

MODEL 110A LIQUID HELIUM LEVEL MONITOR

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

American Magnetics, Inc.

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Rev. 5, June 1999

Declaration of Conformity

Application of Council Directives: Low Voltage Directive 72/23/EEC
EMC Directive 89/336/EEC

Manufacturer's Name: American Magnetics, Inc.

Manufacturer's Address: 112 Flint Road,
P.O. Box 2509
Oak Ridge, TN 37831-2509
U.S.A.

Type of Equipment: Liquid Level Instruments

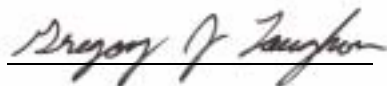
Model Numbers: Model 110A

Standards to which Conformity is Declared:

Safety: EN 61010-1 (1993) w/A1, A2

EMC: EN55011 (1991) Group 1, Class A
EN50082-1 (1997) / EN61000-4-2 (1995) 8kV AD, 4kV CD
EN50082-1 (1997) / EN61000-4-3 (1996) 3V/m
EN50082-1 (1997) / EN61000-4-4 (1995) 1kV Power Supply
0.5kV I/O cables
EN50082-1 (1997) / EN61000-4-5 (1995) 2kV CM, 1kV DM
EN50082-1 (1997) / EN61000-4-6 (1996) 3V
EN50082-1 (1997) / EN61000-4-11 (1994) Voltage dips 30% - 10ms
Voltage dips 60% - 100ms
Short interruption >95% - 5s

I, the undersigned, hereby declare that the equipment specified above complies with the requirements of the aforementioned Directives and Standards and carries the "CE" mark accordingly.



Gregory J. Laugon
Quality Assurance Manager

September 12, 2002

American Magnetics, Inc.
Oak Ridge, TN, U.S.A.

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Foreword

Purpose and Scope

This manual contains the operation and maintenance instructions for the American Magnetics, Inc. Model 110A Liquid Level Monitor. The manual outlines the instructions for instrument use in typical system designs. Since it is impossible to cover all possible system/sensor designs, the most common configuration is discussed and the user 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 introduces the reader to the functions and characteristics of the instrument. It provides the primary illustrations of the front and rear panel layouts as well as documenting the performance specifications.

Installation describes how the instrument is unpacked and installed in conjunction with ancillary equipment in a typical cryogenic system.

Operation describes how the instrument is used to measure liquid level.

Service provides guidelines to assist Qualified Service Personnel in troubleshooting possible system and instrument malfunctions. Information for contacting AMI Technical Support personnel is also provided.

The **Appendix** documents the rear panel connectors.

Foreword

Applicable Hardware

Applicable Hardware

The Model 110A has been designed to operate with an AMI Liquid Helium Level Sensor. Operation with other equipment is not recommended and may void the warranty.

General Precautions

Cryogen Safety

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 coldness 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. Cryogenic 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 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 suspicious of valves on cryogenic systems; the extremes of temperature they undergo causes 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.

Foreword

Safety Summary

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 possess 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 austenitic 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.

Safety Summary

Cryogenic storage systems are complex systems with the potential to seriously injure personnel or equipment if not operated according to procedures. Proper use of safety mechanisms (pressure relief valves,

Foreword

Safety/Manual Legend

rupture disks, etc.) included in the cryostat and top plate assembly are necessary.

Recommended Safety Equipment

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

Safety/Manual Legend



Instruction manual symbol: the product is marked with this symbol when it is necessary for you 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).



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



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.

1 Introduction

1.1 Model 110A Features

The American Magnetics, Inc. (AMI) Model 110A Liquid Helium Level Monitor is an economical level meter designed for systems requiring a basic liquid helium level readout.

The Model 110A is designed to be used in conjunction with an AMI liquid helium level sensor. The liquid helium level sensor consists of a small diameter NbTi filament in a hollow tube. A constant current is passed through this filament causing the portion of the filament in helium gas to become resistive, while the portion in the liquid helium remains superconducting. The resulting voltage across the resistive portion of the filament is read by the instrument, converted to a liquid level, and displayed on the front panel meter.

1.1.1 Convenient display

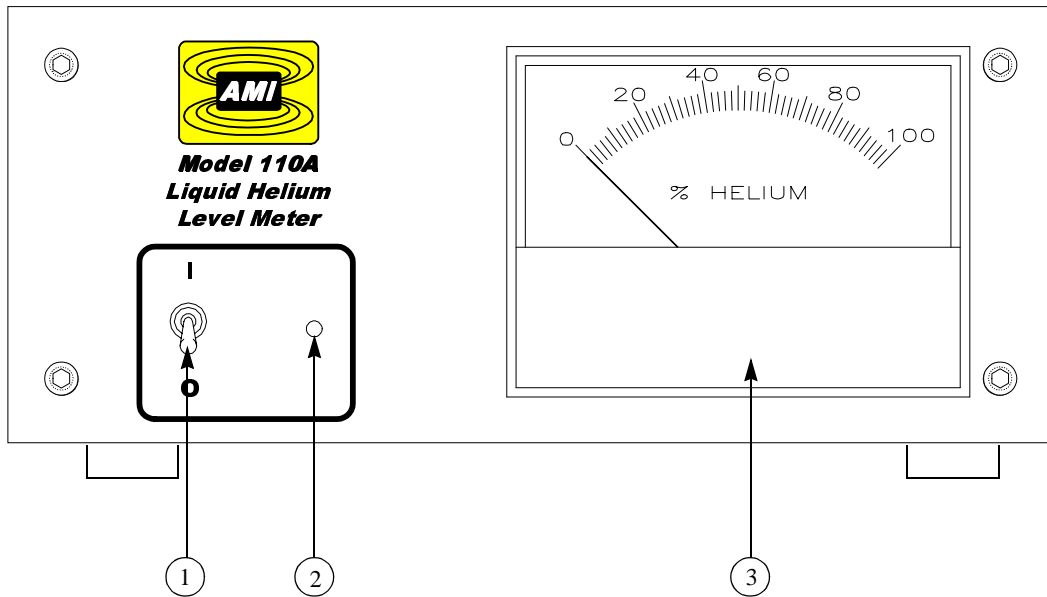
The Model 110A is equipped with an analog display which provides liquid helium level indication in percent.

1.1.2 Remote monitoring

The Model 110A is provided with a 0-10 VDC (or 0-100 millivolt DC) recorder output. A 4-20 mA current loop option is available in lieu of the recorder output.

Introduction

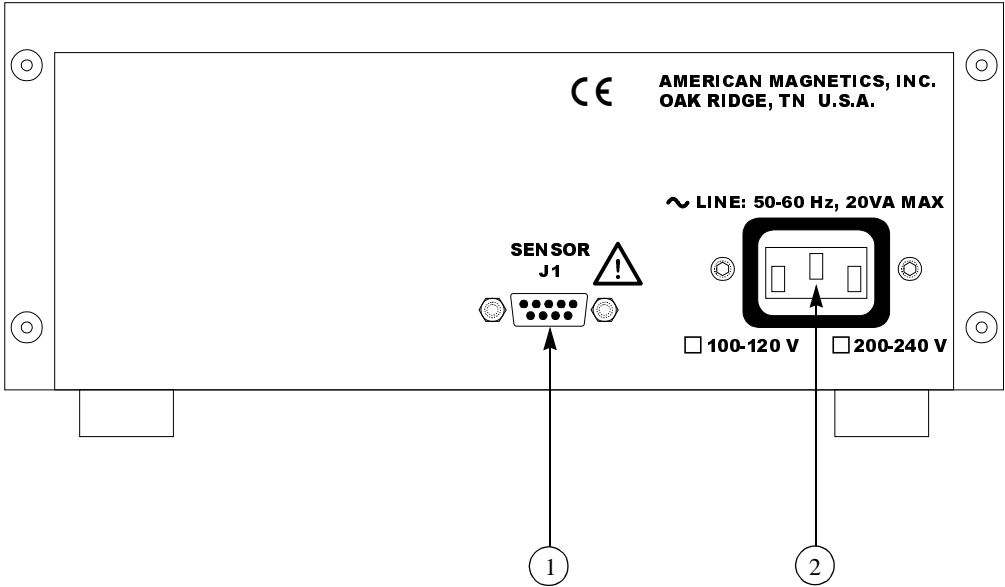
Model 110A Front Panel Layout



1	Power toggle switch	3	Liquid helium level meter (0-100%)
2	Power ON LED		

Introduction

Model 110A Rear Panel Layout



1 Sensor input/analog outputs DB-9 female connector (see the *Appendix* for the pinout diagram)

2 Power cord connector

Introduction

Specifications

1.4 Model 110A Specifications @ 25 °C

Level Measurements

Maximum Sensor Length ^a :	60 inches
Linearity:	± 2%
Sensor Current:	75 mA nominal
Sensor Voltage:	1 VDC x active sensor length (inches)

0-10 Volt Analog Output

Total Error:	± 0.5% for 0-10 V or 0-100 mV output
Voltage Drift:	± 250 ppm / °C for 0-10 V output ± 400 ppm / °C for 0-100 mV output

4-20 mA Analog Output

V _{ext} Supply Range:	12-36 VDC (see <i>Appendix</i> for diagram)
Total Error:	± 0.5% for 4-20 mA output
Current Drift (4-20 mA):	± 350 ppm / °C

Power Requirements

Primary ^a :	100-120 or 200-240 VAC ±10% 50 - 60 Hz
Maximum Current:	20 VA

Physical

Dimensions (Standard):	97 mm H x 213 mm W x 273 mm D (3.8" H x 8.4" W x 10.75" D)
Weight (Standard):	1.8 kg (4.0 lbs.)
Dimensions (Rack Mount):	89 mm H x 483 mm W x 273 mm D (3.5" H x 19" W x 10.75" D)
Weight (Rack Mount):	2.1 kg (4.7 lbs.)

Environmental

Ambient Temperature:	Operating: 0 °C to 50 °C (32 °F to 122 °F) Nonoperating: -20 °C to 60 °C (-4 °F to 140 °F)
Relative Humidity:	0 to 95%; non-condensing

- a. Maximum active sensor length is limited to 56 inches for input line voltages below 99 VAC.

2 Installation

Warning

Before energizing the instrument, 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 one must be used, ensure the ground conductor is intact and capable of carrying the rated current.

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

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

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

If the instrument is used in a manner not specified by AMI, the protection provided by the equipment may be impaired.

2.1 Unpacking the Instrument

Carefully remove the instrument, sensor, and interconnecting coaxial cables from the shipping carton and remove all packaging material. A rack mounting kit is supplied if the instrument was purchased with the rack mount option.

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.

If the chassis is a table top model, place the instrument on a flat, secure surface.

Installation

Sensor Preparation

2.2 Rack Mounting the Instrument

If the instrument has a rack mount chassis, follow the following procedure:

- a. Attach the rack mount adapter pieces to the instrument by first removing the four screws on the side of the instrument that attach the cover to the chassis. Attach the rack mount adapter pieces to the sides of the instrument by reinstalling the screws.
- b. Install the instrument in a 19" rack by securing the front panel to the rail in each of the four corners with mounting hardware supplied by the cabinet manufacturer.

Warning

Do not remove the cabinet feet and then reinsert the original screws. Doing so could present a severe life-threatening electrical hazard. If removal of the cabinet feet is desired, replace the original screws with screws not to exceed 1/4" in length. Screws longer than 1/4" will contact and damage the printed circuit board inside the unit.

2.3 Preparing the Sensor for Connection

Prepare the sensor to be connected to the instrument by soldering the sensor leads to a male 9-pin D-Sub connector which will connect to J1 on the rear panel of the instrument. Refer to the *Appendix* of this manual and the AMI sensor manual for the proper pinout and wire color connections. Connect the sensor to connector J1 on the rear panel.

Warning



The sensor connector is for use with an AMI LHe sensor and the wiring for the sensor is to have no live parts which are accessible. Conductors connected to its terminals must be insulated from user contact, and from other conductors which the user may contact such as the analog output conductors, by basic insulation rated for 100 VAC (Category I).

The lead wire for the sensor may be sized by the following equations. For input line voltages greater than or equal to 99 VAC:

$$R = 387 - 5.79L$$

For input line voltages less than 99 VAC:

$$R = 340 - 5.79L$$

Installation

Sensor Preparation

where R is the maximum allowable resistance (in ohms) for each lead wire from the instrument to the sensor, and L is the active length of the connected helium level sensor in inches. Please note that the maximum allowable active sensor length for input line voltages less than 99 VAC is 56 inches. Tables for active sensor length vs. lead wire distance are provided below.

Minimum recommended gauge for stranded, tinned-copper lead wire for input line voltages greater than or equal to 99 VAC.

Distance	$R=329$	$R=271$	$R=213$	$R=155$	$R=97.5$	$R=39.6$
	$L=10''$	$L=20''$	$L=30''$	$L=40''$	$L=50''$	$L=60''$
10 ft.	36 AWG	36 AWG	36 AWG	36 AWG	36 AWG	36 AWG
20 ft.						
30 ft.						
40 ft.						
50 ft.						
100 ft.						
200 ft.				32 AWG		
500 ft.	34 AWG	32 AWG	28 AWG			

Minimum recommended gauge for stranded, tinned-copper lead wire for input line voltages less than 99 VAC.

Distance	$R=282$	$R=224$	$R=166$	$R=108$	$R=50.5$
	$L=10''$	$L=20''$	$L=30''$	$L=40''$	$L=50''$
10 ft.	36 AWG	36 AWG	36 AWG	36 AWG	36 AWG
20 ft.					
30 ft.					
40 ft.					
50 ft.					
100 ft.					
200 ft.			34 AWG		
500 ft.	34 AWG	32 AWG	28 AWG		

Installation

Verifying power requirements

2.4 Connecting any Analog Output Option

If an analog output option has been installed in the instrument, prepare the mating end of the connector and plug it into the connector J1 on the rear panel. Refer to the *Appendix* of this manual for a description of the connector J1 wiring.

2.5 Connecting the Instrument to Power

Warning

The Model 110A operates on 50-60 Hz power and may be configured for 100-120 or 200-240 VAC $\pm 10\%$. The power requirement for the instrument is marked on the calibration sticker on the bottom of the instrument. Verify that your instrument is configured for your power source prior to plugging in the line cord. Do not fail to connect the input ground terminal securely to an external earth ground.

Verify that the instrument is configured for the proper operating voltage by referring to the calibration sticker affixed to the bottom of the instrument. If the operating voltage is correct, plug the line cord into the appropriate power receptacle.

Warning

Do not install the instrument in a manner that prevents removal of the line cord from the rear panel of the instrument.

3 Operation

This section describes the front panel display and control functions for the Model 110A. In addition to the front panel operation described, analog output signals proportional to the liquid level are provided by rear panel connectors. Refer to the *Appendix* beginning on page 17 for more details regarding the analog outputs.

3.1 Normal Operational Mode

3.1.1 Turn on the power

Turn the power toggle switch to the on position. The green LED located near the power switch will be energized.

Note

The Model 110A instrument is calibrated at the factory. No further calibration is required. Please observe the calibration sticker to verify that the unit is calibrated for the correct active sensor length.

3.1.2 Read the level display

The Model 110A performs continuous level measurements. Simply observe the front panel level meter for the current liquid level.

3.1.3 Connect the analog output signal

The connector J1 on the rear of the instrument also provides a 0-10 VDC or optional 4-20 mA analog signal corresponding to 0-100% of liquid level. Refer to the *Appendix* for the pinout diagram of connector J1.

3.2 Contaminated Sensors

AMI expects the helium level sensor to be reasonably clean and free from oil, water, ice, etc. for proper operation. If correct readings cannot be obtained, the sensor must be warmed to remove ice, or completely removed for cleaning or replacement.

Operation

Dirty Sensor Operational Mode

4 Service Guide

The procedures in this section should only be performed by Qualified Service Personnel (QSP).

4.1 Troubleshooting Procedures

The following paragraphs serve as an aid to assist QSP in troubleshooting a potential problem with the Model 110A. If the QSP is not comfortable with troubleshooting the system, you may contact an Authorized AMI Technical Support Representative for assistance. Refer to “Additional Technical Support” on page 14.

This instrument contains CMOS components which are susceptible to damage by Electrostatic Discharge (ESD). Take the following precautions whenever the cover of the instrument is removed.

1. Disassemble the instrument only in a static-free work area.
2. Use a conductive workstation or work area to dissipate static charge.
3. Use a high resistance grounding wrist strap to reduce static charge accumulation.
4. Ensure all plastic, paper, vinyl, Styrofoam[®] and other static generating materials are kept away from the work area.
5. Minimize the handling of the instrument and all static sensitive components.
6. Keep replacement parts in static-free packaging.
7. Do not slide static-sensitive devices over any surface.
8. Use only antistatic type solder suckers.
9. Use only grounded-tip soldering irons.

Service Guide

No level reading

4.1.1 No level reading

1. Ensure that the sensor is immersed in liquid helium. If the sensor is immersed and/or cooled, then proceed to step 2.

Note

Even if the sensor is not cooled, the instrument will continue to attempt level measurement while powered-on. Energizing the instrument with a sensor connected at room temperature can result in overheating of the superconducting wire and sensor failure.

2. Check the sensor connections. With the sensor at room temperature, check the following resistances between sensor leads:

RED to BLUE = approximately 5 ohms

BLUE to YELLOW = 13.33 ohms x Active Length (inches)

YELLOW to BLACK = approximately 0.7 ohms

RED to BLACK = (RED to BLUE) + (BLUE to YELLOW)

If the indicated conditions do not exist, contact an Authorized AMI Technical Support Representative.

Note

If sensor lead wires in excess of few feet are connected, the above figures may not be applicable.

3. Ensure that the instrument is energized from a live power source of proper voltage. The unit configured voltage is indicated on the rear panel.

Warning

If the instrument has been found to have been connected to an incorrect power source, return the instrument to AMI for evaluation to determine the extent of the damage. Frequently, damage of this kind is not visible and must be determined using test equipment. Nevertheless, connecting the instrument to an incorrect power source could damage the internal insulation and/or the ground requirements, thereby, possibly presenting a severe life-threatening electrical hazard.

4. Verify continuity of the line fuse, F1, located on the instrument printed circuit board.

Service Guide

Erratic or erroneous level reading

Warning

This procedure is to be performed only when the instrument is completely de-energized by removing the power-cord from the power receptacle. Failure to do so could result in personnel coming in contact with high voltages capable of producing life-threatening electrical shock.

- a. Ensure the instrument is de-energized by disconnecting the power cord from the power source. Disconnect the power cord from the connector located on the rear panel of the instrument.
- b. Remove the instrument top cover and check the fuse F1 for continuity.
- c. If the fuse is bad, replace with a 160 mA IEC 127-2 Type T Sheet III 5x20mm fuse for 100-120 VAC operation. For 200-240 VAC operation, replace F1 with a 80 mA IEC 127-2 Type T Sheet III 5x20mm fuse.

Warning

Installing fuses of incorrect values and ratings could result in damage to the instrument in the event of component failure and/or a safety hazard.

- d. Replace the fuse(s) and securely fasten the instrument top cover. Reconnect the power-cord.

4.1.2 Erratic or erroneous level reading

1. Ensure that the sensor is connected properly to the rear panel SENSOR connector, J1 (see the Rear Panel Layout on page 3 and the pinout diagram in the *Appendix* on page 18).

Note

A significant number of trouble calls are the result of the sensor not properly connected to J1 on the rear panel. The proper positioning of the sensor wires and proper solder connections are critical to the proper operation of the Model 110A.

2. Ensure there are no ice formations on the sensor. Ice formations on the sensor inhibit sensing element thermal propagation thereby producing incorrect readings. If ice formation has occurred, the ice must be removed.
3. Check for a dirty sensor. If the sensor collects oil, water, etc., the sensor could possibly not operate correctly.

Service Guide

Custom Instrument Configurations

4. Ensure the sensor is not installed in a restricted area which prohibits the level of helium around the area of the sensor to be an accurate representation of the level to be measured. The gas produced by the sensor when the sensor current is on can depress the liquid level.
5. Ensure the sensor is installed with lead wires at the top. Due to the physical construction of the AMI LHe sensor, a reading of 100% will always result if the sensor is installed upside down.

4.2 Custom Instrument Configurations

4.2.1 Modifying the line voltage requirements

Warning

Before removing the cover of the instrument, remove the power from the instrument by disconnecting the power cord from the power receptacle. Failure to do this could expose the user to high voltages and could result in life-threatening electrical shock.

Caution

The Model 110A instrument operates on 50-60 Hz power and may be configured for 100-120 VAC or 200-240 VAC $\pm 10\%$. The power requirements for each instrument are marked on the rear panel. Be sure the instrument's power requirements match your power source prior to plugging in the line cord. Do not fail to connect the input ground terminal securely to an external earth ground.

If the instrument operating voltage needs to be changed, ensure the instrument is de-energized by disconnecting the power cord from the power source. Remove the instrument cover and slide the voltage selector switch on the main printed circuit board to the proper voltage. Replace the instrument cover and *indelibly mark the rear panel indications to match the new configuration.*

4.3 Additional Technical Support

If the cause of a problem cannot be located, contact an AMI Technical Support Representative at (865) 482-1056 for assistance. The AMI technical support group may also be reached by Internet e-mail at **support@americanmagnetics.com**. Additional technical information, latest software releases, etc. are available at the AMI World Wide Web site at:

Service Guide

Return Authorization

<http://www.americanmagnetics.com>

Do not return the Model 110A or other liquid helium level system components to AMI without prior return authorization.

4.4 Return Authorization

Items to be returned to AMI for repair (warranty or otherwise) require a return authorization number to ensure your order will receive proper attention. Please call an AMI representative at (865) 482-1056 for a return authorization number before shipping any item back to the factory.

Service Guide

Return Authorization

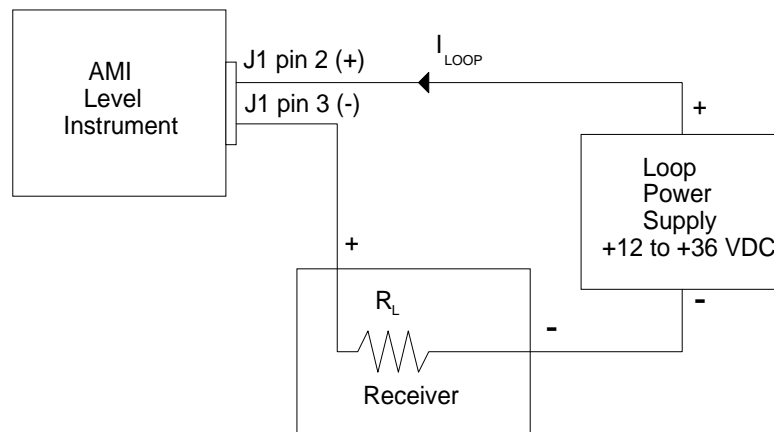
Appendix

A.1 4-20 mA Current Loop Option

The 4-20 mA output utilizes pins 2 and 3 of connector J1. If the 4-20 mA option is present, the voltage output is not available from pins 4 and 5. The figure below shows the wiring diagram and the voltage requirements for the power supply and receiver.

Caution

It is extremely important to observe all polarities and to not exceed +36 VDC for the loop power supply in order to prevent damage to the 4-20 mA driver circuit.



Note

For maximum immunity to external electrical and electromagnetic disturbances, all external cabling (except for the AC input) should be shielded. The cable shield should be connected to the chassis of the instrument by connecting to the J1 D-sub connector shell.

Note

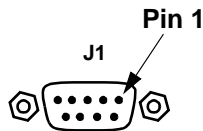
For the 4-20 mA output to work properly, at least 12 V must be present between J1 pin 2 and J1 pin 3, i.e. the voltage drop of the receiver must be considered.

Appendix

Sensor Connector J1 Wiring

A.2 Sensor/Analog Outputs Connector J1 Wiring

Pin	Function
1	Sensor I + (Red)
2	4-20 mA current loop input (optional feature)
3	4-20 mA current loop output (optional feature)
4	0-100 mV DC (or 0-10 VDC) output
5	0-100 mV DC (or 0-10 VDC) output common
6	Sensor V – (Yellow)
7	Sensor I – (Black)
8	Sensor V + (Blue)
9	Ground



Warning



The sensor connector is for use with an AMI LHe sensor and the wiring for the sensor is to have no live parts which are accessible. Conductors connected to its terminals must be insulated from user contact, and from other conductors which the user may contact such as the analog output conductors, by basic insulation rated for 100 VAC (Category I).

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