OPERATING INSTRUCTION MANUAL

FOR THE

MODEL GM-700
HALL EFFECT GAUSSMETER

CRYOMAGNETICS, INC.
INNOVATIVE SUPERCONDUCTING MAGNET SOLUTIONS

WARNING!
DO NOT ATTEMPT TO OPERATE THIS EQUIPMENT BEFORE YOU HAVE
THOROUGHLY READ THIS INSTRUCTION MANUAL.

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1.0   Introduction

The GM-700 Hall Effect Gauss Meter is a state of the art instrument that provides excellent accuracy and resolution. Its versatile architecture allows configuration to virtually any Hall Effect sensor.

The GM-700 has user-adjustable high and low setpoints that may be used to control other equipment the user requires. Also included is an audible alarm that is controlled with separate user-adjustable high and low setpoints. If the magnetic field is between the high and low setpoints the alarm is silent. If below the low setpoint or above the high setpoint the alarm sounds until silenced by the operator.

Computer control via RS-232 is available in the standard configuration. Remote control via the latest IEEE-488.2 command set is available as an option. LabVIEW® virtual instrument drivers are available to allow computer control via a familiar, intuitive interface. A wide variety of other options are also available that allow the instrument to be upgraded and tailored to your particular requirements.

2.0   Factory Calibrations, Installed Options and Certification

GM-700 Serial Number: _____

Internal Reference: _____   Firmware Version: _____

Input Voltage: 100 VAC: ____   115 VAC: ____   230 VAC: ____

Sensor:

Type: HSU-1 ____   HSU-2 ____   HSP-T ____   HSP-A ____   Other: _____

Calibration: Sensor Manufacturer / Serial No: _____

Sensor Sensitivity: _____mV/kg

Excitation Current: _____

Control Output: TTL: _____   Open Collector: _____   Other: _____

Analog Output (Option 1):   Not Installed: _____

Type: 0-1 Volt: _____   4-20mA: _____

Computer Interface Installed: RS-232: __X__   IEEE-488.2 (Option 2): _____

Notes: _____

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Certified: _____

Date: _____

3.0   Setup

The GM-700 is delivered to you fully tested and ready to operate. This includes sensor calibration if Cryomagnetics supplied the sensor with the instrument. Calibration will also be complete if the sensitivity of an existing installed sensor was specified at the time of order.

3.1   Line Voltage and Fuse

Unless otherwise specified, the GM-700 is configured for operation using 100 to 115 VAC +/- 10%, 50/60 Hz input power. The serial number tag on the rear panel of the unit indicates the factory voltage setting.

The line voltage setting can be changed to 230 VAC if desired. Always disconnect the power cord from the unit prior to opening the case. To open the GM-700, remove the two screws from the rear panel of the unit. Also remove the screws on the RS-232 and Sensor(s)/IO connectors. The rear panel can then be pulled back and the cover of the GM-700 can be slid off. Figure 3.0 indicates the changes in circuit board jumpers inside the unit used to make a change in line voltage.

Figure 3.0 - Line Voltage Jumper Settings

Transformer Primary Jumpers

Line Voltage	JP1	JP2	JP3	JP4
100V, 115V	Short	Open	Short	Open
200V, 230V	Open	Short	Open	Short

The fuse for the GM-700 is mounted on the main circuit board inside the unit. Should the fuse need to be changed, open the GM-700 as described above. Locate the fuse - it is a cylindrical device labeled F1 and can be found on the right side of the unit near the main transformer. Replace the fuse only with another fuse of the same type. Use only Wickmann part number 19374-035-K (250V, 0.25A, time lag). Never replace the fuse with a wire.
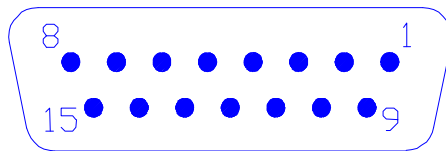

3.2   Connecting Sensors

Sensors connect to the GM-700 through the rear panel DB-15F connector labeled "Sensor(s)/IO". This connector provides service not only to the sensor, but also to the control output signal generated by the GM-700 and the 4-20mA analog output signal, (optional). Figure 3.1 indicates the pin designations for the Sensor(s)/IO connector.

********** IMPORTANT ***********

1) Connections should NEVER be made directly to the connector on the rear panel. Always solder to a mating connector that is not attached to the unit.   Connections should be double-checked for accuracy prior to attaching to the GM-700 and powering the unit ON.
2) NEVER connect/disconnect the sensors with the GM-700 powered ON.

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Figure 3.1 - Sensor Connector Wiring - DB-15F

View Facing Rear Panel Connector

Pin #	Function	Pin #	Function
1	Sensor I+	9	N/C
2	Sensor I-	10	N/C
3	Sensor V+	11	N/C
4	Sensor V-	12	N/C
5	Analog Output (Optional) 4-20 mA I-	13	N/C
6	Analog Output (Optional) 4-20 mA I+	14	Control Output
7	N/C	15	GND
8	N/C		

Cryomagnetics, Inc. Hall Effect sensors have four (4) lead wires. Lead function and wire colors are specified on the data sheet accompanying the sensor.

Cabling between the Hall Effect sensor and the GM-700 should be of appropriate size such that a high voltage drop across the I+ and I- leads does not occur. Voltage drop across I+ to I- at the GM-700 should not exceed 2.0 volts with the sensor connected.

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3.3 Hall Effect Sensor Calibration

Calibration of Hall Effect sensors is performed through the front panel keypad of the GM-700. Calibration can not be performed through the GM-700 computer interfaces.

To calibrate a sensor, power ON the GM-700 (the sensor does not need to be connected). Press the MENU key and use the UP or DOWN arrow keys to select CAL from the opening menu. When CAL is highlighted, the GM-700 will show the present calibration setting (sensitivity) for the sensor on the second display line. Press ENTER to access the calibration values.

The GM-700 indicates "Ch 1 Sensitivity:" on the first line of the display, and the present setting for the sensitivity on the second line. The sensitivity may be set to any value between 10 microvolts per kilogauss and 500 millivolts per kilogauss. The sensitivity may be computed using the sensor calibration information supplied with the sensor and physical location and orientation of the sensor relative to the central field to be measured. Alternatively, if the sensor is placed in a known field and the measurement value observed, the sensitivity may be scaled by multiplying the sensitivity by the known field and dividing the result by the observed measurement. If this method is used, The instrument should be fully warmed up (about 1 hour of operation) and the probe ZERO function should be used with the Hall sensor in a zero field before starting the calibration (see Section 4.2). Press ENTER to accept and save the displayed value, or MENU to exit without saving the value.

4.0   Operation and Menus

Setup of the GM-700 can be performed either through the front panel keypad and simple menu instructions or through remote computer interface (RS-232 or IEEE-488.2). Calibration is only supported through the front panel keypad. In the following sections there are detailed descriptions of how to recalibrate for different sensors, set the audible alarm, and configure the controller functions.

Before connecting the Hall Effect sensor or other cabling to the GM-700, connect the power cord provided with your GM-700 to an appropriate power source. Power the instrument ON and familiarize yourself with the display. The GM-700 has a normal operational display that will show "Magnetic Field" on the upper line and the measured value on the lower line when in Absolute mode.

```
┌─────────────────────────────┐
│       Magnetic Field        │
│        -25.9877 T           │
└─────────────────────────────┘
```

If the control output is active it is indicated by a diamond on the lower display line. If an alarm condition is present is indicated by an "A" on the lower display line.

```
┌─────────────────────────────┐
│       Magnetic Field        │
│      -259.877 kG  ♦A        │
└─────────────────────────────┘
```

The GM-700 may be switched to relative mode to display a reference field on the lower display line, and the difference between the measured field and reference field on the upper display line.

```
┌─────────────────────────────┐
│         35.G  Δ             │
│      -100.000 kG Ref        │
└─────────────────────────────┘
```

To change the mode or relative reference levels, probe zero, alarm points, control output limits, display units, computer communication parameters, calibration, or any other user-settable options, you must press the MENU key. The menu function will be displayed on the first line and present setting on the second line.   Pressing the DOWN key will select the next menu item to the right. Pressing UP will select the next menu item to the left. The display will scroll left or right and display three menu items in each scroll position.

```
┌─────────────────────────────┐
│    >Mode<  Zero  Alarm      │
│         Absolute            │
└─────────────────────────────┘
```

Pressing MENU again returns the instrument to normal display and operations. Be aware that some computer interface commands are not available while the menu system is active (see Appendix A).

There are numerous user-adjustable options available. The following outline indicates options and the menu headings under which they are found.

4.1   Mode

Under the Mode menu item, the user can select either Absolute or Relative operational mode. This item appears first in the menu list since it may be changed frequently to observe either the actual field or changes to a previously established reference field. If Relative is selected, the value of a reference field may be set by selecting Adjust and using the UP, DOWN, and ENTER keys, or the present field may be measured by selecting Measure and pressing ENTER when the measured field is the at the desired reference value.

4.2   Zero

The GM-700 allows the probe to be 'zeroed' when no field is applied to establish zero field which eliminates offsets due to probe temperature, instrument temperature, or drift in electronic components. When Zero is selected from the menu a 'Zero Probe?' prompt is displayed. 'Yes' must be selected to initiate the function. Note that if the probe is zeroed when at a non-zero field there will be no way to display a true absolute field, although relative mode could be used to effectively compensate for the offset due to an erroneous zero.

4.3   Alarm

The GM-700 has an internal audible alarm which can be set to activate when the measured field falls outside of user setpoints. The set points for the high and low alarm limits are set in the "Alarm" menu. The alarm function gives a front panel display indication when it is activated - "A" appears on the right side of the active display line to indicate an alarm condition. The audible alarm can be silenced by pressing any front panel key on the GM-700; however, the visual indication of the alarm condition, "A" on the display, is maintained until the measured field is between the alarm set points.

4.4   Limits

The GM-700 has a control output which will activate when the measured field falls outside of user setpoints. The set points for the high and low control output limits are set in the "Limits" menu. The control output function gives a front panel display indication when it is activated - a diamond pattern appears on the right side of the active display line when the control output is activated. The

control output will remain active until the measured field is between the set points.

4.5   Units

The Units menu item allows the user to set the display units of the GM-700. Available options are Gauss and Tesla. Once the system of units is selected, the GM-700 autoranges between Gauss and kilogauss or Tesla and millitesla.

4.6   Ports

The Ports menu item enables the user to select the computer interface which is active (RS-232 or IEEE-488.2 - if installed), and to set up the parameters of the computer interface such as baud rate, address, etc. When the Ports menu item is highlighted, the current settings of the computer interfaces are displayed on the second line. To change any of the Port options, press ENTER when "Ports" is highlighted. Then select the option that is to be changed:

RS-232   Baud rate may be set to 9600, 4800, 2400, or 1200. Factory default is 9600.

GPIB   Device address may be selected from 0 - 31. Factory default is 0.

In accordance with the IEEE-488.2-1992 specification, changes are not made immediately but are applied the next time the unit is powered up.

4.7   Calibrate

Under the Calibrate (Cal) menu item, the user can set effective sensitivity of the Hall Effect sensor. When "Cal" is highlighted, the present sensor sensitivity setting is shown on the second line of the display. The units used by the GM-700 (kilogauss or Tesla) for calibration is set with the Units menu item. Pressing ENTER while "Cal" is highlighted allows the user to adjust the sensitivity value. Refer to section 3.3 for the Hall Effect sensor calibration procedures.

4.8   Analog Output Limits (Option 1)

The analog output limits (AnlgOut) menu item enables the user to set the lower and upper limits for the analog output. If the measured field is less than the lower limit, the minimum analog output value will be set on the analog output port. If the measured field is above the upper limit, the maximum analog output value will be set on the analog output port. If the measured field is between the lower and upper limits, a linear interpolation will be used to set the value on the analog output port.
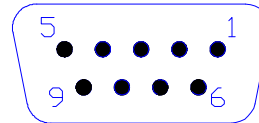
5.0 Interfacing

The GM-700 comes standard with an RS-232 computer interface. Front panel functions, except calibration functions, may be accessed using the corresponding command string over the RS-232 port. In addition, an IEEE-488.2 port is available as an option. This port conforms to the IEEE-488.2-1992 standard.

5.1 RS-232 Computer Interface

An RS-232 computer interface port is provided as standard equipment on all GM-700s. The port is accessed through the DB-9F connector on the rear panel of the instrument. The interface is factory configured for 9600 baud, 8 data bits, 1 stop bit, no parity. Figure 5.0 indicates the proper pin designations for the port. Figure 5.1 details available RS-232 port commands.

Figure 5.0 - RS-232 Port Connector Wiring

Pin #	GM-700 Pin Function
1, 4, 6, 7, 8, 9	N/C
2	RS-232 Transmit
3	RS-232 Receive
5	Ground

View Facing Rear Panel Connector

Commands available to the GM-700 operator over the RS-232 computer interface are given in Appendix A. The commands available through RS-232 are identical to those available through IEEE-488.2; however, some commands may be IEEE-488.2 specific and may not provide responses consistent with the RS-232 interface.

Command strings are normally limited to 30 characters when the RS-232 interface is used. A <RETURN> will be generated internally when any line longer than the maximum is encountered, and any valid commands in the received line prior to the internally generated <RETURN> will be processed. An output buffer of 32 characters is used although longer responses can be successfully generated. All remote commands are case insensitive, allowing upper or lower case to be used without affecting operation of the commands.

When the RS-232 interface is selected all commands sent to the instrument will be echoed including the terminating ASCII <RETURN> character, followed by a <NEWLINE> character when command processing is complete.

5.2 IEEE-488.2 Computer Interface

The GM-700 may have an optional IEEE-488.2 computer interface (Option 2). The GM-700 implements SH1, AH1, T6, L4, SR1, RL0, PP0, DC1, DT0, C0, and E1 options. The commands are compliant with the IEEE-488.2 standard.

Reference: IEEE Standard Codes, Formats, Protocols, and Common Commands (IEEE Std 488.2-1992) provides a detailed description of the IEEE common commands (identifiable in the command list by the asterisk as the first character.)

The command list and structure is identical to the RS-232 command set. Reference Appendix A for a detailed description.

5.3 Analog Output

An analog output from the GM-700 is available as an option (Option 1). This output can be specified at the time of purchase to be either 4-20mA or 0-1V. If the 4-20 mA option is installed, the signal is found on the GM-700 rear panel DB-15F connector, pins 5 and 6 (see Figure 3.1). If the 0-1V analog output option is installed, the signal is found on the GM-700 rear panel BNC connector. In either case, the analog output signal is linear and proportional to the sensor reading as described in section 4.8.

5.4 Audible Alarm

A user-adjustable audible alarm is standard on the GM-700. The alarm may be set through the front panel menu system (see sections 4.3). The alarm gives the user an audible indication if the measured magnetic field falls outside the alarm set points. Once the alarm is activated, it may be silenced by any front panel keystroke. It will only be reactivated after a normal reading (i.e., one between the alarm setpoints) is detected by the GM-700, followed by another reading in which an alarm condition again exists. The audible alarm may be disabled by setting limits beyond the range of field measurements.

5.5 Control Output

The GM-700 in its standard configuration is capable of generating a control signal to be used with remote equipment.

The control output may be set to be either "open collector" or "0-5V". Refer to Section 2.0 of this manual for the factory settings of your particular GM-700. Figure 3.1 indicates the output pins designated to carry the Control Output signals, and Figure 5.1 indicates the jumper setting to change the configuration.

Figure 5.1 - Control Output Format Setting (Jumper 22)

TTL Compatible	Open Collector
Short	Open

If the output will consequently be driving a solenoid valve or relay, the output will typically be configured as open collector. If the control output is simply being monitored by other equipment (e.g., a computer), the output should be configured as TTL Compatible (0-5V).

When the GM-700 is used in conjunction with Option 5, the Line Voltage Controller Module, the unit is capable of driving solenoid valves requiring 115V/230V AC. Option 5 provides the user with a fused and opto-isolated line voltage output. Refer to Appendix C for a technical description of Option 5.

6.0   Theory of Operation

The GM-700 is configured for a specific sensor excitation current at the factory to optimize accuracy and to minimize noise. Although the excitation current may be changed in the factory calibration menu, component changes may be needed to maintain low noise performance, accuracy, and sensor protection. Consult the factory if this is necessary.

6.1   Hall Effect Magnetic Field Sensing

The Hall Effect sensor is a solid state device with four terminals. The GM-700 provides constant current DC excitation through the I+ and I- terminals, and measures the Hall voltage generated by the sensor across the V+ and V- terminals. The Hall Effect sensor generates an output voltage proportional to the excitation current, the magnetic flux density, and the sine of the angle between the magnetic field vector **B** and the plane of the Hall generator.

6.2   GM-700 Circuit Description

The GM-700 is a 68HC11 microprocessor based instrument. This microprocessor has built-in EEPROM that is used to hold factory calibration and configuration data, as well as user entered calibration and setup information. Consequently, it is not possible to simply change the processor with another 68HC11. The unit will not work properly with a new processor until it has been initialized by the factory.

The processor controls virtually all aspects of the GM-700 including the display, keypad, a precision constant current source, a low noise precision preamplifier, and the high stability, 24-bit analog-to-digital converter used to monitor sensor voltages. Due to the flexibility and stability of the GM-700's circuits, very high resolution, accuracy, and low noise performance is achieved.

The GM-700's display is a bright, vacuum fluorescent unit having high contrast. It is capable of full alphanumerics and can clearly be read from a significant distance.

7.0   Limited Warranty Policy

Cryomagnetics, Inc. warrants its products to be free from defects in materials and workmanship. This warranty shall be effective for one (1) year after the date of shipment from Cryomagnetics. Cryomagnetics reserves the right to elect to repair, replace, or give credit for the purchase price of any product subject to warranty adjustment. Return of all products for warranty adjustment shall be FOB Oak Ridge, TN, and must have prior authorization for such return from an authorized Cryomagnetics, Inc. representative.

This warranty shall not apply to any product which has been determined by Cryomagnetics, Inc. inspection to have become defective due to abuse, mishandling, accident, alteration, improper installation or other causes. Cryomagnetics, Inc. products are designed for use by knowledgeable, competent technical personnel.

In any event, the liability of Cryomagnetics, Inc. is strictly limited to the purchase price of the equipment supplied by Cryomagnetics, Inc. Cryomagnetics, Inc. shall not assume liability for any consequential damages associated with use or misuse of its equipment.

Appendix A

Computer Interface Command Reference

Commands available over the computer interface are separated into commands that are IEEE 488.2 specific, commands that are inhibited when the operator menu is accessed, and commands that are always available. All command mnemonics that elicit a response from the instrument end with a question (?) character. The general command format is as follows:

<subcommand1>;<subcommand2>;<subcommand3><RETURN>

where a subcommand is formatted

<Command Mnemonic><SPACE><Parameter>

Example:
*IDN?; UNITS T;UNITS?<RETURN>

Responses to each subcommand are separated by semicolons. The above example would return:
Cryomagnetics,GM-700,2002,2.09;T<RETURN><LINEFEED>

where the serial number is 2002 and the firmware version number is 2.09.

Error Handling and Command Availability

The ERROR command allows error messages to be enabled or disabled when the RS-232 interface is used. The IEEE-488.2 status mechanisms may always be used to determine if an error occurred processing a command, and the category of the error. Some commands are unavailable if the instrument menu is being accessed by an operator at the instrument. If a command available only in operate mode is received while the menus are being accessed, a device dependent error is reported in the Extended Status Register(ESR), and the message "Blocked by menu" will be returned if error reporting is enabled when using the RS-232 interface.

The following table lists the GM-700 commands, shows the GM-700 mode where the command may be used and provides a short command description. Command details are provided in the reference that follows.

Command	Available	Description
ERROR	Operate	Set error response mode for RS-232 interface
ERROR?	Always	Query error response mode
HIGH	Operate	Set high threshold for control output activation
HIGH?	Operate	Query high threshold for control output activation
H-ALM	Operate	Set audible alarm high threshold
H-ALM?	Operate	Query audible alarm high threshold
LOW	Operate	Set low threshold for control output activation
LOW?	Operate	Query low threshold for control output activation
L-ALM	Operate	Set audible alarm low threshold
L-ALM?	Operate	Query audible alarm low threshold
MEAS	Operate	Start measurement
MEAS?	Operate	Query last completed measurement
MODE	Operate	Set absolute or relative display mode
MODE?	Operate	Query selected mode
REF	Operate	Set reference field for relative mode
REF?	Operate	Query reference field
UNITS	Operate	Select units
UNITS?	Operate	Query selected units
ZERO	Operate	Zero probe
*CLS	Always	Clear Status Command
*ESE	Always	Standard Event Status Enable Command
*ESE?	Always	Standard Event Status Enable Query
*ESR?	Always	Standard Event Status Register Query
*IDN?	Always	Identification Query
*OPC	Always	Operation Complete Command
*OPC?	Always	Operation Complete Query
*RST	Always	Reset Command
*SRE	Always	Service Request Enable Command
*SRE?	Always	Service Request Enable Query
*STB?	Always	Read Status Byte Query
*TST?	Always	Self-Test Query
*WAI	Operate	Wait-to-Continue Command

Command Reference

This section describes how each GM-700 command is used and provides a cross reference to related commands. The command syntax sections show required elements enclosed in <angle brackets> and optional parameters enclosed in [square brackets]. All numbers are decimal (base 10).

ERROR	Set error response mode for RS-232 interface
Availability:	Operate Mode
Command Syntax:	ERROR <Error Mode>
Example:	ERROR 1
Parameter Range:	0 or 1 (0 - disable error reporting, 1 - enable error reporting)

Description: The **ERROR** command enables or disables error messages when the RS-232 interface is used. It is much easier to handle errors under program control when using the RS-232 interface if error messages are disabled, but it is desirable to enable error messages if a terminal program is used to interactively control and query the GM-700.

Related Commands: ERROR?

ERROR?	Query error response mode
Availability:	Always
Command Syntax:	ERROR?
Response:	<Error Mode>
Response Example: 0	**Response Range:** 0 or 1

Description: The **ERROR?** query returns the selected error reporting mode.

Related Commands: ERROR

HIGH	Set high threshold for control output activation
Availability:	Operate Mode
Command Syntax:	HIGH [Field Strength]
Example:	HIGH 65.0
Default Parameter: 0.0	**Parameter Range:** Calibration Range

Description: The **HIGH** command sets the high threshold for the control output activation in the present units. If the field strength exceeds the threshold the control output will be activated.

Related Commands: HIGH?, H-ALM, H-ALM?, LOW, LOW?, L-ALM, L-ALM?

HIGH?	Query high threshold for control output activation
Availability:	Operate Mode

Command Syntax: HIGH?

Response: <High Field Strength > <Units>

Response Example: 65.0000 kG   **Response Range:** Calibration Range

Description: The **HIGH?** query returns the high threshold for control output activation in the present units.

Related Commands: HIGH, H-ALM, H-ALM?, LOW, LOW?, L-ALM, L-ALM?

H-ALM   Set audible alarm high threshold

Availability: Operate Mode

Command Syntax: H-ALM [Alarm Field Strength]

Example: H-ALM 65.0

Default Parameter: 0.0   **Parameter Range:** Calibration Range

Description: The **H-ALM** command sets the high threshold for the audible alarm in the present units. If the measured field exceeds the threshold the audible alarm will sound.

Related Commands: H-ALM?, L-ALM, L-ALM?, UNITS, UNITS?

H-ALM?   Query audible alarm high threshold

Availability: Operate Mode

Command Syntax: H-ALM?

Response: <Alarm Field Strength > <Units>

Response Example: 3.20000 T   **Response Range:** Calibration Range

Description: The **H-ALM?** query returns the audible alarm high threshold in the present. If the measured field exceeds the threshold the audible alarm will sound.

Related Commands: H-ALM, L-ALM, L-ALM?, UNITS, UNITS?

LOW   Set low threshold for control output activation

Availability: Operate Mode

Command Syntax: LOW [Field Strength]

Example: LOW 45.0

Default Parameter: 0.0   **Parameter Range:** Calibration Range

Description: The **LOW** command sets the low threshold for the control output activation in the present units. If the field strength falls below the threshold the control output will be activated.

Related Commands: HIGH, HIGH?, H-ALM, H-ALM?, LOW?, L-ALM, L-ALM?

LOW?   Query low threshold for control output activation

Availability: Operate Mode

Command Syntax: LOW?

Response: <Low Field Strength> <Units>

Response Example: 45.0000 kG   **Response Range:** Calibration Range

Description: The **LOW?** query returns the low threshold for control output activation in the present units.

Related Commands: HIGH, HIGH?, H-ALM, H-ALM?, LOW, L-ALM, L-ALM?

L-ALM   Set audible alarm low threshold

Availability: Operate Mode

Command Syntax: L-ALM [Field Strength]

Example: L-ALM 65.0

Default Parameter: 0.0   **Parameter Range:** Calibration Range

Description: The **L-ALM** command sets the low threshold for the audible alarm in the present units. If the field strength falls below the threshold the audible alarm will sound.

Related Commands: H-ALM, H-ALM?, L-ALM?, UNITS, UNITS?

L-ALM?   Query audible alarm low threshold

Availability: Operate Mode

Command Syntax: L-ALM?

Response: <Low Alarm Field Strength> <Units>

Response Example: 65.0000 kG   **Response Range:** Calibration Range

Description: The **L-ALM?** query returns the audible alarm low threshold in the present units. If the field strength falls below the threshold the audible alarm will sound.

Related Commands: H-ALM, H-ALM?, L-ALM, UNITS, UNITS?

MEAS   Start measurement

Availability: Operate Mode

Command Syntax: MEAS

Description: The MEAS command starts a measurement. The DATA READY bit will be set in the status byte returned by the *STB? command when the measurement is complete.

Related Commands: MEAS?, *STB?

MEAS?   Query last completed measurement

Availability: Operate Mode

Command Syntax: MEAS?

Response: <Field Strength> <Units>

Response Example: 15.0000 kG

Description: The **MEAS?** query returns latest reading in the present units. If a reading is in progress the previous reading is returned.

Related Commands: MEAS, *STB?

MODE	Set absolute or relative display mode
Availability:	Operate Mode
Command Syntax:	MODE <Display Mode>
Example:	MODE R
Parameter Range:	Relative or Absolute

Description: The **MODE** command sets the display mode for field measurement. Mode may be set to absolute or relative. When absolute is selected the measured field strength is displayed. When relative is selected the GM-700 display shows a Delta symbol is displayed by the units, the difference between the measured field and the reference field is displayed on the lower display line, and the reference field is displayed on the upper display line. Measurements returned on the computer interface will be relative to the reference field when relative mode is selected.

Related Commands: MODE?, REF, REF?

MODE?	Query display mode
Availability:	Operate Mode
Command Syntax:	MODE?
Response:	<Display Mode>
Response Example: Relative	**Response Range:** Relative or Absolute

Description: The **MODE?** command returns the display mode that is presently selected.

Related Commands: MODE, REF, REF?

REF	Set reference field for relative mode
Availability:	Operate Mode
Command Syntax:	REF <Field Strength>
Example:	REF -0.015
Parameter Range:	Calibration Range

Description: The **REF** command sets the reference field to be used when relative mode is selected. If units are set to Tesla or millitesla the parameter must be given in Tesla. If units are set to kilogauss or Gauss the parameter must be given in kilogauss.

Related Commands: MODE, MODE?, REF?, UNITS, UNITS?

REF?   Query reference field

Availability: Operate Mode

Command Syntax: REF?

Response Example: -0.01500 kG   **Response Range:** Calibration Range

Description: The **REF?** query returns the value set by the last REF command in the present units.

Related Commands: MODE, MODE?, REF

UNITS   Select units

Availability: Operate Mode

Command Syntax: UNITS <Unit Selection>

Example: UNITS T

Parameter Range: T, mT, G, or kG

Description: The **UNITS** command sets the units to be used for all input and display operations. Units may be set to Tesla or Gauss. Note that the instrument display will indicate Tesla or millitesla if set to Tesla, and Gauss or kilogauss if set to Gauss dependent on the measured values. The computer interface supports only Tesla or kilogauss.

Related Commands: HIGH, HIGH?, H-ALM, H-ALM?, LOW, LOW?, L-ALM, L-ALM?, MEAS, MEAS?, UNITS?

UNITS?   Query selected units

Availability: Operate Mode

Command Syntax: UNITS?

Response: <Selected Units>

Response Example: T   **Response Range:** Tesla or Gauss

Description: The **UNITS?** command returns the units used for all input and display operations. Note that the instrument display will indicate Tesla or millitesla if set to Tesla, and Gauss or kilogauss if set to Gauss dependent on the measured values. The computer interface supports only Tesla or kilogauss.

Related Commands: HIGH, HIGH?, H-ALM, H-ALM?, LOW, LOW?, L-ALM, L-ALM?, MEAS, MEAS?, UNITS

ZERO   Zero Probe

Availability: Operate Mode

Command Syntax: ZERO

Description: The **ZERO** command takes measurements at all instrument gains and computes

new offsets that are applied to future readings. It is recommended that the command only be used when the instrument is fully warmed up with the probe in a near zero field. This command requires about 16 seconds to complete, and the unit will not respond to any commands except IEEE-488 serial polls until the command completes.

Related Commands: None

---

*CLS   Clear Status Command

Availability: Always

Command Syntax: *CLS

Description: The ***CLS** command operates per IEEE Std 488.2-1992 by clearing the Standard Event Status Register (ESR) and resetting the MAV bit in the Status Byte Register (STB).

Related Commands: None

---

*ESE   Standard Event Status Enable Command

Availability: Always

Command Syntax: *ESE <mask>

Example: *ESE 255

Default Parameter: 0   **Parameter Range:** 0 to 255

Description: The ***ESE** command operates per IEEE Std 488.2-1992 by setting the specified mask into the Standard Event Status Enable Register (ESE).

Related Commands: *ESE?

---

*ESE?   Standard Event Status Enable Query

Availability: Always

Command Syntax: *ESE?

Response: <ESE Mask>

Response Example: 255   **Response Range:** 0 to 255

Description: The ***ESE?** command operates per IEEE Std 488.2-1992 by returning the mask set in the Standard Event Status Enable Register (ESE) by a prior *ESE command.

Related Commands: *ESE

---

*ESR?   Standard Event Status Register Query

Availability: Always

Command Syntax: *ESR?

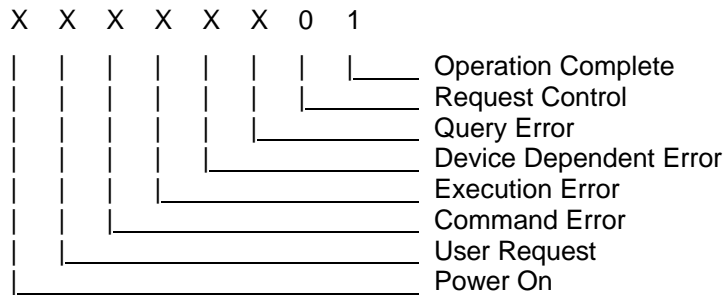**Response:**   <Standard Event Status Register>

Response Example: 128   **Response Range:** 0 to 255

Description: The ***ESR?** command operates per IEEE Std 488.2-1992 by returning the contents of the Standard Event Status Register and then clearing the register.

Status Byte Bit Allocations:

```
X   X   X   X   X   X   0   1
|   |   |   |   |   |   |   |____ Operation Complete
|   |   |   |   |   |   |_____ Request Control
|   |   |   |   |   |_____ Query Error
|   |   |   |   |_____ Device Dependent Error
|   |   |   |_____ Execution Error
|   |   |_____ Command Error
|   |_____ User Request
|_____ Power On
```

Related Commands: *ESE, *ESE?

---

*IDN?   Identification Query

Availability: Always

Command Syntax: *IDN?

Response: <Manufacturer>,<Model>,<Serial #>,<Firmware Level>

Response Example: Cryomagnetics,GM-700,2002,2.09

Serial # Range: 2000 to 9999   **Firmware Level Range:** 1.00 to 9.99

Description: The ***IDN?** command operates per IEEE Std 488.2-1992 by returning the GM-700 manufacturer, model, serial number and firmware level.

Related Commands: None

---

*OPC   Operation Complete Command

Availability: Always

Command Syntax: *OPC

Description: The ***OPC** command operates per IEEE Std 488.2-1992 by placing the Operation Complete message in the Standard Event Status Register (ESR). The GM-700 processes each command as it is received and does not defer any commands for later processing.

Related Commands: *OPC?

---

*OPC?   Operation Complete Query

Availability: Always

Command Syntax: *OPC?

Description: The ***OPC** command operates per IEEE Std 488.2-1992 by placing an ASCII character "1" in the output queue since the GM-700 does not defer any commands for later processing.

Related Commands: *OPC

*RST   Reset Command

Availability: Always

Command Syntax: *RST

Description: The ***RST** command operates per IEEE Std 488.2-1992 by returning the GM-700 to its power up configuration. This initializes the instrument to its lowest gain configuration.

Related Commands: None

---

*SRE   Service Request Enable Command

Availability: Always

Command Syntax: *SRE <mask>

Example: *SRE 255

Default Parameter: 0   **Parameter Range:** 0 to 255

Description: The ***SRE** command operates per IEEE Std 488.2-1992 by setting the specified mask into the Service Request Enable Register (SRE).

Related Commands: *SRE?

---

*SRE?   Service Request Enable Query

Availability: Always

Command Syntax: *SRE?

Response: <SRE Mask>

Response Example: 255   **Response Range:** 0 to 255

Description: The ***SRE?** command operates per IEEE Std 488.2-1992 by returning the mask set in the Service Request Enable Register (SRE) by a prior *SRE command.

Related Commands: *SRE

---

*STB?   Read Status Byte Query

Availability: Always

Command Syntax: *STB?

Response: <Status Byte>

Response Example: 65   **Response Range:** 0 to 255

Description: The ***STB?** command operates per IEEE Std 488.2-1992 by returning the Status Byte.

Status Byte Bit Allocations:

X   X   X   X   X   X   X   X
| | | | | | | |_____ Data Ready

```
|  |  |  |  |  |  |  |_____ Alarm Active
|  |  |  |  |  |  |_____ Control Output Active
|  |  |  |  |  |_____ Unused
|  |  |  |  |_____ MAV (Message Available)
|  |  |  |_____ ESB (Extended Status Byte)
|  |  |_____ MSS (Master Summary Status)
|  |_____ Menu Selected
```

---

* TST?   Self-Test Query

Availability: Always

Command Syntax: *TST?

Response: <Self test status>

Response Example: 1   **Response Range:** 1

Description: The ***TST?** command operates per IEEE Std 488.2-1992 by returning the self test status. Explicit tests are not performed in response to this command, but a 1 is returned for compliance with the specification.

Related Commands: None

---

* WAI   Wait-to-Continue Command

Availability: Always

Command Syntax: *WAI

Description: The ***WAI?** command operates per IEEE Std 488.2-1992 by accepting the command without generating an error. Since the GM-700 only implements sequential commands the no-operation-pending flag is always TRUE.

Related Commands: OPC, *OPC?

Appendix B

Factory Calibration

The GM-700 Factory Calibration is used to establish sensor excitation levels and hardware calibration. If these procedures are not carefully performed the instrument may not function properly. Factory assistance is recommended.

********** **WARNING** **********
Load resistors and/or Sensors must be attached to perform the calibration.
Power MUST be removed while making ALL connections.
****

The factory calibration menu is invoked by holding the MENU and ENTER keys while power is applied to the unit. The display will show

```
Instrument Cal
>Abort<   Ch1   Ch2
```

or,

```
Instrument Cal
>Abort<   Ch1   Ch2   Anlg
```

if the analog output option is installed. If the analog output is installed, it *must* be recalibrated after the Ch1 factory calibration is performed. Use the UP and DOWN keys to select the calibration to be performed, and press ENTER to begin the calibration.

B.1   Factory Calibration of a Hall Effect Sensor Input

Factory calibration of a Hall Effect sensor input requires a 3 to 5 ohm resistor to be placed between I- and I+, and a jumper connected between I- and V-. Stable isolated references of about 1.2 volts and 32 millivolts with source impedances of less than 100 ohms must be available to perform this procedure. Once all connections have been made, enter the factory calibration menu as described in the preceeding paragraph.

Select Ch 1 using the UP or DOWN arrow keys and press ENTER. The value of the GM-700's internal current sense resistor will be displayed. The value should not need to be changed unless R30 has been changed to support a different sensor type. Press ENTER to accept the value of the

current sense resistor.

The value of the sense current will be displayed next. Use the UP or DOWN arrow keys to make this display the desired excitation current and press ENTER to accept the value.

The GM-700 now will display:

```
Short ADC Inputs
<Enter> when ready
```

Connect V+ directly to V-, and press ENTER to begin calibration. This step requires about a minute for completion.

The GM-700 now will display:

```
Attach 1.2 Volt Ref
<Enter> when ready
```

Connect the 1.2V reference between V+ and V-, and press ENTER. The GM-700 will now allow the value of the voltage to be adjusted using the UP and DOWN buttons. Press ENTER when the correct value is displayed to calibrate at the high reference voltage. This step requires about thirty seconds.

The GM-700 now will display:

```
Attach 32mV Ref
<Enter> when ready
```

Connect the 32 mV reference between V+ and V-, and press ENTER to complete the calibration. This step requires about a minute.

B.2   Factory Calibration of the Analog Output Option
The GM-700's Analog Output must be recalibrated whenever the Ch 1 factory calibration is changed. In preparation for calibrating the analog output, the sensor must be connected to the GM-700. If the Analog Output is configured for 0-1 Volt Output, no load is required at the analog output. If the Analog Output is configured as 4-20mA Output, either a load resistor of less than 600 ohms or the actual current loop itself must be attached to pins 5 and 6 of the rear panel DB15 connector (current must be able to flow in order for the calibration to be made). The value of the

resistor is not important.

Select ANLG on the Factory Calibration Menu and press ENTER. The Analog Output calibration is automatic and will be completed in about 3 seconds.

Appendix C

Line Voltage Controller Module – Option 5

Overview

The Line Voltage Controller Module enables the GM-700 to control a 115 VAC load up to 1 Amp using the GM-700 Low and High setpoints.

Connections

An interconnection cable is provided with the Line Voltage Controller Module to connect the GM-700 to the Line Voltage Controller Module and to the sensor. The DB-15M connector attaches to the GM-700, the DB-9F attaches to the Line Voltage Controller Output Module. The sensor connector on the cable is labeled. Output connections are standard 110V output sockets.

> **DB-9M Pinout**
> Pin 1 - Control input (0V - enabled, open - disabled)
> Pin 6 - +15V input (10 ma max)
> Pin 9 - Ground

Fuses

The output is fused on the rear panel of the module with a user replaceable 2 amp 250VAC fuse. Slow blow fuses should not be used.

Theory of Operation

The 'hot' side of the output is switched using an opto-isolated solid state switch rated for 20-500Hz operation. These switches exhibit a 1 mA off-state leakage current which will be observed as 90-100 VAC if the output is checked with a voltmeter with no load attached to the output.