" function, while maintaining a chamber temperature setpoint.
3. A "RATE C/MIN" temperature increase, or decrease, until a "SAMPLE" or "CHAMBER" temperature reaches setpoint.
4. END

By programming one or more sections in sequence, the user can create programs. The total effect of all tasks, running sequentially make for a flexible freezing program.

This section will provide user with step-by-step instructions on entering user defined programs into the Model 8018.

The following is a sample freezing program for a 2ml sample with a predetermined freezing point of -4°.

Example: User Defined Program

Program #1

Section #1: 4 Degrees start temperature

Section #2: 1 Degree per minute to -4 degrees sample

Section #3: 30 Degrees per minute to -60 degrees

Section #4: 15 Degrees per minute to -12 degrees

Section #5: 1 Degree per minute to -45 degrees

Section #6: 10 Degrees per minute to -90 degrees

Section #7: END

Programming Notes:

1. Cool + should be programmed into every temperature section. This is done by depressing "COOL +" on the keypad in the second step of each section.
2. When programming a sample switch point, it is necessary to depress "SAMP" key. It will automatically be a chamber setpoint unless the "SAMP" key is depressed.

Note: Refer to the chart on the following pages, "Entering the Example User defined Program".

Entering the Example User Defined Program:

PROGRAMMING ACTION	KEYSTROKE SEQUENCE	EXPLANATION
Beginning-Selection of Program Number and Section Number	Press "PROG", 1, 2, 3, "ENT" Press Desired Program Number, Section Number. Example: Program 1, Section 1, "ENT"	This is the factory programmed access code. The controller will automatically supply the decimal point, to indicate the "user programmable" sector of memory is being accessed.
Programming Section #1 Start Temp	Press 0, ENT	When "0" is entered, the display area goes blank and the word "WAIT"* appears. **Note:** This indicates that you are instructing the controller to go to the "Start Temp" and maintain that temp until the run key is pressed again.
	Press 4, COOL+, ENT	This indicates that the start temperature selected is +4°C.
**Note:* *When the program is running and comes to a programmed WAIT command, the program will not advance until the operator presses the RUN key.*		
Programming Section #2 Liquid Phase Rate	Press 1, 0, ENT	This enters a rate of 1 degree per minute. **Note**: The "0" must be pressed to move the decimal point to the proper position.
	Press -, 4, SAMP, COOL+, ENT	This is the "start phase change" which is usually a predetermined sample freezing point. **Note:** This is the only temperature setting which is recommended to be a "sample switch point".
Programming Section #3	Press 3, 0, 0, ENT	This is selects a rate of 30° per minute.
Temp Drop	Press -, 6, 0 COOL+, ENT	This selects a temperature drop of -60°C.
Programming Section #4	Press 1, 5, 0, ENT	This selects a rate of 15 degrees per minute.
End of Phase Change	Press -, 1, 2, COOL+, ENT	This is the end of Phase Change temperature, which is generally 8 to 10 degrees colder than the start of phase change.
Programming Section #5	Press 1, 0, ENT	This enters a rate of 1 degree per minute.
Solid Phase Freezing Rate	Press -, 4, 5, COOL+, ENT	**Note:** The "0" must be pressed to move the decimal point to the proper position. This programs the controller to run this rate until the chamber reaches -45°C. Note: The sample is generally considered safe when it reaches between -30C and -50°C.
Programming Section #6 Solid Phase Freezing Rate II	Press 1, 0, 0, ENT	This is selects a rate of 10° per minute. **Note:** The "0" must be pressed to move the decimal point to the proper position.
	Press -, 9, 0, COOL+, ENT	This selects a Target temperature of -90°C.
Programming Section #7 End	Press END, COOL+, ENT	**Note:** Use the down arrow key, to scroll back through the program to check it's accuracy; and to return to Section 1.1.**

***Note:* *You must return to Section 1.1 of the program before pressing "RUN" to execute the program.*

4.7 Running the Program in the Unlimited Access (Manual) Mode

IMPORTANT: Manual operation of the controller, as a general rule, should be avoided. After manual operation is discontinued, program control will resume and compensate for any manual adjustment to the program.

Under normal running conditions, the controller is in a "locked" or "limited" access mode. When running in this mode, no manual operation of the controller can take place. If the program run needs to be modified, the controller must be returned to the "unlimited access" mode.

Depress PROG, 1, 2, 3, ENT

The RUN light will blink on and off, while it continues to run. The blinking indicator indicates that the controller is now in the "unlimited access" mode.

Note: While in this mode, program segments may be modified (for this program run only), such as coolant or heat may be added by pressing the appropriate keys.

1. Add coolant by depressing COOL AND COOL+ on the left side of the unit under Control.
2. Add COOL+ to a Program section (if it was not entered at programming) by depressing COOL+ on the numerical display on the right side of the controller.
3. Add heat by using the up arrow for an increase in temperature; or coolant by using the down arrow for a decrease in temperature.

4.8 Aborting a Program Run

If it becomes necessary to abort the program run, return the controller to the "unlimited access" mode as follows:

1. Depress PROG, 1, 2, 3, ENT.
2. Depress the RUN key while the controller is in the "unlimited access" mode.

Note: If the program is in a "Wait" section, it will be necessary to depress RUN twice, as the first depression of the key advances the program only to the next section.

4.9 Programming the Access Code

The access code "1, 2, 3" was factory-set prior to shipment of the Model 8018. If the user/operator desires to change the access code, perform the following steps.

Example: Change access code to 4, 5, 6.

Depress keys in this sequence: PROG, 1,2,3, ENT, CLR, 4,5,6, ENT.

Note: If the new three-digit access code is not entered within ten seconds, the controller will automatically revert back to the previous access code.

4.10 Programming the Error Limit Setpoints

The error limit setpoints are designed to alert the operator to a temperature deviation in either the CHAMBER or the SAMPLE, by sounding an audible alarm.

Alarm conditions could result from one or more of the following:

- Loss of cooling source (liquid nitrogen)
- Lack of LN2 pressure
- Freezing chamber (solenoid valve stuck open or closed)
- Fan motor overload tripped
- Exhaust blockage
- Incorrect Programming

The error limit setpoint has been factory programmed for 1 °, 5 minutes, and under most circumstances *should not* be changed by the operator. If the temperature deviates 1° from the programmed temperature (for 5 minutes duration) the audible alarm will sound. The error limit setpoint was programmed as follows:

- Example: 1° for 5 minutes
- Keystrokes: PROG, 1, 2, 3, ENT, 0, ENT, 1, ENT, 5, ENT, PROG, 0.

Note: Only one set of error limit setpoints can be stored in memory at one time. They are applicable to all the programs.

4.11 Programming a Sample Freezing Point Determination Run

The Start Phase Change Temperature is the temperature at which the SAMPLE freezes. To determine the freezing point of a new biological sample, refer to the chart at the end of this manual, or execute the sample freezing run on the next page.

Sample Freezing Point Determination Run

PROGRAMMING ACTION	KEYSTROKE SEQUENCE	EXPLANATION
Beginning-Selection of Program Number and Section Number	Press "PROG", 1, 2, 3, "ENT"	This is the factory programmed access code.
	Press Desired Program Number, Section Number. Example: Program 1, Section 1, "ENT"	The controller will automatically supply the decimal point, to indicate the "user programmable" sector of memory is being accessed.
Programming Section #1 Start Temp	Press 0, ENT	When "0" is entered the display area goes blank and the word "Wait"* appears. **Note:** This indicates that you are instructing the controller to go to the "Start Temp" and maintain that temp until the run key is pressed again.
	Press 4, COOL+, ENT	This indicates that the start temperature selected is +4°C.
Programming Section #2 Liquid Phase Rate	Press 1, 0, ENT	This enters a rate of 1° per minute. Note: The "0" must be pressed to move the decimal point to the proper position.
	Press -, 5, 0, COOL+, ENT	This selects a target temperature of -50°C
	END, ENT	

***Note:** When the program is running and comes to a programmed WAIT command, the program will not advance until the operator presses the RUN key.*

After the run has been completed, review and analyze the strip chart cooling trace, it should be similar to the chart titled "DETERMINING THE START PHASE CHANGE TEMPERATURE", located at the rear of the manual.

The trace will show a sudden temperature rise, when the phase change portion of the cycle has been reached. The linear temperature trace, just after the sudden temperature rise (release of latent heat) is the freezing point or start of Phase Change Temperature (Heat of Fusion Plateau Temperature).

Make the following connections:

Note: Refer to the the serial tag on the rear of the controller for specific electrical requirements.

1. POWER TO THE CONTROLLER: With the controller power switch set to the "OFF" position, connect the controller power cord to a grounded power source.
2. Chamber thermocouple input: Provides chamber thermocouple signal to controller, from freezing chamber.

4.12 RS-232

The software within the Model 8018 controller has special features for remote control by another computer, such as an IBM (or an IBM compatible) PC. The remote computer talks to the Model 8018 through the serial RS-232 communication port on the rear of the controller assembly.

Two modes of serial communication are provided. The first mode is designed to operate as a background task, when the controller is in the "RUN" or "WARM" mode. It will format the "RUN" mode parameters into a simple display, and spool it out the serial port. This allows the user to attach a CRT terminal to the serial port, and to monitor the "RUN/WARM" mode status. The information provided by the spooler mode is the same as that displayed on the front panel of the micro controller.

The second serial communication mode is an executive monitor. It disables control of the micro controller through the front panel, and turns over complete control of the system to a master controller attached to the serial port. It could be used in applications where the operator wants the micro controller to be completely controlled by a remote computer. Any type of computer can be used for this mode, provided that it is able to communicate with the Model 8018 microcontroller, through a serial RS-232 link, which can be configured to the following parameters:

9600 BAUD

8 Data bits

1 stop bit

Parity test disabled

Space parity transmitted

The first communication mode is a data spooler, and it is used when the micro controller is operating in either the "RUN" or "WARM" mode. The micro controller is still operated through the front panel, and operation of the data spooler is transparent to all system activity. The spooler mode is turned on by pressing the ">" key and it is turned off by pressing the "<" key. When the spooler mode is turned on, the following display is repeatedly sent to the device attached to the serial port:

PS=0101

FN=11

P1=0000

P2=0028

CT=+004.0

CH=+026.3

SP=+026.8

ST=801C

At the end of each display, the following "Cursor-to-Home" character sequence is issued: ESC, "=", " ", " ".

The first line of the display shows the program and section that is currently being executed. The second line shows the function that was programmed for that section. This is a coded number that contains the information about the programming function, and whether the COOL + output is to be used for cooling. When the tens digit of the number is 0, the use of COOL+ is disabled. When the tens digit is 1, the use of COOL+ is enabled. The following table lists the functions defined by the units digit:

0 = WAIT at the last specified control temperature

1 = WAIT at the control temperature specified by parameter P2

2 = WARM mode function code

3 = RAMP at the rate specified by parameter P1 until the chamber reaches the temperature specified by parameter P2

B = RAMP at the rate specified by parameter P1 until the sample reaches the temperature specified by parameter P2

4 = HOLD for the number of minutes specified by parameter P1, at the last specified control temperature

5 = HOLD for the number of minutes specified by parameter P1, at the control temperature specified by parameter P2

6 = END function code

7 = GOTO function code, program and section are in parameter P1

The third and fourth lines of the display show the auxiliary parameters that were programmed into the current section. They are displayed in a hexadecimal format (the base sixteen number system). The next three lines show the current Control temperature, Chamber temperature, and Sample temperature in degrees Centigrade. The last line shows the current system status. This is also a hexadecimal number, with each bit representing a different condition. The following table lists the meaning of each bit of the status word. Bit15 is in the left-most position, and bit0 is in the right-most position. All of the unspecified bits are always RESET.

bit15 = WARM mode alarm hold-off is disabled when SET

bit10 = error has been marked when SET

bit9 = alarm enabled (LED is on above ALARM key) when SET

bit8 = alarm is on (beeper is sounding) when SET

bit7 = sample TC is selected for A/D conversion when SET
chamber TC is selected for A/D conversion when RESET

bit4 = FAN is on when SET

bit3 = COOL solenoid is on when set

bit2 = COOL+ solenoid is on when set

bit1 = HEAT relay in on when SET

bit0 = BEEPER is on when SET

The second communications mode is the system monitor. It allows the user to take over complete control of the micro controller through the serial port, and it is entered by pressing the "#" key. When the monitor mode is entered, all temperature control stops, all temperature control outputs are turned off, the front panel display is blanked, and the characters "ACS" are shown on the center display to indicate that the micro controller is being accessed through the serial port.

Upon entry to the monitor mode, the following clear screen sequence is issued: ESC, ":". This is a valid clear screen sequence for a Lear-Siegler ADM 3A CRT terminal. After the clear screen sequence is sent, a menu of commands is displayed and the monitor prompt is issued as follows:

GENERATE CHECK SUM-----A bbbb eeee

EXAMINE MEMORY----------E bbbb eeee

MODUIFY MEMORY----------M aaaa

RAM TEST----------R bbbb eeee

LOAD USER PROGRAMS------L

DUMP USER PROGRAMS------D

RESUME EXECUTION----------X

ON-LINE:

At this point, the user can completely interrogate the Model 8018 micro controller by issuing various commands. A command is invoked by typing its associated letter and providing any secondary parameter, where required. The secondary parameters are always hexadecimal numbers, and they should be delimited by one space. Pressing the CONTROL-X character at any point in the monitor mode will cause the prompt to be issued immediately. Press this key to “Cancel” a command before the RETURN key is pressed, or “Abort” a function once it has been invoked.

The “A” command generates the proper validation code for a specified portion of the memory map. It is a special function that is provided for applications where the user (or remote computer) desires to change the USER PROGRAM AREA of the micro controller. Since the check-sum for the data area must always be correct, in order to successfully supply a new temperature control program, the sections must be entered directly (using the “L” or “M” command. The last step of the alteration procedure is to place the new check-sum into memory by using the “M” command.

The “E” command provides a formatted display of the portion of the memory map specified by the two input parameters. The display shows sixteen values per line in the following format: address, data in hexadecimal format delimited by spaces, followed by the same data interpreted as ASCII characters. For the second display field, any value that can not be displayed as a printable ASCII character is shown with a “.” character. The following example shows how the display would appear if the user supplied the beginning and ending address of the USER PROGRAM AREA, after it has been reset to END functions.

```
ON-LINE: E D000 D19F
D000    02 2B 06 00   00 00 00 06   00 00 00 00   06 00 00 00     .+.............
D010    00 06 00 00   00 00 06 00   00 00 00 06   00 00 00 00     ................
D020    06 00 00 00   00 06 00 00   00 00 06 00   00 00 00 06     ................
D030    00 00 00 00   06 00 00 00   00 06 00 00   00 00 06 00     ................
D040    00 00 00 06   00 00 00 00   06 00 00 00   00 06 00 00     ................
D050    00 00 06 00   00 00 00 06   00 00 00 00   06 00 00 00     ................
D060    00 06 00 00   00 00 06 00   00 00 00 06   00 00 00 00     ................

D070    06 00 00 00   00 06 00 00   00 00 06 00   00 00 00 06     ................
D080    00 00 00 00   06 00 00 00   00 06 00 00   00 00 06 00     ................
D090    00 00 00 06   00 00 00 00   06 00 00 00   00 06 00 00     ................
D0A0    00 00 06 00   00 00 00 06   00 00 00 00   06 00 00 00     ................
D0B0    00 06 00 00   00 00 06 00   00 00 00 06   00 00 00 00     ................
D0C0    06 00 00 00   00 06 00 00   00 00 06 00   00 00 00 06     ................

D0D0    00 00 00 00   06 00 00 00   00 06 00 00   00 00 06 00     ................
D0E0    00 00 00 06   00 00 00 00   06 00 00 00   00 06 00 00     ................
D0F0    00 00 06 00   00 00 00 06   00 00 00 00   06 00 00 00     ................
D100    00 06 00 00   00 00 06 00   00 00 00 06   00 00 00 00     ................
D110    06 00 00 00   00 06 00 00   00 00 06 00   00 00 00 06     ................
D120    00 00 00 00   06 00 00 00   00 06 00 00   00 00 06 00     ................
D130    00 00 00 06   00 00 00 00   06 00 00 00   00 06 00 00     ................
D140    00 00 06 00   00 00 00 06   00 00 00 00   06 00 00 00     ................
D150    00 06 00 00   00 00 06 00   00 00 00 06   00 00 00 00     ................
D160    06 00 00 00   00 06 00 00   00 00 06 00   00 00 00 06     ................
D170    00 00 00 00   06 00 00 00   00 06 00 00   00 00 06 00     ................
D180    00 00 00 06   00 00 00 00   06 00 00 00   00 06 00 00     ................
D190    00 00 06 00   00 00 00 02   00 01 00 32   01 02 03 0A     ...........2....
```

The “M” command allows the user to examine/modify one memory location at a time. The parameter provided is the first address for examination. The monitor will show the contents of the memory location and wait for the user to type a character. If the character typed is a hexadecimal value, the monitor will accumulate digits until the RETURN key is pressed, at which time the last two hex digits will be used to modify the memory and the next higher location will be displayed. If the user types a “P” character, the current location remains unaltered, and the next lower (or previous) location will be displayed. If the “N” key is pressed, the current location is left unchanged and the next higher location is displayed. To exit back to the monitor prompt, press the CONTROL-X character. Some examples of the “M” command follow:

ON-LINE: M D000	Modify memory starting at D000 hex.
D000 02 N	Show the next two
D001 2B N	locations of memory.
D002 06 P	Show the previous
D001 2B P	seven locations
D000 02 P	of memory.
CFFF 00 P	
CFFE 80 P	
CFFD 00 P	
CFFC 80 P	
CFFB 00 FF	Change this location to FF hex.
CFFC 80 ^X	Exit back to the monitor prompt.
ON-LINE:	

The “D” command is used to read the USER PROGRAM AREA out of the micro controller, format it into a special form called INTEL ASCII HEX format, and list it out the serial port. If a terminal is attached to the serial port, the formatted data area will be shown on the screen. If a remote computer is attached to the serial port, it can read the uploaded data area and save it away. This type of data transfer is desirable because it incorporates a high level of error checking. The “L” command provides the inverse function for this transfer link. It receives an incoming INTEL ASCII HEX file and loads it into the USER PROGRAM AREA within the model 8018 micro controller. The formatted data file would appear as follows if the “D” command were used with a CRT terminal.

```
ON-LINE: D
:10000000022B06000000000600000000006000000B1
:1000100000060000000006000000000600000000CE
:1000200006000000000600000000006000000006B8
:10003006000000000600000000060000000000600AE
:1000400000000006000000000600000000060000 9E
:1000500000000600000000060000000006000000 8E
:1000600000060000000006000000000600000000 7E
:1000700006000000000600000000060000000000668
:10008006000000000600000000060000000006005E
:1000900000000060000000006000000000600004E
:1000A000000006000000000600000000060000003E
:1000B000000600000000060000000006000000002E
:1000C000060000000006000000000600000000618
:1000D006000000000600000000060000000006000E
:1000E000000000600000000060000000006000 FE
:1000F000000060000000006000000000600000EE
:10010000006000000000600000000060000000DD
:10011000060000000006000000000600000006C7
:10012006000000000600000000060000000600BD
:10013000000000600000000060000000060000AD
:1001400000000600000000060000000060000009D
:1001500000600000000060000000006000000008D
:10016000060000000006000000000600000000677
:10017006000000000600000000060000000006006D
:10018000000000600000000060000000000600005D
:10019000000060000000002000100320102030A14
:0000000000
```

The “X” command is the only means of exiting the monitor mode short of turning the power off. When it is invoked, the CLEAR-SCREEN character sequence is issued, and the micro controller resumes program execution at the program point just prior to entry into the monitor mode. This allows the user to enter the monitor mode by pressing the “#” character, alter some system parameter, and continue execution by entering the “X” command. The user has complete control of the entire micro system when in the monitor mode, therefore if the system memory is altered in such a way that critical information has been corrupted, unpredictable results will occur when the “X” command is executed.

The following table lists the addresses of various devices in the memory map of the Model 8018 microcontroller.

HEXADECIMAL ADDRESS	PERIPHERAL LOCATED AT THAT LOCATION
8000	Temperature Control Output Latch
D000-D19F	Memory Locations Uploaded/ Downloaded by the INTEL ASCII HEX file commands (“D” AND “L”)
D000-D001	Check-sum for the User Program area
D002-D19F	User Program area and address range used to compute the Check-sum (with the “A” command)
0080-00FF	Address range of internal RAM
1005-1006	Data register for the Chart Recorder DAC
1003	Load register for the Chart Recorder DAC

Model 8018 and PC Serial Cable Interface Pinouts

PC 9 PIN FEMALE		PC 25 PIN FEMALE	SIGNAL (REL PC)	MODEL 8018 25 PIN MALE
3	—————>	2 —————>	TXD	—————> 3
2	<—————	3 <—————	RXD	<————— 2
7	—————>	4 —————>	RTS	—————> 5
8	<—————	5 <—————	CTS	<————— 4
6	<—————	6 <—————	DSR	<————— 20
5	—————-	7 —————-	GND	————— 7
4	—————>	20 —————>	DTR	—————> 6

Section 5 - Maintenance

5.1 Cleaning the Freezing Chamber

Caution! After completing the cleaning procedure, it is recommended that the unit be run and tested before placing any valuable contents inside freezing chamber.

Warning! Alcohol, even a 70% solution, is volatile and flammable. Use it only in a well ventilated area that is free from open flame. If any component is cleaned with alcohol, do not expose the component to open flame or other possible hazard.

Caution! Do not use strong alkaline or caustic agents. Stainless steel is corrosion resistant, not corrosion proof.
Do not use chlorinated solvents or other halogens on stainless steel, as they will cause rusting and pitting.

1. The freezing chamber can be easily cleaned with an appropriate disinfectant/detergent. Refer to manufacturer’s directions for the proper dilution ratio and additional information.
2. Remove and wash freezing rack and all interior surfaces.
3. Rinse all surfaces at least twice with sterile distilled water (50K Ohm to 1 Meg Ohm), or until you are satisfied that all of the disinfectant-detergent has been removed.
4. Thoroughly clean door gasket.
5. If desired, all surfaces may then be wiped or sprayed with 70% alcohol.

As a matter of routine maintenance, the cabinet exterior should be kept clean. The cabinet may be cleaned with soap and water or with any non-abrasive commercial spray cleaner.

Use the mildest cleaning procedure that will do the job effectively. To insure maximum effectiveness and to avoid marring the surface, always rub in the direction of the finish polish lines. Be sure to rinse the surface thoroughly after every cleaning operation. To avoid water marks, wipe the surface dry.

5.2 Troubleshooting Chart - Model 8018 Controller

Upon power up, the 8018 Controller will test all of its internal circuits for proper operation. If there is a problem, the controller will sound an audible alarm, and display one of the following error codes in the two large displays in the "PROGRAM DISPLAY" section of the controller.

Problem	Cause	Remedy
ERR 1	Internal RAM test failed.	Turn unit "off", wait one minute, turn unit back "on", if ERR 1 reappears, call the factory. The unit must be returned to the factory for repair.
ERR 2	External RAM test failed.	Turn unit "off", wait one minute, turn unit back "on", if ERR 2 reappears, call the factory. The unit must be returned to the factory for repair.
ERR 3	EEPROM Check-sum Test failed.	Turn unit "off", wait one minute, turn unit back "on", if ERR 3 reappears, call the factory. The unit must be returned to the factory for repair.
ERR 4	Real Time Clock Test failed.	Turn unit "off", wait one minute, turn unit back "on", if ERR 4 reappears, call the factory. The unit must be returned to the factory for repair.
ERR 5	This test will fail if both thermocouples are NOT attached to the controller, when it is turned ON.	Turn unit OFF. Check all thermocouple connections. Turn unit ON.
ERR 6	Non-volatile RAM Test failed. (This could appear in a low voltage, or "brown-out" situation.)	Wait, unit will clear itself. All user programmed memory must be reprogrammed. Factory-set programs will not be lost.
ERR 7	This is the result of an electrical disturbance.	Turn unit "off", wait one minute, turn unit back "on", if ERR 7 reappears, call the factory. The unit must be returned to the factory for repair.

5.3 Troubleshooting Chart - Freezing Chamber

Problem	Probable Cause	Remedy
Nitrogen continually enters the freezing chamber	Controller is improperly set or is malfunctioning.	Reset/repair controller.
	Solenoid valve is stuck in the "open" position.	Repair/replace solenoid.
	Liquid nitrogen supply pressure is above 22 PSIG	Adjust LN2 supply pressure to 22 PSIG
Liquid nitrogen will not enter freezing chamber.	Liquid nitrogen service supply valve is shut.	Open liquid nitrogen service supply valve.
	Power signal, connectors are not properly, or completely, installed.	Check for proper connections.
	Solenoid valve is faulty.	Repair/replace solenoid valve.
	Controller is faulty.	Repair faulty controller.
	Liquid supply empty.	
	Low pressure supply.	
Uneven cooling in freezer chamber.	Freezing rate is improperly set.	Refer to Section 4, for freezing rate information.
	Fan has not been energized at the controller.	

5.3 Troubleshooting Chart - Freezing Chamber (continued)

Problem	Probable Cause	Remedy
Fan is not operating.	Faulty limit switch.	Replace switch.
	Fan has not been energized at the controller.	Energize fan at controller.
	Fan is jammed or motor is defective.	Mechanically free fan and/or replace fan motor.
Inability to sufficiently cool specimens.	LN2 transfer hose connected to vent side of supply tank.	Connect transfer hose to liquid side of supply tank.
	Controller is improperly set.	Readjust controller setting (add Cool+).
	Insufficient liquid nitrogen pressure at freezing chamber.	Increase liquid nitrogen supply pressure to 22 PSIG as measured at the freezing chamber.
	Defective limit switch.	Replace limit switch.
Nitrogen gas is escaping from pressure relief valve at rear of freezing chamber.	Liquid nitrogen pressure supply is too high.	Reduce liquid nitrogen pressure to 22 PSIG.
	Pressure relief valve is defective.	Replace pressure relief valve.
Heater in freezing chamber does not operate.	Heater has not been energized at controller.	Energize heater.
	Element is faulty.	Replace faulty heating element.
	Heater relay is faulty.	Replace faulty heater relay.
	Wiring connections are faulty.	Check wiring harness for proper connector seating at controller.

Section 6 - Specifications

6.1 Model 8018 - Controller Specifications

Dimensions	14”W x 6”H* x 9” F-B (35.6cm x 15.2cm x 22.9cm) *Add 7” (18cm) for stand
Weight	20 lbs (9 kg)
Electrical	95-125VAC, 50/60Hz, 2 FLA (190-250VAC, 50/60Hz)
Temperature range	+50°C to -180°C (+122°F to -290°F)
Rates	.01°C per minute to 99.9°C/minute
Hold times	1 minute to 999 minutes
Error Limits	
Time	1 second to 999 minutes
Temperature	1°C to 180°C (34°F to -290°F)

6.2 Chamber Specifications

	8022 (8023)	8024 (8025)	8026 (8027)
External dimensions	10”W x 14.25H x 15.25 F-B (25.4cm x 36.2cm x 38.7cm)	17.75”W x 16.365H x 16.5” F-B (45cm x 40.7cm x 41.9cm)	24.5”W x 18”H x 13” F-B (62.2cm x 45.7cm x 50.8cm)
Internal dimensions	6” x 11.38H x 5” F-B (15.2cm x 28.9cm x 12.7cm)	9”W x 12”H x 9” F-B (22.9cm x 30.5cm x 22.9cm)	13”W x 13”H x 13” F-B (33cm x 33cm x 33cm)
Volume	353 cu. in.	972 cu. in.	2197 cu. in.
Weight	30 lbs (13 kg)	51 lbs (23 kg)	90 lbs (41 kg)
Electrical (supplied by controller)			
95-125VAC, 50/60 Hz (190-250VAC, 50/60 Hz)	Same	Same	

	8022 (8023)	8024 (8025)	8026 (8027)
Fan			
Diameter	4” (10.2cm)	8” (20cm)	8” (20.3cm)
# of wings	4	5	5
RPM’s	2880	1550	1550
Sensing element	Mounted chamber thermocouple Type T		
Flexible	Sample thermocouple Type T		
Utility connections	1/2” (1.3cm) 45° Flare 4 ft. (122cm) or 6 ft. (183cm) flexible hose with 1/2” (1.3cm) flared tube fittings.*		

**Connects directly to low pressure (22PSI) 180/230 liter LN2 supply tank, or available 35 and 50 liter supply tanks.*

Section 7 - Parts List

Model 8022

Stock No.	Description
4000400	Transfer Hose, 4 Ft.
100085	Fan Blade, 5”, CW
103035	Gasket, Silicone, P-Style, 6x6 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156067	Fan Motor, 1/50 HP, 1550 RPM
189802	Strike Plate, Teflon
250093	Solenoid, Brass, 1/4 FPT, 120V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Pushbutton, SPST, MOM-NO
230066	Fuse, Ceramic, 10A, 250V
300245	Relay, Quick Connect, SPDT
4000381	Thermocouple Sensor, Sample, 2Ml

Model 8023

Stock No.	Description
4000400	Transfer Hose, 4 Ft.
100085	Fan Blade, 5”, CW
103035	Gasket, Silicone, P-Style, 6x6 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156083	Fan Motor, 1/80 HP, 1500 SP 3.3
189802	Strike Plate, Teflon
250094	Solenoid, Brass, 1/4 FPT, 220V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Push-button, SPST, MOM-NO
230093	Fuse, Ceramic, 5A, 250V
300245	Relay, Quick Connect, SPDT
4000381	Thermocouple Sensor, Sample, 2Ml

Model 8024

Stock No.	Description
4000400	Transfer Hose, 4 Ft.
100080	Fan Blade, 8”, CW
103036	Gasket, Silicone, P-Style, 12x11 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156067	Fan Motor, 1/50 HP, 1550 RPM
189801	Strike Plate, Teflon
250093	Solenoid, Brass, 1/4 FPT, 120V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Push-button, SPST, MOM-NO
230066	Fuse, Ceramic, 10A, 250V
300245	Relay, Quick Connect, SPDT
4000385	Thermocouple Sensor, Sample, 2Ml

Model 8025

Stock No.	Description
4000400	Transfer Hose, 4 Ft.
100080	Fan Blade, 8”, CW
103036	Gasket, Silicone, P-Style, 12x11 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156083	Fan Motor, 1/80 HP, 1500 SP 3.3
189801	Strike Plate, Teflon
250094	Solenoid, Brass, 1/4 FPT, 220V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Push-button, SPST, MOM-NO
230093	Fuse, Ceramic, 5A, 250V
300245	Relay, Quick Connect, SPDT
4000385	Thermocouple Sensor, Sample, 2Ml

Model 8026

Stock No.	Description
4000401	Transfer Hose, 6 Ft.
100080	Fan Blade, 8”, CW
103037	Gasket, Silicone, P-Style, 16x13 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156067	Fan Motor, 1/50 HP, 1550 RPM
189801	Strike Plate, Teflon
250093	Solenoid, Brass, 1/4 FPT, 120V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Push-button, SPST, MOM-NO
230066	Fuse, Ceramic, 10A, 250V
300245	Relay, Quick Connect, SPDT
4000385	Thermocouple Sensor, Sample, 2Ml

Model 8027

Stock No.	Description
4000401	Transfer Hose, 6 Ft.
100080	Fan Blade, 8”, CW
103037	Gasket, Silicone, P-Style, 16x13 ID
121047	Latch Handle, Freezing Chamber
121048	Cam Latch, Freezing Chamber
156083	Fan Motor, 1/80 HP, 1500 SP 3.3
189801	Strike Plate, Teflon
250094	Solenoid, Brass, 1/4 FPT, 220V, NC
251004	Pressure Relief Valve, 1/4 MPT
360193	Switch, Push-button, SPST, MOM-NO
230093	Fuse, Ceramic, 5A, 250V
300245	Relay, Quick Connect, SPDT
4000385	Thermocouple Sensor, Sample, 2Ml

THERMO FORMA STANDARD PRODUCT WARRANTY

The Warranty Period starts two weeks from the date your equipment is shipped from our facility. This allows for shipping time so the warranty will go into effect at approximately the same time your equipment is delivered. The warranty protection extends to any subsequent owner during the first year warranty period.

During the first year, component parts proven to be defective in materials or workmanship will be repaired or replaced at Thermo Forma's expense, labor included. Installation and calibration are not covered by this warranty agreement. The Thermo Forma Service Department must be contacted for warranty determination and direction prior to performance of any repairs. Expendable items, glass, filters and gaskets are excluded from this warranty.

Replacement or repair of components parts or equipment under this warranty shall not extend the warranty to either the equipment or to the component part beyond the original warranty period. The Thermo Forma Service Department must give prior approval for return of any components or equipment. At Thermo Forma's option, all defective parts must be returned to Thermo Forma postage paid and replacement parts are shipped FOB destination.

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Your local Thermo Forma Sales Office is ready to help with comprehensive site preparation information before your equipment arrives. Printed instruction manuals carefully detail equipment installation, operation and preventive maintenance.

If equipment service is required, please call your Thermo Forma Service Office at 1-888-213-1790 (USA and Canada) or 1-740-373-4763. We're ready to answer your questions on equipment warranty, operation, maintenance, service and special application. Outside the USA, contact your local distributor for warranty information.

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