MODEL 1720
DUAL LIQUID LEVEL INSTRUMENT

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

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FOREWORD

PURPOSE AND SCOPE

This manual contains the operation and maintenance instructions for the American Magnetics, Inc. Model 1720 Dual Liquid Level Control Instrument and outlines applications for various system configurations. Since it is not possible to cover all equipment combinations for all systems, only the most common configurations are discussed. The customer is encouraged to contact an authorized AMI Technical Support Representative for information regarding specific configurations not explicitly covered in this manual.

CONTENTS OF THIS MANUAL

Introduction describes the functions, specifications, and characteristics of the Model 1720 Instrument. It provides illustrations of the front and rear panel layouts as well as documenting the performance specifications. Additional information is provided in the form of system block diagrams.

Installation describes how the Model 1720 Instrument is unpacked and installed in conjunction with ancillary equipment in typical systems. Block-level diagrams document the interconnects for various system configurations.

Operation describes how the Model 1720 Instrument is used to monitor and automatically control liquid nitrogen levels.

Calibration describes the various calibration techniques for liquid nitrogen level sensors.

Remote Interface Reference documents all remote commands and queries available through the Model 1720 Instrument RS-232 and Ethernet interfaces. A quick-reference summary of commands is provided as well as a detailed description of each.

The ***Appendix*** and ***Glossary*** sections support the information in the sections listed above. See the Appendix section when referenced from other sections. See the Glossary for any words or acronyms presented in the above sections, requiring a more complete understanding.

GENERAL PRECAUTIONS

Cryogen Safety

One of the most common cryogenic liquids used is nitrogen. Liquid nitrogen is extremely cold at atmospheric pressure (–321°F). The following paragraphs outline safe handling precautions for cyrogenic liquids.

Personnel handling cryogenic liquids should be thoroughly instructed and trained as to the nature of the liquids. Training is essential to minimize accidental spilling. Due to the low temperature of these materials, a cryogen spilled on many objects or surfaces may damage the surface or cause the object to shatter, often in an explosive manner.

Inert gases released into a confined or inadequately ventilated space can displace sufficient oxygen to make the local atmosphere incapable of sustaining life. Liquefied gases are potentially extreme suffocation hazards since a small amount of liquid will vaporize and yield a very large volume of oxygen-displacing gas. Always ensure the location where the cryogen is used is well ventilated. Breathing air with insufficient oxygen content may cause unconsciousness without warning. If a space is suspect, purge the space completely with air and test before entry. If this is not possible, wear a forced-air respirator and enter only with a co-worker standing by wearing a forced-air respirator.

Cryogenic liquids, due to their extremely low temperatures, will also burn the skin in a similar manner as would hot liquids. Never permit cryogenic liquids to come into contact with the skin or allow liquid nitrogen to soak clothing. Serious burns may result from careless handling. Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures. The vapors expelled during the venting process are sufficiently cold to burn flesh or freeze optic tissues. Insulated gloves should be used to prevent frost-bite when operating valves on cryogenic tanks. Be cautious with valves on cryogenic

systems; the temperature extremes they are typically subjected to cause seals to fail frequently.

In the event a person is burned by a cryogen or material cooled to cryogenic temperatures, the following first aid treatment should be given pending the arrival and treatment of a physician or other medical care worker:

1. If any cryogenic liquid contacts the skin or eyes, immediately flush the affected area gently with tepid water (102°F – 105°F, 38.9°C – 40.5°C) and then apply cold compresses.

2. Do not apply heat. Loosen any clothing that may restrict circulation. Apply a sterile protective dressing to the affected area.

3. If the skin is blistered or there is any chance that the eyes have been affected, get the patient immediately to a physician for treatment.

Containers of cryogenic liquids are self pressurizing (as the liquid boils off, vapor pressure increases). Hoses or lines used to transfer these liquids should never be sealed at both ends (i.e. by closing valves at both ends).

When pouring cryogenic liquids from one container to another, the receiving container should be cooled gradually to prevent damage by thermal shock. The liquid should be poured slowly to avoid spattering due to rapid boil off. The receiving vessel should be vented during the transfer.

Introduction of a substance at or near room temperature into a cryogenic liquid should be done with great caution. There may be a violent gas boil-off and a considerable amount of splashing as a result of this rapid boiling. There is also a chance that the material may crack or catastrophically fail due to forces caused by large differences in thermal contraction of different regions of the material. Personnel engaged in this type of activity should be instructed concerning this hazard and should always wear a full face shield and protective clothing. If severe spraying or splashing could occur, safety glasses or chemical goggles along with body length protective aprons will provide additional protection.

The properties of many materials at extremely low temperatures may be quite different from the properties that these same materials exhibit at room temperatures. Exercise extreme care when handling materials cooled to cryogenic temperatures until the properties of these materials under these conditions are known.

Metals to be used for use in cryogenic equipment application must posses sufficient physical properties at these low temperatures. Since ordinary carbon steels, and to somewhat a lesser extent, alloy steels, lose much of their ductility at low temperatures, they are considered unsatisfactory and sometimes unsafe for these applications. The

austinetic Ni-Cr alloys exhibit good ductility at these low temperatures and the most widely used is 18-8 stainless steel. Copper, Monel®, brass and aluminum are also considered satisfactory materials for cryogenic service.

CRYOGEN SAFETY SUMMARY

Cryogenic systems are complex systems with the potential to seriously injure personnel or equipment if not operated according to procedures. The use of safety mechanisms (pressure relief valves, rupture disks, etc.) in cryogenic systems is usually necessary.

Recommended Safety Equipment

The use of proper safety equipment is necessary. Such equipment may include, but not limited to, the following items:

- First Aid kit
- Fire extinguisher rated for class C fires
- Cryogenic gloves
- Face shield
- Signs to indicate that there are potentially dangerous cryogens in use in the area.

SAFETY LEGEND

Instruction manual symbol: the product is marked with this symbol when it is necessary to refer to the instruction manual in order to protect against damage to the product or personal injury.

Hazardous voltage symbol.

~ Alternating Current (Refer to IEC 417, No. 5032).

o Off (Supply) (Refer to IEC 417, No. 5008).

I On (Supply) (Refer to IEC 417, No. 5007).

WARNING **The Warning sign denotes a hazard. It calls attention to a procedure or practice, which if not correctly adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.**

CAUTION **The Caution sign denotes a hazard. It calls attention to an operating procedure or practice, which if not adhered to, could cause damage or destruction of a part or all of the product. Do not proceed beyond a Caution sign until the indicated conditions are fully understood and met.**

EQUIPMENT WARNINGS

Before energizing the equipment, the earth ground of the power receptacle must be verified to be at earth potential and able to carry the rated current of the power circuit. Using extension cords should be avoided. However, if an extension cord must be used, insure the ground conductor is intact and the cord is capable of carrying the rated current without excessive voltage drop.

In the event that the ground path becomes less than sufficient to carry the rated current of the power circuit, the equipment should be disconnected from power, labeled as unsafe, and removed from place of operation.

Do not operate this equipment in the presence of flammable gases. Doing so could result in a life-threatening explosion.

Do not modify this equipment in any way. If component replacement is required, return the equipment to AMI facilities as described in the troubleshooting section of this manual.

If used in a manner not specified in this manual, the protection provided by the design, manufacture and documentation of the Model 1720 Instrument may be impaired.

OTHER MANUAL CONVENTIONS

This manual may often refer to measuring liquid nitrogen (LN_2) when referring to capacitance-based level measurement since nitrogen is by far the most common cryogenic liquid measured by a capacitance-based sensor. The capacitance sensor technology can be used to measure most any cryogenic liquid, with the exception of liquid helium (LHe) which requires a superconductor-based sensor.

INTRODUCTION

MODEL 1720 INSTRUMENT

The AMI Model 1720 Liquid Level Instrument is a sophisticated measurement and control instrument which provides monitoring of two capacitance-based level sensors as inputs and provides for automatic level control (autofill) based on user set parameters.

DUAL CRYOGENIC (CAPACITANCE-BASED) LIQUID LEVEL SENSORS

The Model 1720 Instrument is designed for use with up to two capacitance-based sensors for cryogenic liquids (except for helium).

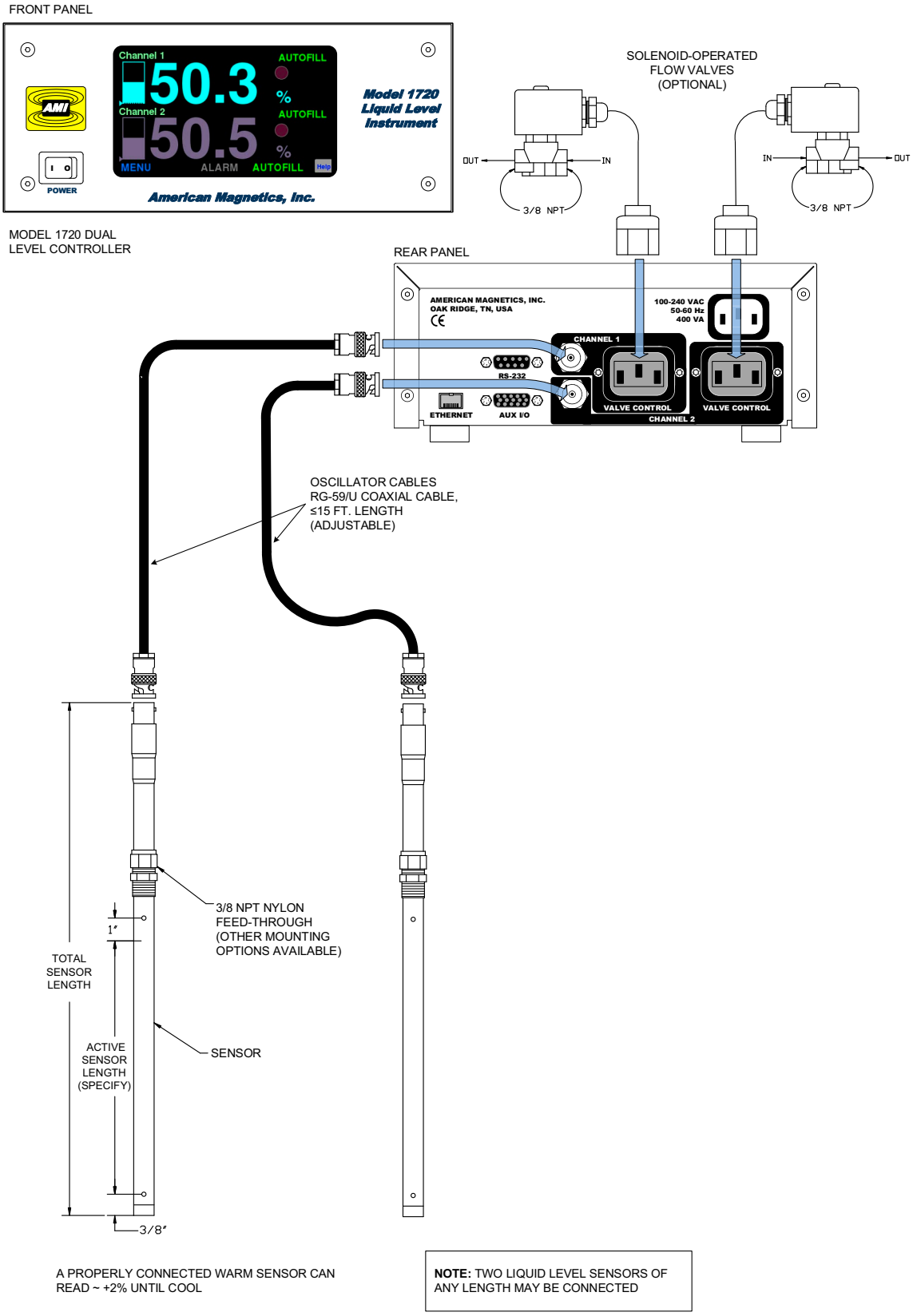
The Model 1720 Instrument must use an oscillator device to measure cryogenic liquid levels. This instrument has internal oscillators if the distance between the sensor and the instrument is less than or equal to 15 feet (457 cm) so no external oscillator is necessary. If the distance between the sensor and the instrument is greater than 15 feet, an external oscillator/transmitter unit is necessary. The instrument will automatically configure itself at boot time to use the internal oscillator unless the external oscillator/transmitter is connected to the BNC connector on the rear panel.

DIGITALLY-CONTROLLED

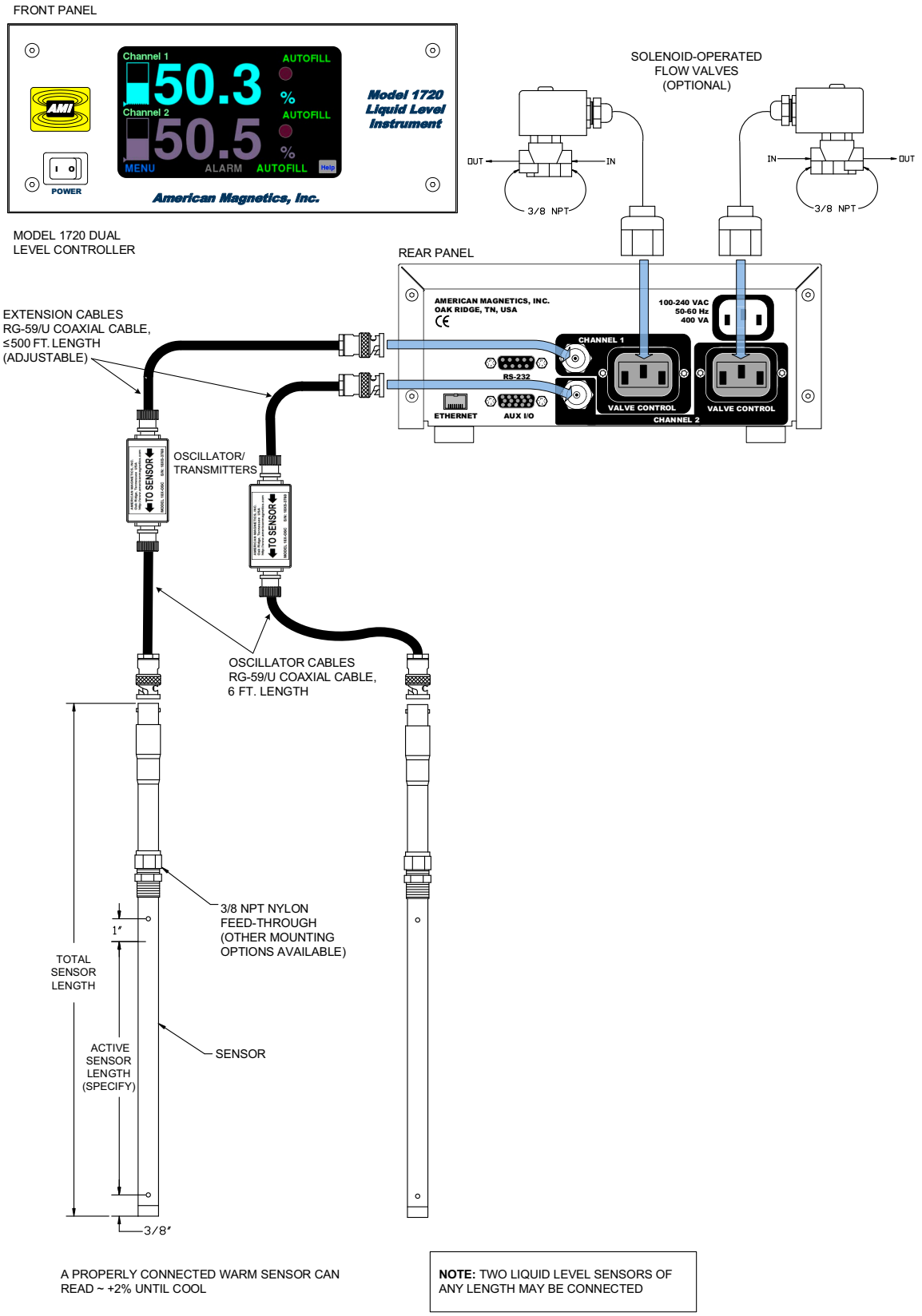
The Model 1720 contains a microcomputer which controls analog data conversion, display/keypad functions, communications I/O, dry contact closures, generation of analog output signals and relay control of a mains power outlet for solenoid valve autofill applications.

SYSTEM FLEXIBILITY

The Model 1720 instrument incorporates data converters to translate signals between the analog and digital domains. Precision instrumentation techniques and potentiometer-free designs are



Model 1720 System Diagram using *internal* oscillator/transmitter



Model 1720 System Diagram using *external* oscillator/transmitters

employed throughout the Model 1720 Instrument to ensure long term stability and accurate signal translation for a wide range of conditions.

DISPLAY

The Model 1720 Instrument has a 4.3” diagonal measure TFT (Thin Film Transistor) color liquid crystal display of 480 x 272 pixels. The display has a 4-wire resistive touch overlay for easy operator input.

INTUITIVE HUMAN-INTERFACE DESIGN

The Model 1720 instrument is designed to simplify the touch-screen based user interface. All functions were analyzed and subsequently programmed so that the most commonly used functions are addressed with the least number of keystrokes. The menus are presented in a logical fashion so that the operation of the Model 1720 is intuitive to the user. Context-sensitive Help screens are also provided.

MEASUREMENT FLEXIBILITY

The Model 1720 can be configured to monitor and display up to two capacitance-based liquid level sensors. Set points can be assigned to control two dry-contact relay outputs. The make or break function of each relay can be set independently. Two solid-state relays allow mains power to be switched according to set points to operate a solenoid-operated valve or other load.

REAL TIME CLOCK

The Model 1720 Instrument incorporates a real time clock, which can be manually set or synchronized via NTP, with support for worldwide timezones including automatic DST adjustment.

VALVE CONTROL OUTPUT

The Model 1720 Instrument has two switched, 2 ampere at mains voltage, outputs for energizing up to two solenoid operated flow valve or other loads. The outputs are controlled by zero-crossing solid state relays.

In the *Normal* mode, each output can be configured for independent autofill operation. The fill start is triggered by a level reading. The fill is stopped by reaching a user-set level, or exceeding a maximum fill time.

ALTERNATE CONTROL MODES

In addition to the standard two-channel independent autofill configuration, term the normal mode, the Model 1720 supports *Auto-Changeover* and *Pre-Cool* control modes.

In Auto-Changeover mode, Channel 1 is assigned both valve control outputs which can switch between two source tanks for uninterrupted filling operation. When a source tank is depleted, the Model 1720 will automatically switch to the alternate tank and the depleted tank can be

removed for refill or replaced with a full tank without interrupting the fill operations.

In Pre-Cool mode, Channel 1 is assigned both valve control outputs where one valve operates as a line vent in order to “pre-cool” the fill line and minimize the introduction of vapor into the level-controlled target tank. Once the cooling time has expired, the vent valve is closed and the second valve control output opens the line to fill.

ANALOG OUTPUTS

The Model 1720 Instrument has four analog outputs, two 0-10 V_{DC} voltage outputs and two 4-20 mA_{DC} current loop outputs. The 4-20 mA_{DC} loop outputs have 1500 V_{PK} circuit isolation. The outputs can be used simultaneously. The sources for any of the analog outputs can be either one of up to two configured sensors (Channel 1 or 2). Multiple outputs can be driven from the same source, if desired.

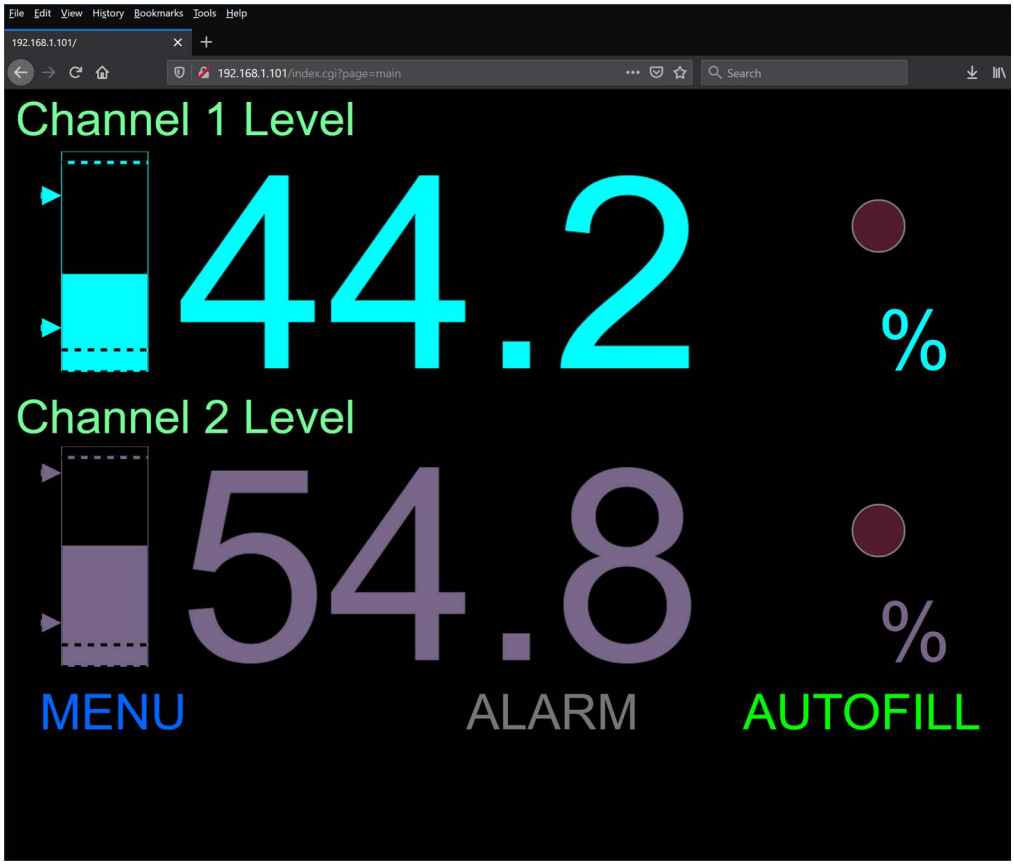
SIGNAL RELAYS

The Model 1720 Instrument has four signal relays that change state based on a measured input. The set points of these relays are user-selectable as is their function, alarm on level above or below a set point. Relays can be assigned to either channel.

CONNECTIVITY

The Model 1720 Instrument has a 10Base-T Ethernet connection as well as an RS-232 port for connecting to other equipment. The instrument communicates remotely via a SCPI-based command set. The command set is backward compatible with the AMI Model 286 instrument.

The Model 1720 Instrument allows for remote operation with an external browser via TCP/IP connection. All commands that are available by touching the local screen are available via the web browser

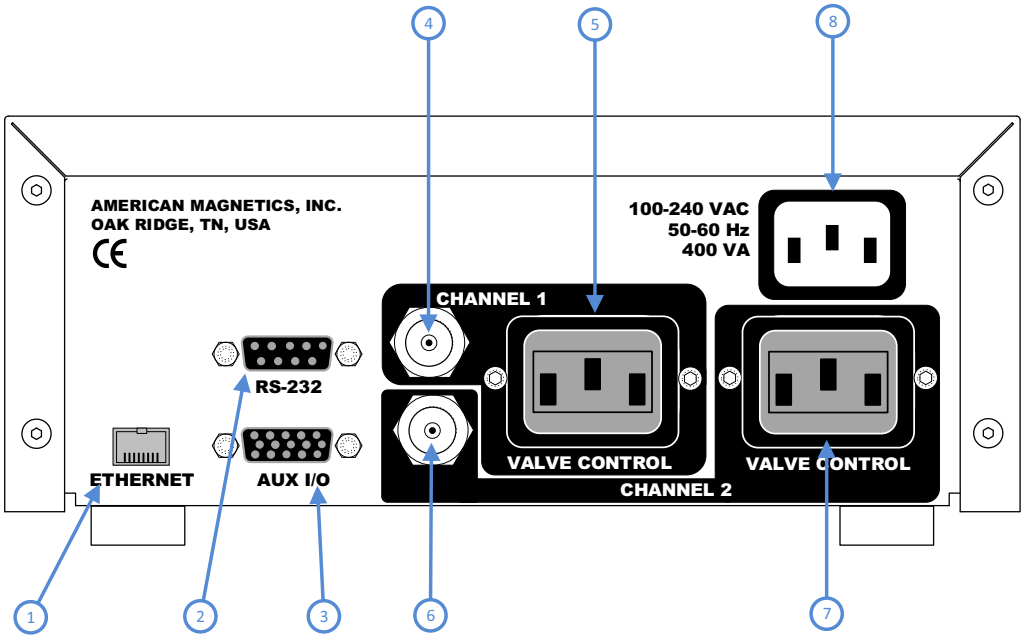


NOTE **Using a web browser to connect to the instrument allows use of a computer keyboard to enter text and numeric values which may be more convenient when making a large number of changes.**

MODEL 1720 FRONT PANEL LAYOUT

Model 1720 Front View

MODEL 1720 REAR PANEL LAYOUT



Model 1720 Rear Panel Description

1	Ethernet Network Connector (RJ-45)
2	RS-232 Serial and Contact Sense Connector (DB9 female)
3	Aux I/O Connector (HD15 female)
4	Channel 1 Capacitive Sensor Input Connector (BNC female)
5	Channel 1 Switched Valve Outlet Socket (IEC-60320 C13)
6	Channel 2 Capacitive Sensor Input Connector (BNC female)
7	Channel 2 Switched Valve Outlet Socket (IEC-60320 C13)
8	Mains Power Entry Connector (IEC-60320 C14 inlet)

MODEL 1720 SPECIFICATIONS @ 25°C

System Architecture

Display:	4.3” 24-bit color TFT display, 480x272 pixel with resistive touch screen
Sensor Types:	Capacitance-based liquid level
Maximum Length Readout:	Capacitance-based liquid level up to 999 in
System Operating Firmware Storage:	microSD card
System Clock:	Real time clock with timezone support, automatic DST adjustment, and NTP synchronization
Display Measurement Units:	Liquid level in cm, in or percent

Level Measurement

Resolution:	0.1%, 0.1 cm, 0.1 in
Accuracy:	±0.5% of active sensor length
Linearity:	±0.1% or 1 mm (whichever is greater)
Capacitance Sensor Excitation Voltage:	5 V_{DC}
Capacitance Transmitter Measurement Resolution:	0.7 pF
Maximum Measured Capacitance:	10,000 pF
Extension Cable Limits with External Oscillator:	6-500 ft

Operating Parameters

Alarm Set Points:	0% to 100%, adjustable; Alarm condition settable to above or below set point; Assignable to any channel as high or low alarm for dual instrument
Controller Outputs:	Two outputs, Line voltage @ 2 A_{AC} (maximum) each
Audible alarm:	3500 ± 500 Hz, 73 to 86 dB(A)

Analog Outputs

Output Types:	Two 0-10 V_{DC} and two 4-20 mA_{DC} simultaneous outputs (four total); Each assignable to either level channel
4-20 mA Current Loop Power Supply Voltage:	12-32 V_{DC}
0-10 V_{DC} Recorder Output Load:	50k ohms or greater
0-10 V_{DC} Recorder Output 0% Max Offset:	+20 mV
0-10 V_{DC} Recorder Output 100% Max Error:	± 80 mV
Voltage and Current Output Converter Resolution:	12 bits
Integral Non-linearity:	±1LSB
Differential Non-linearity[a]:	±1LSB

Relays	
№1, №2, №3, №4 (W171DIP-7, or equivalent):	Contact Form: 1 Form A (SPST-NO) Maximum Switched Current: 3 A Switching Voltage: 60 V_{AC} / 100 V_{DC}
Level Control (Solid State):	Rated Load Voltage: 2 A at 100 to 240 V_{AC} Load Voltage Range: 75 to 264 V_{AC} (Line Dependent) Load Current: 0.1 to 2 A Surge Current: 30 A (60 Hz, 1 cycle)
Auto Fill	
Controller Output Sockets:	IEC 60320-13 sockets on rear panel
Controller Output Power:	2 A_{AC} at line voltage for each socket
Controller Modes:	Normal (dual channels), Autochangeover, and Precool
Autofill Start/Stop Triggering:	Level-based; 0% to 100%, adjustable
Fill Timeout Period:	1 minute to 99 hours, 59 minutes
Fill Error Alarm:	Fill timeout or Contact Sense (contact sense for Autochangeover mode only)
Communication Protocol	
Host Computer Network Protocol:	Ethernet 10Base-T TCP/IP and RS-232
IP Addressing:	DHCP or static, IPv4
Network Connectivity and Traffic Indication:	Link and Activity LEDs on instrument rear panel
RS-232 Connector Specifications:	9-pin D-sub female connector to connect standard DTE 9-pin D-sub male connector using a standard straight cable
Communication Command Set:	SCPI-based. Backward compatible with the Model 286 instrument.
Power Requirements	
Primary:	100-240 ±10% V_{AC}, 50-60 Hz, 2.2 A maximum (200 VA plus sum of controller output)
Backup Battery for RTC:	CR2032
Physical	
Dimensions[b]:	Table top configuration: 3.8” H x 8.4” W x 11.4” D [97 mm H x 213 mm W x 290 mm D] Single rack mount configuration: 3.5” H x 19.0” W x 11.4” D [89 mm H x 483 mm W x 290 mm D]
Weight:	Table-top configuration: 3.3 lbm [1.5 kG]; Single rack-mount configuration: 4.0 lbm [1.8 kG]

Environmental Limits

Ambient Temperature:	Operating: 0°C to 40°C [32°F to 104°F]; Non-operating: -20 °C to 60 °C [-4 °F to 140 °F]
Relative Humidity:	0 to 95%; non-condensing
Maximum Instrument Background Field:	Gauss (TBD)

Standards

Test Standards	Testing of Equipment for Measurement, Control, and Laboratory Use (IEC 61326-1:2012, EN 61326-1)
	Electrostatic Discharge (ESD) (EN 61000-4-2)
	Radiated Immunity (EN 61000-4-3)
	Fast Transient Burst (EN 61000-4-4)
	Surges (EN 61000-4-5)
	Conducted Immunity (EN 61000-4-6)
	Power Frequency Magnetic Field (EN 61000-4-8)
	Voltage Dips and Interrupts (EN 61000-4-11)
	Harmonics (EN 61000-3-2)
	Flicker (EN 6100-3-3)
	Conducted Emissions (EN 55011/IEC/CISPR 11)
	Radiated Emissions (EN 55011/IEC/CISPR 11)
	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use (IEC 61010-1)

a. Guaranteed monotonic over operating temperature range

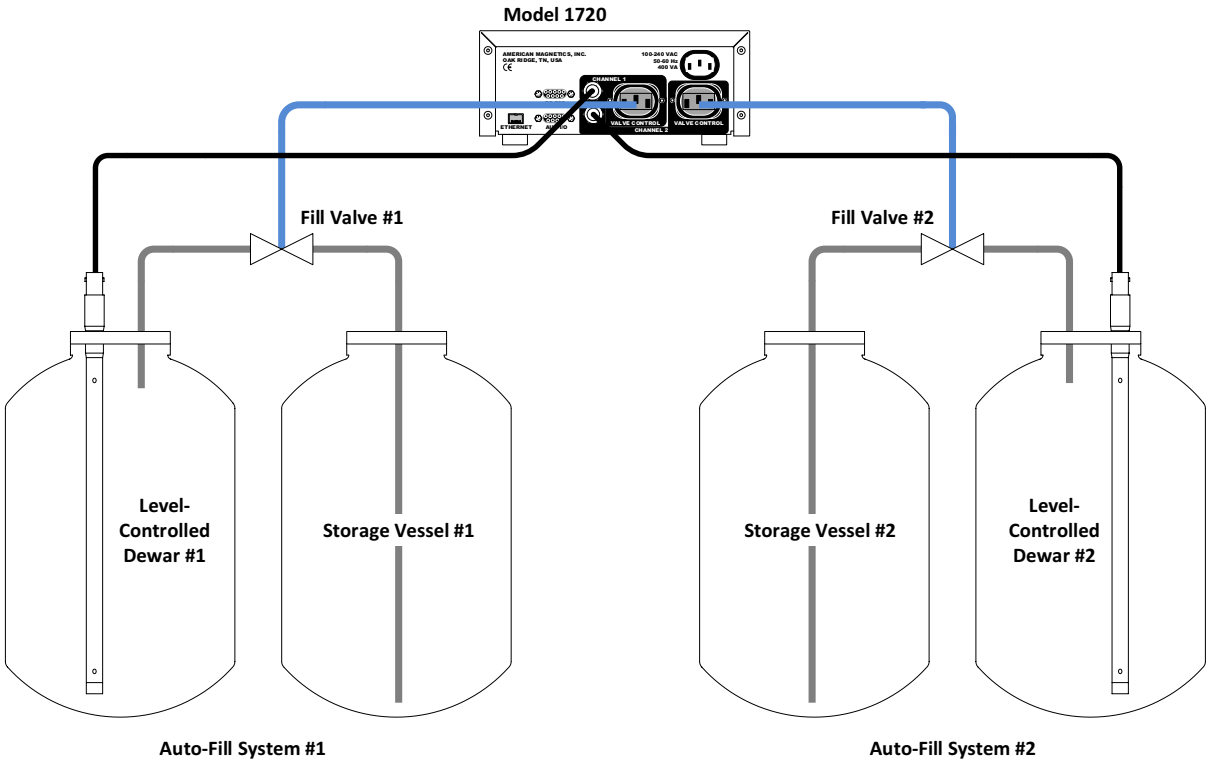
b. H = height; W = width; D = depth

CONTROLLER MODES DESCRIPTION

The Model 1720 provides a unique feature in the availability of three modes for level control. The function of each mode is summarized below and a diagram is provided to help illustrate the function. The controller modes provide flexibility for solving a wide range of level control problems with a minimum of external hardware or logic.

NORMAL MODE

In the normal mode, as shown in the figure below, Channels 1 and 2 of the Model 1720 act as independent auto-fill systems. As each level falls below the "Fill Start" setpoint, an independent fill cycle is initiated and fills the controlled dewar to the "Fill Stop" setpoint via two separate solid-state-relay-controlled AC outputs which can drive solenoid-actuated valves. The fill start and stop setpoints for Channels 1 and 2 operate as independent liquid level control bands.

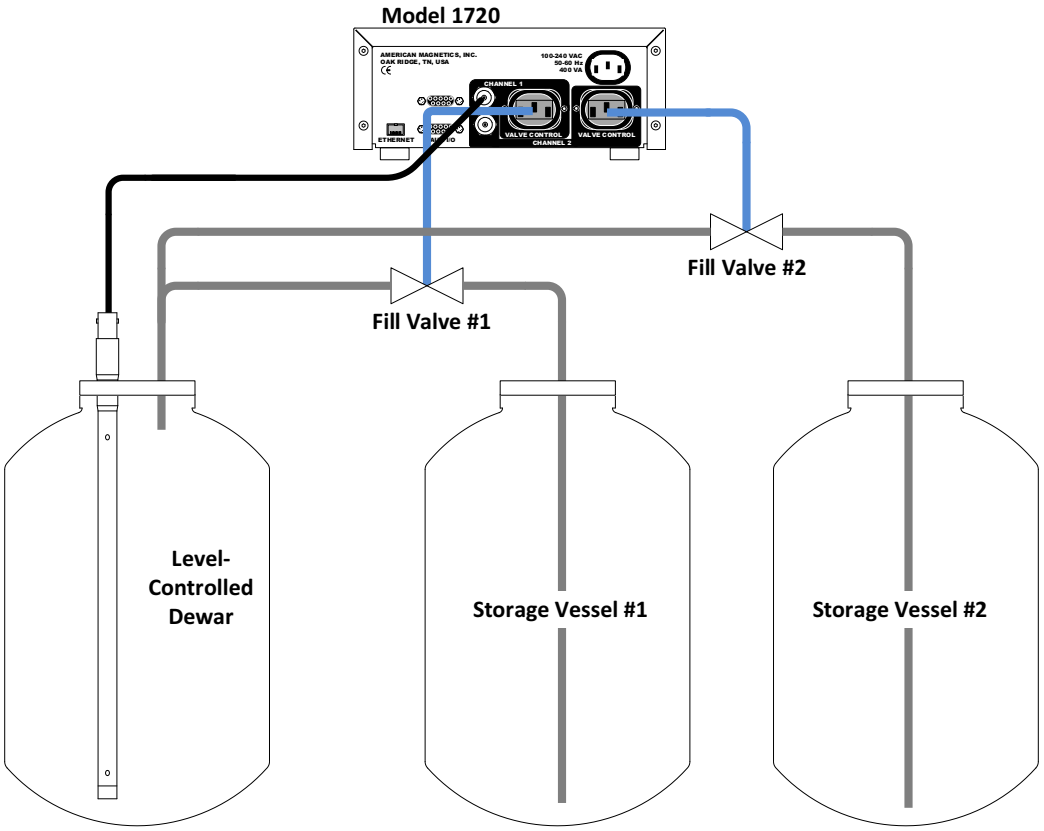


Normal mode diagram illustrating two *independent* auto-fill systems.

AUTO-CHANGEOVER MODE

In auto-changeover mode, as illustrated in the figure below, the Model 1720 monitors and controls liquid level measured via Channel 1, and uses liquid supplied from two storage vessels. The fill start and stop setpoints for Channel 1 function as the liquid level control band for the single level-controlled dewar. The dual AC outputs control a fill valve for each of the two storage vessels. Channel 2 level measurement is unavailable in the auto-changeover mode.

The instrument either monitors dry contacts to determine availability of liquid from each of the two storage vessels or determines availability by fill timeouts. The Model 1720 automatically switches from one storage vessel to the next. This allows one of the two storage vessels to be replaced when empty without interrupting the availability of liquid to the level-controlled dewar.

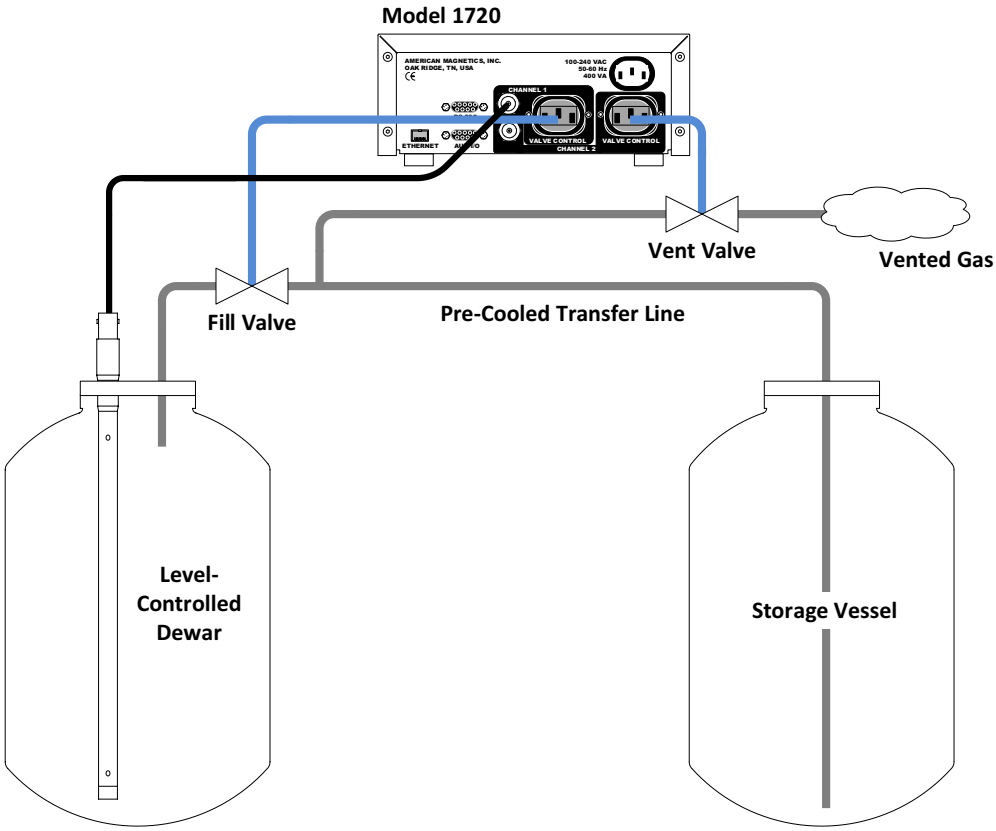


Auto-changeover mode diagram illustrating two storage vessels and one level-controlled dewar.

PRE-COOL MODE

The pre-cool mode, as illustrated in the figure below, provides for cooling of a cryogen transfer line before opening the transfer line to the controlled dewar. The fill start and stop setpoints for Channel 1 function as the liquid level control band for the single level-controlled dewar. AC Output 1 controls a fill valve for the controlled dewar, while AC Output 2 controls a vent valve. Channel 2 level measurement is unavailable in the pre-cool mode.

When a fill cycle is initiated, the vent valve is initially opened for a user-programmed time, after which the vent valve is closed and the fill valve to the level-controlled dewar is opened. During the time the vent valve is open, the cryogen cools the transfer line, so that there is a minimal amount of cryogen gas entering the controlled dewar once the fill valve is opened.



Pre-cool mode diagram illustrating one storage vessel, a vent valve, and one level-controlled dewar.

INSTALLATION

WARNING **Equipment warnings apply to all system installation configurations. Refer to "Equipment Warnings" on page xi, in the Foreword to be familiar with the safety requirements for a system installation.**

UNPACKING AND INSPECTING THE INSTRUMENT

Carefully remove the equipment, interconnecting cabling, and documentation from the shipping carton, and remove all packaging material.

NOTE **If there is any shipping damage, save all packing material and contact the shipping company representative to file a damage claim. Do not return to AMI unless prior authorization has been received.**

MOUNTING THE MODEL 1720 INSTRUMENT

If the Model 1720 Instrument is to be used as a table top model, place the equipment on a flat, secure surface.

If the Model 1720 Instrument is to be rack mounted, install it in a 19" wide instrument rack using the mounting hardware supplied by the rack cabinet manufacturer. The feet on the bottom of the instrument may be removed to facilitate rack mounting by using a prying device to remove the glossy black cap from the center of the foot and then prying the rubber foot itself from the chassis. Secure the front panel to the rack rail in each of the four corners.

CAPACITANCE-BASED LIQUID LEVEL SENSOR INSTALLATION

Refer to the installation instructions provided with the level sensor(s). The following steps are general installation notes and should be used to supplement the installation instructions provided with the sensor.

Exercise care when installing the capacitance sensor since dents, crimps, bends or other physical distortions in the cylindrical capacitor will change electrical characteristics, possibly causing calibration errors and/or disruption of proper instrument operation. Before installing the sensor, review “Calibration” on page 71 to determine what, if any, calibration procedures may be necessary prior to operation.

NOTE **The coaxial interconnecting cables and the transmitter should be located in such a manner as to avoid large temperature changes such as those encountered in the path of dewar vents.**

1. Carefully remove the sensor from the shipping container and remove all packaging material.

NOTE **If there is any shipping damage, save all packing material and contact the shipping representative to file a damage claim. Do not return the instrument to AMI unless prior authorization has been received.**

2. Install the sensor in the vessel using the specified fitting of the sensor.

CAUTION **Ensure the sensor is mounted with the top vent hole located inside of the cryostat.**

CAUTION **Avoid installing in a location where icing may occur. Ice formations or moisture buildup on the BNC connector may cause the sensor to short out indicating a higher liquid level than actually exists.**

CAUTION **Moisture or contaminants in any of the BNC coaxial connectors can short out the sensor and cause measurement errors. A pack of non-conductive electrical connection lubricant (ECL or “Dielectric Tune-up Grease”) has been included with the liquid level sensor packaging to reduce the possibility of this occurring. If desired, apply a small amount of ECL to any of the BNC connectors that may be exposed to moisture. Mate the ECL-coated connectors**

then remove any excess ECL from the outside of the connector. Added protection can be achieved by covering the ECL-coated connections with a short section of heat-shrink tubing.

MSDS sheets for the ECL are available upon request.

CAUTION **Exercise care when installing the sensor since dents, crimps, bends or other physical distortions in the thin wall capacitor will change electrical characteristics possibly causing calibration errors and/or disruption of proper instrument operation.**

CONNECTING THE CAPACITANCE SENSOR

The capacitance sensor may be connected directly to the BNC connector on the instrument rear panel if the length of the coaxial cable is 15 feet or less. If the sensor is greater than 15 feet from the instrument, an external oscillator/transmitter unit must be used. Refer to figures “Model 1720 System Diagram using internal oscillator/transmitter” on page 2 and “Model 1720 System Diagram using external oscillator/transmitter” on page 3 as appropriate.

If the transmitter is connected to the sensor with a length of coaxial cable, then a 15 ft standard length cable (part number EH2362) is available from AMI. Contact the factory for more details and speak to an Authorized AMI Technical Representative before using cables longer than 15 feet.

NOTE **In order to maintain system performance and accuracy, the coaxial cable used to connect the capacitance level sensor to the instrument or oscillator/transmitter must be RG-59/U or equivalent[1] and should not be longer than 15 feet [4.57 m]. If a longer length section of coaxial cable is necessary, please discuss with an Authorized AMI Technical Representative.**

NOTE **If an external oscillator/transmitter is used, the length of coaxial cable between the oscillator/transmitter and the instrument may be up to 500 feet in length.**

1. Essential Specifications: Characteristic Impedance: 75 ohms, Dielectric Material: Foamed PE, Maximum Capacitance: 17.3 pF/ft

CAUTION **Moisture or contaminants in any of the BNC coaxial connectors can short out the sensor and cause an erroneous readings or transmitter failure. A pack of non-conductive electrical connection lubricant (ECL or "Dielectric Tune-up Grease") has been included with the liquid level sensor packaging to reduce the possibility of this occurring.**

To connect the coaxial cable to the BNC connector on the capacitance level sensor:

1. Apply a small amount of ECL to any of the BNC connectors that may be exposed to moisture.
2. Mate the ECL-coated connectors then remove any excess ECL from the outside of the connector.
3. Cover the ECL-coated connections with a short section of heat-shrink tubing, also included, for added moisture protection.

NOTE **MSDS sheets for the ECL are available upon request.**

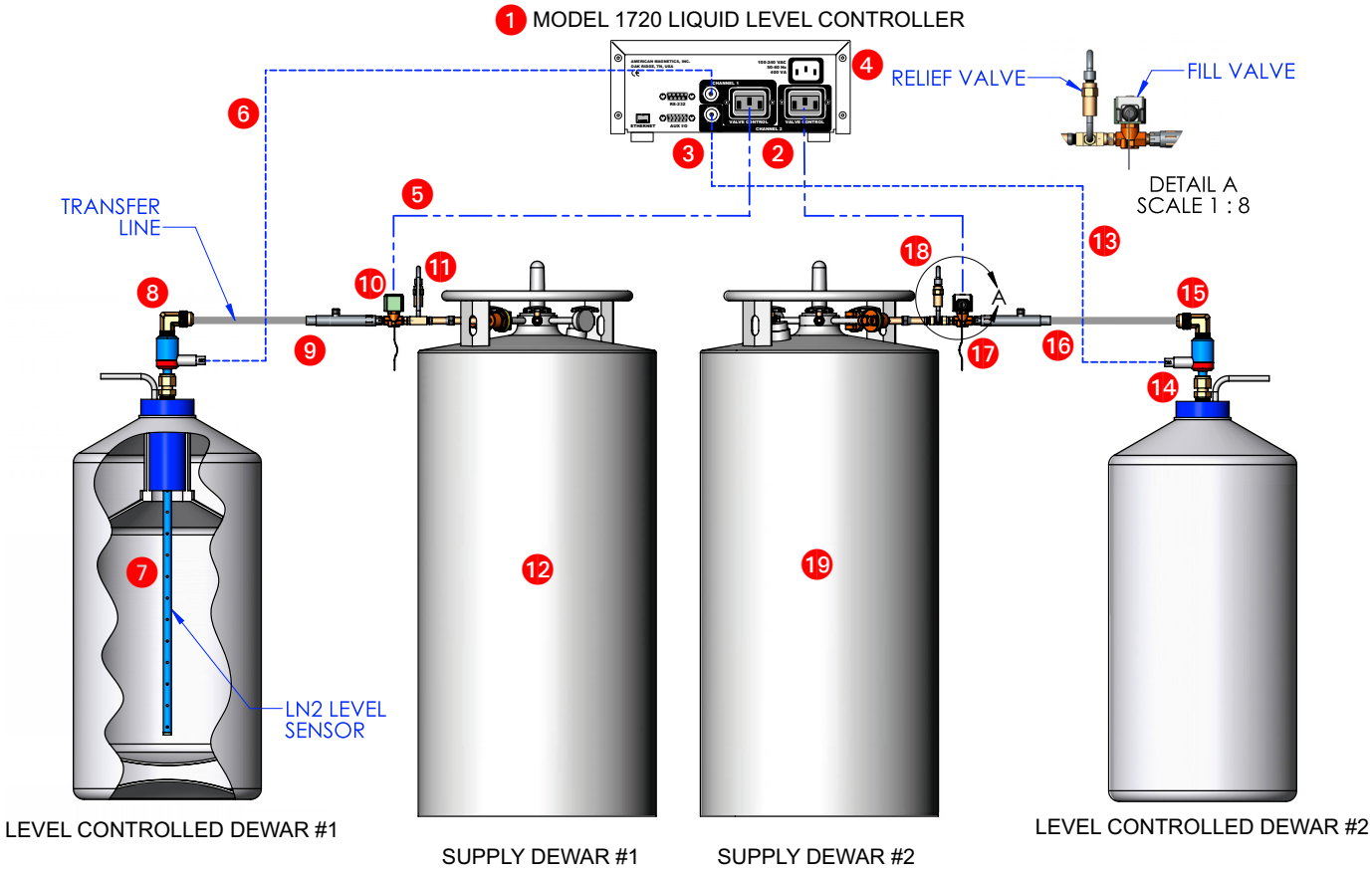
CONFIGURING AN AUTOFILL SYSTEM

Autofill systems are useful in applications where liquid level in a dewar must be maintained without operator intervention.

To create an autofill system, a cryogenic liquid source must be attached to the target or level controlled dewar via a solenoid-controlled valve. The valve should be controlled by the Model 1720 Instrument.

NORMAL DUAL-AUTOFILL SYSTEM SETUP

For the standard dual-autofill function, each channel acts independently. The system consists of a Model 1720 Instrument with two liquid level sensors, and a solenoid-operated flow valve for *each channel*. The instrument makes continuous level measurements and based on level, energizes each fill valve to begin liquid transfer. The transfer is stopped when the measured level reaches a user-determined point.



Typical Autofill Setup for Dual-Autofill Mode

Dual-Autofill Setup Description

Number	Item
1	Model 1720 Liquid Level Instrument (Level Controller)
2	IEC60320 C13 sockets labeled **VALVE CONTROL (CHANNEL 1, CHANNEL 2)**
3	BNC connectors for sensor inputs **(CHANNEL 1, CHANNEL 2)**
4	Instrument IEC60329 C14 Power cord inlet
5	Solenoid-operated flow control valve line cord with IEC60320 C14 plug
6	Coaxial cable connecting the Level Sensor in Level Controlled Dewar #1 to the **CHANNEL 1** sensor input
7	Level Sensor for Level Controlled Dewar #1
8	Fill port on Level Controlled Dewar #1
9	Transfer line attached to the target dewar and the fill solenoid valve on the Supply Dewar #1
10	Solenoid-operated fill valve for Supply Dewar #1
11	Supply Dewar #1 relief valve
12	Supply Dewar #1
13	Coaxial cable connecting the Level Sensor in Level Controlled Dewar #2 to the **CHANNEL 2** sensor input
14	Level Sensor connector for Level Controlled Dewar #2
15	Fill port on Level Controlled Dewar #2
16	Transfer line attached to the target dewar and the fill solenoid valve on the Supply Dewar #2
17	Solenoid-operated fill valve for Supply Dewar #2
18	Supply Dewar #2 relief valve
19	Supply Dewar #2

CAUTION **A relief valve must be used in autofill systems to ensure no cryogenic liquid can be trapped in a transfer line volume where expansion can cause damaging pressure. This can occur if the solenoid operated fill valve and the supply dewar isolation valve are closed, trapping a cryogenic liquid in a confined volume. All AMI transfer line systems include a relief valve to preclude this sort of event.**

CAUTION **The switched valve outlet socket switches the line voltage to which the instrument mains power is connected. Ensure any connected valve is rated to support the local VAC line voltage.**

SETUP STEPS FOR AUTOFILL CHANNEL 1:

1. Mount the level sensor 8 in the Level Controlled Dewar #1.
2. Connect the transfer line 9 and fill solenoid valve 10 or supply manifold to the Supply Dewar #1 12.
3. Connect the other end of the transfer line to the fill port 8 on the valve/manifold of the target dewar.
4. Connect the capacitance sensor to the instrument.
    a. For distances of 15 feet and less, connect the coaxial cable 6 between the BNC connector on the liquid level sensor 7 and the BNC connector on the back of the instrument labeled **CHANNEL 1** 3.
    b. For distances greater than 15 feet, insert an external oscillator/transmitter in-line with the coaxial cable 6.
5. Connect the solenoid valve 10 to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 1 VALVE CONTROL** 2.

Connect the IEC320 C14 inlet connector and instrument power cord 4 to an appropriate power source (see the Power Requirements on page 16).

SETUP STEPS FOR AUTOFILL CHANNEL 2:

1. Mount the level sensor 14 in the Level Controlled Dewar #2.
2. Connect the transfer line 16 and fill solenoid valve 17 or supply manifold to the Supply Dewar #1 19.
3. Connect the other end of the transfer line to the fill port 15 on the valve/manifold of the target dewar.
4. Connect the capacitance sensor to the instrument.
    a. For distances of 15 feet and less, connect the coaxial cable 13 between the BNC connector on the liquid level sensor 14 and the BNC connector on the back of the instrument labeled **CHANNEL 2** 3.

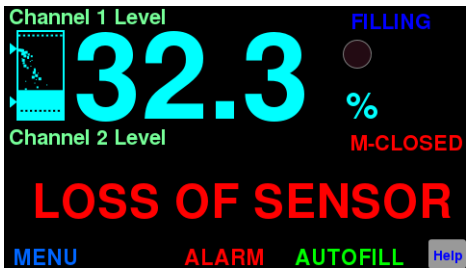
1. The valve cord connector must be IEC60320 C14 type.

b. For distances greater than 15 feet, insert an external oscillator/ transmitter in-line with the coaxial cable 13.

5. Connect the solenoid valve 17 to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 2 VALVE CONTROL** 2.

Connect the IEC320 C14 inlet connector and instrument power cord 4 to an appropriate power source (see the Power Requirements on page 16).

NOTE **Should the level sensor become disconnected from the instrument or an interconnecting cable fails for a given Autofill Channel, a LOSS OF SENSOR message will be displayed (as shown at right) and the autofill valve for the channel will be shut (M-CLOSED). When the sensor connection has been restored, the instrument will display the level but the autofill state for the channel will have to be manually changed back to AUTO-ON.**

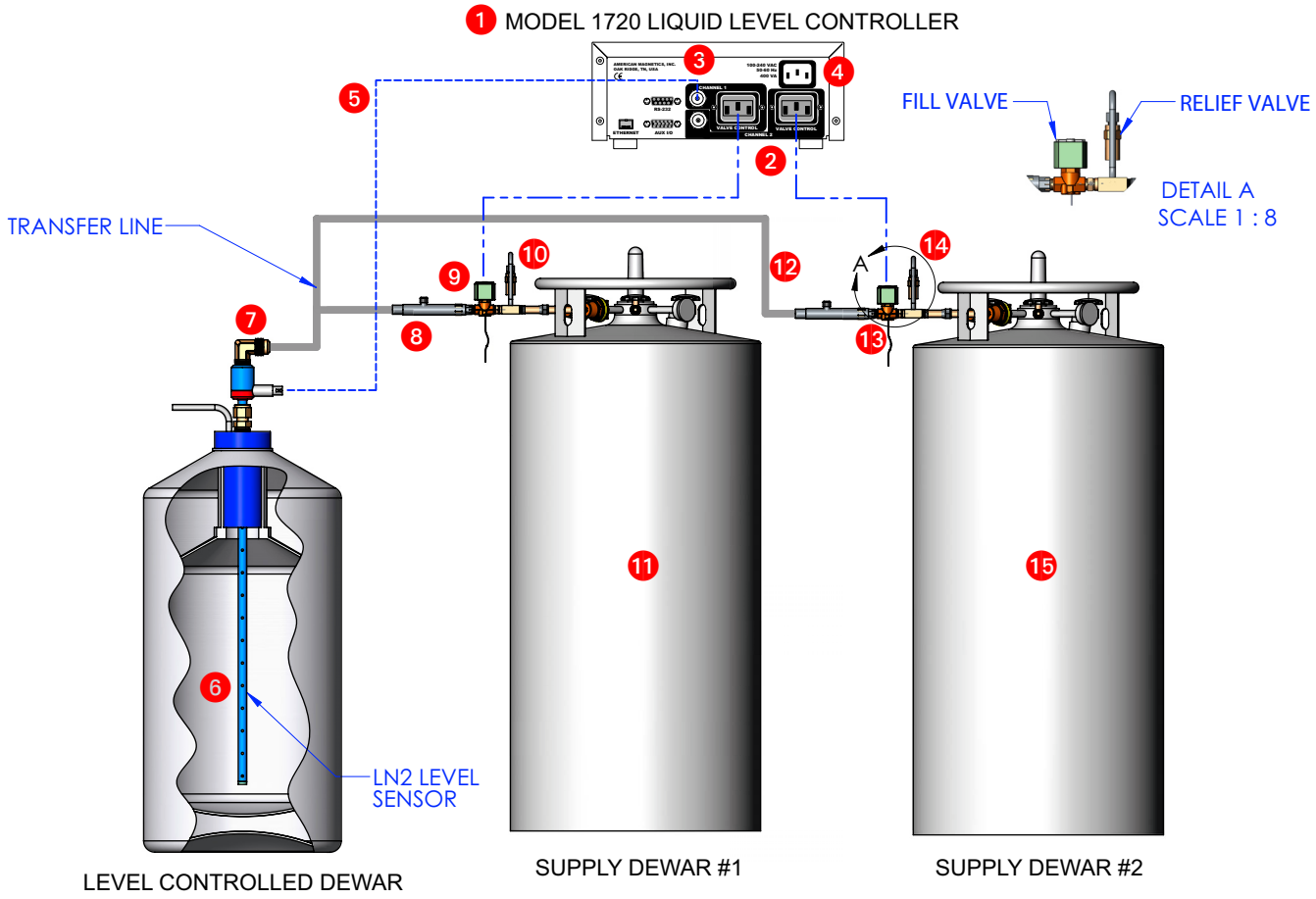


1. The valve cord connector must be IEC60320 C14 type.

AUTO-CHANGEOVER SYSTEM SETUP

For the Auto-Changeover System Setup both fill channels are utilized to maintain a single Level Controlled Dewar. The supply is alternated between the two supply dewars. When one dewar is emptied, the Model 1720 switches to the alternate dewar allowing the autofill function to proceed while the emptied dewar is refilled or replaced.

The system consists of a Model 1720 Instrument with a liquid level sensor,and a solenoid-operated flow valve for *each supply dewar*. The instrument makes continuous level measurements and based on level, energizes the selected supply dewar valve to begin liquid transfer. The transfer is stopped when the measured level in the Level Controlled Dewar reaches a user-determined point.



Typical Auto-Changeover System Setup

Auto-Changeover Setup Description

Number	Item
1	Model 1720 Liquid Level Instrument (Level Controller)
2	IEC60320 C13 sockets labeled **VALVE CONTROL (CHANNEL 1, CHANNEL 2)**
3	BNC connector for sensor input for **CHANNEL 1**
4	Instrument IEC60329 C14 Power cord inlet
5	Coaxial cable connecting the Level Sensor in Level Controlled Dewar to the **CHANNEL 1** sensor input
6	Level Sensor for Level Controlled Dewar
7	Fill port on Level Controlled Dewar
8	Transfer line attached to the target dewar and the fill solenoid valve on the Supply Dewar #1
9	Solenoid-operated fill valve for Supply Dewar #1
10	Supply Dewar #1 relief valve
11	Supply Dewar #1
12	Transfer line attached to the target dewar and the fill solenoid valve on the Supply Dewar #2
13	Solenoid-operated fill valve for Supply Dewar #2
14	Supply Dewar #2 relief valve
15	Supply Dewar #2

CAUTION **A relief valve must be used in autofill systems to ensure no cryogenic liquid can be trapped in a transfer line volume where expansion can cause damaging pressure. This can occur if the solenoid operated fill valve and the supply dewar isolation valve are closed, trapping a cryogenic liquid in a confined volume. All AMI transfer line systems include a relief valve to preclude this sort of event.**

CAUTION **The switched valve outlet socket switches the line voltage to which the instrument mains power is connected. Ensure any connected valve is rated to support the local VAC line voltage.**

SETUP STEPS FOR AUTO-CHANGEOVER SYSTEM:

1. Mount the level sensor 6 in the Level Controlled Dewar #1.

2. Connect the Supply Dewar #1 transfer line 8 and fill solenoid valve 9 or supply manifold to the Supply Dewar #1 11.

3. Connect the other end of the Supply Dewar #1 transfer line to the fill port 7 on the valve/manifold of the target dewar.

4. Connect the capacitance sensor to the instrument.

   a. For distances of 15 feet and less, connect the coaxial cable 5 between the BNC connector on the liquid level sensor 6 and the BNC connector on the back of the instrument labeled **CHANNEL 1** 3.

   b. For distances greater than 15 feet, insert an external oscillator/ transmitter in-line with the coaxial cable 5.

5. Connect the solenoid valve 9 power cord to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 1 VALVE CONTROL** 2.

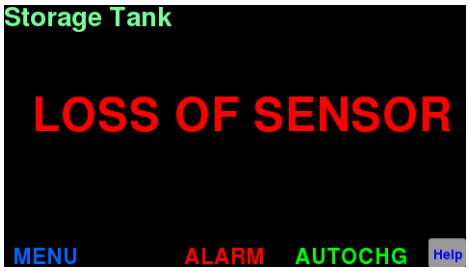
6. Connect the Supply Dewar #2 transfer line 12 and fill solenoid valve 13 or supply manifold to the Supply Dewar #2 15.

7. Connect the other end of the Supply Dewar #2 transfer line to the fill port 7 on the valve/manifold of the target dewar.

8. Connect the solenoid valve 13 power cord to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 2 VALVE CONTROL** 2.

Connect the IEC320 C14 inlet connector and instrument power cord 4 to an appropriate power source (see the Power Requirements on page 16).

NOTE **Should the level sensor become disconnected from the instrument or an interconnecting cable fails, a LOSS OF SENSOR message will be displayed (as shown at right) and the autofill valves will be shut (M-CLOSED). When the sensor connection has been restored, the instrument will display the level but the auto-changeover autofill state for the channel will have to be manually changed back to AUTO-ON.**

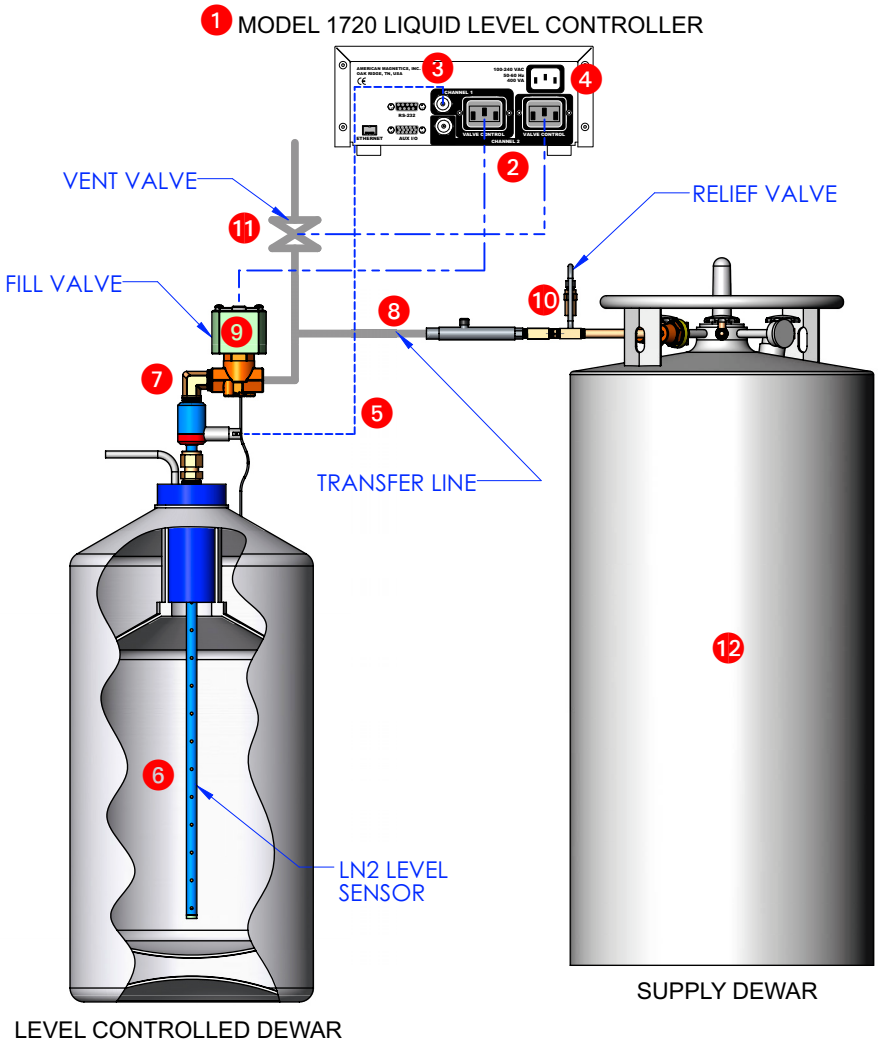


1. The valve power cord connector must be IEC60320 C14 type.

PRE-COOLED SYSTEM SETUP

For the Pre-Cooled System Setup the Channel 1 Valve Control is used to actuate a venting valve that will allow the transfer line to pre-cool for a user-determined time period before switching over to the Channel 2 Valve Control to complete an autofill. Only one Supply Dewar is utilized in this system mode.

The system consists of a Model 1720 Instrument with a liquid level sensor, a solenoid-operated flow valve for the venting function, and a solenoid-operated flow valve for the autofill. The instrument makes continuous level measurements and based on level, energizes the supply dewar valve to begin liquid transfer after the pre-cool venting period expires. The transfer is then stopped when the measured level in the Level Controlled Dewar reaches a user-determined point.



Typical Pre-Cooled System Setup

Pre-Cooled Setup Description

Number	Item
1	Model 1720 Liquid Level Instrument (Level Controller)
2	IEC60320 C13 sockets labeled **VALVE CONTROL (CHANNEL 1, CHANNEL 2)**
3	BNC connector for sensor input for **CHANNEL 1**
4	Instrument IEC60329 C14 Power cord inlet
5	Coaxial cable connecting the Level Sensor in Level Controlled Dewar to the **CHANNEL 1** sensor input
6	Level Sensor for Level Controlled Dewar
7	Fill port on Level Controlled Dewar
8	Transfer line attached to the Supply Dewar
9	Solenoid-operated fill valve for the Level Controlled Dewar
10	Supply Dewar relief valve
11	Solenoid-operated venting valve for the transfer line placed as close as practical to the fill valve for the Level Controlled Dewar
12	Supply Dewar

CAUTION **A relief valve must be used in autofill systems to ensure no cryogenic liquid can be trapped in a transfer line volume where expansion can cause damaging pressure. This can occur if the solenoid operated fill valve and the supply dewar isolation valve are closed, trapping a cryogenic liquid in a confined volume. All AMI transfer line systems include a relief valve to preclude this sort of event.**

CAUTION **The switched valve outlet socket switches the line voltage to which the instrument mains power is connected. Ensure any connected valve is rated to support the local VAC line voltage.**

SETUP STEPS FOR PRE-COOLED SYSTEM:

1. Mount the level sensor 6 in the Level Controlled Dewar #1.
2. Connect the transfer line 8 or supply manifold of the Supply Dewar.
3. Connect the other end of the transfer line to the fill solenoid valve 9 attached to the fill port 7 on the valve/manifold of the target dewar.
4. Connect the capacitance sensor to the instrument.

a. For distances of 15 feet and less, connect the coaxial cable 5 between the BNC connector on the liquid level sensor 6 and the BNC connector on the back of the instrument labeled **CHANNEL 1** 3.

b. For distances greater than 15 feet, insert an external oscillator/ transmitter in-line with the coaxial cable 5.

5. Connect the venting valve 11 power cord to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 2 VALVE CONTROL** 2.

6. Connect the fill solenoid valve 9 power cord to the IEC60320 C13 valve socket[1] on the Model 1720 Instrument rear panel labeled **CHANNEL 1 VALVE CONTROL** 2.

Connect the IEC320 C14 inlet connector and instrument power cord 4 to an appropriate power source (see the Power Requirements on page 16).

NOTE **Should the level sensor become disconnected from the instrument or an interconnecting cable fails, a LOSS OF SENSOR message will be displayed (as shown at right) and the vent and autofill valves will be shut (M-CLOSED). When the sensor connection has been restored, the instrument will display the level but the precooled-mode autofill state for the channel will have to be manually changed back to AUTO-ON.**

1. The valve power cord connector must be IEC60320 C14 type.

POWER REQUIREMENTS

WARNING

The Model 1720 Instrument operates on 50-60 Hz power and may be powered from 100-240 VAC. Insure that the input ground terminal is connected securely to an external earth ground.

Ensure the detachable mains supply cord is of suitable rating, i.e. 10 A (min) at 125 VAC for North America.

Ensure the power switch is in the OFF (**O**) position. Plug the Model 1720 Instrument line cord into the power entry module on the instrument rear panel and into the appropriate power receptacle.

CONNECTING THE ANALOG OUTPUTS

The Model 1720 instrument provides two 0-10 V_{DC} and two 4-20 mA_{DC} outputs as standard. These outputs may be optionally connected to external equipment per the instructions below.

NOTE **Both analog outputs can be connected to the same or different level measurement source as desired, and all can operate simultaneously.**

0-10 V_{DC} RECORDER OUTPUT

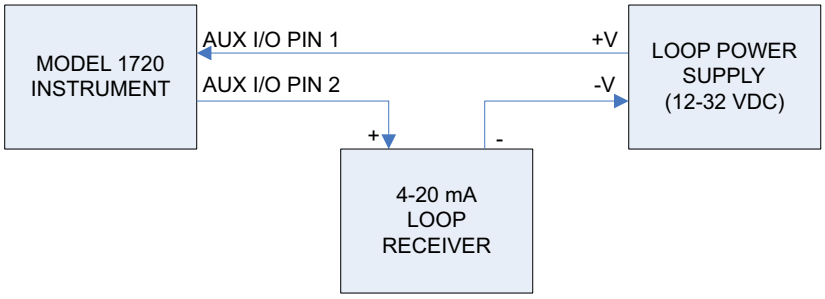
The Model 1720 instrument provides two 0-10 V_{DC} outputs on the AUX I/O connector (refer to “Aux I/O Pin Definitions” on page 134) corresponding to 0-100% of liquid level. The outputs can be assigned to either level measurement channel (refer to “Analog Output Signals” on page 65). Connect the voltage output on the AUX I/O connector to a suitable receiver being careful not to exceed the impedance restrictions (refer to “Model 1720 Specifications @ 25°C” on page 9).

4-20 MA CURRENT LOOP OUTPUT

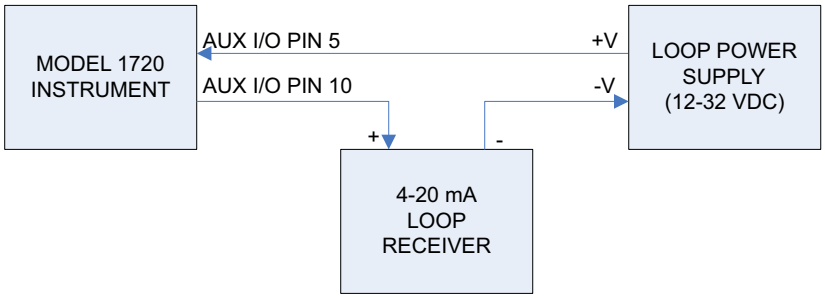
The Model 1720 instrument provides two 4-20 mA_{DC} outputs on the AUX I/O connector (refer to “Aux I/O Pin Definitions” on page 134) corresponding to 0-100% of liquid level. The outputs can be assigned to either level measurement channel (refer to “Analog Output Signals” on page 65).

The instrument requires an external power supply for current loop operation. Connect a suitable power supply as shown below.

CAUTION **It is extremely important to observe all polarities and to not exceed +32VDC for the loop power supply in order to prevent damage to the 4-20mA driver circuit.**



4-20 mA Output #1 Connections



4-20 mA Output #2 Connections

OPERATION

This section describes the operation of the Model 1720 Instrument.

ENERGIZING THE MODEL 1720 INSTRUMENT

1. Turn the power switch on the front panel of the instrument to the On (**I**) position. The display will briefly show a boot image and then display the home screen showing level(s).
2. The boot process takes approximately 30 seconds. Boot time can be longer (approximately 2 minutes) if the instrument has been configured for a network connection and then is booted without the network present.
3. When the boot process is complete, the instrument will display the home (level) screen.
4. If the instrument requires calibration[1], refer to instructions in the next chapter to calibrate the instrument with an AMI level sensor.

SCREEN NAVIGATION

The Model 1720 can operate in various autofill modes. The normal mode is dual channels that measure and optionally control level independently. Therefore, up to two level measurements can be displayed in the normal configuration.

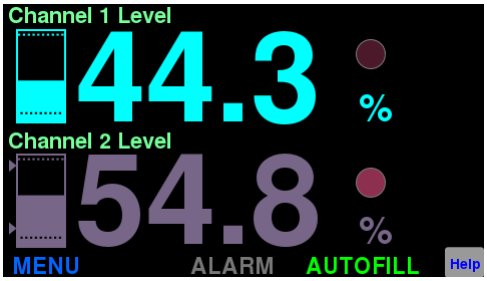
Two other configurations are possible including “Auto-Changeover” and “Pre-Cooled” autofill modes. These optional configurations are described in detail in “Configuring the Normal Autofill Function” on page 49.

1. If the instrument was purchased with level sensor(s), the instrument will be shipped set up and calibrated.

HOME SCREEN

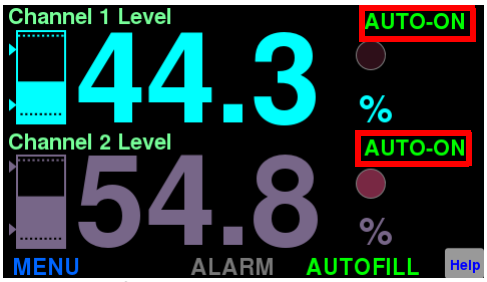
NOTE **If the instrument was purchased with a level sensor, the instrument will be pre-configured and calibrated at the factory.**

The display will look similar to the image shown at right if both channels are active in the normal configuration:



Home Screen with Dual Channels

If a channel has enabled the autofill function, the autofill status will display in the home screen as highlighted at right:



Autofill Status on Home Screen

The autofill status text can be touched to cycle through the available options. For more details regarding the available autofill status selections, see “Configuring the Normal Autofill Function” on page 49. A “Save” is required as prompted to make the autofill status selection active.

HOME SCREEN FOOTER

The level home screen displays both status information and buttons in the footer to navigate to other screens.

The home screen footer appears as shown at right:

Home Screen Footer

Model 1720 Instrument Home Screen Footer

No.	Name	Function
①	MENU	Takes the user to the main menu screen.
②	ALARM	When illuminated, indicates an active alarm condition. Touch to enter the ALARM STATUS screen.
③	AUTOFILL	When illuminated, indicates the AUTOFILL function is enabled for one or both channels. Touch to enter the AUTOFILL configuration screen.
④	HELP	Takes the user to a Help screen where available.

EDITING A FIELD

Once a field or multi-choice button on a screen has been edited, the footer changes to appear as follows:

Field Editing Footer

Model 1720 Instrument Footer during editing a field

No.	Name	Function
①	SAVE	Saves the entries made on the screen. The footer then reverts to the default footer as shown in the previous section.
②	CANCEL	Cancels a change while *not saving entries*. The footer then reverts to the default footer as shown in the previous section.

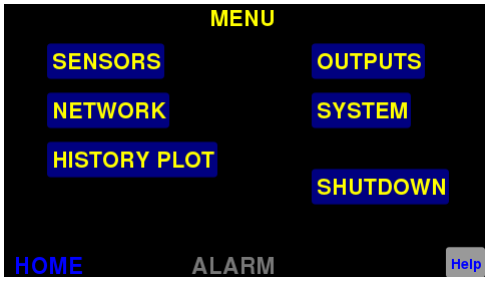
The functions of the **ALARM**, **AUTOFILL**, and **Help** footer items are as described in the previous section.

NAVIGATING THE INSTRUMENT MENUS

The menu system is invoked by pressing the **MENU** button in the lower left corner of the instrument level display screen.

MENU button on HOME screen

When invoked, the main **MENU** screen will be displayed:



MENU Selection Screen

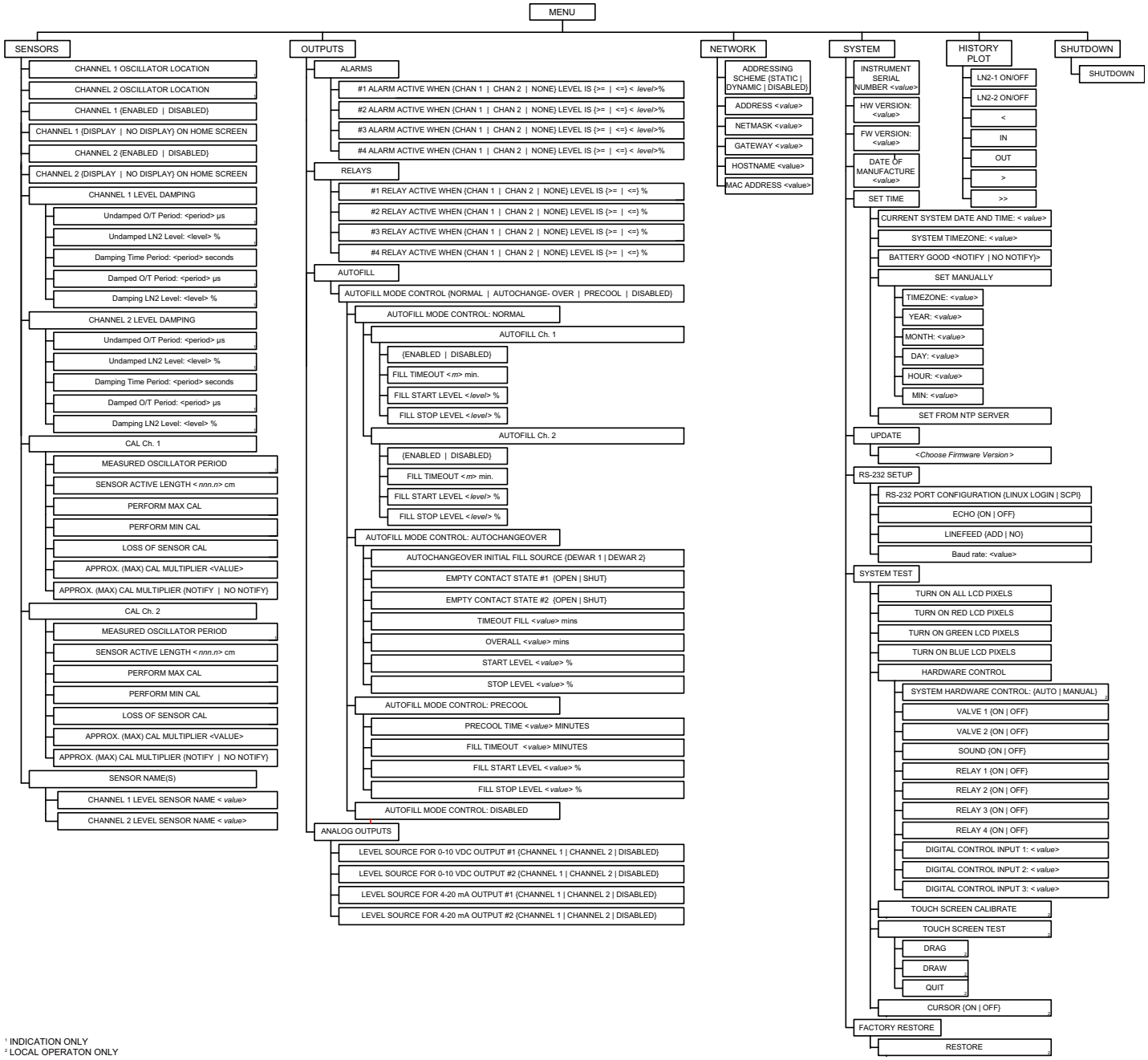
Pressing **HOME** in the lower left corner of the screen will display the home level display screen.

HOME button on MENU screen

Once a **MENU** has been chosen, a back button will be presented to the right of **HOME**. This button will return the user to the previously displayed screen.

BACK button

MENU STRUCTURE



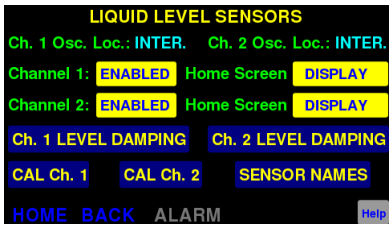
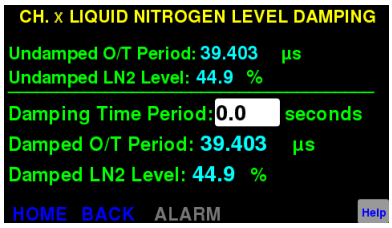
[1] INDICATION ONLY
[2] LOCAL OPERATON ONLY

Model 1720 Menu Structure

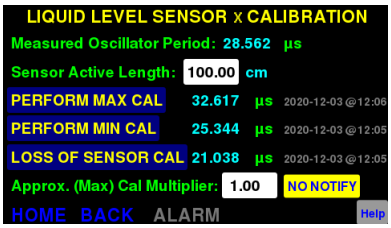
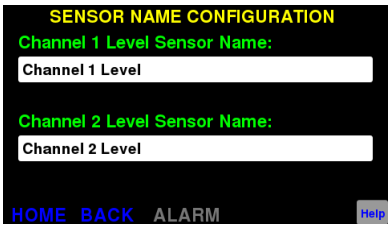
SCREEN DESCRIPTIONS

The Model 1720 Instrument displays various screens on the graphic display when a MENU item is chosen. The items for each screen are described in the following table.

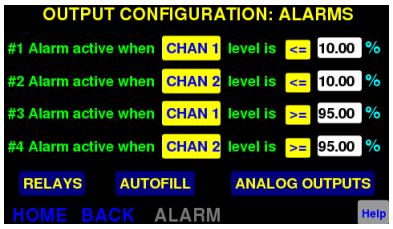
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
LIQUID LEVEL SENSORS  MENU > SENSORS	Ch. 1 Osc. Loc.:	Information: INTER., EXTER.[b]
	Ch. 2 Osc. Loc.:	Information: INTER., EXTER.[b]
	Channel 1:	Toggles between: ENABLED, DISABLED
	Home Screen (first occurrence)	Toggles Channel 1 home screen display between: DISPLAY, NO DISPLAY
	Channel 2:	Toggles between: ENABLED, DISABLED
	Home Screen (second occurrence)	Toggles Channel 2 home screen display between: DISPLAY, NO DISPLAY
	Ch. 1 LEVEL DAMPING	Move to Channel 1 damping adj screen
	Ch. 2 LEVEL DAMPING	Move to Channel 2 damping adj screen
	CAL Ch. 1	Move to Channel 1 calibration screen
	CAL Ch. 2	Move to Channel 2 calibration screen
	SENSOR NAMES	Move to another screen
CH. X=(1 *or* 2) LIQUID NITROGEN LEVEL DAMPING  MENU > SENSORS > Ch. 1 LEVEL DAMPING *or* Ch. 2 LEVEL DAMPING	Undamped O/T Period:	Information: <value>[b] µs (present value)
	Undamped LN2 Level:	Information: <value>[b] % (present value)
	Damping Time Period:	Data entry: <value> seconds
	Damped O/T Period:	Information: <value>[b] µs (present value)
	Damped LN2 Level:	Information: <value>[b] % (present value)

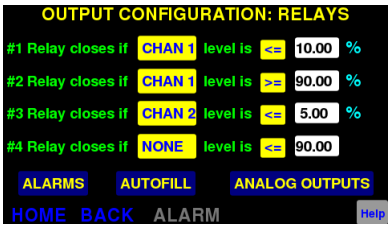
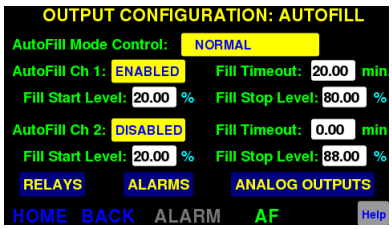
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
LIQUID NITROGEN SENSOR X=(1 *or* 2) CALIBRATION  MENU > SENSORS > CAL Ch. 1 *or* CAL Ch. 2	Measured Oscillator Period:	Information: <value>[b] µs (present value)
	Sensor Active Length:	Data entry: <value> cm *or* in (tap units to change)
	PERFORM MAX CAL	Move to another screen and Information: <value>[b] in µs followed by the date/time of last entry
	PERFORM MIN CAL	Move to another screen and Information: <value>[b] in µs followed by the date/time of last entry
	NO SENSOR CAL	Move to another screen and Information: <value>[b] in µs followed by the date/time of last entry
	Approx. (Max) Cal Multiplier:	Data entry: <value> followed by a button that toggles between: NO NOTIFY, NOTIFY[c]
SENSOR NAME CONFIGURATION  MENU > SENSORS > SENSOR NAME(S)	Channel 1 Level Sensor Name:	Data entry: <value>
	Channel 2 Level Sensor Name:	Data entry: <value>

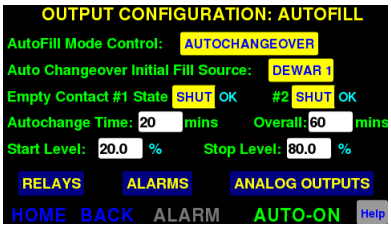
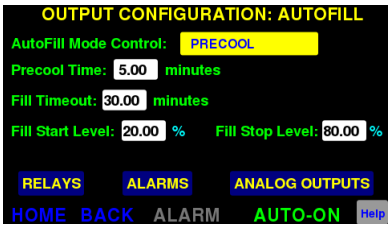
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
OUTPUT CONFIGURATION: ALARMS  MENU > OUTPUTS > ALARMS	#1 Alarm active when <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (first) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#2 Alarm active when <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (second) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#3 Alarm active when <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (third) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#4 Alarm active when <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (fourth) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	RELAYS	Move to another screen
	AUTOFILL	Move to another screen
	ANALOG OUTPUTS	Move to another screen

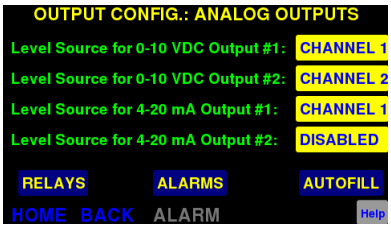
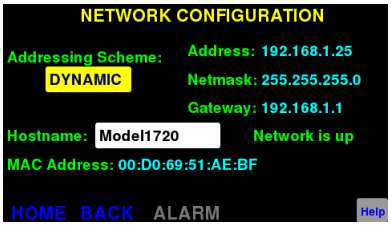
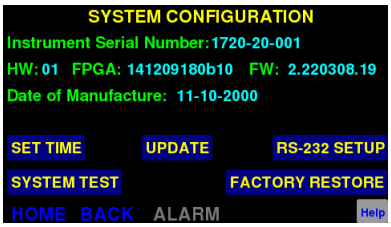
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
OUTPUT CONFIGURATION: RELAYS  MENU > OUTPUTS > RELAYS	#1 Relay closes if <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (first) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#2 Relay closes if <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (second) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#3 Relay closes if <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (third) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	#4 Relay closes if <input>	Toggles between: NONE, CHAN 1, CHAN 2
	level is (fourth) <state>	Toggles between: ≤, ≥ followed by data entry <value> %, in, *or* cm (tap units to change)
	ALARMS	Move to another screen
	AUTOFILL	Move to another screen
	ANALOG OUTPUTS	Move to another screen
OUTPUT CONFIGURATION: **AUTOFILL** (NORMAL)  MENU > OUTPUTS > AUTOFILL	AutoFill Mode Control:	Toggles between: NORMAL, AUTO-CHANGEOVER, PRECOOL, DISABLED
	AutoFill Ch. 1:	Toggles between: ENABLED, DISABLED
	Fill Timeout: (for Ch. 1)	Data entry <value> minutes
	Fill Start Level: (for Ch. 1)	Data entry <value> %, in, *or* cm (tap units to change)
	Fill Stop Level: (for Ch. 1)	Data entry <value> %, in, *or* cm (tap units to change)
	AutoFill Ch. 2:	Toggles between: ENABLED, DISABLED
	Fill Timeout: (for Ch. 2)	Data entry <value> minutes
	Fill Start Level: (for Ch. 2)	Data entry <value> %, in, *or* cm (tap units to change)
	Fill Stop Level: (for Ch. 2)	Data entry <value> %, in, *or* cm (tap units to change)
	RELAYS	Move to another screen
	ALARMS	Move to another screen
	ANALOG OUTPUTS	Move to another screen

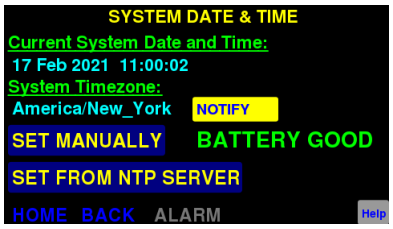
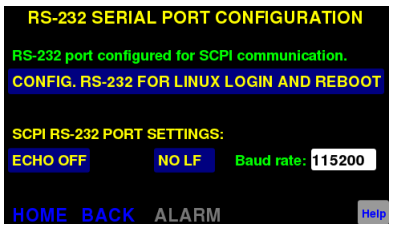
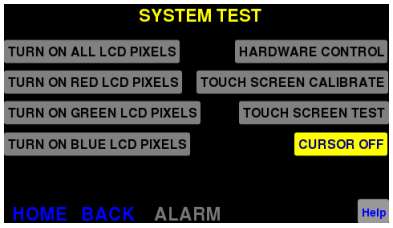
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
OUTPUT CONFIGURATION: **AUTOFILL** (AUTOCHANGEOVER)  MENU > OUTPUTS > AUTOFILL	AutoFill Mode Control:	Toggles between: NORMAL, AUTO-CHANGEOVER, PRECOOL, DISABLED
	Auto Changeover Initial Fill Source:	Toggles between: DEWAR 1, DEWAR 2
	Empty Contact State (Source) #1:	Toggles between: SHUT (relay closed) or OPEN
	(Empty Contact State Source) #2:	Toggles between: SHUT (relay closed) or OPEN
	Autochange Time:	Data entry <value> minutes
	Overall (Timeout):	Data entry <value> minutes
	(Fill) Start Level:	Data entry <value> %, in, *or* cm (tap units to change)
	(Fill) Stop Level:	Data entry <value> %, in, *or* cm (tap units to change)
	RELAYS	Move to another screen
	ALARMS	Move to another screen
	ANALOG OUTPUTS	Move to another screen
OUTPUT CONFIGURATION: **AUTOFILL** (PRECOOL)  MENU > OUTPUTS > AUTOFILL	AutoFill Mode Control:	Toggles between: NORMAL, AUTO-CHANGEOVER, PRECOOL, DISABLED
	Precool Time:	Data entry <value> minutes
	Fill Timeout:	Data entry <value> minutes
	Fill Start Level:	Data entry <value> %, in, *or* cm (tap units to change)
	Fill Stop Level:	Data entry <value> %, in, *or* cm (tap units to change)
	RELAYS	Move to another screen
	ALARMS	Move to another screen
	ANALOG OUTPUTS	Move to another screen

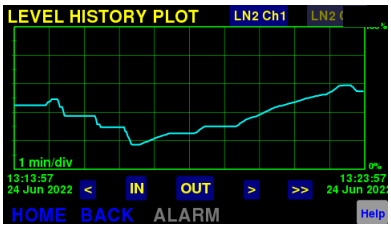
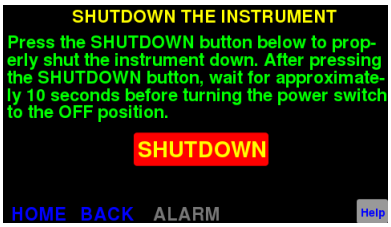
Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
OUTPUT CONFIG.: ANALOG OUTPUTS  MENU > OUTPUTS > ANALOG OUTPUTS	Level Source for 0-10 VDC Output #1:	Toggles between: DISABLED, CHANNEL 1, CHANNEL 2
	Level Source for 0-10 VDC Output #2:	Toggles between: DISABLED, CHANNEL 1, CHANNEL 2
	Level Source for 4-20 mA Output #1:	Toggles between: DISABLED, CHANNEL 1, CHANNEL 2
	Level Source for 4-20 mA Output #2:	Toggles between: DISABLED, CHANNEL 1, CHANNEL 2
	RELAYS	Move to another screen
	ALARMS	Move to another screen
	AUTOFILL	Move to another screen
NETWORK CONFIGURATION  MENU > NETWORK	Addressing Scheme:	Toggles between: DYNAMIC, DISABLED, STATIC
	Address:	Information: <value>[d] (DYNAMIC) Data entry: <value> (STATIC)
	Netmask:	Information: <value>[d] (DYNAMIC) Data entry: <value> (STATIC)
	Gateway:	Information: <value>[d] (DYNAMIC) Data entry: <value> (STATIC)
	Hostname:	Data entry: <value>
	MAC Address:	Information: <value>[b]
SYSTEM CONFIGURATION  MENU > SYSTEM	Instrument Serial Number:	Information: <value>[b]
	HW (Hardware Version):	Information: <value>[b]
	FPGA (FPGA Version):	Information: <value>[b]
	FW (Firmware Version):	Information: <value>[b]
	Date of Manufacture:	Information: <value>[b]
	SET TIME	Move to another screen
	UPDATE	Move to another screen
	RS232 SETUP	Move to another screen
	SYSTEM TEST	Move to another screen
	FACTORY RESTORE	Move to another screen

Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
SYSTEM DATE & TIME  MENU > SYSTEM > SET TIME	Current System Date and Time:	Information[b]
	System Timezone:	Information[b]
	SET MANUALLY	Move to another screen
	SET FROM NTP SERVER	Action with status screen
RS-232 SERIAL PORT CONFIGURATION  MENU > SYSTEM > RS232 SETUP	Current Configuration:	Information[b]
	Configuration Choice:	Choose alternate function by touching
	Echo Setting:	Choose ECHO OFF or ECHO ON
	Line Ending:	Choose NO LF or ADD LF
	Baud rate:	Enter desired baud rate
INSTALL SYSTEM FIRMWARE  MENU > SYSTEM > UPDATE	A list of firmware versions	Selection list: <values> and then moves to INSTALL verification on selection
SYSTEM TEST  MENU > SYSTEM > SYSTEM TEST	TURN ON ALL LCD PIXELS	Move to multi-color test screen
	TURN ON RED LCD PIXELS	Move to red test screen
	TURN ON GREEN LCD PIXELS	Move to green test screen
	TURN ON BLUE LCD PIXELS	Move to blue test screen
	HARDWARE CONTROL	Move to hardware test screen
	TOUCH SCREEN CALIBRATE	Move to touch calibration screen
	TOUCH SCREEN TEST	Move to touch test screen
	CURSOR ON/CURSOR OFF	Toggles visibility of cursor

Model 1720 Level Instrument Screen Descriptions

Screen[a]	Item Label	Field Type or Function
LEVEL HISTORY PLOT  MENU > HISTORY PLOT	LN2 Ch1	Enables/disables Channel 1 trace
	LN2 Ch2	Enables/disables Channel 2 trace
	<	Move graph back in time
	IN	Zoom in (less time per division)
	OUT	Zoom out (more time per division)
	>	Move graph forward in time
	>>	Shift graph to most recent levels
SHUTDOWN  MENU > SHUTDOWN	SHUTDOWN	Shuts down the instrument in an orderly fashion which reduces boot time for the next power on.

a. The path below each illustration indicates the necessary actions in the menu structure required to display the indicated screen.

b. Displays the state or value (display only).

c. If the NOTIFY state is selected and the Approx. Cal factor is not equal to 1.00, a brief message will be displayed indicating an approximate calibration is in effect when the instrument boots.

d. Value displayed is chosen by the DHCP server for the network in DYNAMIC mode.

CAPACITANCE LEVEL DISPLAY

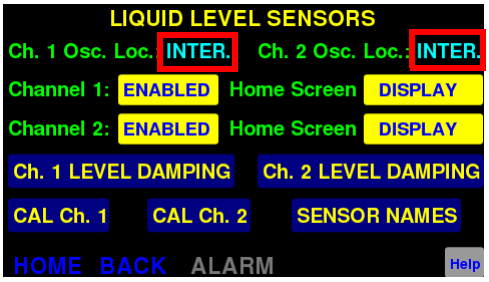
CONFIGURE THE INSTRUMENT TO DISPLAY CHANNEL LEVEL

NOTE **If the instrument was purchased with a capacitance-based level sensor, Steps 1 through 4, below, have already been performed.**

NOTE **The sensor connection(s) should be completed *before* powering on the Model 1720 as the OSCILLATOR LOCATION is sensed during the boot process.**

1. From the main screen, choose the following: **MENU** > **SENSORS**. Ensure the desired channels are enabled.

2. The instrument has a built-in sensor oscillator for each channel which will be used if the level sensor is connected directly to the BNC connector on the rear panel of the instrument with a maximum of 15 feet of RG59/U coaxial cable (refer to the figure on page 2). Ensure the **Oscillator Location** field displays **INTER.** (internal).

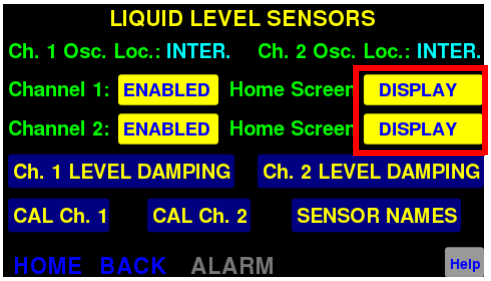


INTERNAL Oscillator Indicated

NOTE **If the sensor is greater than 15 feet from the instrument, an external oscillator/transmitter is required and the OSCILLATOR LOCATION for that channel will display EXTER. (refer to the figure on page 3).**

3. Ensure that **Home Screen** selection for a given channel is set to **DISPLAY**.

4. Press **HOME** at the bottom of the screen to return to the home screen and verify the display.



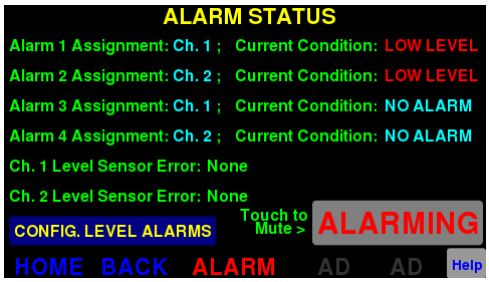
Channel Displayed on Home Screen

ALARMS AND RELAYS

The Model 1720 Instrument has two types of alarms, level-based and time-based alarms.

ALARM STATUS SCREEN

The Model 1720 provides an Alarm Status screen that summarizes all alarm states and provides a button for muting.



Alarm Status Screen

The Alarm Status screen can be accessed at any time by tapping on the **ALARM** text in the footer. All alarms are summarized in the Alarm Status screen. If the Alarm Status screen shows the “ALARMING” button (as illustrated above), then touching the button will mute the alarm(s). This mute function will remain in effect until a new alarm is activated, or the status of any active alarm changes. A shortcut may also be provided on the Alarm Status screen to enter the Level Alarms configuration screen.

LEVEL-BASED ALARMS DESCRIPTION

The Model 1720 Instrument has four user-configurable level alarms. Each alarm can be triggered by either channel’s level measurement. Each alarm can be configured to be active above or below a user-defined setpoint.

When an alarm condition occurs, an audible alert will sound and visual indication will appear on the front panel.

Four relays can also be configured with independent setpoints to actuate independently of the alarm states. These relays have Normally Open (NO) contacts. Each of the relays can be assigned to either channel and each can be configured to close when the reading is either ≤ or ≥ the setpoint.

As an example of this flexibility in the setup, a level channel can be configured to have an *alarm condition* when the level is outside a normal operating band. The *relay actions* can be set to act identically, or configured for other conditions, per the user-defined application.

TIME-BASED FILL ALARMS DESCRIPTION

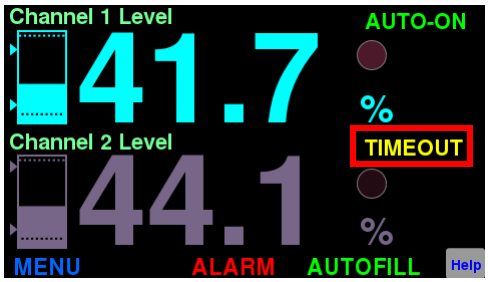
The Model 1720 Instrument has an alarm available on each channel to indicate that there is a problem with the autofill function. If enabled, the instrument will start a timer when an autofill condition is initiated, and if the level has not reached the fill stop level within the user-set period of time, an Autofill Timeout alarm will occur.

The alternative autofill modes such as Auto-Changeover and Pre-Cooled may also provide their own customized timeouts. These are described in detail for those respective autofill modes in “Configuring the Normal Autofill Function” on page 49.

This alarm will cause three things to occur:

1. The de-energizing of the fill valve socket on the instrument rear panel,
2. An audible alarm will sound,
3. A **TIMEOUT** visual indication on the Home screen (as shown at right) or the “**TO**” indicator in the footer for other screens.

NOTE **The Autofill Timeout function can be disabled by setting the Fill Timeout interval to 0 minutes.**



Fill Timeout Alarm Indicator

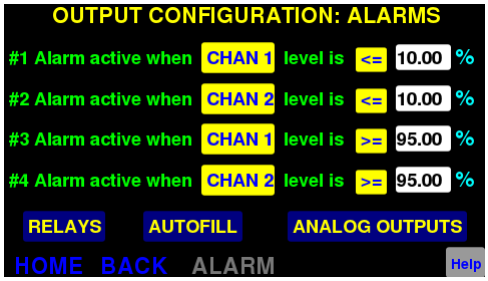
MULTIPLE ALARMS

More than one alarm condition can occur at the same time. If that is the case, the Alarm Status screen summarizes all the alarm states. Access the Alarm Status screen by touching the **ALARM** text in the footer.

CONFIGURING THE ALARM SETPOINTS

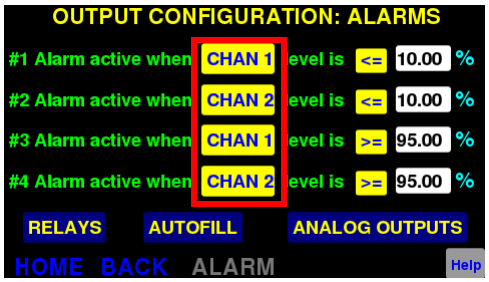
1. From the **MENU** screen, select **OUTPUTS** and the **OUTPUT CONFIGURATION: ALARMS** screen will be displayed.

   (If already in another **OUTPUT CONFIGURATION** screen, choose the **ALARMS** button.)



Output ALARMS Configuration Screen

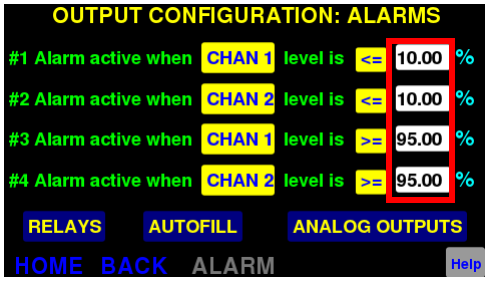
2. Choose the source channel for each alarm (**CHAN 1**, **CHAN 2**, or **NONE**).



Alarm Source Configuration

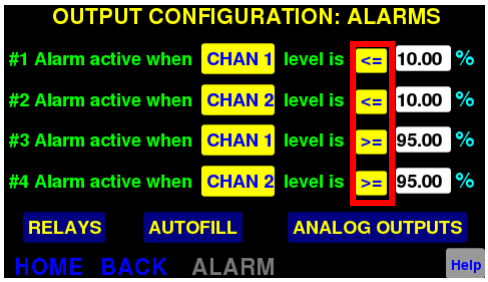
3. Set the levels at which the alarm will be triggered in the Setpoint fields highlighted in red in the image at right.

NOTE **Tapping the units symbol (%, in, or cm) allows selection of the available unit selections for that channel.**



ALARMS Setpoints

4. Use the ≤ or ≥ button to toggle between the two states of alarm, either alarm when the indicated level is less than or equal to the setpoint or alarm when the indicated level is greater than or equal to the alarm setpoint.



Alarm Condition Above or Below Setpoints

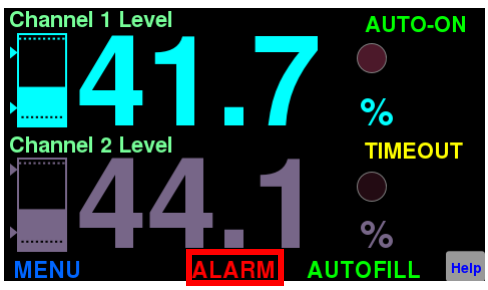
ACKNOWLEDGING AN ALARM

NOTE **The alarms are not "latched" so if the alarm condition clears itself, the instrument will remove the alarm condition.**

1. When an alarm is initiated, several things will occur:

   a. The **ALARM** text in the footer will illuminate in bold, red text.

   b. An audible alarm will be energized.

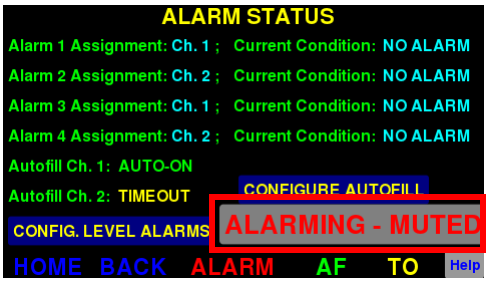


Alarm Annunciator

c. The Alarm Status screen, accessible by touching the **ALARM** text in the footer, will display a summary of all alarms.

MUTING AN ALARM

To mute the audible alarm, first touch the **ALARM** text in the footer. The Alarm Status screen will appear with the "ALARMING" status shown. Tap the "ALARMING" button to mute all active alarms. A change in any alarm state will also re-enable the audible alarm for any remaining active alarms. There is no permanent mute.

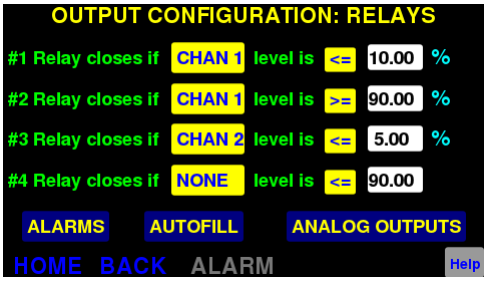


Muted Alarm Condition

CONFIGURING RELAY SETPOINTS

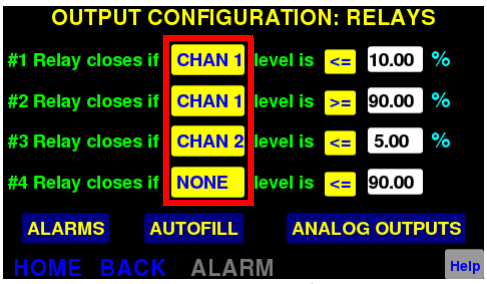
The relay outputs are available via the AUX I/O connector on the rear panel of the instrument per the pinout provided on page 134.

1. From the **MENU** screen, select **OUTPUTS** and then choose **RELAYS**.



OUTPUT CONFIGURATION: RELAYS Screen

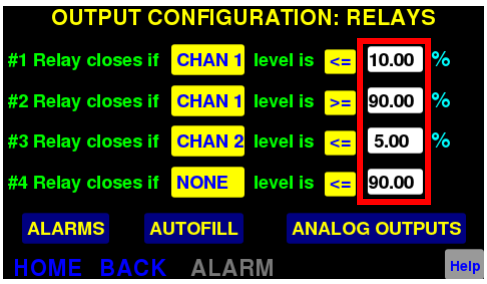
2. Choose the source channel for each relay (**CHAN 1**, **CHAN 2**, or **NONE**).



RELAYS Source Configuration

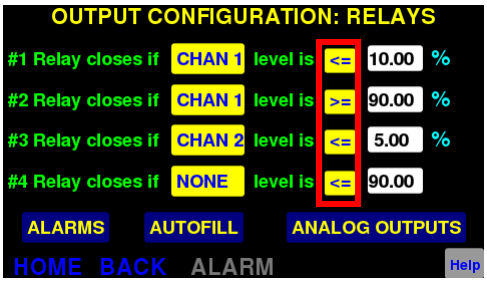
3. Set the levels at which the relay will be closed in the Setpoint fields.

NOTE **Tapping the units symbol (%, in, or cm) allows selection of the available unit selections for that channel.**



RELAYS Setpoints

4. Use the ≤ or ≥ button to toggle between the two states of actuation. Either the relay will close when the indicated level is less than or equal to the setpoint, or when the indicated level is greater than or equal to the setpoint.



Relay Closed Above or Below Setpoints

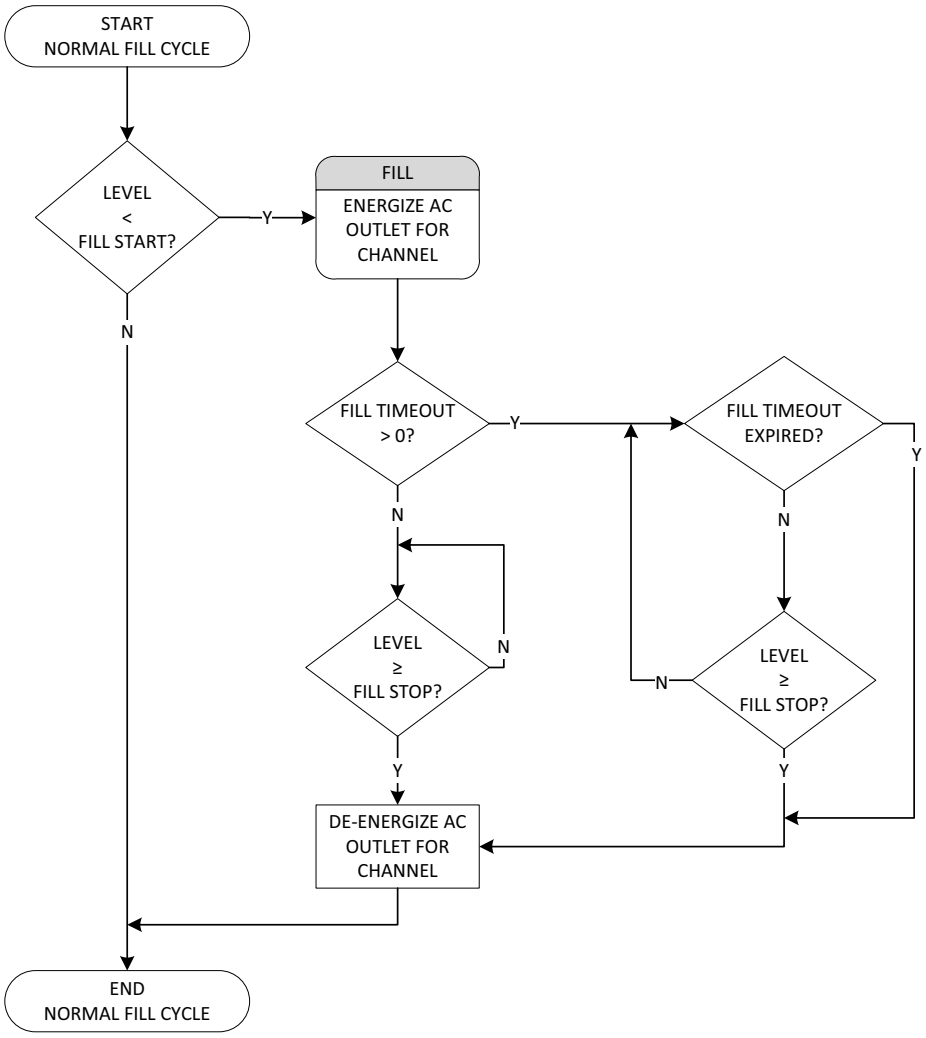
CONFIGURING THE NORMAL AUTOFILL FUNCTION

The **NORMAL** mode autofill function consists of two independent autofill controls, one for each sensor channel. The Normal autofill mode concept is described on page 12 and the step-by-step hardware installation guide can be found on page 19.

Each autofill channel has several variables that must be addressed to set up an autofill system. These include the Fill Start level (A), the Fill Stop Level (B), and the Fill Timeout interval.

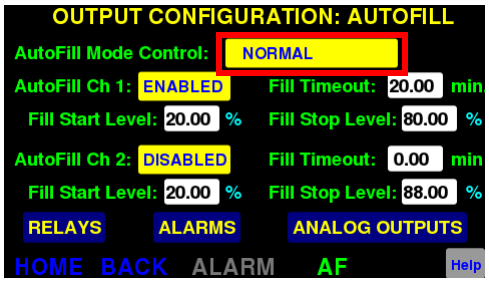
FLOWCHART OF NORMAL AUTOFILL FUNCTION

The diagram below illustrates the logical flow of the Normal Autofill function which is independent and identical for each channel.



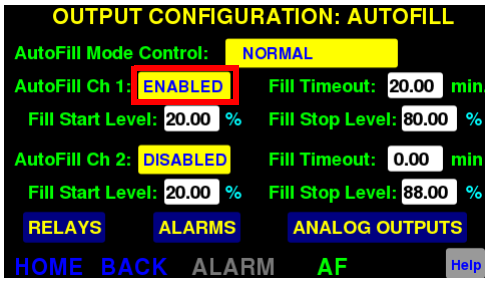
SETTING THE NORMAL AUTOFILL PARAMETERS

1. From the **MENU** screen, choose **OUTPUTS** and then choose **AUTOFILL**.
2. Toggle the **AutoFILL Mode Control** button until **NORMAL** is displayed.



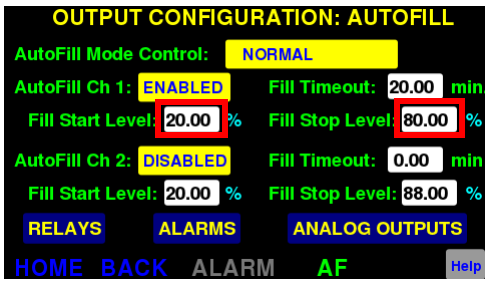
NORMAL Autofill Mode Selection

3. Choose whether **Autofill Ch. 1** is **ENABLED** or **DISABLED**. A selection of **DISABLED** turns off the autofill function altogether.



Autofill Channel 1 Source

4. Enter the **Fill Start** and **Stop Levels** for **Autofill Ch. 1**.

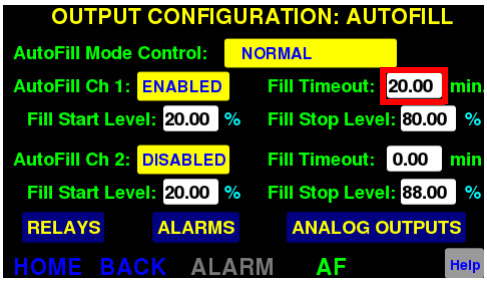


Autofill Channel 1 Fill Start and Stop Level Settings

NOTE If the START value is set to 0.0% the autofill function will be effectively disabled.

NOTE Tapping the units symbol (%, in, or cm) allows selection of the available unit selections for that channel.

5. Enter the **Fill Timeout** interval. If this is a non-zero value, then if the **Fill Stop Level** is not reached within the **Fill Timeout** interval, a Timeout alarm will be activated (see page 44), the fill cycle will be interrupted, and the valve control for the channel will de-energize.



Autofill Channel 1 Fill Timeout Setting

NOTE **If the Fill Timeout value is set to 0 minutes, the timeout function is disabled.**

6. Repeat steps 3, 4, and 5 for the **Autofill Ch. 2** settings.

7. Ensure **SAVE** is selected to save the settings and then press **HOME** in the footer to return back to the level display.

ENABLE THE NORMAL AUTOFILL FUNCTION

The autofill function must be confirmed after the settings are configured. After the autofill control loop has been configured (via the parameters in the prior section) an enabled autofill channel will enter the **AUTO-OFF** state.

To enable the autonomous autofill function for a given channel:

1. Touch the **AUTO-OFF** text in the **HOME** display (or the **AD** text in the footer) until it reads **AUTO-ON** (or **AF** in the footer).

2. Touch **SAVE** to enable the autonomous autofill function.

The Normal autofill function has four manually-selectable states by touching the fill state indicator either in the **HOME** screen or in abbreviated form in the footer when not in the **HOME** screen:

Normal Autofill States

State	Abbreviation in Footer	Description	Overrides
AUTO-ON	**AF**	Automatically maintains level between fill START and STOP set-point (i.e. autonomous mode).	Autofill will generate a Time-out alarm and cease if fill valve stays open for ≥ the FILL TIMEOUT setting.
M-OPEN	**MO**	Manual Open: Energizes the valve control socket on the rear panel.	Any active ALARM with >= setpoint defined for the channel will close valve.

Normal Autofill States

State	Abbreviation in Footer	Description	Overrides
M-CLOSED	**MC**	Manual Close: De-energizes the valve control socket on the rear panel.	None
AUTO-OFF	**AD**	Disables the AUTOFILL function.	None

Normal Autofill *Information-Only* States

State	Abbreviation in Footer	Description
FILLING	**FL**	*Information-only display* indicating the fill valve is open to the respective target dewar.
TIMEOUT	**TO**	*Information-only display* for the Fill Timeout Alarm active state for the respective fill channel.

NOTE **The abbreviations of the autofill state will only be used in the footer for screens other than the HOME screen due to the lack of physical space to show the full text for both autofill channels.**

CLEARING THE AUTOFILL TIMEOUT ALARM

NOTE **A Loss of Sensor error condition (see page 25) for the assigned sensor input for the channel will also halt an active autofill in addition to the autofill timeout feature.**

1. Touch the **TIMEOUT** text in the **HOME** screen, or **TO** in the footer, for the channel in the timeout condtition until **AUTO-ON** is displayed.
2. Touch **SAVE** in the footer. This will restart the autonomous autofill function.
3. To clear the **TIMEOUT** *without restarting* the autofill function, choose the **M-CLOSED** state and then choose **SAVE** in the footer.

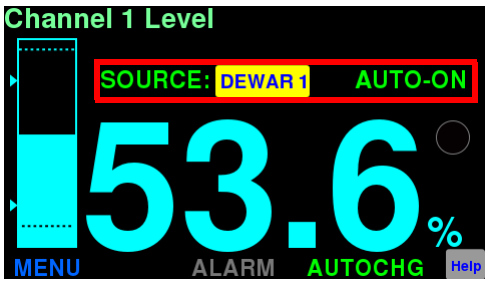
CONFIGURING THE AUTO-CHANGEOVER AUTOFILL FUNCTION

The **AUTOCHANGEOVER** mode autofill function consists of a single autofill channel using the sensor input for Channel 1, while switching the autofill source between two supply dewars. The Auto-Changeover autofill mode concept is described on page 13 and the step-by-step hardware installation guide can be found on page 23.

DISPLAY FOR AUTO-CHANGEOVER AUTOFILL MODE

When the Model 1720 is in the Auto-Changeover autofill mode, the **HOME** screen provides additional touch text items for status display and control of the autofill state.

The **SOURCE** item shows which supply dewar is presently set as the autofill source. It will update as the supply is switched between dewars, or it may be touched to force a change. A **SAVE** is necessary to complete any manual change.



Auto-Changeover Status and Control on HOME Screen

The text immediately to the right of the **SOURCE** setting is the autofill state per the description in the table on page 58. Tap it to cycle through the available states. A **SAVE** is necessary to complete any change.

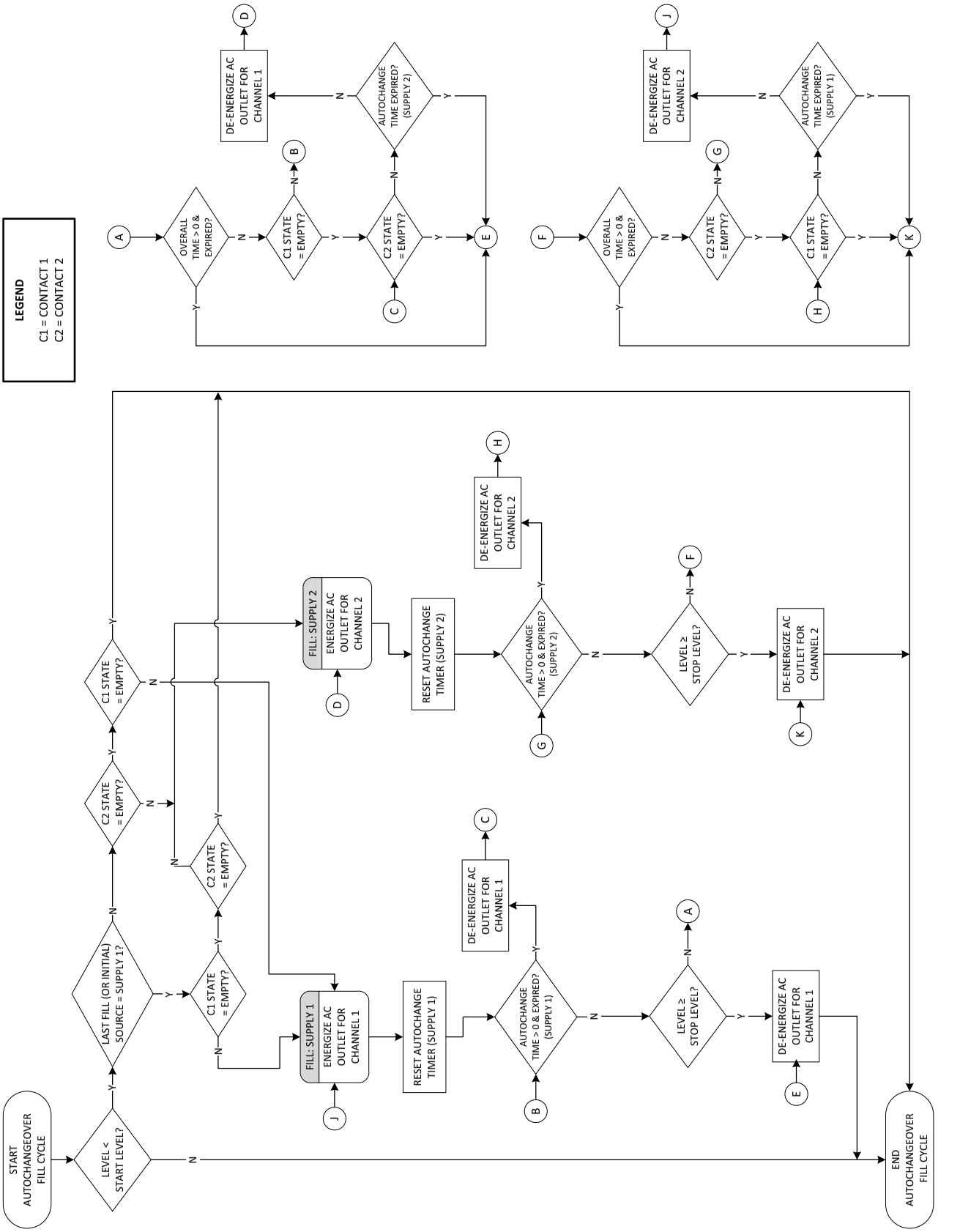
When not in the **HOME** screen, the same state display/control text will be shown in the screen footer.

FLOWCHART OF AUTO-CHANGEOVER FUNCTION

The diagram on the following page illustrates the logical flow of the Auto-Changeover autofill function.

SETTING THE AUTO-CHANGEOVER AUTOFILL PARAMETERS

The Auto-Changeover mode has several variables that must be configured. These include the initial supply dewar source, external contact states that indicate if a supply dewar is available, the fill Start Level (A), the fill Stop Level (B), and the Fill Timeout intervals.


LEGEND
C1 = CONTACT 1
C2 = CONTACT 2
START AUTOCHANGEOVER FILL CYCLE
LEVEL < START LEVEL?
LAST FILL (OR INITIAL) SOURCE = SUPPLY 1?
C1 STATE = EMPTY?
C2 STATE = EMPTY?
C2 STATE = EMPTY?
C1 STATE = EMPTY?
FILL: SUPPLY 1 ENERGIZE AC OUTLET FOR CHANNEL 1
FILL: SUPPLY 2 ENERGIZE AC OUTLET FOR CHANNEL 2
RESET AUTOCHANGE TIMER (SUPPLY 1)
RESET AUTOCHANGE TIMER (SUPPLY 2)
AUTOCHANGE TIME > 0 & EXPIRED? (SUPPLY 1)
AUTOCHANGE TIME > 0 & EXPIRED? (SUPPLY 2)
LEVEL ≥ STOP LEVEL?
LEVEL ≥ STOP LEVEL?
DE-ENERGIZE AC OUTLET FOR CHANNEL 1
DE-ENERGIZE AC OUTLET FOR CHANNEL 2
DE-ENERGIZE AC OUTLET FOR CHANNEL 1
DE-ENERGIZE AC OUTLET FOR CHANNEL 2
END AUTOCHANGEOVER FILL CYCLE
A
B
C
D
E
F
G
H
J
K
OVERALL TIME > 0 & EXPIRED?
C1 STATE = EMPTY?
C2 STATE = EMPTY?
AUTOCHANGE TIME EXPIRED? (SUPPLY 2)
DE-ENERGIZE AC OUTLET FOR CHANNEL 1
OVERALL TIME > 0 & EXPIRED?
C2 STATE = EMPTY?
C1 STATE = EMPTY?
AUTOCHANGE TIME EXPIRED? (SUPPLY 1)
DE-ENERGIZE AC OUTLET FOR CHANNEL 2

The availability of a supply dewar to accomplish an autofill cycle can be indicated by one or both of the following methods: a fill time limit (i.e. Autochange Time) or external dry contact sense (i.e. Empty Contact State).

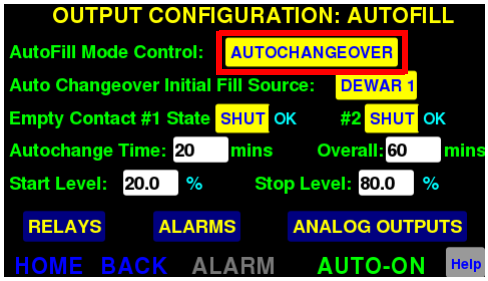
If the Autochange Time expires before reaching the Stop Level for a given supply dewar, then the Auto-Changeover function will automatically switch over to the alternate supply dewar and continue the autofill cycle as long as the contact state for the alternate supply dewar does *not* indicate an empty condition.

NOTE **The Contact States and the Autochange Time values are logically "OR'ed" if *both* are active, meaning that either can interrupt or preclude a fill if an empty fill source state is indicated by a remote contact, or the Autochange Time expires.**

For more details about the rear contact sense inputs, see the Appendix and page 132.

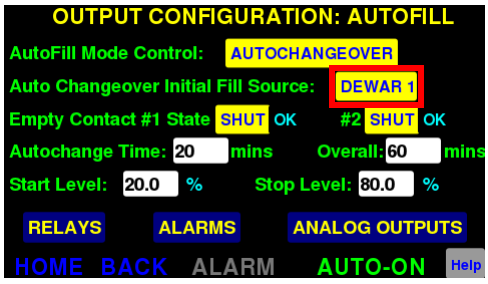
Remember that changes are not effective until **SAVE** is applied.

1. From the **MENU** screen, choose **OUTPUTS** and then choose **AUTOFILL**.
2. Toggle the **AutoFILL Mode Control** button until **AUTOCHANGEOVER** is displayed.



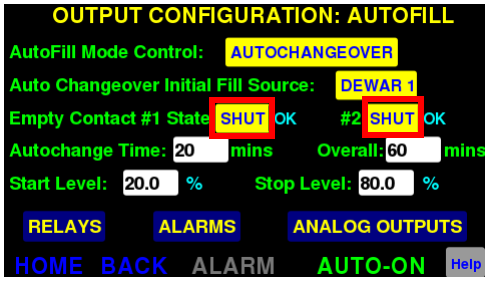
AUTOCHANGEOVER Autofill Mode Selection

3. Choose the initial fill source for the Auto-Changeover by choosing **DEWAR1** or **DEWAR2**.



Auto-Changeover Initial Source

4. Choose the **Empty Contact State** for supply dewars (i.e. fill sources) #1 and #2. The selected contact state specifies the remote (external) relay contact state that *indicates a respective tank is empty* and cannot be used for a fill cycle. The choices are **SHUT** (closed contacts) relay or **OPEN** (open contacts).

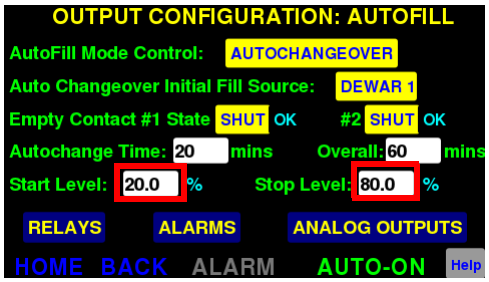


Empty Fill Source Indication Contact States

The light blue text to the right of each selection indicates the *currently sensed state* of each contact. A value of "OK" means the contact indicates a fill source is available. A value of "EMPTY" means the remote contact indicates that a fill source is presently unavailable.

NOTE **The remote contact sense feature is optional and can be effectively disabled by setting the Empty Contact State to SHUT and leaving the respective rear panel connector pins unconnected (see RS-232 connector pinout on page 132).**

5. Enter the fill **Start Level** and **Stop Level** for the single target dewar.

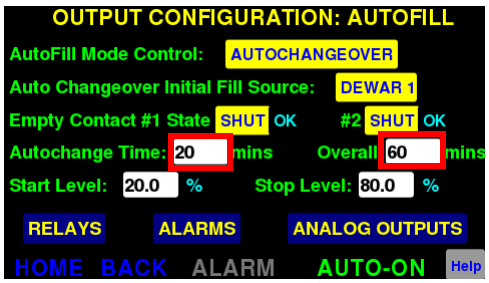


Auto-Changeover Fill Start and Stop Level Settings

NOTE **If the Start Level value is set to 0.0% the autofill function will be effectively disabled.**

NOTE **Tapping the units symbol (%, in, or cm) allows selection of the available unit selections for that channel.**

6. Enter the **Autochange Time** intervals. The **Autochange Time** indicates a timeout in minutes for each supply dewar. If the **Autochange Time** expires before the fill cycle reaches the **Stop Level**, then the unit will switch the supply to the alternate dewar.



Auto-Changeover Timeout Settings

If *both* supply dewars expire the **Autochange Time** without

reaching the **Stop Level** for a given fill cycle, a timeout alarm will activate and the fill cycle will be interrupted.

The **Overall** timeout specifies a total time limit in minutes for the autofill cycle regardless of the supply dewar source. The timeout alarm will activate and the fill will be interrupted if the fill cycle does not achieve the **Stop Level** in the **Overall** time.

NOTE **If either the Autochange Time or Overall value is set to 0 minutes, that timeout function is disabled. It is not recommend to set the Autochange Time to zero, as that effectively disables the Auto-Changeover function entirely *unless* the Empty Contact States are actively in use to indicate availability of each supply dewar.**

7. Ensure **SAVE** is selected to save the settings and then press **HOME** in the footer to return back to the level display.

ENABLE THE AUTO-CHANGEOVER AUTOFILL FUNCTION

The Auto-Changeover autofill function must be enabled after the settings are configured. After the autofill control loop has been configured (via the parameters in the prior section) autofill will enter the **AUTO-OFF** state.

To enable the autonomous Auto-Changeover autofill function:

1. Touch the **AUTO-OFF** text in the **HOME** display or the footer until it reads **AUTO-ON**.
2. Touch **SAVE** to enable the autonomous autofill function.

The Auto-Changeover autofill function has four manually-selectable states by touching the fill state indicator either in the **HOME** screen or in the footer:

Auto-Changeover Autofill States

State	Description	Overrides
AUTO-ON	Automatically maintains the single target dewar level between fill START and STOP setpoints (i.e. autonomous mode).	Autofill will generate a Timeout alarm and cease filling if the fill valves stay open for ≥ the Overall Timeout setting, or if both supply dewars reach Autochange Time expiration, before reaching the Stop Level.
M-OPEN	Manual Open: Energizes the VALVE CONTROL socket for Channel 1 on the rear panel.	Any active ALARM with >= setpoint defined for Channel 1 will close valve.
M-CLOSED	Manual Close: De-energizes the VALVE CONTROL socket for Channel 1 on the rear panel.	None
AUTO-OFF	Disables the AUTOFILL function.	None

Auto-Changeover *Information-Only* States

State	Description
FILLING	*Information-only display* indicating the fill valve is open to the target dewar.
TIMEOUT	*Information-only display* for the Overall Timeout Alarm active state.

CLEARING THE AUTO-CHANGEOVER OVERALL TIMEOUT ALARM

NOTE **A Loss of Sensor error condition (see page 25) will also halt an active Auto-Changeover autofill in addition to the Overall timeout feature.**

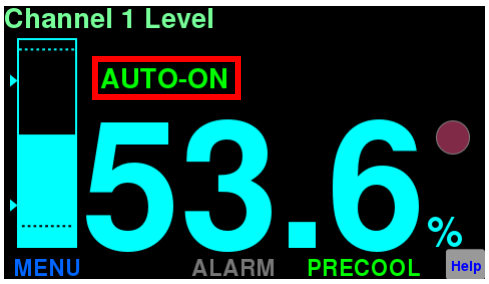
1. Touch the **TIMEOUT** text in the **HOME** screen, or **TO** in the footer, for the channel in the timeout condition until **AUTO-ON** is displayed.
2. Touch **SAVE** in the footer. This will restart the autonomous autofill function.
3. To clear the **TIMEOUT** *without restarting* the autofill function, choose the **M-CLOSED** state and then choose **SAVE** in the footer.

CONFIGURING THE PRE-COOLED AUTOFILL MODE

The **PRECOOL** mode autofill function consists of a single fill channel using the sensor input for Channel 1, while operating two valves for purposes of pre-cooling the liquid transfer line. The Pre-Cooled autofill mode concept is described on page 14 and the step-by-step hardware installation guide can be found on page 26.

DISPLAY FOR PRE-COOLED AUTOFILL MODE

When the Model 1720 is in the Pre-Cooled autofill mode, the **HOME** screen provides additional touch text items for status display and control of the autofill state.



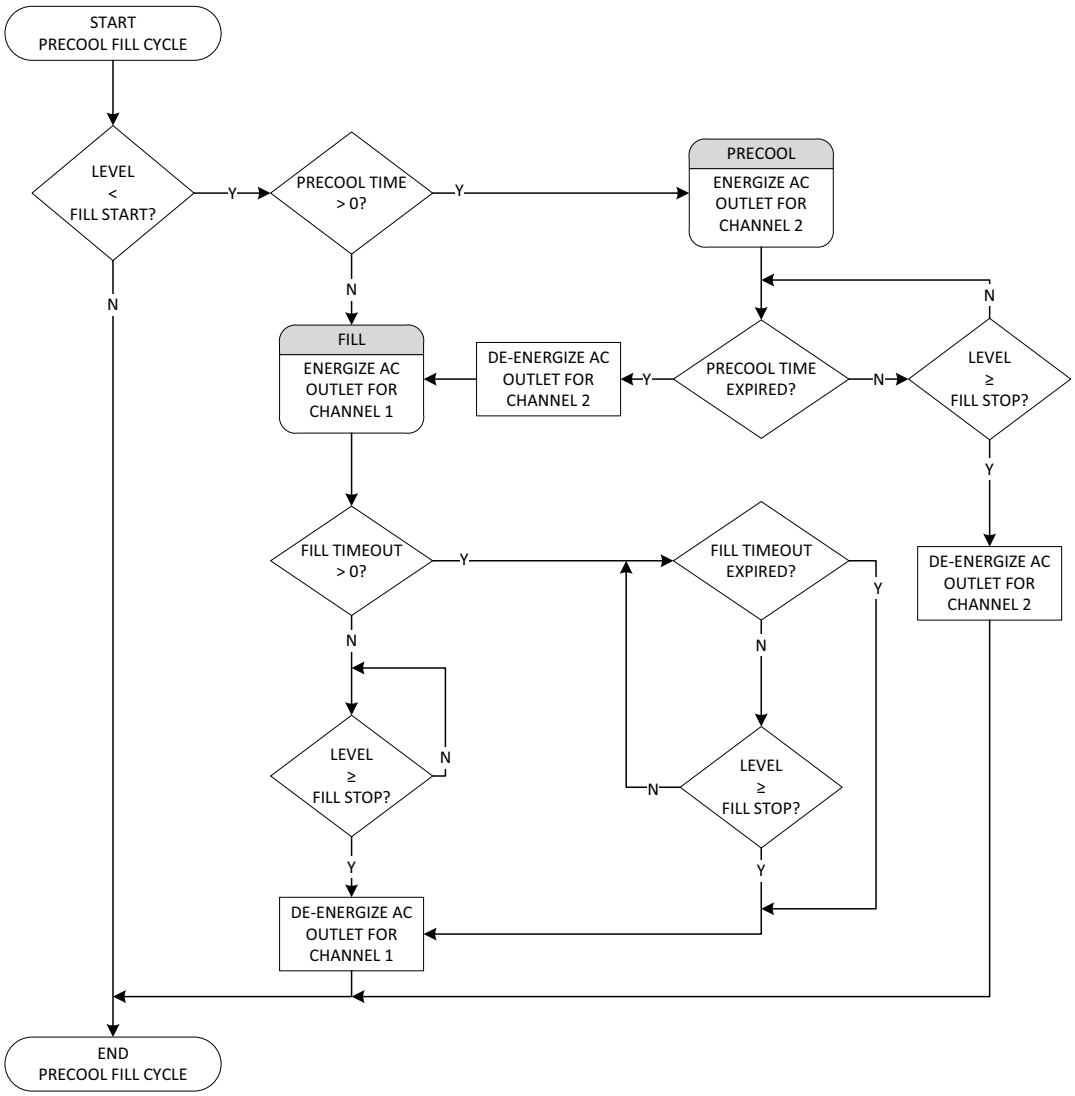
Pre-Cooled Status and Control on HOME Screen

The text above the level reading is the pre-cooled autofill state display/control text per the description in the table on page 62. Tap it to cycle through the available states. A **SAVE** is necessary to complete any change.

On the **HOME** screen, the footer shows **PRECOOL** as the present autofill mode and is also a shortcut to the **OUTPUT CONFIGURATION: AUTOFILL** screen. When not in the **HOME** screen, the pre-cooled state display/control text will be shown in the screen footer per the table on page 62.

FLOWCHART OF PRE-COOLED AUTOFILL FUNCTION

The diagram below illustrates the logical flow of the Pre-Cooled Autofill function.



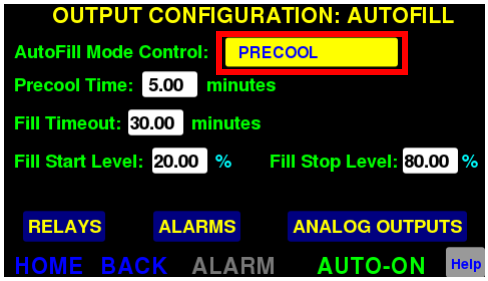
SETTING THE PRE-COOLED AUTOFILL PARAMETERS

The Pre-Cooled mode has several variables that must be configured. These include the the Fill Start Level (A), the Fill Stop Level (B), the Pre-Cool Time, and the Fill Timeout intervals.

Remember that changes are not effective until **SAVE** is applied.

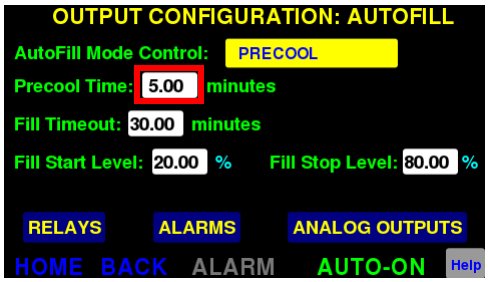
1. From the **MENU** screen, choose **OUTPUTS** and then choose **AUTOFILL**.

2. Toggle the **AutoFILL Mode Control** button until **PRECOOL** is displayed.



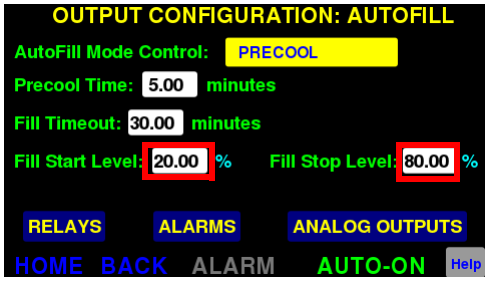
PRECOOL Autofill Mode Selection

3. Enter the **Precool Time** value in minutes. This is the time span where the venting valve is opened to allow gases to escape while the transfer line is cooling, but the fill valve is closed to the target dewar.



Pre-cooled Time Entry

4. Enter the fill **Start Level** and **Stop Level** for the single target dewar.

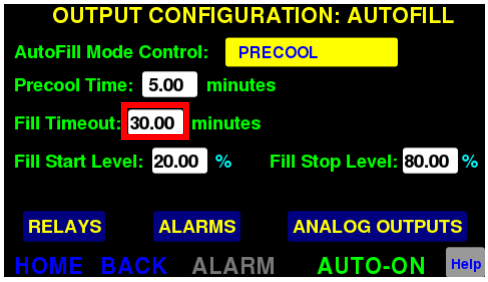


Pre-cooled Fill Start and Stop Level Settings

NOTE **If the Start Level value is set to 0.0% the autofill function will be effectively disabled.**

NOTE **Tapping the units symbol (%, in, or cm) allows selection of the available unit selections for that channel.**

5. Enter the **Fill Timeout** interval in minutes. The **Fill** timeout indicates a timeout for the target dewar once the **Precool Time** expires and the autofill is initiated. If the **Fill Timeout** expires during the autofill cycle, then the fill cycle will be interrupted and an alarm will be generated.



Pre-cooled Fill Timeout Setting

NOTE **If the Fill Timeout value is set to 0 minutes, the timeout function is effectively disabled.**

6. Ensure **SAVE** is selected to save the settings and then press **HOME** in the footer to return back to the level display.

ENABLE THE PRE-COOLED AUTOFILL FUNCTION

The Pre-Cooled autofill function must be enabled after the settings are configured. After the autofill control loop has been configured (via the parameters in the prior section) autofill will enter the **AUTO-OFF** state.

To enable the autonomous Pre-Cooled autofill function:

1. Touch the **AUTO-OFF** text in the **HOME** display or the footer until it reads **AUTO-ON**.
2. Touch **SAVE** to enable the autonomous autofill function.

The Pre-Cooled autofill function has four manually-selectable states by touching the fill state indicator either in the **HOME** screen or in the footer:

Pre-Cooled Autofill User-Selectable States

State	Description	Overrides
AUTO-ON	Automatically maintains the single target dewar level between **Fill Start** and **Fill Stop** setpoints (i.e. autonomous mode).	Autofill will generate a Timeout alarm and cease if the fill valve stays open for ≥ the **Fill Timeout** setting before reaching the **Fill Stop Level**.
M-OPEN	Manual Open: Energizes the VALVE CONTROL socket for Channel 1 on the rear panel. **NOTE:** *The Precool cycle will be executed first if the Precool Time > 0.*	Any active ALARM with >= setpoint defined for Channel 1 will close both valves and transition to M-CLOSED.
M-CLOSED	Manual Close: De-energizes the VALVE CONTROL sockets for Channel 1 and Channel 2 on the rear panel.	None
AUTO-OFF	Disables the AUTOFILL function.	None
M-PRECOOL	Manually initiates a PRECOOL cycle.	Once the PRECOOL time expires, the system will move to the **M-OPEN** state.

Pre-Cooled *Information-Only* States

State	Description
PRECOOL	*Information-only display* indicating the autofill cycle is in the venting state before the actual fill cycle.
FILLING	*Information-only display* indicating the fill valve is open to the target dewar and is timed according to the Fill Timeout setting.
TIMEOUT	*Information-only display* for the Fill Timeout Alarm active state. Filling is interrupted.

CLEARING THE PRE-COOLED FILL TIMEOUT ALARM

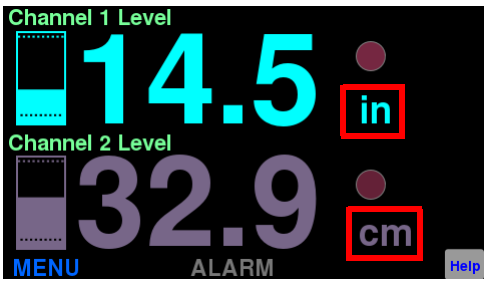
NOTE **A Loss of Sensor error condition (see page 25) will also halt an active Pre-Cooled autofill in addition to the fill timeout feature.**

1. Touch the **TIMEOUT** text in the **HOME** screen, or **TO** in the footer, for the channel in the timeout condition until **AUTO-ON** is displayed.
2. Touch **SAVE** in the footer. This will restart the autonomous autofill function.
3. To clear the **TIMEOUT** *without restarting* the autofill function, choose the **M-CLOSED** state and then choose **SAVE** in the footer.

SELECTING THE APPROPRIATE UNITS ON THE DISPLAY

Touch the units on the display to change the units. The available units are percent (**%**), inches (**in**), and centimeters (**cm**).

NOTE **Tapping the units symbol (%, in, or cm) in a configuration screen also allows selection of the available unit selections for that channel. The units selection is channel-wide for all indication and configuration values.**



Units Display on HOME Screen

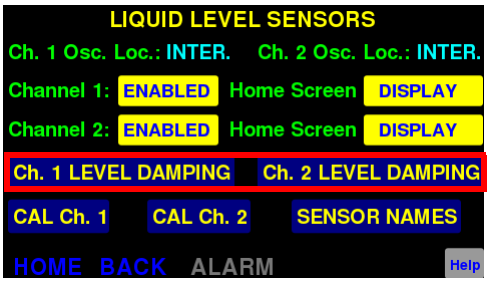
DAMPING CONFIGURATION

The level measurement function offers a damping feature which can be used to dampen fluctuations in the level reading that arise from sloshing liquids or other surface disruptions.

To set the damping for a given sensor channel:

1. From the main screen, choose the following: **MENU** > **SENSORS**. Ensure the desired channel is enabled.

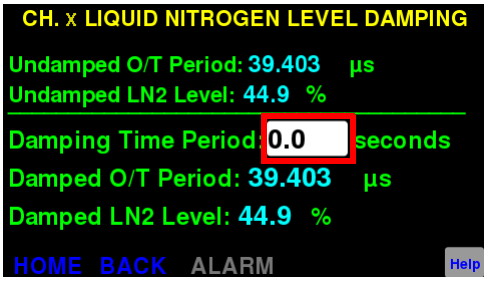
2. Choose **Ch. 1 or Ch. 2 LEVEL DAMPING**. This moves the display to the **LEVEL DAMPING** screen for the selected channel.



Choose Channel Damping

3. In the **LEVEL DAMPING** screen for the selected channel, enter the desired damping time in seconds. The damping is a first-order low-pass filter function where the damping period is equal to *five times the filter time constant* (99% of final reading).

   A damping period of 0.0 seconds means the damping function is disabled.



Damping Configuration

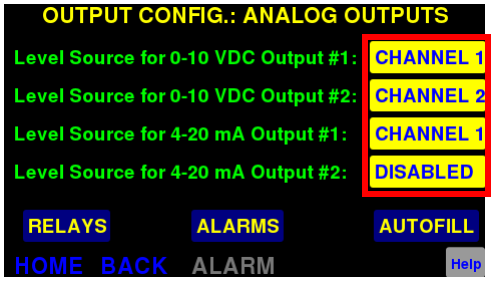
NOTE **If the damping period is set to a non-zero value for a given channel, the damping function will then be applied to the level measurement used for *all* indication and control functions for that channel. This includes analog output and fill cycle functions.**

ANALOG OUTPUT SIGNALS

Refer to "Aux I/O Connector" on page 134 of the Appendix for a connector pin-out.

CONFIGURING THE ANALOG OUTPUTS

1. From the **MENU** screen, choose **OUTPUTS**, then **ANALOG OUTPUTS**.
2. Choose the source for the **0-10 VDC** outputs and **4-20 mA** outputs as desired.
3. Press the **SAVE** button to save all choices (or **CANCEL** to quit without making a change).



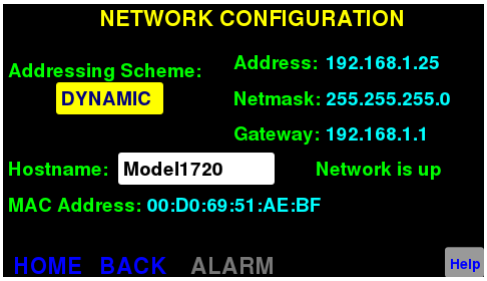
ANALOG OUTPUTS Source Selection

4. Press **HOME** to go back to the home screen.

ETHERNET CONNECTIVITY

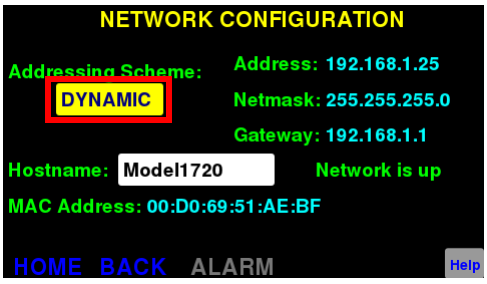
IP ADDRESSING SCHEME

1. From the **MENU** screen, choose **NETWORK**. The current settings will be displayed.



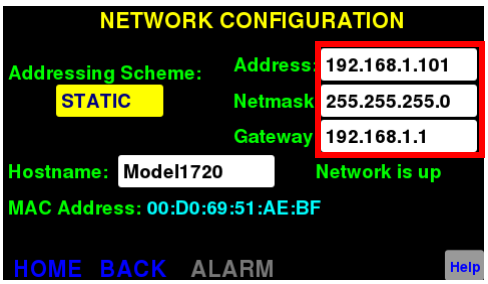
Network Configuration Screen

2. Touch the networking mode button, to choose **STATIC**, **DYNAMIC**, or **DISABLED** as appropriate.



Editing the Networking Mode

3. If **STATIC** is chosen for the addressing scheme, enter **Address**, **Netmask**, And **Gateway** values that are appropriate for the connected network. Once an address field is touched, the pop-up keyboard will be presented for data entry. Press **SAVE** when done.



Editing Static Network Parameters

4. Set the **Hostname** field as desired.

5. If the **DYNAMIC** addressing scheme is chosen, the **Address**, **Netmask**, and **Gateway** addresses will automatically be assigned from a network DHCP server. Press **SAVE** when done.

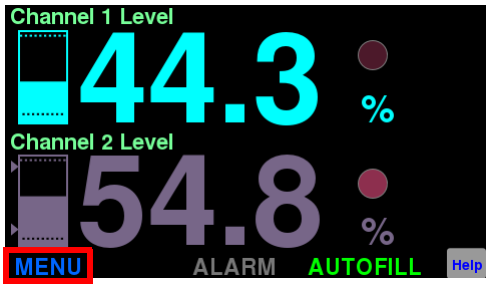
6. If changes are made, select the **SAVE** button and then the instrument will reconfigure itself with the chosen network settings.

SERIAL CONNECTIVITY

The serial (RS-232) connectivity can be customized per the following instructions.

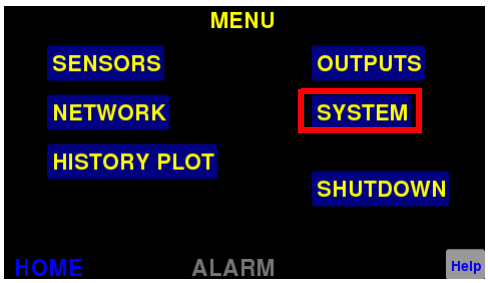
CONFIGURING THE RS-232 SETTINGS

1. From the home screen, choose **MENU**.



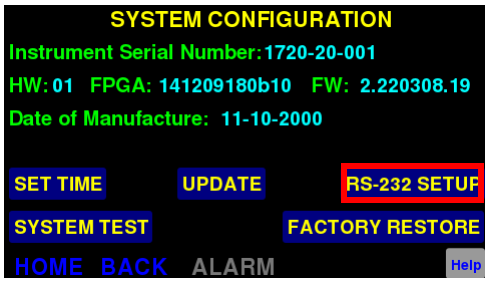
Menu Selection From Home Screen

2. From the **MENU** screen, choose **SYSTEM**.



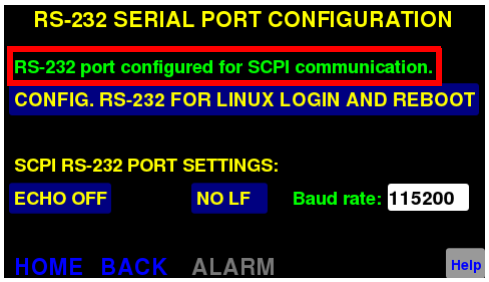
MENU Selection Screen

3. From the **SYSTEM CONFIGURATION** screen choose **RS232 SETUP**.



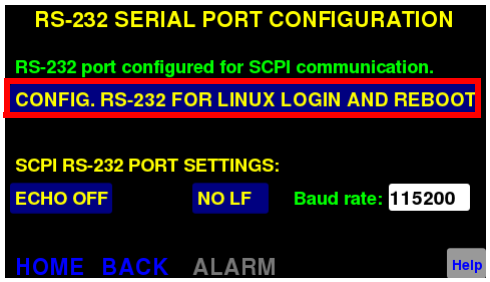
SYSTEM CONFIGURATION Screen

4. The RS-232 Configuration screen shows the current function for the serial connection.



RS-232 SERIAL PORT CONFIGURATION Screen

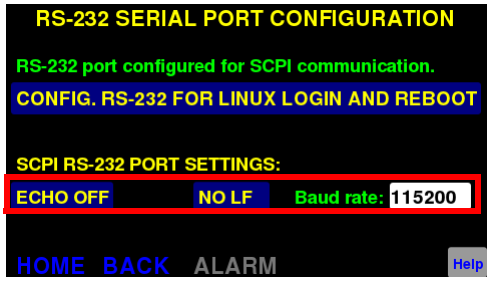
5. Choose the alternate function for the serial connection if desired.



RS-232 SERIAL PORT CONFIGURATION Screen

6. Choose to customize the port behavior for character echo, line ending, and baud rate.

7. If changes are made, select the **SAVE** button in the footer.



RS-232 SERIAL PORT CONFIGURATION Screen

ABNORMAL OPERATION

CAPACITANCE SENSOR CONTAMINATION

To ensure proper instrument calibration and operation, care must be taken to ensure the sensor is kept free of contaminants and not subjected to any force which would physically distort the sensor. Water or other electrically conducting substances in the sensor will disturb the measured capacitance and the instrument's response. Physically distorting the sensor in any way will also cause abnormal instrument operation by introducing variations in the sensor capacitance not due to liquid level. The absolute calibration of the instrument can be inaccurate if care is not taken to ensure the sensor is in the proper environment.

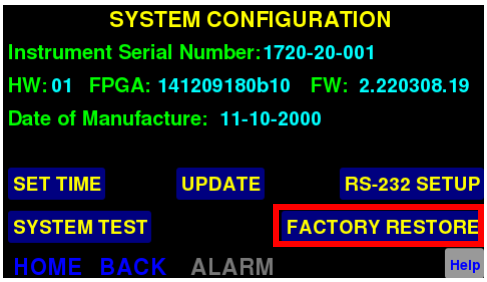
Cold sensors exposed to humidified air can show erroneous high level readings because the air contains moisture that can condense between the cold sensing tubes. A minute film of water can cause a shorted or partially shorted condition, which results in false level readings. As the sensor warms, the moisture may evaporate and the sensor will again read correctly. This is a physical phenomenon and does not indicate any problem with your AMI level equipment. Limit or eliminate exposure of cold sensors to humidified air to avoid this condition.

If a sensor should require cleaning and the sensor is for use with liquids other than liquid oxygen, flushing with pure alcohol is recommended. The sensor cannot be used again until all the alcohol has been evaporated. Under no circumstances should the sensor be disassembled.

For sensors to be used with liquid oxygen (LOX), although measures are taken to minimize oils and greases during manufacture, no special cleaning required for LOX service is provided by AMI. Certified LOX cleaning is the responsibility of the customer.

RESETTING THE INSTRUMENT TO FACTORY DEFAULTS

1. Press **MENU**, then **SYSTEM**, then **FACTORY RESTORE**.



System Configuration Screen

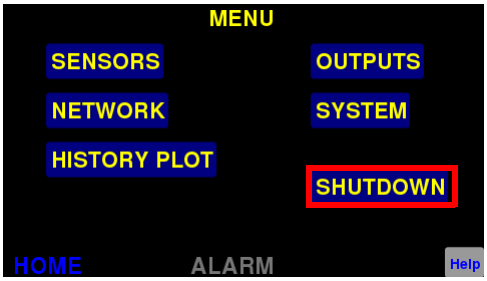
2. Press **RESTORE**.
3. The instrument will be reset to factory defaults.

Resetting Instrument to Factory Defaults

SHUTTING THE INSTRUMENT DOWN

NOTE **The Model 1720 Instrument is a Linux-based computer system and in order to ensure the file system is properly unmounted, the SHUTDOWN function should be invoked. If it is not, i.e. the instrument is shut down by removing power via the front panel power switch, the next time the instrument boots up, it will have to scan the memory system to ensure everything is in order.**

1. The instrument should be shut down by using the menu function **SHUTDOWN**.



Invoking Instrument Shut Down

2. Choose **SHUTDOWN** again to confirm.

3. When prompted, turn off the front panel power switch.

Confirming Instrument Shutdown

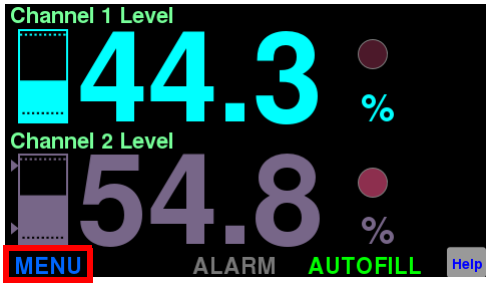
CALIBRATION

Model 1720 instrument is calibrated at the factory for a specific length sensor(s) for use in a specific liquid(s). The calibration length(s) and calibration liquid(s) are listed on the calibration sticker on the bottom of the instrument.For capacitance sensors, if the factory calibration method utilized was approximate, the calibration will be noted as an approximate value.

SETTING THE SYSTEM DATE AND TIME

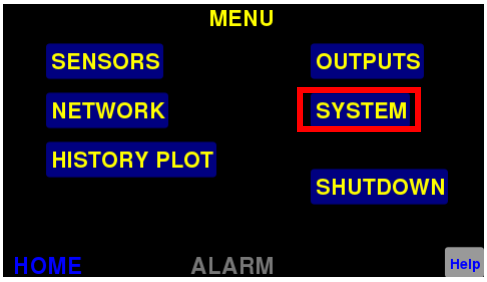
Setting the local date, time, and timezone is recommended to support accurate timestamps on calibration data and the logging function.

1. From the home screen, choose **MENU**.



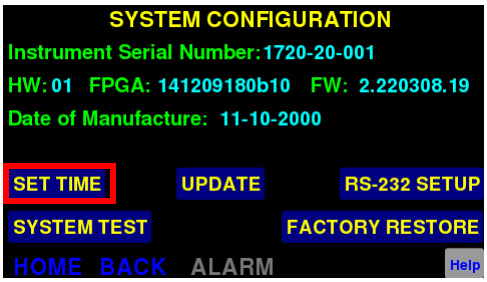
Menu Selection From Home Screen

2. From the **MENU** screen, choose **SYSTEM**.



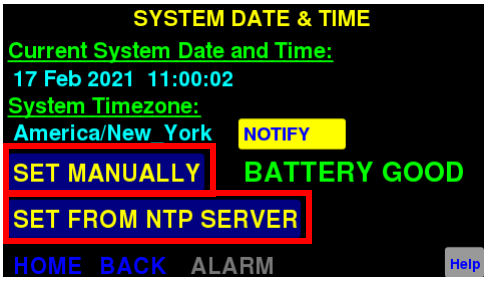
MENU Selection Screen

3. From the **SYSTEM CONFIGURATION** screen choose **SET TIME**.



SYSTEM CONFIGURATION Screen

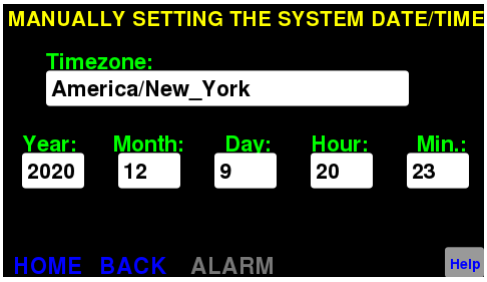
4. In the **SYSTEM DATE & TIME** screen, choose to either set the date and time *manually*, or set it automatically from an NTP server if the instrument has Internet access. Please note that NTP does not set the **System Timezone**.



SYSTEM DATE/TIME Screen

NOTE **Use the NOTIFY/NO NOTIFY button to enable/disable periodic clock battery discharge warning messages to the footer area.**

5. For the **SET MANUALLY** selection, edit the **Timezone**, **Year**, **Month**, **Day**, **Hour**, and **Min** fields as necessary. Touching in a field will launch the keyboard on the screen. Edit the information in the field as necessary and choose **ENTER** to enter the data in the field and close the pop up keyboard.



SYSTEM DATE/TIME Manual Entry

NOTE **The clock is set to GMT at the factory and is battery backed. The Timezone field must be set to a value from the TZ database.[1] The list of Timezone values can be found at:**

https://en.wikipedia.org/wiki/List_of_tz_database_time_zones

The Timezone entry must exactly match the entire field as listed in the above URL in the *TZ database name* column and it is case sensitive. An instrument reboot may be required for the Timezone

1. The tz database is a collaborative compilation of information about the world's time zones, primarily intended for use with computer programs and operating systems. The topic of worldwide timezones is a complex issue so please refer to the on-line resource noted above.

to take effect. If the entered Timezone supports Daylight Savings Time (DST), then the local time will be automatically adjusted to DST.

6. Choose **SAVE** in the footer after all the fields have been edited as necessary.

CAPACITANCE-BASED LEVEL CALIBRATION

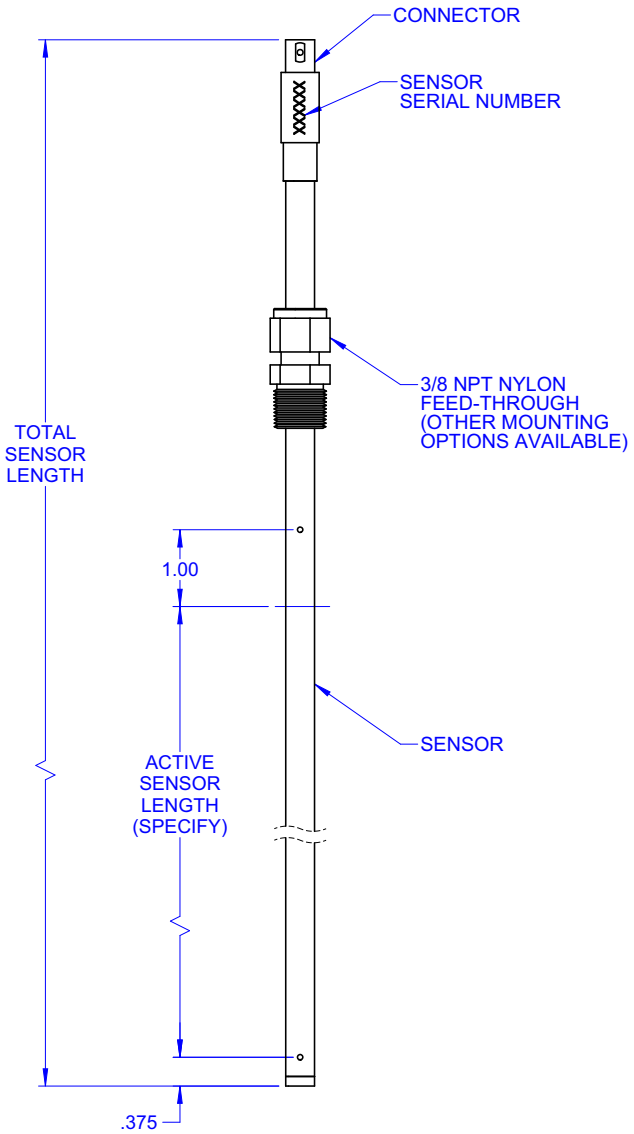
UNDERSTANDING THE SENSOR ACTIVE LENGTH

American Magnetics, Inc. fabricates the liquid level sensor with two vent holes; a lower vent hole in the side wall near the bottom which is typically the minimum liquid level calibration point and the upper vent hole in the sensor side typically near the top of the sensor. The liquid level location approximately 2.5 cm (1 in) below the upper vent hole is typically the 100% calibration point.

NOTE **Without entry of the active length, the instrument will not be able to read out in units other than percent.**

The Model 1720 Instrument requires the user to enter the calibrated, or active length, (physical distance between the MIN and MAX calibration locations on the sensor) in order for the absolute units function (inches, cm) to be displayed if desired.

The user must enter the sensor length in centimeters. Use the *Active Length* value noted on the level sensor documentation or measure the distance between the lower vent hole on the sensor and 1.0 inch (2.5 cm) below the upper vent hole on the sensor as illustrated at right.



Typical Capacitance-based Liquid Level Sensor

RELATIONSHIP BETWEEN CALIBRATION AND SENSOR LENGTH

The capacitance-based method of measuring the liquid level operates by measuring the period of a signal from an oscillator, which can be internal or contained in an external oscillator/transmitter unit. As the liquid level varies, the value of the sensor capacitance varies proportionally. Since the dielectric properties of liquids vary and the component tolerances for the sensor and oscillator introduce variations, a calibration is required to assure maximum accuracy for a specific sensor immersed in the target liquid. The calibration MIN and MAX settings correspond to the minimum and maximum oscillation periods, respectively, for a given sensor and target liquid configuration.

The length setting of the instrument is only provided as a means of scaling the 0% (minimum calibration) to 100% (maximum calibration) range of the measurement to meaningful units of length. During the calibration it is important to accurately measure the distance between the physical locations on the sensor corresponding to the MAX and MIN calibration points. The measured value for the length will be used in configuring the instrument for operation.

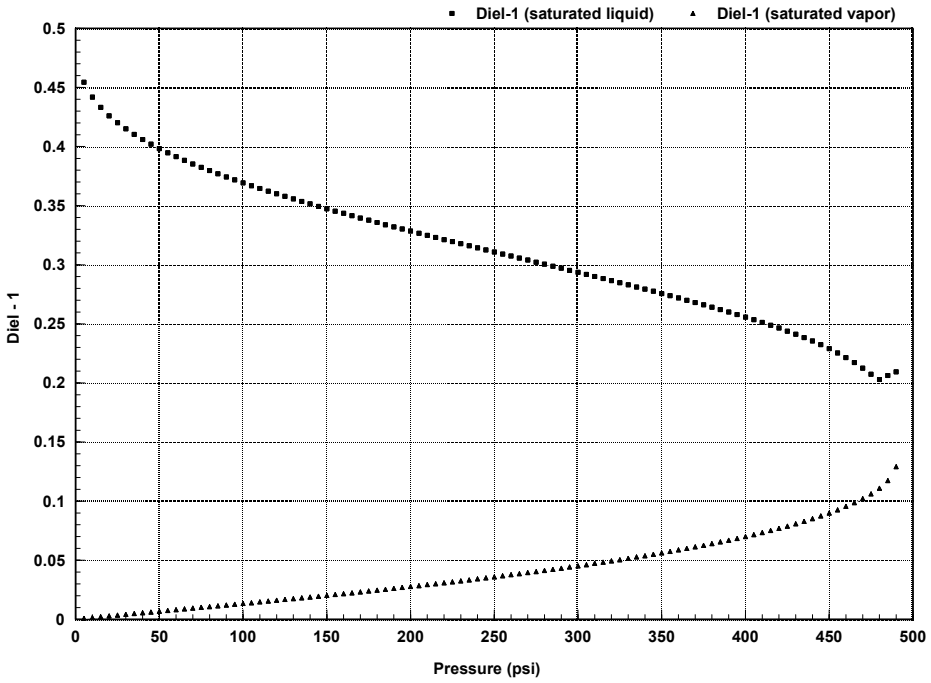
VARIATIONS IN THE DIELECTRIC WITH CHANGING DENSITY

For cryogenic liquids, the dielectric of the liquid will change with a change in density. The amount of change is dependent on the properties of the specific liquid. The figure below illustrates the variations in dielectric for nitrogen vs. pressure under *saturated* conditions.[1] Since the instrument uses a capacitance-based method for determining liquid level, such a change in the dielectric of the liquid will result in a shift in the level reading of the instrument. The calibration procedures described herein are most accurate when applied in situations where the operating conditions of the cryo-vessel are relatively constant, i.e. the operating pressure and temperature of the cryo-vessel are relatively constant.

To minimize the effects of shifts in the dielectric of the target liquid, perform a closed dewar calibration (see page 84) at the expected operating condition of the cryo-vessel. If this is not feasible, then calibrate the sensor at atmospheric pressure and use the approximate calibration method to compensate for the shift of the dielectric when the cryogenic liquid is under pressure. For this type of approximate calibration, the *reference liquid* will be the *target liquid* at atmospheric pressure — see page 89 for a detailed discussion of the approximate calibration method. If any questions exist in regard to calibration issues, contact AMI for assistance in determining the optimal calibration strategy.

NOTE **All references to "dielectric constant" herein refer to the unitless relative dielectric to ε_0 (e_0 is the dielectric constant of a vacuum).**

1. Data obtained from NIST Standard Reference Database 12.



Dielectric vs. pressure for nitrogen under saturated conditions.

CAPACITANCE-BASED SENSOR CALIBRATION METHODS

The most straightforward calibration method is the *Open Dewar Calibration* which requires the customer to have access to a filled dewar where the full active length of the sensor can be dipped. The *Closed Dewar Calibration* method can be performed in situations where it is not feasible for the customer to dip the sensor into an open dewar, such as situations where the target liquid is under pressure. The closed dewar calibration is more complex and may require initial preparations to insure success and avoid saturation of the signal during the calibration.

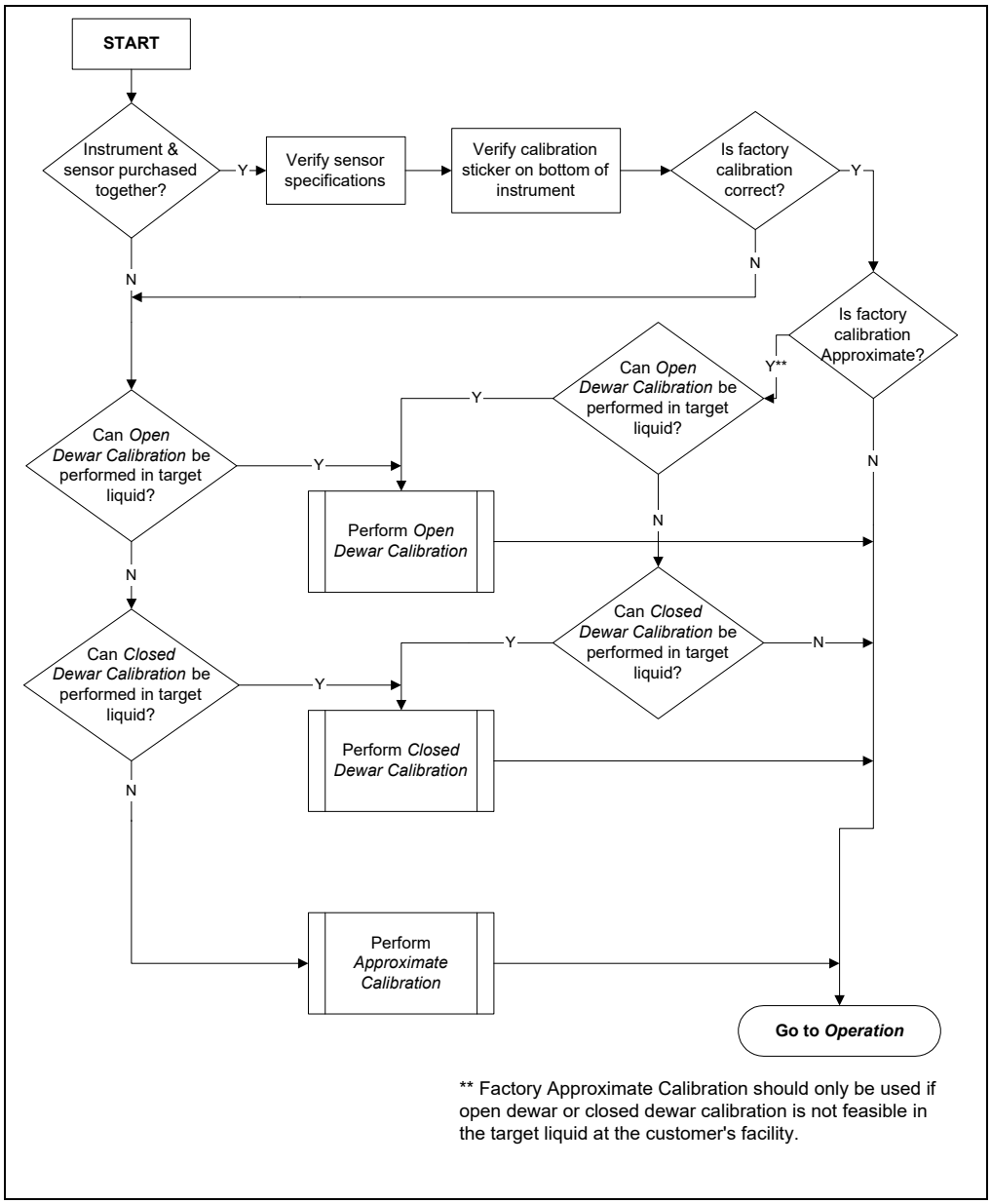
Occasionally customers ask AMI to calibrate an instrument and sensor for a liquid which is not available at AMI for calibration purposes and/or for a sensor which is too long to be calibrated at our facilities.

For the case of the target liquid being unavailable, AMI uses liquid nitrogen as the reference liquid and an *Approximate Calibration* is performed using mathematical manipulation of the ratio of the dielectric constants between liquid nitrogen and the desired liquid. This procedure is outlined in the *Approximate Calibration* section beginning on page 89. The technique is intended to provide the instrument with an approximate calibration so that it can be used immediately by the customer. However, the customer is still expected to perform a more accurate calibration where feasible, such as the open dewar or closed dewar calibration, with the target liquid.

For the case where a sensor is too long to be calibrated in AMI facilities, AMI will perform a partial length open dewar calibration in liquid nitrogen, and then calculate the MAX calibration point. A dielectric ratio may also be subsequently utilized to adjust for a target liquid other than liquid nitrogen. The customer is expected to perform a more accurate open dewar or closed dewar calibration if feasible.

SELECTION OF CAPACITANCE SENSOR CALIBRATION METHODS

As a quick guide for selection of the best calibration method available, a calibration selection diagram is presented below.



Calibration method selection diagram.

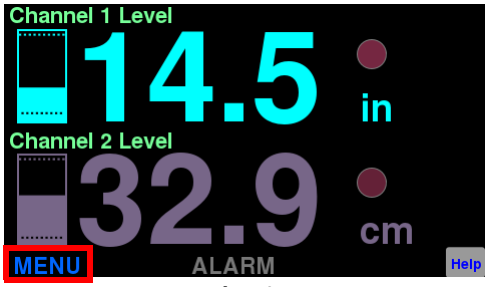
If the instrument and sensor are purchased as a unit from AMI, then the factory calibration, including sensor serial number and sensor physical parameter information entered at the factory, will be adequate in most cases. However, for the exceptions noted in the previous paragraphs (which are *approximate* calibrations), the customer should perform a more accurate open dewar or closed dewar calibration if at all possible. A customer-performed calibration is also *required* for sensors that are purchased as a separate item from the instrument, since the instrument and sensor were not both available for calibration at AMI facilities.

Each Model 1720 Instrument must be calibrated with a sensor before use. If the instrument was purchased with a sensor to be used in liquid nitrogen, the instrument has been calibrated at the factory.

PRE-CALIBRATION PROCEDURE

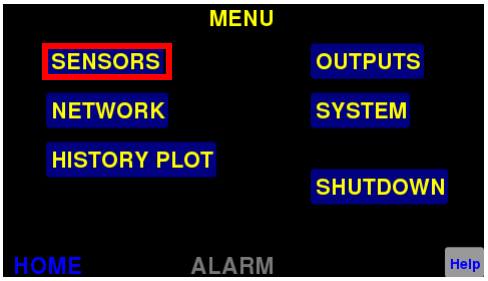
ENTER CAPACITANCE SENSOR INFORMATION

1. Press the **MENU** button in the lower left corner of the display screen.



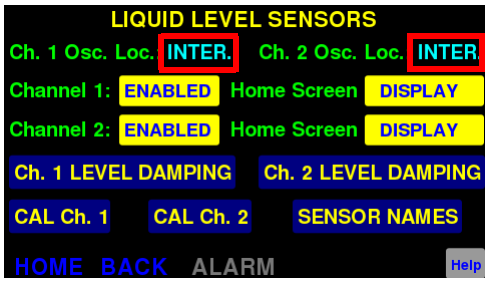
MENU Selection Button

2. Choose the **SENSORS** selection from the **MENU** screen.



SENSORS Selection

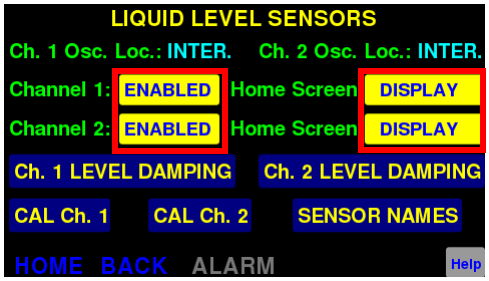
3. Verify that the oscillator source selection is correct, either **INTER.** (internal) or **EXTER.** (external). Note that this setting is auto-detected by the instrument at power-up or reboot,



OSCILLATOR Selection

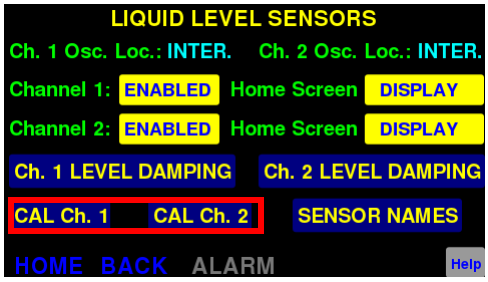
NOTE **If the capacitance sensor will be longer than 15 feet from the instrument, ensure an Oscillator/Transmitter is used between the instrument and the sensor.**

4. Choose which channels are enabled and displayed on the **HOME** screen.



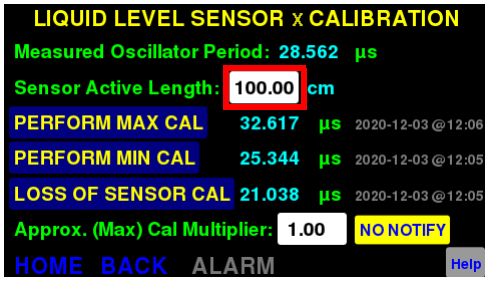
Enabling and Displaying Channels

5. Press the **CAL Ch. 1** *or* **CAL Ch. 2** button



CALIBRATE Channel Selection

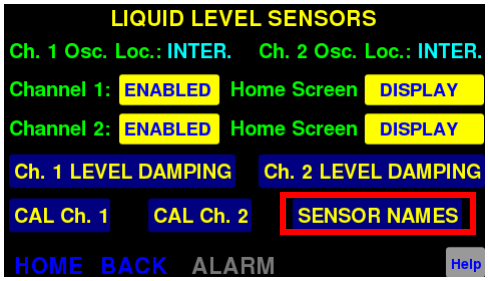
6. Touch in the **SENSOR ACTIVE LENGTH** field and using the numerical keypad, enter the sensor active length in cm. Press **ENTER** and then **SAVE** at the bottom of the screen when finished.



Sensor Active Length field

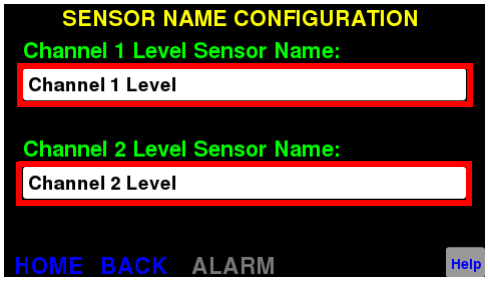
NOTE **Tapping the units symbol (in or cm) allows selection of the other available unit selection for that channel.**

7. Press the **SENSOR NAMES** button.



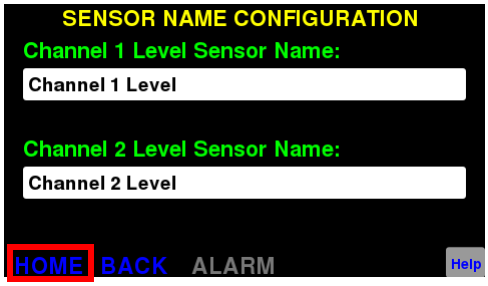
SENSOR NAMES Selection

8. Touch in the **Channel 1 (or 2) Level Sensor Name:** field. The keyboard will be displayed. Edit the displayed name and press **ENTER** at the bottom of the screen.



PERFORM MAX CAL. Selection Button

9. Press **HOME** in the screen footer to return to the level display screen.



Home Selection Button

PERFORMING LOSS OF SENSOR CALIBRATION

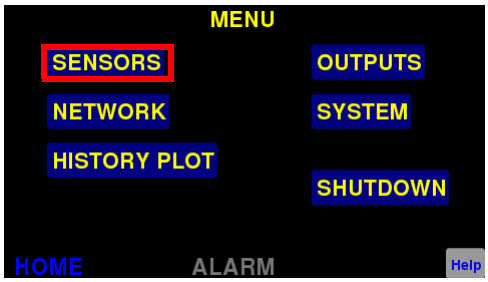
The Model 1720 will detect when the liquid level sensor has been disconnected from the instrument and display a notification on the front panel. If the instrument has been configured for autofill, the fill valve will be shut, requiring operator intervention to resume autofill operation. This loss of sensor threshold must be calibrated as follows:

For a system where the internal oscillator is used, connect the coaxial cable to the BNC connector on the instrument rear panel but leave the cable disconnected from the sensor BNC connector. For a system where an external oscillator is used, connect the coaxial cable between the instrument and the oscillator/transmitter unit. Connect the second (6 ft) coaxial cable to the input of the oscillator/transmitter unit but leave the cable disconnected from the sensor BNC connector.

1. Press the **MENU** button in the lower left corner of the display screen.

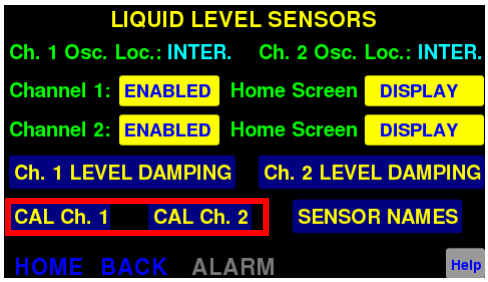
MENU Selection Button

2. Choose the **SENSORS** selection from the **MENU** screen.



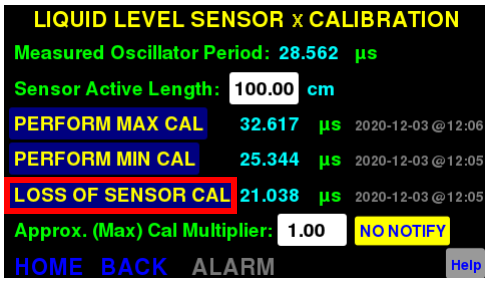
SENSORS Selection

3. Press the **CAL Ch. 1** *or* **CAL Ch. 2** button.



CAL Channel Selection

4. Select the **LOSS OF SENSOR CAL** button.
5. When the calibration procedure is completed, choose **SAVE** in the footer of the screen.
6. Press **HOME** to return to the home screen.
7. Connect the coaxial cable to the liquid level sensor.

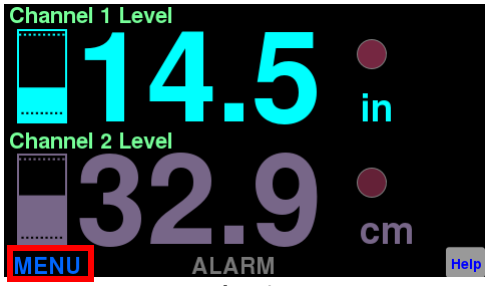


LOSS OF SENSOR CAL button

OPEN DEWAR CALIBRATION

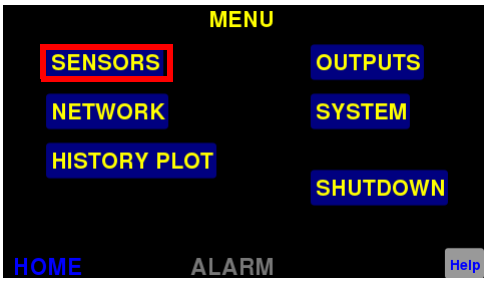
The *Open Dewar Calibration* requires the customer to have access to a filled dewar where the full active length of the sensor can be dipped.

1. Press the **MENU** button in the lower left corner of the display screen.



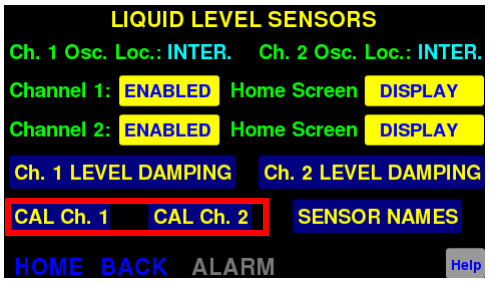
MENU Selection Button

2. Choose the **SENSORS** selection from the **MENU** screen.



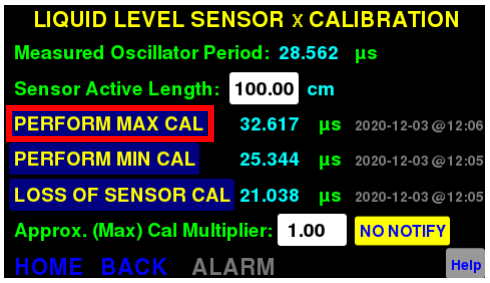
SENSORS Selection

3. Press the **CAL Ch. 1** *or* **CAL Ch. 2** button.



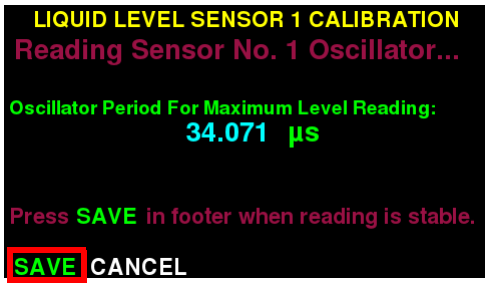
CAL Channel Selection

4. Position the capacitance sensor in the target liquid at the 100% level. Hold the sensor at this location and press the **PERFORM MAX CAL** button.



PERFORM MAX CAL Selection

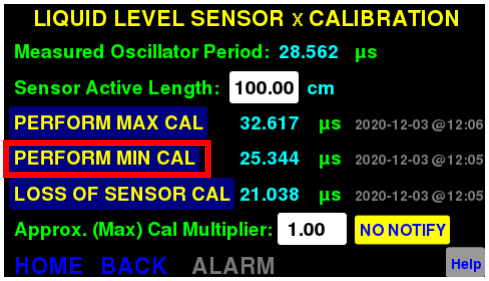
5. The instrument will display the following screen as it takes data. Once the calibration measurement stabilizes, press the **SAVE** button. The operator *must* press the **SAVE** button for the new cal point to be saved.



Updating MAX CAL Period

6. Position the capacitance sensor in the target liquid at the 0% level. Hold the sensor at this level and press the **PERFORM MIN CAL** button.

7. While displaying "**Reading Sensor...**", the instrument will display the **MIN LEVEL PERIOD**. Press the **SAVE** button to save the new minimum level calibration point.



PERFORM MIN CAL Selection

NOTE **Note that the waveform periods listed to the right of the PERFORM MAX CAL and PERFORM MIN CAL buttons are updated as well as the date and time stamps of the calibration points.**

NOTE **The minimum and maximum calibration can be performed in either order. Also, either the minimum or maximum calibration point can be updated without altering the other calibration point.**

CLOSED DEWAR CALIBRATION

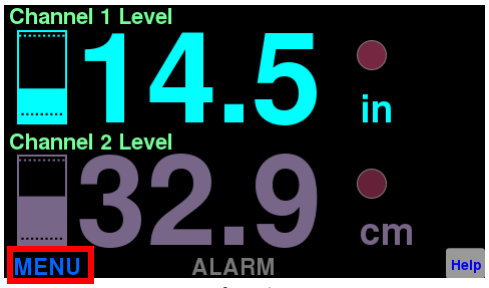
A calibration can be performed in a closed dewar system by monitoring the liquid level while transferring the target liquid to an initially empty (or near empty) dewar at a constant rate. In order to insure success with the closed dewar technique, it is necessary to prepare the instrument by presetting the calibration minimum and maximum calibration points outside the estimated level range. If the instrument is not prepared in this manner before the calibration procedure, it is possible to reach the maximum calibration point of the instrument before the target vessel is at the desired maximum level point. If minimum and maximum liquid level indication is available via some other means (e.g. flow calculation, visual determination, point sensors, etc.), then the presetting of the instrument is not necessary.

PRESETTING THE MAXIMUM AND MINIMUM CALIBRATION POINTS

The following procedure should be performed before installation of the sensor in the target cryo-vessel.

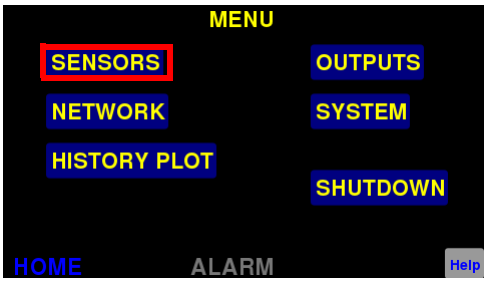
1. Connect the sensor coaxial cable to the BNC connector on the rear panel of the instrument (see page 17). *Do not connect the sensor.* Energize the instrument.

1. Press the **MENU** button in the lower left corner of the display screen.



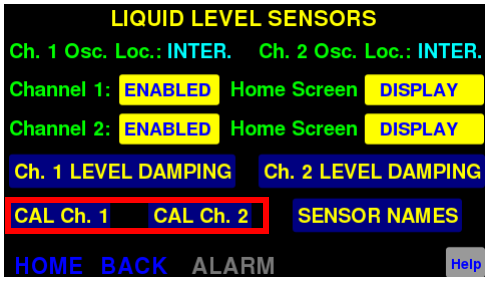
MENU Selection Button

2. Choose the **SENSORS** selection from the **MENU** screen.



SENSORS Selection

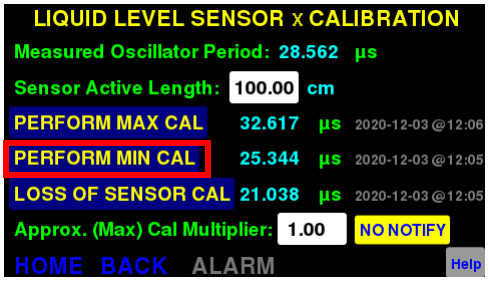
3. Press the **CAL Ch. 1** *or* **CAL Ch. 2** button.



CAL Channel Selection

4. Press the **PERFORM MIN CAL** button.

5. While displaying "**Reading Sensor...**", the instrument will display the **MIN LEVEL PERIOD**. Press the **SAVE** button to save the new minimum level calibration point.



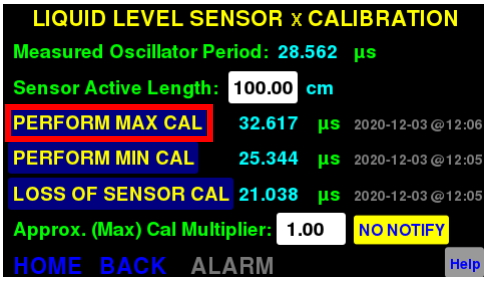
PERFORM MIN CAL Selection

NOTE **Note that the waveform period listed to the right of the PERFORM MIN CAL button is updated as well as the date and time stamp of the calibration point.**

6. Connect the sensor to the oscillator coaxial cable that is connected to the instrument.

7. Perform the maximum level calibration by pressing **PERFORM MAX CAL**.

8. While displaying "**Reading Sensor...**", the instrument will display the **MAX LEVEL PERIOD**. Press the **SAVE** button to save the new maximum level calibration point.



PERFORM MAX CAL Selection

9. Calculate the factor C_{adj} using the following equation:

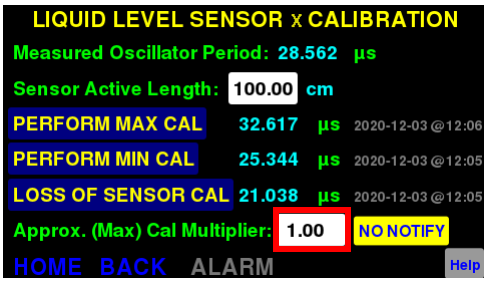
$$C_{adj} = 1.20\left[1 + \frac{2.1(L_{active})}{5.2(L_{total})}\right]\left[\frac{\varepsilon - 1}{0.454}\right]$$

where L_{total} is the total sensor length in inches, L_{active} is the active sensor length in inches, and ε is the dielectric constant of the *target liquid*.

10. Enter C_{adj} into the instrument by touching the **APPROX MAX CAL** field.

11. Using the pop up numeric keypad, enter the C_{adj} value and press the **SAVE** button.

12. With the sensor connected, again press the **PERFORM MIN CAL** button and **SAVE** the result. The presetting procedure is complete.
Proceed to the remainder of the closed dewar calibration procedure as presented below.



APPROX MAX CAL Entry

COMPLETING THE CLOSED DEWAR CALIBRATION PROCEDURE

1. Install the sensor in the dewar and energize the instrument with the sensor connected to the instrument via the oscillator (if required) and extension cable(s) (see the system diagram on page 2).

2. Connect a strip chart recorder or graphical data logging application to the recorder output terminals on the rear panel of the instrument. If the recorder output is not available, the 4-20 mA current loop output may be used if installed, or an installed communications option can be used to query the instrument for the liquid level at regular time intervals during the calibration procedure to plot the result. If no remote monitoring or communication option is installed, the level display must be manually plotted vs. time during the procedure.

3. Refer to “Analog Output Signals” on page 65. to configure the recorder output or current loop output.

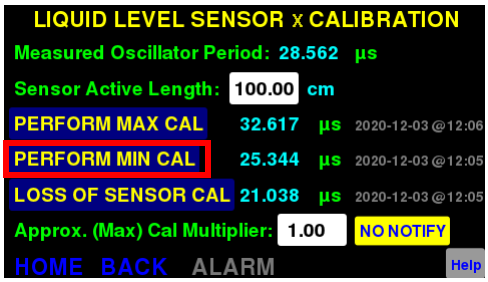
4. Commence filling the dewar. While the sensor is cooling down, there may be a slow drift in the displayed liquid level. However, when the liquid actually touches the bottom of the sensor, contact with the liquid surface may become apparent by virtue of more random and frequent fluctuations in the displayed liquid level. The liquid level trace will also start to show an increasing profile with positive slope.

   Once the indications of the contact between the sensor and liquid become readily apparent, use the **PERFORM MIN CAL** procedure below to save the new minimum calibration point. This point is the 0% level of the sensor when the **PERFORM MIN CAL** procedure is finished and saved becomes the 0% level.

NOTE **If the sensor is installed in the dewar with some small amount of liquid already in contact with the sensor, then the final minimum calibration point can be set before filling begins but after any thermally induced fluctuations in the observed output have diminished. However, note that the measured span of the liquid level is reduced by the initial level of liquid in contact with the sensor.**

5. Press the **PERFORM MIN CAL** button.

6. While displaying "**Reading Sensor...**", the instrument will display the **MIN LEVEL PERIOD**. Press the **SAVE** button to save the new minimum level calibration point.



PERFORM MIN CAL Selection

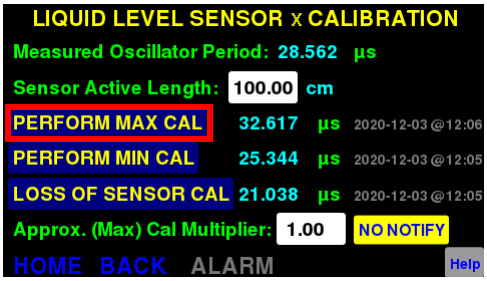
NOTE **Note that the waveform period listed to the right of the PERFORM MIN CAL button is updated as well as the date and time stamp of the calibration point.**

7. Continue the transfer while observing the liquid level trace on the strip chart recorder or computer display, whose slope is proportional to the transfer rate. The slope of the liquid level trace should decrease significantly when the liquid reaches the hole in the top of the sensor.

   When the break in the slope of the level trace occurs (i.e. the slope of the level trace becomes 0 or horizontal), perform a **PERFORM MAX CAL** procedure below. The level on the sensor when the **PERFORM MAX CAL** procedure is finished and saved becomes the 100% level.

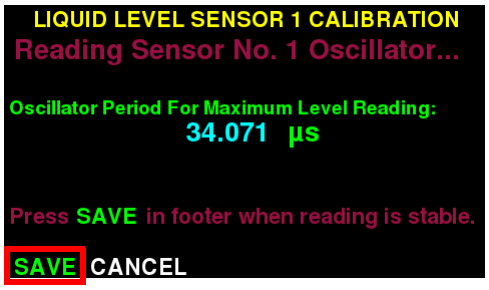
NOTE **If the instrument displayed a 100% reading before a break is observed in the slope of the level trace, then the maximum calibration point set prior to the current procedure has interfered. If this occurs, the customer has two options: 1) stop the procedure, repeatedly multiply C_{adj} by 1.20 (see steps 4 and 5 of the presetting procedure) and enter as the new APPROX MAX CAL value until the current liquid level display falls below 100%, and then continue the procedure; or 2) continue the liquid transfer until the liquid level is determined to be 100% by means other than feedback from the instrument and then performing the maximum calibration procedure.**

8. Perform the maximum level calibration by pressing **PERFORM MAX CAL**.



PERFORM MAX CAL Selection

9. While displaying "**Reading Sensor...**", the instrument will display the **MAX LEVEL PERIOD**. Press the **SAVE** button to save the new maximum level calibration point.



Updating MAX CAL Period

NOTE **Note that the waveform period listed to the right of the PERFORM MAX CAL button is updated as well as the date and time stamp of the calibration point.**

10. To achieve a standard calibration of the sensor with the active region located from the lower hole to one inch below the upper hole, use the level data from the instrument to recalibrate the maximum point when the percent level corresponds to one inch below the upper hole. Use the following equation to determine the percent level at which to reset the maximum calibration point:

$$MAX_{percent} = 100 - 100\left[\frac{1}{L_{active}}\right]$$

where L_{active} is the active length of the sensor in inches. This technique can be used assuming the sensor was built as a standard sensor. If the sensor was made in a custom configuration, refer to the sensor documentation and/or drawing or contact AMI.

***Example**: 20" active length sensor:*

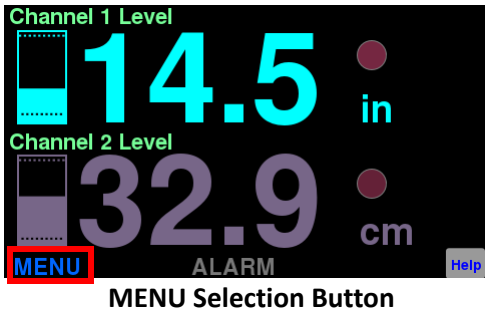
When the sensor is calibrated by the closed dewar procedure, the actual length of calibration will be 21" (distance between the bottom and top holes in the sensor). When the liquid is 1" below the upper hole, the display will show 95.2% [e.g. 100% – (1"/21" x 100%)]. When the liquid level reaches this point during usage, perform the **PERFORM MAX CAL** operation and **SAVE** the result. The instrument and sensor are now calibrated with a standard active region of 20". The length setting of the sensor in the instrument should also be configured for 50.8 cm (20").

APPROXIMATE CALIBRATION

This procedure is the least accurate form of calibration and should be used only when the aforementioned calibration procedures are not viable. The approximate calibration method can be used in cases where the sensor cannot be dipped into the target liquid, the full active length of the sensor cannot be dipped into an open dewar, or both. Approximate calibration may also be useful for situations where the sensor cannot be dipped into the target liquid under the expected operating pressure.

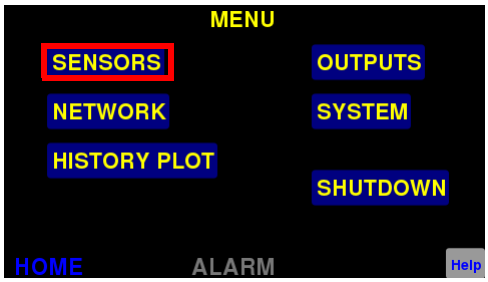
If the target liquid is not available for dipping, a substitute non-conducting reference liquid can be used. If the full length of the sensor cannot be dipped, then a partial length dip can be performed. If both situations are encountered, then a partial length dip can be performed in a substitute reference liquid.

1. Press the **MENU** button in the lower left corner of the display screen.



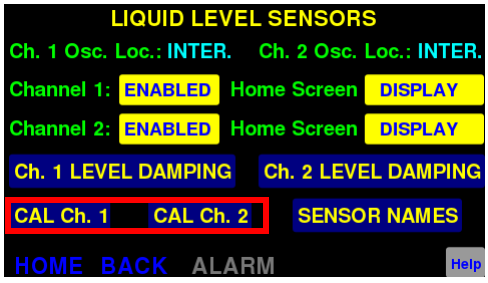
MENU Selection Button

2. Choose the **SENSORS** selection from the **MENU** screen.



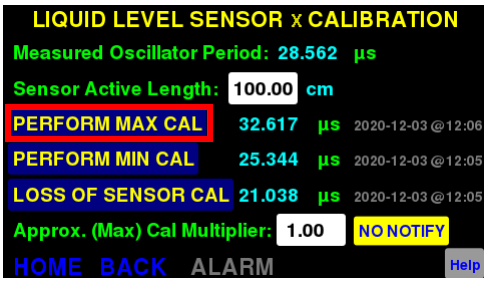
SENSORS Selection

3. Press the **CAL Ch. 1** *or* **CAL Ch. 2** button.



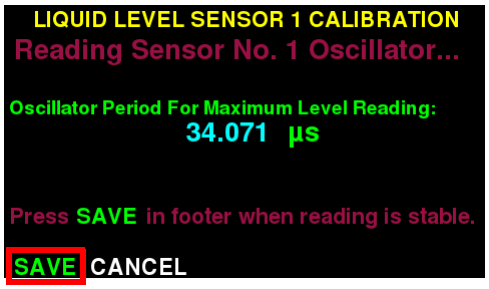
CAL Channel Selection

4. Position the capacitance sensor in the substitute liquid at the 100% level. Hold the sensor at this location and press the **PERFORM MAX CAL** button.



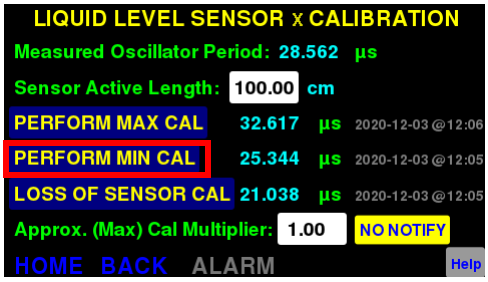
PERFORM MAX CAL Selection

5. "**Reading Sensor...**", the instrument will display the maximum period. Press the **SAVE** button to save the new maximum level calibration point.



Updating MAX CAL Period

6. Position the capacitance sensor in the target liquid at the 0% level. Hold the sensor at this level and press the **PERFORM MIN CAL** button.
7. While displaying "**Reading Sensor...**", the instrument will display the minimum period. Press the **SAVE** button to save the new minimum level calibration point.



PERFORM MIN CAL Selection

NOTE **Note that the waveform periods listed to the right of the PERFORM MAX CAL and PERFORM MIN CAL buttons are updated as well as the date and time stamps of the calibration points.**

NOTE **The minimum and maximum calibrations can be performed in either order. Also, either the minimum or maximum calibration point can be updated without altering the other calibration point.**

8. Measure the distance between the bottom hole of the sensor and the location of the liquid level dipped for max calibration. This measured length is L_{dipped}.
9. The dielectric constant for the reference liquid, ε_1, and the target liquid, ε_2, must be known to complete the approximate calibration. These values must

be placed in the equation:

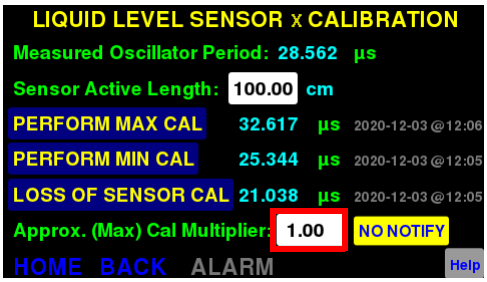
$$\text{APPROX MAX CAL} = \left[\frac{\varepsilon_2 - 1}{\varepsilon_1 - 1}\right]\frac{L_{active}}{L_{dipped}}$$

where L_{dipped} is the length of the sensor dipped in the reference liquid and L_{active} is the active sensor length.

NOTE **If the target liquid is available for dipping (i.e. the reference liquid and target liquid are the same), then the dielectric ratio, $(\varepsilon_2 - 1)/(\varepsilon_1 - 1)$, becomes 1. If the full active length of the sensor can be dipped, then the length ratio, L_{active} / L_{dipped}, becomes 1.**

Note that ε_1 = 1.454 for liquid nitrogen at -203°C at atmospheric pressure. Dielectric constants for several liquids are provided in the Appendix. The dielectric constant varies with temperature and pressure, therefore for best accuracy use the dielectric constant for the target liquid at the temperature and pressure maintained in the containing vessel.

10. Touch the **APPROX MAX CAL** field and using the numerical keypad that pops up, enter the value to be applied and press **SAVE** in the footer.



APPROX MAX CAL Entry

NOTE **The calibration values are retained in the instrument memory, therefore it is possible to repeatedly adjust the APPROX MAX CAL value without losing the original MIN/MAX calibration points.**

Example: Purchased a 100" active length sensor for operation in liquid argon at atmospheric pressure, however only liquid nitrogen is available for calibration at a maximum depth of 30":

First, the sensor is dipped as far as possible into the liquid nitrogen and cooled. The minimum point is then set as outlined in step 2. The maximum point is set as outlined in step 3 while the sensor is submerged 30" in liquid nitrogen. The dielectric constant for liquid nitrogen is 1.454 and for liquid argon is 1.53. Substituting all values into the approximate calibration factor equation yields:

$$\text{APPROX MAX CAL} = \left[\frac{1.53 - 1}{1.454 - 1}\right]\frac{100}{30} = 3.891$$

A value of 3.891 would be entered as the **APPROX MAX CAL** factor as outlined in step 10 above. The sensor is now approximately calibrated for 100" active length operation in liquid argon.

11. The sensor can now be installed in the dewar containing the target liquid. The approximate calibration can be used until an open dewar or closed dewar calibration can be performed with the target liquid.

Proceed to the *Operation* section for directions for configuring the instrument.

REMOTE INTERFACE REFERENCE

The Model 1720 Instrument provides both serial (RS-232) and Ethernet interfaces as standard features. The serial and Ethernet interfaces can be operated simultaneously. Separate output buffers are provided for the serial and Ethernet return data. The serial and Ethernet interfaces accept SCPI syntax for commands and queries.

The Model 1720 provides a web browser connection (port 80) via TCP/IP and presents a mirror of the local display which has hot spots that can be clicked or tapped, and which also accepts keyboard entry for textual and numerical input. The instrument's IP address can be ascertained by referring to the section titled "IP Addressing Scheme" on page 65. By using a web browser to connect to the instrument, all functionality of the Model 1720 can be controlled via the remote connection.

Communication with the Model 1720 via Ethernet or RS-232 (serial) interface can also be accomplished via the interactive mode of a commercially available terminal emulation program, or by socket (port 7180) or COM port programming. When the Model 1720 receives a terminated ASCII string, it *always* sends back a reply as soon as the string is processed. *When sending commands to the Model 1720, you should wait for the reply from the Model 1720 before sending another command even if the reply consists of only termination character(s)*.

SCPI COMMAND SUMMARY

The following manual conventions are used for SCPI (*Standard Commands for Programmable Instruments*) syntax for the remote interface commands:

- Braces { } enclose valid parameter choices.
- A vertical bar | separates multiple choices for each parameter.

- Triangle brackets < > indicate that you *must* supply a value (do not include the brackets in the command).
- Parentheses ( ) within < > indicate alternative units are available.
- Capitalized portions of the commands indicate acceptable abbreviations.

For example, the command `CONFigure:RELay1:CHannel {0|1|2}` indicates that the command `CONFigure:RELay1:CHannel` has three parameter options: `0`, `1`, or `2`, with `0` (disabled) being the default value.

The following section is a reference list of SCPI commands. Refer to the detailed description of each command for information regarding specific parameter choices and their meanings. Default settings are shown in bold.

COMPATIBILITY SUPPORT FOR THE AMI MODEL 1700

Support is provided for the command set from the AMI Model 1700. These commands are differentiated by the command text `N2`. *These commands will apply only to Channel 1 in the Model 1720.* More details are provided in the detailed Command Description section beginning on page 103.

COMPATIBILITY SUPPORT FOR THE LEGACY AMI MODEL 286

Support is also provided for a *subset* of the command set from the legacy instrument AMI Model 286. These compatibility commands are typically synonyms for the standard Model 1720 mnemonics, however, there are exceptions. More details are also provided in the detailed Command Description section.

UNDOCUMENTED COMMANDS/QUERIES

AMI Technical Support may at times recommend use of some undocumented remote commands/queries for the Model 1720. These are typically prefaced by the `set-var` and `get-var` directives. These commands directly write and read, respectively, the internal system variables. The variable names are not guaranteed to be forward- or backward-compatible and generally should not be relied upon for production system operation.

System-Related Commands

(see page 103 for more information)

```
*IDN?
*RST
*TST?

SERial_NUMber?
DATE_MANUFacture?
HardWare_VERsion?
FirmWare_VERsion?
Scpi_VERsion?

SYStem:BEEPer:IMMediate <seconds>
SYStem:BEEPer:STATe {0|1}
SYStem:BEEPer:STATe?

SYStem:KLOCK {0|1}
SYStem:KLOCK?

SYStem:DATE <yyyy>,<mm>,<dd>
SYStem:DATE?

SYStem:TIME <hh>,<mm>,<ss>
SYStem:TIME?

SYStem:REBOOT

IPV4addr?
MACADDR?
GATEWAY?
HOSTname?

SCREENCAP
SYStem:LOcal
SYStem:REMote
```

Display Configuration Commands and Queries

(see page 106 for more information)

```
{CH1|CH2}:N2?
N2?
DISPlay:{CH1|N2|CH2}?
CONFigure:NAME:SENSor:{CH1|N2|CH2} "<string>"
NAME:SENSor:{CH1|N2|CH2}?
```

Relay Configuration Commands and Queries

(see page 106 for more information)

```
CONFigure:{RELay1|RELay2|RELay3|RELay4}:CHannel {0|1|2}
{RELay1|RELay2|RELay3|RELay4}:CHannel?

CONFigure:{RELay1|RELay2|RELay3|RELay4}:SETpoint <level>
{RELay1|RELay2|RELay3|RELay4}:SETpoint?

CONFigure:{RELay1|RELay2|RELay3|RELay4}:OPeration {0|1}
{RELay1|RELay2|RELay3|RELay4}:OPeration?

{RELay1|RELay2|RELay3|RELay4}:STATus?
```

Alarm Configuration Commands and Queries

(see page 107 for more information)

```
CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:CHannel {0|1|2}
{ALArm1|ALArm2|ALArm3|ALArm4}:CHannel?

CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:SETpoint <level>
{ALArm1|ALArm2|ALArm3|ALArm4}:SETpoint?

CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:OPeration {0|1}
{ALArm1|ALArm2|ALArm3|ALArm4}:OPeration?

{ALArm1|ALArm2|ALArm3|ALArm4}:STATus?

ALARm:MUTE {0|1} or {NO|YES}
ALARm:MUTE?
```

HI/LO Configuration Commands and Queries

(For Model 286 compatibility, see page 108 for more information)

```
{CH1|CH2}:ALARm:HI <level>
{CH1|CH2}:ALARm:HI?

{CH1|CH2}:ALARm:LO <level>
{CH1|CH2}:ALARm:LO?
```

Measurement Commands and Queries

(see page 109 for more information)

```
MEASure:{CH1|N2|CH2}:LEVel?
MEASure:{CH1|N2|CH2}:PERIod?
```

Fill Control and Queries

(see page 109 for more information)

CONFigure:FILL:MODE {**0**|1|2|3} *or*
{**NORMAL**|AUTOCH|PRECOOL|DISABLED}

FILL:MODE?

CONFigure:FILL:{CH1|CH2}:STATE {**0**|1|4|5} *or*
{**AUTO-OFF**|AUTO-ON|M-OPEN|M-CLOSED}

FILL:{CH1|CH2}:STATE?
{CH1|CH2}:FILL:STATE?

STOP LEVEL, ALL FILL MODES

CONFigure:FILL:{CH1|CH2}:A <*level*>
CONFigure:FILL:A <*level*>
FILL:{CH1|CH2}:A?
FILL:A?

START LEVEL, ALL FILL MODES

CONFigure:FILL:{CH1|CH2}:B <*level*>
CONFigure:FILL:B <*level*>
FILL:{CH1|CH2}:B?
FILL:B?

NORMAL FILL TIMEOUTS

CONFigure:{CH1|CH2}:FILL:TIMEout <*minutes*>
{CH1|CH2}:FILL:TIMEout?

(Deprecated:)
CONFigure:INTerval:FILL:{CH1|CH2} <*minutes*>
CONFigure:INTerval:FILL <*minutes*>
{CH1|N2|CH2}:INTERVAL?

AUTO-CHANGEOVER PARAMETERS

```
CONFigure:AUTOCH:FILL:TIMEout <minutes>
AUTOCH:FILL:TIMEout?

CONFigure:SOURce:DEWar {0|1} or {DEWAR1|DEWAR2}
SOURce:DEWar?

CONFigure:CONTact:STAte1 {0|1} or {OPEN|SHUT}
CONTact:STAte1?

CONFigure:CONTact:STAte2 {0|1} or {OPEN|SHUT}
CONTact:STAte2?

CONFigure:OVErall:LIMit <minutes>
OVErall:LIMit?
```

PRECOOL PARAMETERS

```
CONFigure:PRECOOL:FILL:TIMEout <minutes>
PRECOOL:FILL:TIMEout?
```

A/B Configuration Commands and Queries

(For Model 286 compatibility, see page 114 for more information)

```
{CH1|CH2}:ALARm:A <level>
{CH1|CH2}:ALARm:A?

{CH1|CH2}:ALARm:B <level>
{CH1|CH2}:ALARm:B?
```

Assignment Commands and Queries

(see page 115 for more information)

```
CONFigure:{SOURce|SOURce1|SOURce2}:REC_OUT {0|1|2}
{SOURce|SOURce1|SOURce2}:REC_OUT?

CONFigure:{SOURce|SOURce1|SOURce2}:CURrent_LOOP {0|1|2}
{SOURce|SOURce1|SOURce2}:CURrent_LOOP?
```

Channel Calibration Commands and Queries

(see page 116 for more information)

```
CONFigure:{CH1|N2|CH2}:LENgth <value>
{CH1|N2|CH2}:LENgth?

{CH1|CH2}:MINCAL
{CH1|CH2}:MINCAL?

{CH1|CH2}:MAXCAL
{CH1|CH2}:MAXCAL?

{CH1|CH2}:NOSENSorCAL
{CH1|CH2}:NOSENSorCAL?

{CH1|CH2}:APPROXMAXCAL <value>
{CH1|CH2}:APPROXMAXCAL?
```

Remote Units Commands and Queries

(see page 117 for more information)

```
CONFigure:{CH1|N2|CH2}:UNIT {0|1|2} or
{PERCENT|INCH|CM}
{CH1|N2|CH2}:UNIT?

PERCent
INches
CM
UNITS {0|1|2}
UNITs?
```

RS-232 CONFIGURATION

An RS-232 serial communication port is available as a 9-pin D-type connector on the rear panel of the instrument for serial communication function.

The Model 1720 uses the following *fixed* parameters related to the RS-232 interface:

- *Parity:* No Parity
- *Data Bits*: 8 Data Bits
- *Number of Start Bits*: 1 bit
- *Number of Stop Bits*: 1 bit
- *Flow Control*: None

The baud rate default is 115200, but is adjustable in the SYSTEM CONFIGURATION > RS232 SETUP menu (see page 66).

SERIAL PORT CONNECTOR AND CABLING

A PC-compatible computer's serial port can be directly connected to the Model 1720 via a standard USB-to-serial cable if the Contact Sense inputs are not required. Refer to the computer's documentation to determine which ports are available on a computer and the required connector type.

The Model 1720 uses only three wires of the rear-panel DB9 connector: pin 2 (transmit), pin 3 (receive), and pin 7 (common). There are no software or hardware handshaking options. The Model 1720 is classified as a DCE (Data Communication Equipment) device since it transmits data on pin 3 and receives data on pin 2. The instrument to which the Model 1720 is attached must do the opposite, i.e., transmit on pin 2 and receive on pin 3 (the requirements for a DTE, or Data Terminal Equipment device).

COMMAND/RETURN TERMINATION CHARACTERS

All commands are transmitted and received as ASCII values and are case insensitive. The Model 1720 can be configured to return <CR> (i.e. a *carriage return*) or <CR><LF> (i.e. a *carriage return* followed by a *linefeed*) at the end of a transmission (see page 66). The Model 1720 can accept <CR>, <LF>, <CR><LF>, or <LF><CR> as termination characters from an external computer.

ETHERNET CONFIGURATION

The Model 1720 provides a 10/100Base-T Ethernet interface as a standard feature. It complies with the IEEE 802.3u 100Base-TX and 802.3 10Base-T standards.

The Model 1720 allows its IP address, subnet mask and gateway IP address to be assigned either statically or dynamically. To make these values static and assign them manually, set IP Address Assignment to Static (see page 65) and then set the values using the Edit parameter list. To enable the values to be dynamically assigned by a network DHCP server, set IP Address Assignment to DHCP.

The system name (also known as *host name* or *computer name*), can be set using the Network screen (see page 66) or remote communications (either Ethernet or RS-232).

All network parameters (even those assigned by a DHCP server) can be viewed using the Network submenu (see page 65).

ETHERNET CONNECTOR

The Model 1720 uses a standard RJ-45 jack for Ethernet communications. The Ethernet jack pinout is fully documented on page 133 in the *Appendix*.

TERMINATION CHARACTERS

All commands and queries are transmitted and received as ASCII values and are case insensitive. The Model 1720 always transmits *<CR><LF>* (a *carriage return* followed by a *linefeed*) at the end of an Ethernet transmission. The Model 430 can accept *<CR>*, *<LF>*, *<CR><LF>*, or *<LF><CR>* as termination characters from an external computer.

PORT ASSIGNMENT

The Model 1720 accepts remote connections to port 7180. Multiple connections to port 7180 are allowed.

COMMAND REFERENCE

All commands sent to the Model 1720 are processed and the Model 1720 responds with a return value (if applicable) and termination. If the command is invalid, the Model 1720 will respond with an error code (see the *Error Codes* section). All return values including error codes are terminated with <CR><LF> (i.e. a *carriage return* followed by a *linefeed*). For those commands that do not return a value, the Model 1720 will return the <CR><LF> termination only.

The remote units settings are saved in non-volatile memory and are restored at power-up.

SYSTEM RELATED COMMANDS

- `*IDN?`

Returns the identification string of the Model 1720. The identification string contains the manufacturer name, model number, serial number, and firmware revision code. Example output:

```
AMERICAN MAGNETICS INC.,MODEL 1720,1720-16-002,2.4.32015
```

- `*RST`

Performs a Factory Restore if a restore file is available. All prior settings are lost!

- `*TST?`

Returns a value incremented by “1” for each query to the requesting interface if unit is functioning. Return value does not indicate any operational status other than a functioning interface.

- `SERial_NUMber?`

Returns the serial number of the instrument as a string, for example: `1720-16-002`.

- `DATE_MANUFacture?`

Returns the date of manufacture as a string in the form $yyyy\text{-}mm\text{-}dd$, for example: `2016-11-30`.

- `HardWare_VERsion?`

Returns the hardware version of the instrument.

- `FirmWare_VERsion?`

Returns the firmware version of the instrument, for example: `2.4.32015`

- `Scpi_VERsion?`

Returns the SCPI command version of the instrument.

- `SYStem:BEEPer:IMMediate <`*seconds*`>`

The receipt of this command with a valid argument causes an audible tone to be generated by the instrument. The duration time parameter is specified in seconds.

- `SYStem:BEEPer:STATe {`**0**`|1}`

Enables/disables the beeper. When `STATe` “0” (OFF) is selected, no instrument condition, except the `SYStem:BEEPer:IMMediate` command, shall cause an audible beep to be emitted. When the instrument restarts, this value is reset to a default of “1” (ON).

- `SYStem:BEEPer:STATe?`

Returns present beeper state. A value of “0” indicates the beeper is disabled. A value of “1” indicates it is enabled.

- `SYStem:KLOCK {`**0**`|1}`

This command locks the local controls of an instrument if set to a value of “1” (ON). This includes all front panel, keyboard, or other local interfaces. The state of the lock defaults to “0” (OFF) when the instrument is restarted.

- `SYStem:KLOCK?`

Returns the state of the instrument local controls lock. A return value of “0” indicates the lock is OFF. A return value of “1” indicates the local interfaces, such as the touch display, of the instrument are locked.

- `SYStem:DATE <`*yyyy*`>,<`*mm*`>,<`*dd*`>`

Sets the date per <*yyyy*> as a four-digit number; <*mm*> month with range of 1 to 12 inclusive; <*dd*> day of the month. Do not include the <> in the actual command.

- `SYStem:DATE?`

Returns the system date if the form *yyyy,mm,dd*.

- `SYStem:TIME <hh>,<mm>,<ss>`

This command is used to set the instrument's clock:

<*hh*> Range of hours is 0 to 23 inclusive.
<*mm*> Range of minutes is 0 to 59 inclusive.
<*ss*> Range of seconds is 0 to 60.

Do not include the <> in the actual command.

- `SYStem:TIME?`

Returns the system time if the form *hh,mm,ss*.

- `SYStem:REBOOT`

Reboots the instrument.

- `SYStem:RESTORE`

Reboots the instrument and sets all parameters back to factory defaults. All prior settings are lost!

- `IPV4ADDR?`

Returns the presently assigned TCP/IP version 4 address in the form: `xxx.xxx.xxx.xxx`

- `MACADDR?`

Returns the MAC address of the network interface.

- `GATEWAY?`

Returns the Gateway address of the network interface.

- `HOSTname?`

Returns the hostname of the network interface.

- `SCREENCAP`

Snaps a TGA-formatted (TARGA) image of the current local display screen of the instrument and places it in the "Log files" folder of the instrument's network share.

- `SYSTem:LOCal`

Enables the front panel touchscreen. All front panels controls are enabled by default after a power-up or `REBOOT` command.

- `SYSTem:REMote`

Disables front panel touchscreen.

DISPLAY CONFIGURATION COMMANDS AND QUERIES

- `{CH1|CH2}:N2?`
- `N2?`

Returns a “0” if the channel is disabled (`CH1` or `CH2`) and a “1” if it is enabled. A disabled channel does not perform a measurement. Using `N2?` is synonymous with `CH1:N2?`.

- `DISPLAY:{CH1|N2|CH2}?`

Returns a “0” if the instrument is not configured to display the specified sensor level (`CH1` or `CH2`) on the home screen and a “1” if it is. Using `N2` in the query is synonymous with `CH1`.

- `CONFigure:NAME:SENSor:{CH1|N2|CH2} "<string>"`

Sets the displayed name of the level sensor for the selected `CH1` or `CH2`. Using `N2` in the command is synonymous with `CH1`. The double quote characters enclosing the string are *required*. An example that sets the sensor name for `CH2` is:

```
CONF:NAME:SENS:CH2 "Storage Tank #234A"
```

The `CONFigure:` prefix is also optional for this command and can be omitted.

- `NAME:SENSor:{CH1|N2|CH2}?`

Returns the displayed name of the level sensor for the selected `CH1` or `CH2`. Using `N2` in the query is synonymous with `CH1`.

RELAY CONFIGURATION COMMANDS AND QUERIES

The Model 1720 provides four relay contact pairs, №1, №2, №3, and №4, accessible from the rear panel AUX I/O connector (see page 134). These relays can be assigned settings that are independent of the alarm settings.

- `CONFigure:{RELay1|RELay2|RELay3|RELay4}:CHannel {0|1|2}`

Assigns relay №1, №2, №3, or №4 as disabled (`0`), or to Channel 1 (`1`) or Channel 2 (`2`).

- `{RELay1|RELay2|RELay3|RELay4}:CHannel?`

Returns a “0” if the specified relay is disabled, a “1” if the relay is assigned to the Channel 1, and a “2” if the relay is assigned to Channel 2. An error return code is generated if an attempt is made to assign the relay to a non-existent or disabled measurement channel in the present instrument configuration.

- `CONFigure:{RELay1|RELay2|RELay3|RELay4}:SETpoint <level>`

Configures the relay №1, №2, №3, or №4 trip setpoint in the current remote units.

- `{RELay1|RELay2|RELay3|RELay4}:SETpoint?`

Returns the specified relay №1, №2, №3, or №4 setpoint in the current remote units.

- `CONFigure:{RELay1|RELay2|RELay3|RELay4}:OPeration {0|1}`

Configures relay №1, №2, №3, or №4 such that it closes when the level is ≤ the setpoint (`0`) or ≥ the setpoint (`1`).

- `{RELay1|RELay2|RELay3|RELay4}:OPeration?`

Returns a “0” if the specified relay №1, №2, №3, or №4 closes when the level is ≤ the setpoint and a “1” if the relay closes when the level is ≥ the setpoint.

- `{RELay1|RELay2|RELay3|RELay4}:STATus?`

Returns the present status of the specified relay. A return value of “0” indicates the relay is not closed. A value of “1” indicates the relay is closed.

ALARMS CONFIGURATION COMMANDS AND QUERIES

The Model 1720 provides four software alarms. These alarms can be assigned settings that are independent of the hardware relay settings.

- `CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:CHannel {0|1|2}`

Assigns the specified alarm (1, 2, 3, or 4) as disabled (`0`), or to Channel 1 (`1`) or Channel 2 (`2`).

- `{ALArm1|ALArm2|ALArm3|ALArm4}:CHannel?`

Returns a “0” if the specified alarm is disabled, a “1” if the relay is assigned to the Channel 1, and a “2” if the relay is assigned to Channel 2. An error return code is generated if an attempt is made to assign the

alarm to a non-existent or disabled measurement channel in the present instrument configuration.

- `CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:SETpoint <level>`

Configures the alarm trip setpoint in the current remote units.

- `{ALArm1|ALArm2|ALArm3|ALArm4}:SETpoint?`

Returns the specified alarm setpoint in the current remote units.

- `CONFigure:{ALArm1|ALArm2|ALArm3|ALArm4}:OPeration {0|1}`

Configures the specified alarm such that it alarms when the level is ≤ the setpoint (`0`) or ≥ the setpoint (`1`).

- `{ALArm1|ALArm2|ALArm3|ALArm4}:OPeration?`

Returns a “0” if the specified alarm activates when the level is ≤ the setpoint and a “1” if the alarm activates when the level is ≥ the setpoint.

- `{ALArm1|ALArm2|ALArm3|ALArm4}:STATus?`

Returns the present status of the specified alarm. A return value of “0” indicates the alarm is inactive. A value of “1” indicates the alarm is active.

- `ALARm:MUTE {0|1}` *or* `{NO|YES}`

Mutes the audible alarm for any active alarm(s) when set to “1” or “YES”. Unmutes the audible alarm if set to “0” or “NO”.

- `ALARm:MUTE?`

Returns “0” if audible alarm is muted. Returns “1” if not muted.

HI/LO CONFIGURATION COMMANDS AND QUERIES

In support of AMI Model 286 compatibility and historical precedent with AMI liquid level instruments, the following shortcut commands for setting the HI and LO alarms for each channel are provided.

The function of HI has historically been to set both an alarm and relay indication when the level meets or exceeds the HI setpoint. The function of LO has historically been to set both an alarm and relay indication when the level reaches or falls below the LO setpoint. Therefore, the following commands set *both* the ALARM and RELAY functions of the Model 1720 to synchronize the two according to this historical function.

- `{CH1|CH2}:ALARm:HI` *<level>*

If CH1 is specified, this assigns the alarm 1 to activate *and* relay №1 to close when the measured level is ≥ the specified value in the current remote units.

If CH2 is specified, this assigns the alarm 3 to activate *and* relay №3 to close when the measured level is ≥ the specified value in the current remote units.

- `{CH1|CH2}:ALARm:HI?`

Returns the HI setpoint value in the current units for the specified channel.

- `{CH1|CH2}:ALARm:LO` *<level>*

If CH1 is specified, this assigns the alarm 2 to activate *and* relay №2 to close when the measured level is ≤ the specified value in the current remote units.

If CH2 is specified, this assigns the alarm 4 to activate *and* relay №4 to close when the measured level is ≤ the specified value in the current remote units.

- `{CH1|CH2}:ALARm:LO?`

Returns the LO setpoint value in the current units for the specified channel.

MEASUREMENT COMMANDS AND QUERIES

- `MEASure:{CH1|N2|CH2}:LEVel?`

Returns the liquid level in the current units for the specified channel. Using `N2` in the query is synonymous with `CH1`. The prefix `MEASure:` is optional.

- `MEASure:{CH1|N2|CH2}:PERIod?`

Returns the liquid nitrogen level measurement period for the specified channel in microseconds. Using `N2` in the query is synonymous with `CH1`. The prefix `MEASure:` is optional.

FILL CONTROL AND QUERIES

- `CONFigure:FILL:MODE {0|1|2|3}` *or* `{NORMAL|AUTOCH|PRECOOL|DISABLED}`

Sets the fill mode for the Model 1720. The fill modes are discussed in detail in the Operations section beginning on page 49. The argument

values can be either integer or text. A value of "0" or "NORMAL" sets the fill mode function to normal, which operates Channels 1 and 2 as independent fills.

A value of "1" or "AUTOCH" sets the unit to auto-changeover fill mode. A value of "2" or "PRECOOL" sets the unit to precool fill mode.

Finally, a value of "3" or "DISABLED" disables all fill functions.

An example of configuring the unit for auto-changeover mode is:

```
CONFIGURE:FILL:MODE AUTOCH
```

- `FILL:MODE?`

Returns the present fill mode setting for the unit with the integer value followed by a command and then the textual form of the value. The possible return values are:

```
0, NORMAL
1, AUTOCH
2, PRECOOL
3, DISABLED
```

- `CONFigure:FILL:{CH1|CH2}:STAte {`**`0`**`|1|4|5|7}` *or* `{`**`AUTO-OFF`**`|AUTO-ON|M-OPEN|M-CLOSED|M-PRECOOL}`

Sets the accessible fill states of the fill function according to either the integer argument or textual form for the selected channel. If a channel is not available for fill, then the command returns "-9" for an invalid argument.

A value of "0" or "AUTO-OFF" turns off the automatic fill functions for the selected channel. A value of "1" or "AUTO-ON" enables automatic fill function for the selected channel. A value of "4" or "M-OPEN" manually opens the fill valve for the specified channel. A value of "5" or "M-CLOSED" manually closes the fill valve for the specified channel.

A value of "7" or "M-PRECOOL" starts a manual precool valve cycle if the autofill system is configured for **PRECOOL** mode.

An example for setting the Channel 1 fill function to AUTO-ON state is:

```
CONF:FILL:CH1:STATE 1
```

- `FILL:{CH1|CH2}:STAte?`
  `{CH1|CH2}:FILL:STAte?`

Either form of this command returns the present fill state of the selected channel as an integer value followed by a comma and the textual form, e.g. "`1, AUTO-ON`".

SCPI Fill States for Selected Channel

Integer Value	State	Description
0	**AUTO-OFF**	AUTOFILL function disabled.
1	**AUTO-ON**	Unit is maintaining level between fill START and STOP setpoint (i.e. autonomous mode).
2	**PRECOOL**	Precool vent valve is open and venting.
3	**FILLING**	Fill valve is open and actively filling a target dewar.
4	**M-OPEN**	The fill valve is in manually open command state.
5	**M-CLOSED**	The fill valve is in manually closed command state.
6	**TIMEOUT**	The fill function is in a timeout state and filling has halted.
7	**M-PRECOOL**	The precool vent valve has been commanded to open manually to perform a venting cycle.

STOP LEVEL FOR ALL FILL MODES

- `CONFigure:FILL:{CH1|CH2}:A` <*level*>
- `CONFigure:FILL:A` <*level*>

Sets the A setpoint (control band STOP limit) for the selected channel in the current remote units for that channel. The A setpoint (autofill STOP) must be greater than the B setpoint (fill START) and must also be between 0% and 100%. Omitting the channel specifier applies the setting to Channel 1.

- `FILL:{CH1|CH2}:A?`
- `FILL:A?`

Returns the A setpoint (control band STOP limit) for the specified channel in the current remote units. Omitting the channel specifier returns the value for Channel 1.

START LEVEL FOR ALL FILL MODES

- `CONFigure:FILL:{CH1|CH2}:B <level>`
- `CONFigure:FILL:B <level>`

Sets the B setpoint (control band START limit) for the selected channel in the current remote units for that channel. The B setpoint (autofill start) must be less than the A setpoint (fill stop) and must also be between 0% and 100%. Omitting the channel specifier applies the setting to Channel 1.

- `FILL:{CH1|CH2}:B?`
- `FILL:B?`

Returns the B setpoint (control band STOP limit) for the specified channel in the current remote units. Omitting the channel specifier returns the value for Channel 1.

NORMAL FILL TIMEOUTS

- `CONFigure:{CH1|CH2}:FILL:TIMEout <minutes>`

Sets the fill timeout in minutes for the specified channel. If the level does not reach or exceed the A (STOP) setpoint within the fill time, the fill is terminated. Setting the value of the timeout to "`0`" disables the fill timeout function. Omitting the channel specifier applies the setting to Channel 1.

NOTE **Use the Channel 1 fill timeout value, e.g.**

`CONF:CH1:FILL:TIME <value>`

to control the timeout of the normal dewar fill of the precool fill mode. See page 61.

- `{CH1|CH2}:FILL:TIMEout?`

Returns the fill timeout setting in minutes for the specified channel.

The following `INTerval` commands are still supported but are *deprecated*. The `TIMEout` keyword is preferred for all new fill time control.

- `CONFigure:INTerval:FILL:{CH1|CH2} <minutes>`
- `CONFigure:INTerval:FILL <minutes>`

Sets the fill timeout in minutes for the specified channel. If the level does not reach or exceed the A (STOP) setpoint within the fill time, the fill is

terminated. Setting the value of FILL to "0" disables the fill timeout function. Omitting the channel specifier applies the setting to Channel 1.

- {CH1|N2|CH2}:INTerval?

Returns the fill timeout setting in minutes for the specified channel. Using N2 in the query is synonymous with CH1.

AUTO-CHANGEOVER PARAMETERS

The following commands are specifically related to the auto-changeover fill mode, see page 53

- CONFigure:AUTOCH:FILL:TIMEout <*minutes*>

Set the auto-changeover fill timeout in minutes. If this fill timeout expires, then the source tank is switched to the alternate tank if it is available (i.e. *not* empty). If *both* source tanks reach this fill timeout state, a fill cycle TIMEOUT alarm is generated and the auto-changeover fill cycle is interrupted.

- AUTOCH:FILL:TIMEout?

Returns the auto-changeover fill timeout in minutes.

- CONFigure:SOURce:DEWar {**0**|1} *or* {**DEWAR1**|DEWAR2}

Manually chooses the source dewar to be "0" or "DEWAR1" (for fill valve connected to the Channel 1 AC output), or "1" or "DEWAR2" (for fill valve connected to Channel 2 AC output).

- SOURce:DEWar?

Returns "0, DEWAR1" or "1, DEWAR2" as the present source dewar.

- CONFigure:CONTact:STAte1 {**0**|1} *or* {**OPEN**|SHUT}

Configures the *empty indication state* of the contact 1 sense (for DEWAR1) for either "0" or "OPEN", or "1" or "SHUT". Shut means the closed contact state.

- CONTact:STAte1?

Returns the configured empty indication contact 1 state as either "0, OPEN" or "1, SHUT". This is the configured empty state indication, *not* the present contact sense state.

- `CONFigure:CONTact:STAte2 {0|1}` *or* `{OPEN|SHUT}`

Configures the *empty indication state* of the contact 2 sense (for DEWAR2) for either "`0`" or "`OPEN`", or "`1`" or "`SHUT`". Shut means the closed contact state.

- `CONTact:STAte2?`

Returns the configured empty indication contact 2 state as either "`0, OPEN`" or "`1, SHUT`". This is the configured empty state indication, *not* the present contact sense state.

- `CONFigure:OVErall:LIMit <minutes>`

This command configures the overall timeout of the fill cycle for the auto-changeover mode in minutes. If the target dewar has not reached the stop level in this amount of time, the fill function is interrupted and a TIMEOUT alarm is generated.

- `OVErall:LIMit?`

Returns the overall fill timeout value for the auto-changeover fill mode in minutes.

PRECOOL PARAMETERS

The following commands are specifically related to the precool fill mode, see page 59.

- `CONFigure:PRECOOL:FILL:TIMEout <minutes>`

This command sets the precool venting valve time in minutes that cools the fill line before the normal dewar fill cycle begins.

- `PRECOOL:FILL:TIMEout?`

Returns the precool venting time in minutes.

A/B CONFIGURATION COMMANDS AND QUERIES

In support of Model 286 compatibility, the following remote commands and queries for the A/B fill control band setpoints are provided. Please refer to the previous section for the detailed description of the synonymous command or query.

- `{CH1|CH2}:ALARm:A <level>`

Synonymous with the command:

`CONFigure:FILL:{CH1|CH2}:A <level>`

- `{CH1|CH2}:ALARm:A?`

Synonymous with the query:

`FILL:{CH1|CH2}:A?`

- `{CH1|CH2}:ALARm:B` <*level*>

Synonymous with the command:

`CONFigure:FILL:{CH1|CH2}:B` <*level*>

- `{CH1|CH2}:ALARm:B?`

Synonymous with the query:

`FILL:{CH1|CH2}:B?`

ASSIGNMENT COMMANDS AND QUERIES

The following commands set the channel source for each of four analog outputs (two voltage outputs and two current loops) available from the AUX I/O connector on the rear panel (see page 134). In this context, the `SOURce` and `SOURce1` choices are synonymous. `SOURce` is provided for Model 1700 compatibility.

- `CONFigure:{SOURce|SOURce1|SOURce2}:REC_out {0|1|2}`

Configures the 0-10 V_{DC} Recorder Output 1 or Output 2 source to disabled (`0`), Channel 1 (`1`), Channel 2 (`2`). An error return code is generated if attempting to assign the output to a non-existent channel.

- `{SOURce|SOURce1|SOURce2}:REC_out?`

Returns a "`0`" if the 0-10 V_{DC} Recorder Output 1 or Output 2 is disabled, a "`1`" if it is configured to use Channel 1 as the source, and a "`2`" if it is configured to use Channel 2.

- `CONFigure:{SOURce|SOURce1|SOURce2}:CURrent_LOOP {0|1|2}`

Configures the 4-20 mA Current Loop Output 1 or Output 2 source to disabled (`0`), Channel 1 (`1`), Channel 2 (`2`). An error return code is generated if attempting to assign the output to a non-existent channel.

- `{SOURce|SOURce1|SOURce2}:CURrent_LOOP?`

Returns a "`0`" if the 4-20 mA Current Loop Output 1 or Output 2 is disabled, a "`1`" if it is configured to use Channel 1 as the source, and a "`2`" if it is configured to use Channel 2.

CHANNEL CALIBRATION COMMANDS AND QUERIES

- `CONFigure:{CH1|N2|CH2}:LENgth <value>`

Configures the sensor active length for the specified channel in the current remote units for that channel. Returns an error code if the current units are percent. Using `N2` in the command is synonymous with `CH1`.

- `{CH1|N2|CH2}:LENgth?`

Returns the configured active length of the sensor for the specified channel in the current units for that channel. Returns an error code if the current units are percent. Using `N2` in the query is synonymous with `CH1`.

- `{CH1|CH2}:MINCAL`

Performs and saves a **MIN** calibration point calibration for the specified channel. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:MINCAL?`

Returns the last saved **MIN** calibration point in microseconds. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:MAXCAL`

Performs and saves a **MAX** calibration point calibration for the specified channel. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:MAXCAL?`

Returns the last saved **MAX** calibration point in microseconds. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:NOSENSorCAL`

Calibrates and saves the **LOSS OF SENSOR** condition for the specified channel. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:NOSENSorCAL?`

Returns the last saved **LOSS OF SENSOR** calibration point in microseconds. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:APPROXMAXCAL <value>`

Sets the **Approx Cal (Max) Multiplier** factor (see page 89) to a decimal value. The value is nominally 1.000 for no modification to the MAX calibration point. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

- `{CH1|CH2}:APPROXMAXCAL?`

Returns the **Approx Cal (Max) Multiplier** factor (see page 89) as a decimal value. Omitting `{CH1|CH2}` in the command is synonymous with `CH1`.

REMOTE UNITS COMMANDS AND QUERIES

- `CONFigure:{CH1|N2|CH2}:UNIT {0|1|2}` *or* `{PERCENT|INCH|CM}`

Sets the specified remote level units of measurement for the specified channel to percent (`0` or `PERCENT`), inches (`1` or `INCH`), or centimeters (`2` or `CM`). The default is `PERCENT` units. Using `N2` in the command is synonymous with `CH1`.

- `{CH1|N2|CH2}:UNIT?`

Returns the current remote units in use for the specified channel as either `%, I,` or `C.` Using `N2` in the query is synonymous with `CH1`.

MODEL 286 COMPATIBILITY

The following commands and query are provided for Model 286 compatibility. These commands set the units for both channels as the Model 286 did not provide channel-independent unit settings.

- `PERCent`

Sets the remote units to percent for all level values for both channels.

- `INches`

Sets the units to inches for all level values for both channels.

- `CM`

Sets the units to centimeters for all level values for both channels.

- `UNITS {0|1|2}`

Selects between the percent (`0`), inches (`1`), and centimeters (`2`) units. For example, the command:

```
UNITS 1
```

selects inches for the remote units. The setting is applied to both channels.

NOTE **The short form of the command omitting the "S" is not available due to the conflict with the 18x legacy `UNIT` command.**

- `UNITs?`

Returns the present units for Channel 1. Since the Model 1720 optionally supports independent units setting for each channel, there is no guarantee this return value is the same for Channel 2 unless the operator is in full control of the units setting history.

`0, "PERCENT"` is returned if the remote units are percent.

`1, "INCHES"` is returned if the remote units are inches.

`2, "CM"` is returned if the remote units are centimeters.

ERROR CODES

The Model 1720 returns specific error codes for invalid commands and/or arguments. If an error condition is returned, the command is not processed and the configuration of the instrument is not modified. The table below provides a list of error codes, their meaning, and any associated limits.

Error Code	Meaning	Valid Range
-1	LO[a] setpoint out of range	$0 \leq LO^a \leq LENGTH$
-2	Fill B setpoint (fill start) out of range	$0 \leq B < A$
-3	Fill A setpoint (fill stop) out of range	$B < A \leq LENGTH$
-4	HI[a] setpoint out of range	$0 \leq HI^a \leq LENGTH$
-5	Attempted to set or query for LENGTH in PERCENT units mode	
-6	Invalid argument, value out of maximum calibration range	$1\ cm \leq value \leq 650\ cm$
-7	INTERVAL setting out of range	$0 \leq INTERVAL \leq 99999\ min$
-8	Unrecognized command	
-9	Invalid argument, value was negative or non-numeric	
-10	Approximate calibration *factor* out of range	$0.1 \leq factor \leq 999.9$
-11	Command exceeds SCPI input buffer limit	256 characters, including whitespace
-12	Command invalid for selected Channel (e.g. inactive channel)	

a. For Channel 1: HI value assigned to alarm and relay №1 and LO assigned to alarm and relay №2 for legacy compatibility; For Channel 2: HI value assigned to alarm and relay №3 and LO assigned to alarm and relay №4 for legacy compatibility.

LEGACY COMMAND REFERENCE

The legacy command set is included for compatibility with existing Model 18x installations. New installations should consider using the modern command set that conforms more closely with the SCPI specification. The modern and legacy command sets can be mixed as desired.

All legacy command or queries sent to the Model 1720 *are applied to Channel 1 only* and the Model 1720 responds with a return value (if applicable) and termination. If the command is invalid, the Model 1700 will respond with an error code (see the *Error Codes* section). All return values including error codes are terminated with `<CR><LF>` (i.e. a *carriage return* followed by a *linefeed*). For those commands that do not return a value, the Model 1720 will return the `<CR><LF>` termination only.

COMMANDS FOR CONTROLLING THE UNITS OF MEASUREMENT

Command:	CM	Function:	Sets the units of measurement to centimeters	Returns:	<CR><LF>

Command:	INCH	Function:	Sets the units of measurement to inches	Returns:	<CR><LF>

Command:	PERCENT	Function:	Sets the measurement to % of sensor length	Returns:	<CR><LF>

Command:	UNIT	Function:	Returns the current units in use	Returns:	C, I, or % <CR><LF>

The CM command sets the units of measurement to centimeters and the INCH command selects inches. The PERCENT command sets the units of measurement to the percentage of active sensor length that is immersed in liquid. **The units of measurement selected through the remote interface are controlled independently from the units shown on the front panel display.**

The remote units setting is *automatically* saved in permanent memory and is restored at power-up. The UNIT command returns a one character value (and termination) indicating the current units — C for centimeters, I for inches, or % for percentage.

COMMANDS FOR CONFIGURING PERMANENT MEMORY

Command:	HI=<*value*>	Function:	Configures the HI setpoint limit	Returns:	<CR><LF>
Command:	LO=<*value*>	Function:	Configures the LO setpoint limit	Returns:	<CR><LF>
Command:	A=<*value*>	Function:	Configures the A setpoint (control band STOP limit)	Returns:	<CR><LF>
Command:	B=<*value*>	Function:	Configures the B setpoint (control band START limit)	Returns:	<CR><LF>
Command:	INTERVAL=<*value*>	Function:	Configures the fill timer in minutes	Returns:	<CR><LF>
Command:	LENGTH=<*value*>	Function:	Configures the active sensor length	Returns:	<CR><LF>
Command:	SAVE	Function:	None (for backward compatiblity only).	Returns:	<CR><LF>

The HI and LO command configure the high and low setpoint limit values, respectively. For example, HI=90.0 would configure the high setpoint limit to 90.0 in whichever units of measurement last selected through the serial interface. The A and B commands configure the upper limit and lower limit of the control band, respectively. The HI, LO, A, and B commands are compatible with the percent units selection.

NOTE **The HI setting is associated with alarm and hardware relay №1. The LO setting is associated with the alarm and hardware relay №2. This association is fixed and cannot be changed. When set via the remote interface, the associated alarm and relay settings will be set accordingly.**

The LENGTH command configures the active sensor length setting in the current units. LENGTH=35.0 would configure the active sensor length to 35.0 units of centimeters or inches.

NOTE **The LENGTH=<value> command will only function if CM or INCH are currently selected as the units of measurement. The LENGTH command does not configure the Model 1720 if the units of measurement are PERCENT.**

The INTERVAL command sets the nitrogen fill timer in minutes as described in the *Operation* section on page 50. Setting the value of INTERVAL to 0 disables the fill timer function.

The HI, LO, A, B, INTERVAL, LENGTH, and current remote units settings are automatically saved to permanent memory. Saved settings are then recalled each time the power is turned off and then reapplied to the instrument on subsequent power on.

QUERYING THE CONFIGURATION

Command:	HI	Function:	Returns the HI setpoint limit in the current units	Returns:	<value> <CR><LF>
Command:	LO	Function:	Returns the LO setpoint limit in the current units	Returns:	<value> <CR><LF>
Command:	A	Function:	Returns the A setpoint limit in the current units	Returns:	<value> <CR><LF>
Command:	B	Function:	Returns the B setpoint limit in the current units	Returns:	<value> <CR><LF>
Command:	INTERVAL	Function:	Returns the fill timer setting in minutes	Returns:	<value> <CR><LF>
Command:	LENGTH	Function:	Returns the active sensor length in the current units	Returns:	<value> <CR><LF>

The HI, LO, A, B, INTERVAL, and LENGTH queries return the current configuration of the instrument. Each return value is terminated with *<CR><LF>*.

RETURNING A LEVEL MEASUREMENT

Command:	LEVEL	Function:	Returns the liquid level in the current units	Returns:	<value> <CR><LF>

The LEVEL query returns the liquid level in the current units selected through the communication interface.

SERVICE AND REPAIR

CLEANING

To prevent electrical shock, disconnect the instrument from AC mains power and disconnect all connected wiring before cleaning. Clean the outside of the instrument using a soft, lint-free, cloth slightly dampened with water.

Do not use detergent or solvents.

Do not attempt internal cleaning.

USER REPLACEABLE PARTS

Replacement parts for the instrument are listed in the table below.

AMI Part Number	Description
HG0128	Instrument foot
SA 1045	Single Rack Mount Kit
SA 1046	Dual Rack Mount Kit
EF1700	Fuse, 3 A, 250 Vac, 5x20 mm, fast acting, UL/CSA recognized.
HG0005	Battery, 3V lithium, 20mm x 3.2 mm coin cell; CR2032.

BATTERY REPLACEMENT

This section describes the procedure for replacing the battery on the instrument's main circuit board.

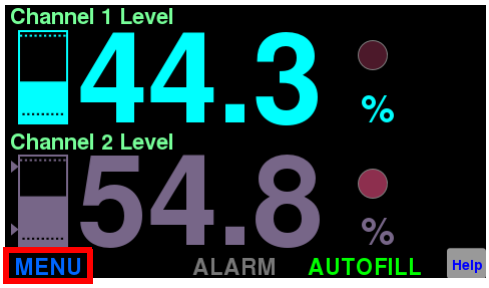
WARNING **This procedure should only be performed by a technician who is familiar with electronic instrumentation and trained in electrical safety and ESD precautions. Always disconnect the power cord and any external wiring before removing the instrument cover.**

Always disconnect all inputs, cords, and cables before disassembling the instrument.

LOW BATTERY INDICATION

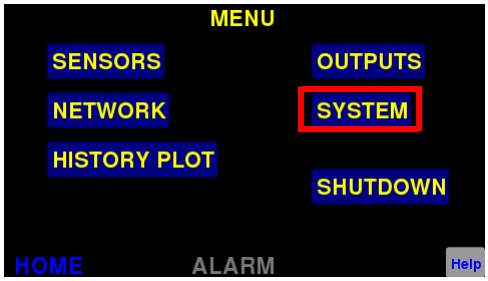
Battery status is displayed in the **SYSTEM DATE & TIME** dialog. To access the dialog:

1. From the home screen, choose **MENU**.



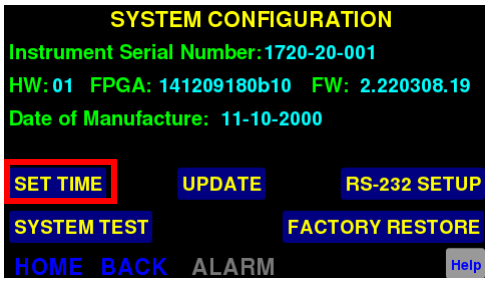
Menu Selection From Home Screen

2. From the **MENU** screen, choose **SYSTEM**.



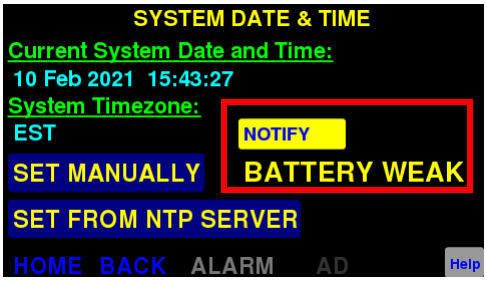
MENU Selection Screen

3. From the **SYSTEM CONFIGURATION** screen choose **SET TIME**.



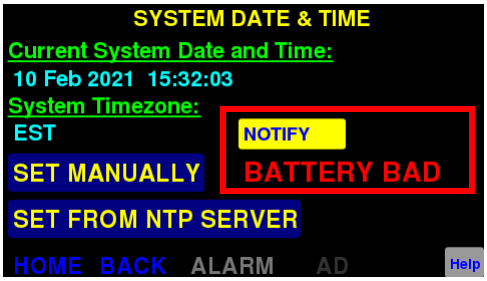
SYSTEM CONFIGURATION Screen

4. The battery status is displayed in the **SYSTEM DATE & TIME** screen. If the battery is weak and should be replaced soon, the message will appear as shown at right.



Weak Battery Indication

5. If the battery is expired, the message will appear as shown at right.



Expired Battery Indication

NOTE **The NOTIFY button state will cause a warning message to appear in the the HOME screen footer. NO NOTIFY supresses the HOME screen warning.**

The following sections detail how to replace the battery.

TOOLS REQUIRED

- Torx Plus (T.M.) size 10 driver (Wera 028034 or equivalent)
- Torx Plus (T.M.) size 15 driver (Wera 028035 or equivalent)
- Small, flat-blade screw driver (for prying)

PROCEDURE

1. Unplug the instrument from the AC power source.
2. Using the T-15 driver, remove the four 8-32 machine screws on the sides of the instrument cover. Set these screws aside as they will be re-used.
3. Using the T-10 driver, remove the four 6-32 machine screws on the rear of the instrument cover. Set these screws aside as they will be re-used.
4. Lift the instrument cover off of the instrument chassis and set aside.

5. Using the small, flat-blade screwdriver, carefully pry the battery from the holder BH1.
6. Install the new battery into the battery holder BH1.
7. Replace the top cover and secure using the eight machine screws which were removed previously.

FUSE REPLACEMENT

This section describes the procedure for replacing the two fuses on the instrument's main circuit board.

WARNING **This procedure should only be performed by a technician who is familiar with electronic instrumentation and trained in electrical safety and ESD precautions. Always disconnect the power cord and any external wiring before removing the instrument cover.**

Always disconnect all inputs, cords, and cables before disassembling the instrument.

TOOLS REQUIRED

- Torx Plus (T.M.) size 10 driver (Wera 028034 or equivalent)
- Torx Plus (T.M.) size 15 driver (Wera 028035 or equivalent)
- Small, flat-blade screw driver (for prying)

PROCEDURE

1. Unplug the instrument from the AC power source.
2. Using the T-15 driver, remove the four 8-32 machine screws on the sides of the instrument cover. Set these screws aside as they will be re-used.
3. Using the T-10 driver, remove the four 6-32 machine screws on the rear of the instrument cover. Set these screws aside as they will be re-used.
4. Lift the instrument cover off of the instrument chassis and set aside.
5. Using the small, flat-blade screwdriver, carefully pry the fuse(s) from the fuse holders F1 and/or F2.
6. Install the new fuse(s) into the fuse holder(s) F1 and/or F2.
7. Replace the top cover and secure using the eight machine screws which were removed previously.

FIRMWARE UPGRADES

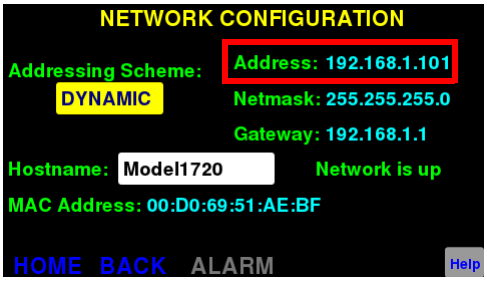
The following procedures can be utilized by users to upgrade the Model 1720 by downloading firmware upgrade archives (.tar.gz) from the AMI support website.

UPGRADE VIA ETHERNET-BASED FILE SHARING

If the local network configuration is compatible with Samba shares, the instrument should expose several folders to allow firmware upgrades through a standard file manager application.

1. Connect the instrument to the local computer network via Ethernet cable and energize the instrument.

2. When the instrument has completed booting, note the IP Address: **MENU > NETWORK > Address**. There should be a message in green on the screen indicating "Network is up".



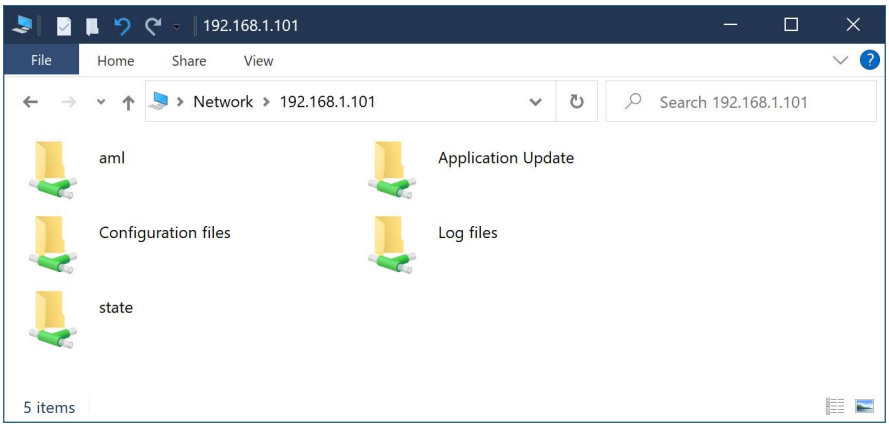
Network Configuration Screen

3. Determine the currently installed version of firmware. From the home page, press **MENU > SYSTEM > FW Version**.

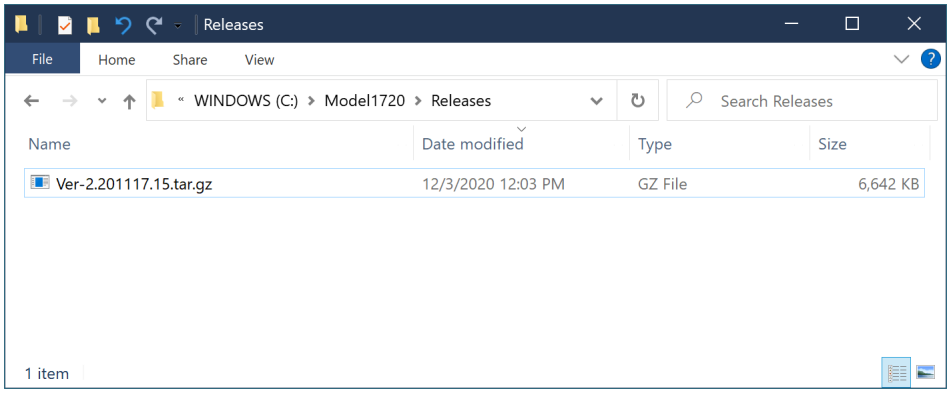
4. Download the available new version of firmware and place on a PC on the same network as the instrument.

NOTE **The following steps assume the computer is Windows-based.**

5. Start Windows Explorer and enter the instrument's IP address noted from Step 2 above in the address field. Be sure to use the format such as `\\192.168.1.101`. Ensure the Explorer screen looks similar to the following.



6. Open a second Windows Explorer and locate the previously downloaded firmware file:



7. Drag the firmware file to the instrument's Application Update folder in the first Explorer screen, or use the standard Windows copy/paste actions in Explorer.

8. Install the new firmware by pressing **MENU > SYSTEM > UPDATE** on the instrument and choose the name of the firmware file copied to the instrument. It is likely the top choice of the files listed.

9. Press INSTALL on the instrument when prompted.

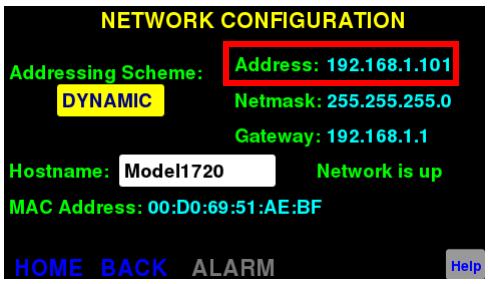
10. The instrument will install the new firmware and reboot when completed.

UPGRADE VIA SCP

If the instrument's file shares are not visible on the local network, it is possible to copy the firmware upgrade directly to the instrument using the `root` login and password using SCP (Secure Copy) over Ethernet.

1. Connect the instrument to the local computer network via Ethernet cable and energize the instrument.

2. When the instrument has completed booting, note the IP Address: **MENU > NETWORK > Address**. There should be a message in green on the screen indicating "Network is up".



Network Configuration Screen

3. Determine the currently installed version of firmware. From the home page, press **MENU > SYSTEM > FW Version**.

4. Download the available new version of firmware and place on a Windows, Linux, or Mac computer on the same network as the instrument.

5. Open a command line application and set the current directory to the folder where the newly download firmware from the prior step resides.

6. Enter the following command where the example IP address of `192.168.1.101` is replaced by the IP of the instrument noted in step 2 above, and the example firmware file of `Ver-2.22719.15.tar.gz` is replaced by the actual file downloaded from AMI:

   ```
   scp ./Ver-2.220719.15.tar.gz root@192.168.1.101:/update
   ```

   Note that you will prompted to enter the root account password to complete the file transfer. If you do not know the password, contact an Authorized AMI Technical Support Representative for assistance.

7. Install the new firmware by pressing **MENU > SYSTEM > UPDATE** on the instrument and choose the name of the firmware file copied to the instrument via SCP. It is likely the top choice of the files listed.

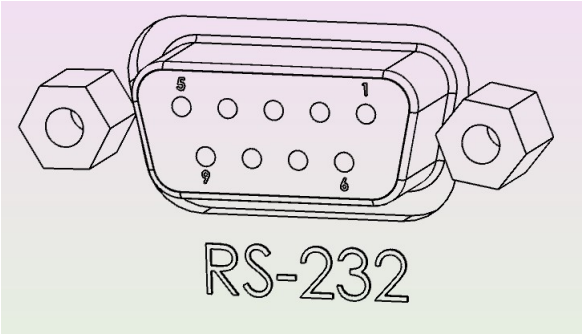
8. Press INSTALL on the instrument when prompted.

9. The instrument will install the new firmware and reboot when completed.

APPENDIX

SERIAL (RS-232) AND CONTACT SENSE CONNECTOR

The RS-232 and Contact Sense connector is a 9-pin D-sub female connector with serial I/O and contact sense inputs interleaved. For serial applications a NULL modem adapter is not required.



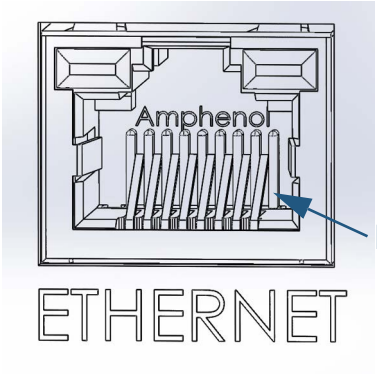
Serial (RS-232) and Contact Sense Pin Out

NOTE **Contact Sense inputs are interleaved in the connector, therefore serial and USB-to-serial cables that contain internal connections to pins other than 2, 3, and 5 may result in changes in the Contact Sense inputs.**

Serial (RS-232) and Contact Sense Pin Definitions

Pin	Mnemonic	Function
1	N/C	No connection
2	TXD	Transmit Data
3	RXD	Receive Data
4	N/C	No connection
5	GND	Signal Ground and Contact Sense Return
6		Contact Sense #1
7		Contact Sense #2
8		Contact Sense #3
9	N/C	No connection

ETHERNET CONNECTOR



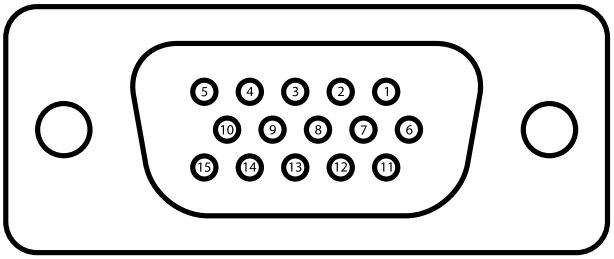
Ethernet Connector Socket Pin out

Ethernet RJ-45 Connector Pin Definitions

Pin	Mnemonic	Function
1	TXD+	Transmit differential output +
2	TXD-	Transmit differential output -
3	RXD+	Transmit differential input +
4	not used	
5		
6	RXD	Transmit differential input -
7	not used	
8		

AUX I/O CONNECTOR

The AUX I/O connector is a 15-pin high-density D-sub female connector.



Aux I/O Connector

Aux I/O Pin Definitions

Pin	Function	Polarity
1	# 1: 4-20 mA Loop	+
2		–
3	# 1: 0-10 VDC Output	+
4	Shared common for both Channel 1 & 2: 0-10 VDC Output	–
5	# 2: 4-20 mA Loop	+
6	Relay № 1 Dry Contact	N/A
7	Relay № 2 Dry Contact	N/A
8		N/A
9	Relay № 1 Dry Contact	N/A
10	# 2: 4-20 mA Loop	–
11	Relay № 3 Dry Contact	N/A
12	Relay № 4 Dry Contact	N/A
13		N/A
14	Relay № 3 Dry Contact	N/A
15	# 2: 0-10 VDC Output	+

TROUBLESHOOTING

The following paragraphs serve as an aid to assist the user in troubleshooting a potential problem with the Model 1720 Instrument. If a customer is not comfortable in troubleshooting the system, contact an AMI Technical Support Representative.

If the cause of the problem cannot be located, contact an AMI Technical Support Representative at +1 (865) 482-1056 for assistance. The AMI Technical Support group may also be reached by e-mail at:

support@americanmagnetics.com

INSTRUMENT DISPLAYS "LOSS OF SENSOR" CONDITION FOR LN_2 LEVEL MEASUREMENT

This message indicates one of two things: the signal from the external oscillator/transmitter has been lost (disconnection) or the capacitance measured by the instrument is significantly less than the minimum capacitance expected during level measurement[1]. Ensue the instrument has been calibrated (especially "Performing Loss of Sensor Calibration" on page 80) and is properly connected via coaxial cable(s) to the correct BNC connector on the back of the instrument for a given Channel.

INSTRUMENT DISPLAYS "SENSOR SHORTED" CONDITION FOR LN_2 LEVEL MEASUREMENT

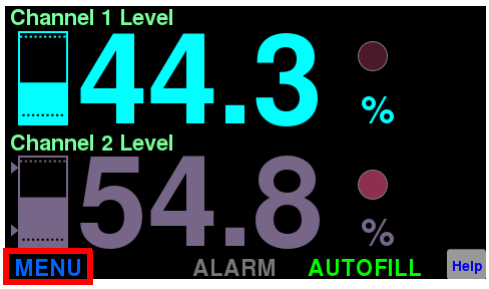
This message indicates that the sensor oscillator circuit has ceased oscillating for the indicated Channel. This is usually caused by a contaminated level sensor where a conductive substance (usually water) is shorting out the sensor tubes.[2] Dry or clean out the sensor and this condition is usually removed. Note that the sensor resistance measured across the BNC connector should be $>10^7$ ohms.[3]

1. The threshold is the midpoint between the MINimum CALibration and the NO SENSOR CALibration.
2. The threshold is approximately 200 kohms with a sensor capacitance of 2 nF.
3. Any resistance between the sensor elements will cause the instrument to read higher than actual level.

SYSTEM TEST SCREENS

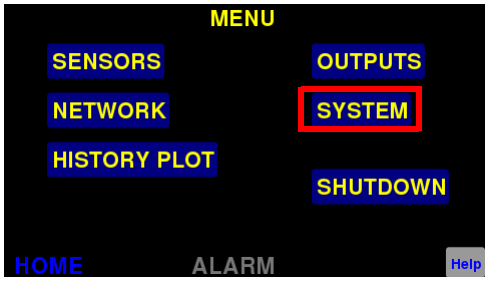
The instrument provides various system test functions that can be performed from the front panel touchscreen. The system test functions are not available to the web browser interface nor the SCPI remote interface over serial or Ethernet connections. To access the test functions:

1. From the home screen, choose **MENU**.



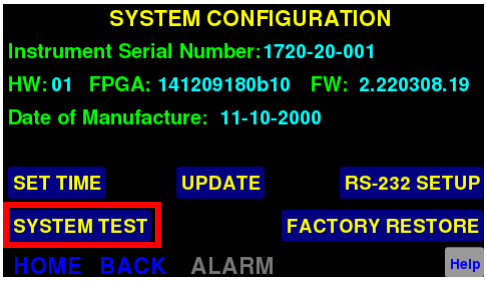
Menu Selection From Home Screen

2. From the **MENU** screen, choose **SYSTEM**.



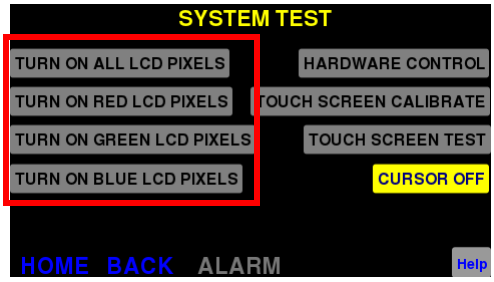
MENU Selection Screen

3. From the **SYSTEM CONFIGURATION** screen choose **SYSTEM TEST**.



SYSTEM CONFIGURATION Screen

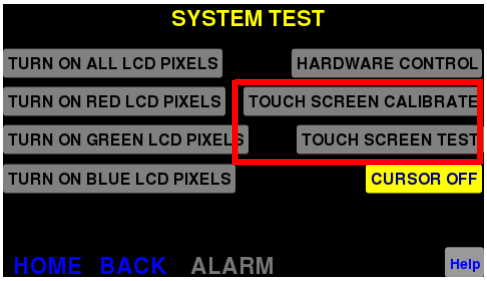
4. In the **SYSTEM TEST** screen, several selections are available to test the touchscreen colors. Pressing a pixel test button will cause the screen to show a scrolling test pattern. When touched again, the display will then return to normal.



SYSTEM TEST Pixel Tests

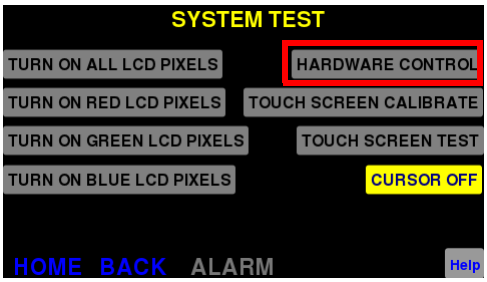
5. To calibrate or test the touch function of the screen, use the **TOUCH SCREEN CALIBRATE** or **TOUCH SCREEN TEST** selections in the **SYSTEM TEST** screen.

   The calibrate function will display a screen with touch targets. Touch all the targets as they are displayed to complete the calibration. The instrument will then automatically store the new touch calibration.



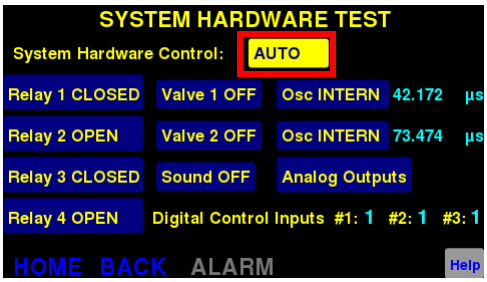
SYSTEM TEST Touch Cal/Test

6. The **HARDWARE CONTROL** selection in the **SYSTEM TEST** screen allows the user to observe in real time and/or manually test various functions of the instrument hardware. Press the **HARDWARE CONTROL** button to move to the detailed test screen.



Hardware Test Selection

7. The **HARDWARE CONTROL** screen includes several controls to manually exercise the hardware. However, to do so the operator must press the Control button to toggle it from **AUTO** to **MANUAL** mode.



Hardware Control Screen

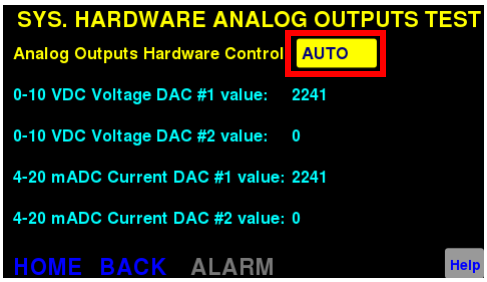
NOTE **The Digital Control Inputs correspond to the Contact Sense inputs #1, #2, and #3 documented on page 132.**

8. Once in **MANUAL** mode, the user can touch any of the buttons to toggle the state of the hardware. The **Analog Outputs** button is, however, not a toggle but will move the operator to the **ANALOG OUTPUTS TEST** screen.

NOTE **In the AUTO mode, the Test screen displays the real time measurement or state of each labeled function.**

NOTE **When changing to MANUAL test mode, please be aware that the automatic functions of the instrument will be overridden. Functions such as autofill will be interrupted, or a fill initiated, by the manual actions. Be sure the system is in a *safe condition* before exercising manual control.**

9. The **ANALOG OUTPUTS TEST** screen requires the operator press the Control button to toggle from **AUTO** to the **MANUAL** mode to exercise control over the output values. The output values range from 0 to 4095 where 0 is the minimum output value and 4095 is the maximum output value. Tap a value to enter a manual override.

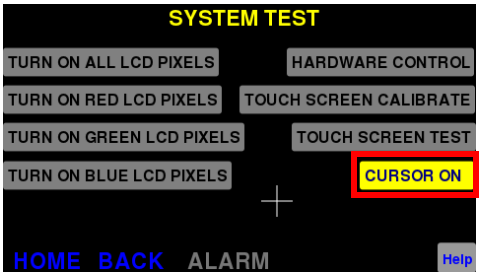


Analog Outputs Tests Screen

NOTE **The hardware control state will return to AUTO after a few seconds if the operator does not explicitly return to automatic control. However, the state of the hardware or autofill functions are *not guaranteed to be the same* as when the MANUAL control state was entered.**

10. Finally, the **CURSOR ON/OFF** button in the **SYSTEM TEST** screen allows the operator to turn the cursor off and on. The cursor display can be useful for verifying the touchscreen response if it appears to function incorrectly.

11. Use the **HOME** button to return to the main level display.



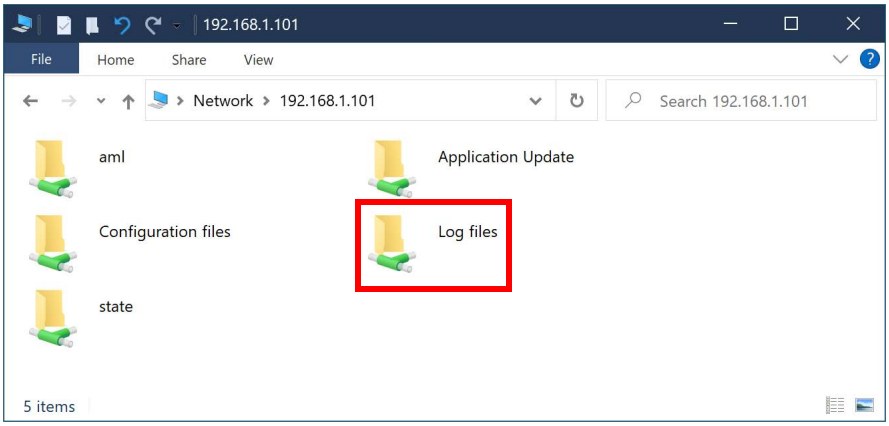
CURSOR Display Selection

SYSTEM LOGS

The Model 1720 provides a logging feature that saves detailed information regarding the liquid level and system events. The information can be very useful in troubleshooting suspected system errors.

The Model 17XX family of liquid level instruments keeps log files in a local Ethernet network accessible folder via Samba file shares. The log

folder is labeled "`Log files`" and can found on a network by opening a file explorer at the instrument IP address or hostname.



In the `Log files` folder, there will be a variety of logging files:

`N2-1.log`: Contains a log of Channel 1 liquid nitrogen measurement events, with each entry timestamped and a record of the hardware bits at that time.

`N2-2.log`: Contains a log of Channel 2 liquid nitrogen measurement events, with each entry timestamped and a record of the hardware bits at that time.

`operations.csv`: Contains a log of all operations/events, with each entry timestamped and appropiate data for the event in a comma separated file format.

LOG FILE FORMATS

The text based logging format is in a comma separated value format. It consist of a unix timestamp, followed by the current level, and then the status bits encoded in a hexadecimal number.

The status bits contains information for both the channels, even if the channels are disabled.

The status bits are a summation of the hardware flags, each flag has a unique bit position, and so the status byte displayed is a hexadecimal representation of those bits.

Refer to the Status Bits table on page 142 for the bit values assigned for each hardware flag.

A log entry is made when either the level changes by 0.1% or if the status bits change from last entry. Levels and bits are checked every second.

A Unix timestamp is the time in seconds since Jan 1, 1970 in Coordinated Universal Time.

DESCRIPTION OF THE N2-1.LOG AND N2-2.LOG FORMAT

Here is an example of measurements of changing level, with a loss of sensor event for Channel #1.

```
    timestamp, %level, status bits
#1  1626708988,  88.2,000020
#2  1626708989,  77.8,000020
#3  1626708990,  54.1,000020
#4  1626708991,  41.3,000020
#5  1626708992,  34.4,000020
#6  1626708994,  16.1,000020
#7  1626708996,   0.0,000221
#8  1626708999,  16.1,000020
```

Entry #1: timestamped at Mon Jul 19 2021 11:36:28 (Eastern Daylight Time) with a read level of 88.2%. The status bits (`000020`) indicated that the external/internal N2 sensor oscillator selection was internal.

Entries #2-#6: shows the level changing over a 5 second span, settling at 16.1%

Entry #7: timestamped at Mon Jul 19 2021 11:36:36 showed a loss of sensor event. The level will be 0.0%, and the status bits show that the sensor was disconnected and the alarm bit was set.

Entry #8: timestamped at Mon Jul 19 2021 11:36:36 showed back to normal operation, with a reading of 16.1%.

Refer to the Log Status Bits table on page 142 for information on the status bits.

DESCRIPTION OF THE OPERATIONS LOGGING FILE

The `operations.csv` file is a text file that records a log of all operations/events: remote, local, and SCPI.

This file contains operations log entries in a comma separated value format, as follows:

```
<unix timestamp>, <class>, <data field 1>, <data field 2>, <data field 3>
```

A data field can be empty, that is, no text.

An overview of the classes:

Class	Description of Event
AF	Master System Autofill
A1	Channel #1 Autofill
A2	Channel #2 Autofill
AL	Alarm(s)
BT	Battery Status
CE	System commands
N1	Liquid Nitrogen channel #1 sensor
N2	Liquid Nitrogen channel #2 sensor
LE	GUI page load event
LF	GUI link (AML function link)
LL	GUI link (AML page link)
LS	GUI link (system variable)
RY	Hardware Relay Status
SC	SCPI command that modified the instrument
SF	State file operation
PU	Power Up
TG	GUI toggle
VM	Modification of a instrument variable

More detailed information on each class is available from your Authorized AMI Technical Representative.

Here is a simple example of operations logging file entries for a shutdown initiation:

```
   timestamp, class,data1,data2,data3
#1 1626712173,LL,MENU,menu.aml,
#2 1626712191,LL,SHUTDOWN,../shutdown.aml,
#3 1626712200,LL,SHUTDOWN ,../shutdown.aml,
#4 1626712200,SF,shmem_dump,checksum,6A7E48E4
#5 1626712200,CE,shutdown,,
```

Line by line description:

```
1626712173,LL,MENU,menu.aml,
```

The operator pressed the MENU button on the home page.

Menu.aml indicated the screen page loaded was menu.aml, that is, the MENU page.

The class LL indicates that this was a link label button event, that is, the label on the button was MENU, and that the linked page loaded was menu.aml.

```
1626712191,LL,SHUTDOWN,../shutdown.aml,
```

The operator pressed the SHUTDOWN menu button which then loaded the ../shutdown.aml page.

```
1626712200,LL,SHUTDOWN ,../shutdown.aml,
```

The operator touched the SHUTDOWN command button which then executed the shutdown procedure.

```
1626712200,SF,shmem_dump,checksum,6A7E48E4
```

The instrument saved the variables to the state file. Class SF indicates this is a state file operation.

```
1626712200,CE,shutdown,,
```

The command executed (CE) was the shutdown command. The data fields #2 and #3 in this line are empty as shown by the two commas after the shutdown command.

LOG STATUS BITS TABLE

Status Bit Representation (in hexadecimal)

STATUS_Alarm	0x00001
STATUS_relay1	0x00002
STATUS_relay2	0x00004
STATUS_Sensor_2_on	0x00010
STATUS_Ext_1_osc	0x00020
STATUS_Valve_1_open	0x00040
STATUS_N2_1_LossOfSensor	0x00200
STATUS_N2_1_SensorShorted	0x00400
STATUS_PowerUp	0x00800
STATUS_relay3	0x01000
STATUS_relay4	0x02000
STATUS_N2_2_LossOfSensor	0x10000
STATUS_N2_2_SensorShorted	0x20000
STATUS_Ext_2_osc	0x40000
STATUS_Valve_2_open	0x80000

GLOSSARY

ABBREVIATIONS AND ACRONYMS

Term	Meaning
AC; ac	Alternating Current; strictly, electrical *current* that periodically reverses direction. Typically used also to describe an electrical power source in terms of the *voltage*. For example, 240 VAC.
ASCII	American Standard Code for Information Interchange; numerical representation of characters such as 'a' or '@' or an action (such as line-feed); 'plain' raw text with no formatting such as tabs, bold or underscoring
BNC connector	A miniature quick connect/disconnect RF connector used for coaxial cable, featuring two bayonet lugs on the female connector.
CR *or* <CR>	Text Carriage-Return character
Cryogen	A substance for obtaining low temperatures. In the case of use with the Model 1700 instrument, a cryogen is a liquefied gas such as liquid nitrogen or liquid helium.
D-Sub	Term referring to the family of connectors containing an odd number of pins in two parallel rows with a 1-pin difference in pins-per-row (DB9, DB15, and DB25 are most common)
DB9	Type of electrical connector containing 9 pins arranged in two parallel rows of 4 pins and 5 pins each
DCE	Data Circuit-terminating Equipment - a device that sits between the Data Terminal Equipment (DTE) and a data transmission circuit.
DHCP	Dynamic Host Configuration Protocol; a computer networking protocol which dynamically distributes the IP address to networked devices
DTE	Data Terminal Equipment - an end instrument that converts user information into signals or reconverts received signals. A DTE device communicates with the Data Circuit-terminating Equipment (DCE).
ECL	Electrical Connection Lubricant - also known as Dielectric Tune-up Grease, a protective lubricant that prevents corrosion.

Term	Meaning
i, I	Electrical current flow
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output; The hardware and associated protocol that implement communication between information processing systems and/or devices. Inputs are the signals or data received by the system or device, and outputs are the signals or data sent from it.
IP	Internet Protocol; when used with “address”, refers to a numerical Internet address
LED	Light-Emitting Diode; a semiconductor device that emits light when energized - used for visual status indication
LF *or* <LF>	Text Linefeed character
LHe	Liquid Helium
LN2	Liquid Nitrogen
Max	Maximum
Min	Minimum
MSDS	Material Safety Data Sheet - provides workers and emergency personnel with procedures for handling or working with a specific substance in a safe manner and includes information such as physical data, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures.
RG-59/U	A specific type of coaxial cable, often used for low-power video and RF signal connections, with a characteristic impedance of 75 ohms.
RS-232	RS-232 is a long-established standard and protocol for relatively low speed serial data communication between computers and related devices; originally established for teletypewriter communication.
SCPI	Standard Commands for Programmable Instruments
V	Volts
VA	Volt-amperes (V x I); a unit of electrical reactive power

T

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