F.W. BELL

9000 SERIES GAUSSMETERS

OPERATION & MAINTENANCE MANUAL

SERIES 9900 GAUSSMETER

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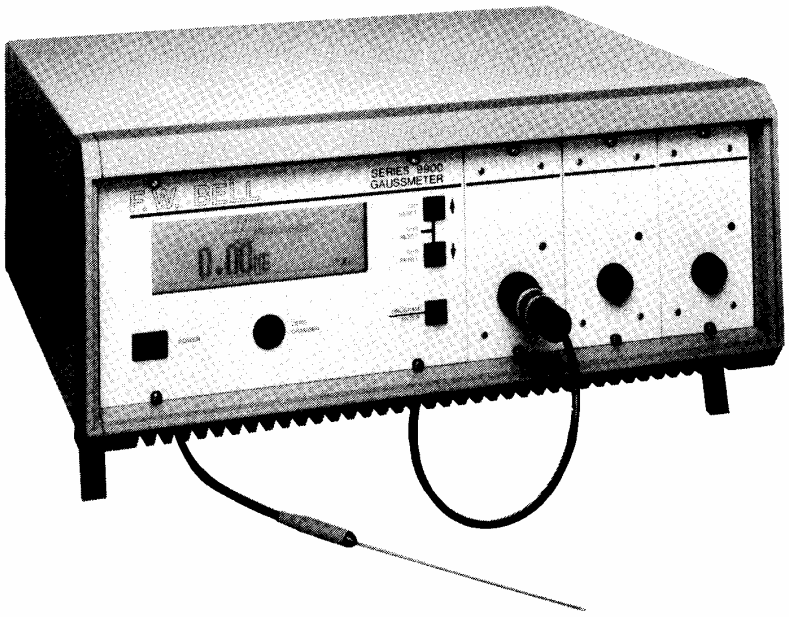
SERIES
GAUSSMETERS



SERIES 9900 GAUSSMETER
Operation and Maintenance Manual

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TABLE OF CONTENTS

SERIES-9900 SPECIFICATIONS

RANGES/RESOLUTION

01X PROBE

RANGES		RESOLUTION	
GAUSS	TESLA	GAUSS	TESLA
30 mG	3 uT	10 uG	0.001 uT
300 mG	30 uT	10 uG	0.001 uT
3 G	300 uT	100 uG	0.01 uT

.01 X Probe can not be used for measurements above 2 Gauss

1x PROBE

RANGES		RESOLUTION	
GAUSS	TESLA	GAUSS	TESLA
3 G	300 uT	1 mG	0.1 uT
30 G	3 mT	1 mG	0.1 uT
300 G	30 mT	10 mG	1 uT
3 kG	300 mT	100 mG	10 uT
30 kG	3 T	1 G	100 uT
300 kG	30 T	10 G	1 mT

10 X PROBE

RANGES		RESOLUTION	
GAUSS	TESLA	GAUSS	TESLA
30 G	3 mT	10 mG	1 uT
300 G	30 mT	10 mG	1 uT
3 kG	300 mT	100 mG	10 uT
30 kG	3 T	1 G	100 uT
300 kG	30 T	10 G	1 mT
3 MG	300 T	100 G	10 mT

dc ACCURACY

Range	± % of Reading	± Number of Counts
30 mG to 30 G	.05	14
300 G to 3 MG	.05	6

Additional Influences:
Temperature Coefficient: <±(0.02% of Reading, ± 3 Counts) /C
From 0C to +50 C
dc Calibration Reference: ± 0.1 % of Reading
1 year; 23C, ± 5C

ANALOG OUTPUT

Output Voltage:	3.0 Vrms (ac Mode) or ±3 Vdc (dc Mode) Full Scale
Source Impedance:	<100 ohms
Termination:	Standard BNC Connector

dc ANALOG OUTPUT ACCURACY

Range	±% of Reading	±% of Full Scale
30 mG to 3 G	.25	4.0
30 G	.25	0.3
300 G to 3 MG	.25	0.1

For output >10% of Full Scale

1 year; 23° C, ±5° C

Additional Influences:

Temperature Coefficient: <± (0.03% of Reading, +0.005% FS) / ° C
From 0° C to + 50 ° C

ac ANALOG OUTPUT ACCURACY

	RANGES			
	30 mG to 30 G		300 G to 3 MG	
Frequency (Hz)	±% of Reading	± % of Full Scale	±% of Reading	± % of Full Scale
20-49	36%	2.0	36%	0.25
50-99	17%	2.0	17%	0.25
100-499	10%	2.0	10%	0.25
500-9.9 k	5%	2.0	5%	0.25
10 k-24 k	7%	2.0	7%	0.25
25 k -39 k	15%	2.0	15%	0.25
40 k-50 k	22%	2.0	22%	0.25

1 Year; 23° C, ±5° C

Sinewave input, >10% of Full Scale

Additional Influences:

Temperature Coefficeint: <± (0.04% of Reading, +0.005% FS)/ ° C
From 0° C to +50° C

FREQUENCY RANGE (Analog Output)

dc Mode:	dc to 400 Hz
ac Mode:	20 Hz to 50 kHz

OUTPUT NOISE, ac MODE

Range	rms Noise
30 mG to 3 G	300 mV
30 G	30 mV
300 G to 3 MG	7 mV

FREQUENCY RANGE (Displayed Reading)	dc Mode:	dc
	ac Mode:	20 Hz to 50 kHz
TEMPERATURE RANGE	Operating:	0° C to +50° C
	Storage:	-20° C to +70° C
FRONT PANEL DISPLAY	Type:	240 x 64 dot matrix LCD with a backlight
	Viewing Area:	5.2 in. (13.2 cm) wide, 1.6 in. (4.1 cm) high
POWER	Volts:	90-125 or 180-250
	Frequency:	50-60 Hz 50-60 Hz
	Current:	2.0 A 1.0 A
SIZE	17.67 in. (44.9 cm) wide, 7.53 in. (19.1 cm) high including feet, 16.18 in. (41.1 cm) deep	
WEIGHT (Maximum)	Net:	35.9 lbs. (16.3 kg)
	Shipping:	43.4 lbs. (19.7 kg)
FRONT PANEL ZERO GAUSS CHAMBER		
	Cavity Size:	0.344 in. (0.9 cm) I.D., 2.0 in. (5.1 cm) deep
	Attenuation:	80 dB in a 300 G field
COMMUNICATION PORTS	RS-232:	Standard 25 pin "D" connector
	IEEE-488:	Standard 24 pin IEEE-488 connector
WARM UP TIME	1 hour to achieve rated specifications	
HUMIDITY RANGE	0° C to + 35° C	80% RH
	+35° C to + 50° C	70% RH

SIMPLIFIED OPERATING INSTRUCTIONS FOR THE 9900 SERIES GAUSSMETERS

1) Check the rear panel power receptacle to insure that the voltage showing is the voltage you will be using, 115 volts ac or 230 volts ac. If it is necessary to change this setting, refer to Section II-A.

2) With the power turned off, connect the required probes and probe modules to the channels desired via the connectors on the front panel of the gaussmeter. See Section II-B and II-C.

3) Connect power to the 9900 and turn on the instrument by locating the Power Switch on the front panel and depressing the side marked 1.

NOTE: At turn-on, the screen should display a large F.W. Bell logo. Beneath the logo, various messages will indicate the progress of the initialization. If any error messages occur at this time, refer to Section VII, Diagnostic Error Codes.

4) Assuming no error codes are present, the gaussmeter is now in the MEASURE mode and will begin field measurements.

NOTE: All operating parameters such as range setting, peak/hold, classifier, display format, communication format, etc... will be initialized to the same settings that were present when the gaussmeter was last turned off.

5) Prior to making accurate readings, it is necessary to zero each probe by following the procedures below:

a) Press the ENTER/PROGRAM pushbutton. The MAIN MENU will appear.

b) Using the the up (↑) and down (↓) pushbuttons, advance the cursor to PROBE ZERO function.

c) Press ENTER. The PROBE ZERO menu will appear.

d) Using the the up (↑) and down (↓) pushbuttons, advance the cursor to the desired channel. Press ENTER.

e) Install the probe tip in the ZERO GAUSS CHAMBER located directly below the display. Press ENTER.

f) The gaussmeter will proceed to zero the probe on each range setting for either AC or DC operation, depending on the present mode setting.

g) Upon completion, the PROBE ZERO menu will reappear. Repeat steps d-f for all remaining channels.

h) Advance the cursor to RUN. Press ENTER to resume field measurements.

6) Consult Section IV for more information on MENU operations, or the TABLE OF CONTENTS for references to other gaussmeter features.

NOTE: Greatest accuracy will be obtained after a 1-hour warm up period.

SECTION I

GENERAL DESCRIPTION

I-A INTRODUCTION

The SERIES-9900 gaussmeter represents the latest developments in the science of measuring magnetic flux density using the Hall effect. The unit is available in three configurations capable of processing a single channel (Model 9901), two channels (Model 9902) or three channels (Model 9903) of magnetic field information. Either steady-state (dc) or alternating (ac) fields can be measured. When matched with the appropriate F.W. Bell fourth-generation Hall generator probe, fields as low as 10 μG (0.001μT) or as high as 2.9999 MG (299.99 T), at frequencies up to 50 kHz, can be measured with extreme accuracy and 4-3/4 digit resolution.

The SERIES-9900 features PEAK HOLD, AUTORANGING, CLASSIFIER and RELATIVE operation, auto ZEROing, GAUSS or TESLA readout, digital and bargraph representation, diagnostics and remote operation with an IEEE-488 (GPIB) instrumentation bus and an RS-232 communications port. All information is displayed on an illuminated graphics liquid crystal display (LCD).

The gaussmeter employs a menu-driven format to allow the user to program all aspects of gaussmeter operation with ease and speed. Each gaussmeter channel is completely and independently programmable.

I-B FUNCTIONAL DESCRIPTION

Figures I-A and I-B depict the SERIES-9900 front and rear panels, respectively. The gaussmeter is housed in a standard 6.87" high x 17.67" wide x 16.18" deep cabinet featuring pop-up feet for tabletop use and (optional) brackets for rack mounting.

FRONT PANEL

(1) DISPLAY	1920-pixel (240 x 64) dot matrix (graphics) LCD with backlight. Contrast is preset at the factory.
(2) POWER SWITCH	Rocker type power switch with international legends ("0"=OFF, "1"=ON).
(3) ZERO GAUSS CHAMBER	Recessed double-wall Mu-metal chamber used to shield the probe from stray magnetic fields during the PROBE ZERO operation. Attenuation is 80 dB in a 300 G field.
(4) "↑" /CHANNEL 1 "RESET" PUSHBUTTON	Dual-function momentary-contact pushbutton switch used to reset PEAK readings for CHANNEL 1 in the MEASURE mode or advance the cursor up in the MENU mode.

SECTION I continued
General Description

(5) "↓" /CHANNEL 2 "RESET" PUSHBUTTON	Dual-function momentary-contact pushbutton switch used to reset PEAK readings for CHANNEL 2 in the MEASURE mode or advance the cursor down in the MENU mode. NOTE: Pressing both pushbuttons (4) and (5) in the MEASURE mode will reset the PEAK reading for CHANNEL 3.
(6) "PROGRAM/ENTER" PUSHBUTTON	Dual-function momentary-contact pushbutton switch used to enter the MENU mode and validate selections during MENU operations.
(7) MODEL-99S PROBE INTERFACE MODULE	Modular electronics package that accepts fourth-generation Hall generator probe. Unit interfaces to gaussmeter via a 64-pin dual-row DIN connector.
(7-a) PROBE CONNECTOR	9-pin twist-lock non-magnetic connector that mates to F.W. Bell fourth-generation Hall generator probes.
(7-b) ACTIVITY INDICATOR	Red LED indicating module/probe activity.
(8) INTERFACE MODULE CAVITY	Accepts MODEL-99S interface module (7) or CAVITY blank panel (9). Cavity contains an upper and lower card guide to ensure that the interface module is properly aligned with the rear mating connector. ***WARNING*** ! If a cavity is not used it must be covered with a SERIES-9900 blank panel (9) to ensure proper ventilation and protection from contaminates. ***DO NOT USE CAVITY AS A STORAGE AREA.***
(9) CAVITY BLANK PANEL	Used to cover an unused cavity (8). Order F.W. Bell Item #338032.
REAR PANEL	
(10) POWER RECEPTACLE/ FUSE HOLDER/ LINE VOLTAGE SWITCH	This is a multi-purpose receptacle that accepts an international instrumentation power line cord. The middle (ground) contact is connected to the chassis. This receptacle also contains the line fuse, storage space for a spare fuse and a line voltage selector. ***WARNING! See SECTION II before applying power to the gaussmeter or damage may result!!***
(11) VENTILATION FAN	Regulates internal temperature of the gaussmeter. *DO NOT COVER !*

SECTION I continued
General Description

(12) RS-232 PORT CONNECTOR	Standard 25-pin "D" type female connector for RS-232 communications.
(13) IEEE-488 BUS CONNECTOR	Standard 24-pin GPIB connector for IEEE-488 bus interface.
(14) ANALOG OUTPUTS	Calibrated analog outputs from each channel. Standard BNC connectors.
(15) INFORMATION LABEL	Label identifies the model number and serial number along with analog output (14) identification and line power data.

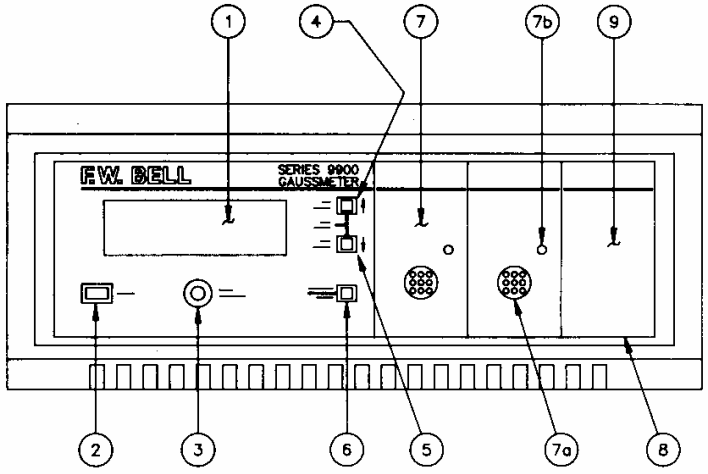


Figure I-A
SERIES-9900 Front Panel

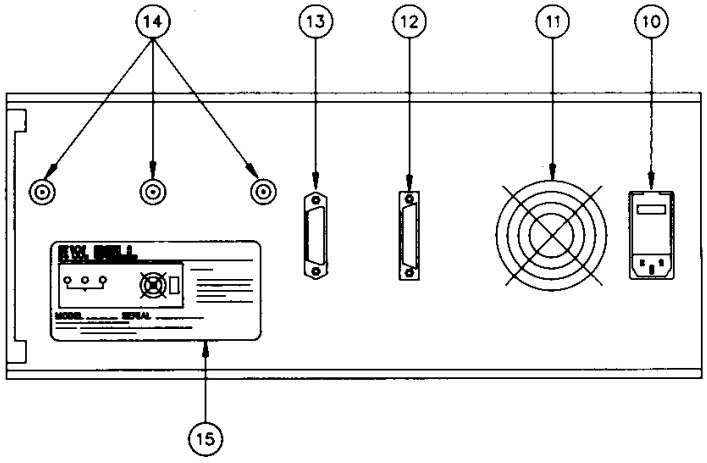


Figure I-B
SERIES-9900 Rear Panel

SECTION II

II-A POWER RECEPTACLE

WARNING! READ THIS CAREFULLY

The SERIES-9900 gaussmeter has been factory-configured to operate on a line voltage of 115 Vac. If operation at 230 Vac is required, perform the following steps ***or damage may result.***

SERIES-9900 GAUSSMETER PREPARATION

1) See figure II-A. This is the line power cord receptacle designed to accept an international instrumentation line cord. This assembly also contains the line fuse and voltage selector. Remove the line cord.

2) Near the top of the assembly is a slot. Insert a narrow screwdriver and *gently* release the access door (the door will not open unless the line cord is removed). The door will swing down.

3) Remove the voltage selector drum (marked "115 VAC") by pulling straight out.

4) Remove both fuse holders (marked with a "→") by pulling straight out. The left-hand holder location is the actual in-circuit fuse. The gaussmeter is shipped with a 230 Vac, 1 A fuse in the spare location, and a 115 Vac, 2 A fuse in the active location. Reverse the positions of the holders and reinstall, making sure that the "→" points to the right.

5) Rotate the voltage selector drum to read "230 VAC" and reinstall.

6) Close access door. The "230 VAC" legend should be visible through the access door window. Reinstall the line cord.

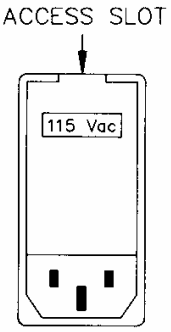


Figure II-A
Rear Panel Power Receptacle

II-B MODEL-99S INTERFACE MODULE INSTALLATION

WARNING! DO NOT INSTALL AN INTERFACE MODULE WHILE THE GAUSSMETER IS TURNED ON OR DAMAGE MAY RESULT.

1) The MODEL-99S probe interface module can occupy any one of the three available slots in the SERIES-9900 gaussmeter.

2) Remove the blank panel by rotating both screws counter-clockwise until they release from the chassis. The screws will remain with the blank panel. Do not discard the panel. It must be reinstalled if the module is removed.

SECTION II continued
Gaussmeter Preparation

3) Locate the upper and lower card guides in the card rack. Install the module so that the upper and lower card edges of the module mate with the card guides. Slowly slide the module in until the rear connectors mate. Firmly push the module into the chassis. Secure with the upper and lower screws.

II-C PROBE INSTALLATION

1) Install the probe connector so that the molded keys in the connector body line up with similar keyways in the interface module's receptacle (Figure II-B). Push the connector in until the threaded sleeve on the connector makes contact with the receptacle. Rotate the sleeve clockwise to secure the connector to the receptacle.

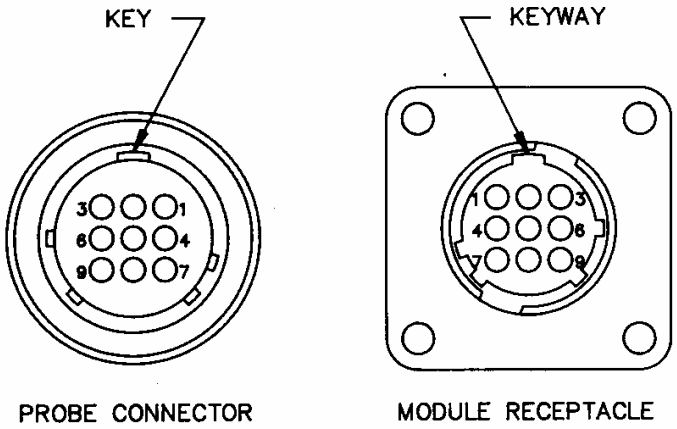


Figure II-B
Probe Connector and Receptacle

II-D POWER-UP

Locate the power switch on the front panel and depress the side marked "1". The display's backlight should turn on and the "F.W. Bell" logo will appear. Beneath the logo various messages will appear to indicate the progress of the power-up initialization. Internal diagnostics are performed first, followed by retrieval of calibration data from each of the probe interface modules and their probes. Finally, all display screens are constructed and various operating parameters initialized.

If any of the internal diagnostic tests fail, an error message will appear and the gaussmeter will halt the power-up procedure. See Section VII if this occurs.

If no aberations are detected, the MEASURE mode is entered and field measurements will begin. The activity indicator light on each probe interface module will light if a probe is connected. If no modules are present or no probes connected, an error message will appear.

All operating parameters, such as range settings, peakhold, classifiers, display format, communications, etc. will be initialized to the same condition they were in when the gaussmeter was last turned off. (See Section III-I.) When the gaussmeter is turned off again it will save the present setup for next time. The probe's zero and relative values are not saved.

SECTION III

FIELD MEASUREMENT OPERATIONS

III-A DISPLAY FORMAT

In the MEASURE mode of operation the format of the display varies with the number of probes present. The user can also modify the display format with the DISPLAY FORMAT menu. (MENU mode is discussed in Section IV.)

For single-channel operation the entire display area is used as seen in Figure III-A. For dual-channel operation, Figure III-B, the display is split in half with each half dedicated to one channel. For three-channel operation the display is split into three sections, one for each channel, as seen in figure III-C. CHANNEL 1 is always the left-most channel in the chassis, CHANNEL 2 the middle channel and CHANNEL 3 the right-most.

In all cases the display fields contain the same information. Refer to Figure III-D for the following discussions.

III-B DIGITAL READING

This area ① contains the reading's polarity, five digits of information including a decimal point, and the scale (range) of the reading.

In the dc mode of operation the polarity will be "+" or "—" (or blank if the reading is exactly zero). In the ac mode a sinusoidal symbol will appear (~). The mode of operation (dc or ac) is selected from the MODE SELECTION menu.

In the ac mode the reading represents the *true rms* value of the field waveform.

The user can remove the digital reading from the display using the DISPLAY FORMAT menu. If this is done the digits and scale will be removed, but the polarity symbol will remain to remind the user that a dc or ac field is being measured.

If the CLASSIFIER function has been turned on, the digital field reading will be replaced by, or alternate with, the phrase "LOW," "HIGH" or "ACCEPT." See Section IV-K for more information.

Figure III-A
One- Channel Display Screen

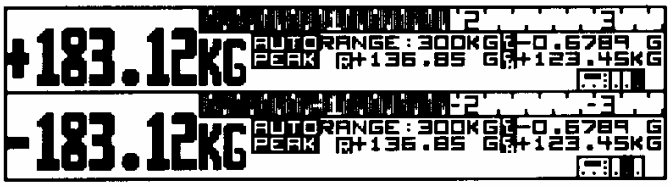


Figure III-B
Two-Channel Display Screen

SECTION III continued
Field Measurement Operations

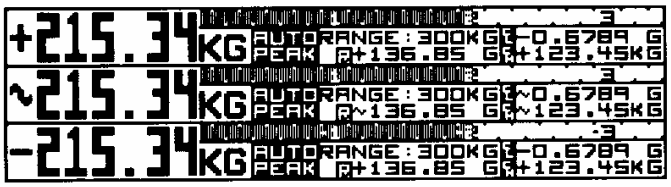


Figure III-C
Three-Channel Display Screen

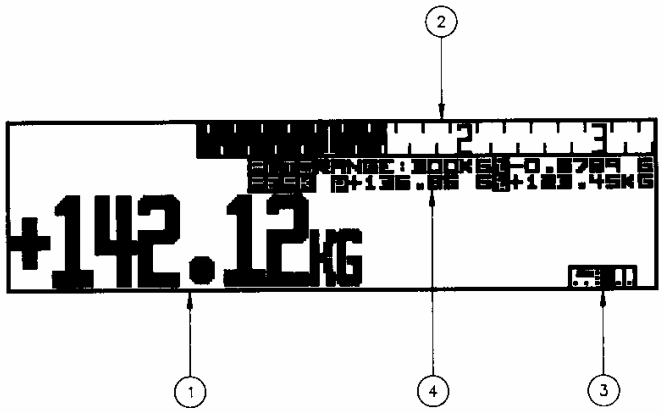


Figure III-D
Information Fields

III-C BARGRAPH

The bargraph ② provides an "analog" representation of the present field reading. Each bar on the graph represents 1/150th (0.667%) of full scale of the presently-selected range. For instance, if the range is 3 kG (3000 G), each bar represents 20 G (3000/150=20). On the 300 μT range, each bar represents 2 μT.

The bargraph has a scale marker at every 5th bar. The 50th bar is marked with a digit "1," the 100th with "2" and the 150th with "3."

The user can remove the bargraph from the display using the DISPLAY FORMAT menu.

III-D ACTIVE CHANNEL INDICATOR

The active-channel indicator ③ appears only on the one-channel and two-channel display. The indicator is a pictorial diagram of the SERIES-9900 gaussmeter with one of the channel locations blacked out. This reminds the users that the information contained on the display is for the channel shown.

On the three-channel display, the top field is for CHANNEL 1 (the left-most channel), the middle field is for CHANNEL 2 (middle channel) and the bottom field for CHANNEL 3 (right-most channel).

SECTION III continued
Field Measurement Operations

III-E INFORMATION BLOCK

The information block ④ contains various annunciators and information about the present state of the channel as follows:

"AUTO" ANNUNCIATOR	If the autoranging function has been turned on (RANGE SELECT menu), the "AUTO" annunciator will be present.
"PEAK" ANNUNCIATOR	If the PEAK HOLD function has been turned on (PEAK HOLD menu), the "PEAK" annunciator will be present. The "PEAK" annunciator is also used to indicate a particular overrange condition as described in Section III-G.
RANGE SETTING	The present range setting for the channel.
RELATIVE OFFSET	This field contains the RELATIVE field reading that was present when the PROBE RELATIVE operation began (See PROBE RELATIVE menu). The reading is preceded by the "R" annunciator. If the RELATIVE function is turned off this field will be blank.
CLASSIFIERS	These fields contain the user-defined CLASSIFIER settings preceded by the C/L and C/H annunciators. If the CLASSIFIER function has been turned off these fields will be blank.

III-F CHANNEL DEACTIVATION

In some cases the user may have several channels installed but may be interested in observing only one or two. A channel can be deactivated by turning off *both* the digital reading *and* the bargraph via the DISPLAY FORMAT menu, or by disconnecting the probe from the interface module. This places the channel in a standby position and removes it from the display. For instance if all three channels are present and CHANNEL 2 is deactivated, the gaussmeter will automatically reformat for a two-channel display; CHANNEL 1 on the top half and CHANNEL 3 on the bottom half of the display.

In the REMOTE mode of operation, field measurements are not possible unless the deactivated channel is reactivated. This can be accomplished from the remote device (see Section V).

III-G OVERRANGE CONDITIONS

If the present field density exceeds the present range of the gaussmeter both the digital reading and the bargraph will flash. Overrange occurs when the magnitude of the reading exceeds 29999 (2.9999 kG, 299.99 T, etc.). Field readings will continue up to about 9% higher than this magnitude, or 32767.

In some instances the magnetic field being measured may contain spikes or ripples that cause the present range to be exceeded even though the *average* reading is within limits. When this occurs the "PEAK" annunciator will flash to indicate that the displayed reading may be inaccurate and a higher range should be used.

SECTION III continued
Field Measurement Operations

III-H PEAK HOLD OPERATION

When the PEAK HOLD function is engaged (via the PEAK HOLD menu) the largest absolute field reading will be held on the display. For instance a +200.00 G reading will replace a +100.00 G reading and be held, and a -250.00 G reading will replace the previously-held +200.00 G reading.

The user can reset a held reading at any time by pressing *and* releasing that channel's RESET pushbutton on the front panel. As the pushbutton is pressed the "PEAK" annunciator will flash to indicate that the reset command has been recognized but the actual reset operation will not occur until the pushbutton is released.

One pushbutton is dedicated to resetting CHANNEL 1, another for CHANNEL 2 and both for CHANNEL 3. In the case of a CHANNEL 3 reset, the user might press one pushbutton before the other, say CHANNEL 1 before CHANNEL 2. In this case the CHANNEL 1 "PEAK" annunciator will flash. As soon as the CHANNEL 2 pushbutton is pressed the CHANNEL 1 annunciator will return to normal and the CHANNEL 3 annunciator will flash. This will not cause a problem since the actual resetting operation will not occur until *both* pushbuttons are released, properly resetting CHANNEL 3's peak reading only.

III-I POWER UP INITIALIZATION

The gaussmeter permanently stores each channel's MEASURE mode setup. When the gaussmeter is powered off and on again, the previous settings are restored and the gaussmeter is reinitialized to those settings. The following information is saved:

- MODE (ac/dc AND GAUSS/TESLA)
- RANGE SETTING (INCLUDING AUTORANGE)
- PEAK HOLD ON/OFF (LAST PEAK READING WILL NOT BE SAVED)
- CLASSIFIER SETTINGS
- CLASSIFIER ON/OFF STATUS
- DIGITS ON/OFF
- BARGRAPH ON/OFF
- BACKLIGHT ON/OFF
- IEEE-488 PRIMARY ADDRESS
- RS-232 PARITY, STOP BITS, CHARACTER LENGTH AND BAUD RATE

The RELATIVE mode will be turned off and the relative offset will be reset to zero.

III-J PROBE ORIENTATION VERSUS POLARITY

In the dc mode of operation the polarity of the reading versus the orientation of the probe is depicted in Figure III-E. (Note the "F.W. BELL" logo is in an upright, right-reading orientation.) As shown, the magnetic flux lines traveling in the direction indicated by a "B" will result in a positive (+) polarity.

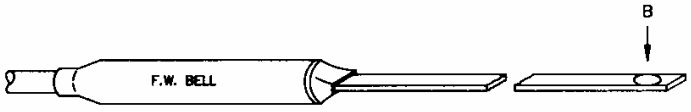


Figure III-E
Probe Orientation Versus Readout Polarity

SECTION III continued
Field Measurement Operations

III-K ANALOG OUTPUTS

On the rear panel of the gaussmeter are connections that, when *connected to an oscilloscope*, allow the user to observe the actual magnetic field waveforms.

In the ac mode, the waveform is the actual field waveform calibrated to 3 volts rms full scale. For instance, with the gaussmeter programmed for a 3 kG range setting (3000 G) a 2.0000 Vrms signal correlates to a 2.0000 kG field density.

In the dc mode, the output is instantaneously proprotional to the field in magnitude and polarity from dc to 400 Hz.

NOTE: The gaussmeter digitally corrects the magnetic field density signals for errors due to probe offset, amplifier offset, frequency-related attenuation, temperature-related effects, etc. before the final reading is displayed. ***The signals available at the ANALOG OUTPUT connectors ARE NOT CORRECTED for these errors.***

III-L REMOTE TERMINAL ("MASTER") OPERATION

There are two modes of remote operation available in the SERIES-9900 gaussmeter. In the "SLAVE" mode, available from either the RS-232 serial port or the IEEE-488 bus, a remote device (typically a computer system or industrial controller) controls all gaussmeter operations. This is discussed in Section V.

In the "MASTER" mode, available only from the RS-232 serial port, the gaussmeter controls a remote terminal or printer device. This is particularly useful if the the user and gaussmeter must be separated by some distance, or if the user wishes to have a hardcopy of all gaussmeter activity.

The terminal/printer may be connected directly to the gaussmeter, or indirectly through a modem following the electrical connections shown in Section VI. The RS-232 characteristics of both devices must match. The gaussmeters' parameters can be modified via the COMMUNICATIONS FORMAT menu. All MEASURE mode and MENU mode operations are accessible from the terminal. See Section IV-M for further information.

Whenever field measurements are taking place the gaussmeter will transmit a continuous listing of field measurements and channel status in a formatted ASCII character stream as shown in Figure III-F. Note that CHANNEL 1 is programmed for the RELATIVE mode, CHANNEL 2 has been deactivated and CHANNEL 3 has been programmed for CLASSIFIER operation. CHANNEL 1 has a 1X bulk Hall generator probe attached, CHANNEL 3 a 10X thin film device.

Initially, a FORMFEED (FF) control character is transmitted. If a printer is connected this should cause the paper feeder to advance to the top of the next sheet of paper. If a terminal is connected this usually clears the screen. The FF is followed by CARRIAGE RETURN (CR) and LINEFEED (LF) control character and then a three-line header containing 79 printable characters per line. Each line is followed by a CR and LF.

Each line of measurement data contains 79 printable ASCII characters followed by a CR and LF. The third (CHANNEL 3) information line is followed by one more LF to create a blank line between each group of readings.

SECTION III continued
Field Measurement Operations

F.W. BELL *** SERIES-9900 GAUSSMETER *** VERSION 1.0

Chan	Reading	Relative	Range	Class-LO	Class-Hi	Classify	Auto	Peak	Probe Type
1	~1.6676 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	+22.445 G		30 G	-5.1000 G	+20.000 G	HIGH	ON	OFF	THIN 10X
1	~1.7288 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	+22.998 G		30 G	-5.1000G	+20.000 G	HIGH	ON	OFF	THIN 10X
1	~1.7299 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	+10.900 G		30 G	-5.1000G	+20.000 G	ACCEPT	ON	OFF	THIN 10X
1	~1.7299 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	+01.222 G		30 G	-5.1000G	+20.000 G	ACCEPT	ON	OFF	THIN 10X
1	~1.7299 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	-70.339 G		30 kG	-5.1000 G	+20.000 G	LOW	ON	OFF	THIN 10X
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

NOTE: Once 64 lines (including header and blank lines) have been transmitted, the process starts over with the FF character.

F.W. BELL *** SERIES-9900 GAUSSMETER *** VERSION 1.0

Chan	Reading	Relative	Range	Class-LO	Class-Hi	Classify	Auto	Peak	Probe Type
1	~1.7299 kG	~55.338 G	3 kG			OFF	OFF	ON	BULK 1X
2	INACTIVE								
3	+22.445 G		30 G	-5.1000 G	+20.000 G	HIGH	ON	OFF	THIN 10X
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

Figure III-F
Sample "MASTER" Mode Transmission

SECTION III continued
Field Measurement Operations

NOTE: The user should be aware that the serial transmission rate is much slower than the rate at which the display is updated with new readings. In other words the gaussmeter does not wait for a transmission to complete before taking another reading. Readings taken during transmissions will never appear in a transmission, as the following scenario illustrates:

DISPLAY UPDATE (CHANNEL 1)	TRANSMISSION HISTORY
+23.998 kG	Transmission starts (CHANNEL 1 = +23.998 kG)
+24.220 kG	Transmission continues
+25.770 kG	Transmission continues
+24.556 kG	Transmission continues
+24.234 kG	Transmission ends
+21.002 kG	New Transmission starts (CHANNEL1 = +21.002 kG)

III-M INTERNAL RECALIBRATION

Occasionally, the gaussmeter will inititate an internal calibration cycle in order to maintain optimum performance. During this time, the phrase "GAUSSMETER BEING RECALIBRATED" will appear on the display and field measurement activity will be suspended. A recalibration will occur:

a) Immediately after the power-up initialization sequence.
b) Any time a new probe is connected.
c) Whenever the internal temperature has changed more than ±5° C since the last recalibration cycle.

SECTION IV

MENU OPERATIONS/ GAUSSMETER PROGRAMMING

IV-A INTRODUCTION

The gaussmeter's MENU mode allows the user to modify all aspects of the instrument operation; range settings, display format, peak hold, communications format, etc. Probe ZEROING and RELATIVE operations are also initiated from the MENU mode.

IV-B MENU MODE OPERATION

The MENU mode can be entered at any time by pressing the PROGRAM/ENTER pushbutton. When this occurs all measurement operations cease and each channel and its probe are placed in a standby position. The master selection list (MAIN MENU) will appear.

Generally, each menu will contain a primary selection list accompanied by one or more operations lists. Pressing the up (↑) or down (↓) pushbutton allows an item to be chosen from each list. Each time this happens the cursor will advance up or down accordingly. A selection is then validated by pressing the ENTER pushbutton. In some menus the up (↑) and down (↓) pushbuttons will be used to enter numeric values.

Each menu is accompanied by a brief explanation of the operation that it affects. This will appear by selecting HELP. Once the explanation appears, press the ENTER pushbutton to return to the menu. Choosing MAIN MENU will cause a return to the master selection list. Field measurements may be resumed at any time by choosing the RUN selection.

Each gaussmeter channel is individually programmed by selecting CHANNEL 1, CHANNEL 2 or CHANNEL 3. It is not necessary for the selected channel's interface module or its probe to be physically present while programming except during the PROBE ZERO or PROBE RELATIVE operations. If the channel *is* present, the red LED indicator near the probe connector will light when the channel is selected. As mentioned earlier, CHANNEL 1 is always the left-hand channel in the chassis, CHANNEL 2 the middle position and CHANNEL 3 the right-hand location.

IV-C MAIN MENU

This is the master selection list that appears when entering the MENU mode or when returning from any other menu. The up (↑) or down (↓) pushbutton is used to choose a selection, and the ENTER pushbutton is used to advance to the chosen operation.

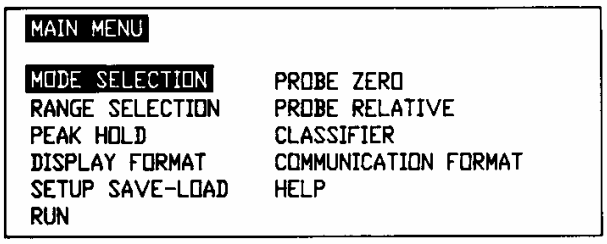


Figure IV-A
MAIN Menu

SECTION IV continued
Menu Operation/Gaussmeter Programming

IV-D MODE SELECTION

Mode selection affects two operating parameters: the type of magnetic field being measured (ac for alternating or dc for steady-state) and the units of measurement (GAUSS or TESLA).

In the ac mode, field readings will be preceded by a symbol representing a sinusoidal waveform (~), whereas dc readings will be preceded by the appropriate polarity (+ or —).

GAUSS is defined as a flux density of 10^8 lines per square meter. TESLA is defined as 10^{12} lines per square meter. One TESLA =10 kG.

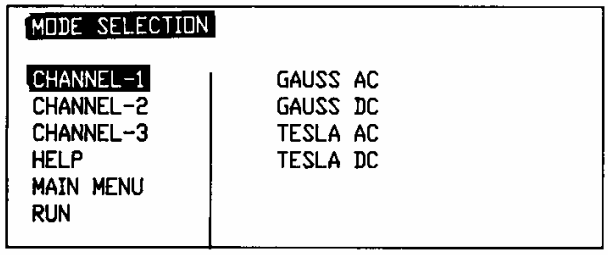


Figure IV-B
MODE SELECTION Menu

IV-E RANGE SELECTION

The choice of ranges depends upon whether the channel has been programmed to measure GAUSS or TESLA (via MODE SELECTION). The range the user selects will depend on the intensity of the field to be measured versus the resolution required. Figure IV-C depicts this relationship.

RANGES		RESOLUTION		PROBE
GAUSS	TESLA	GAUSS	TESLA	
30 mG	(3 μT)	10 μG	(0.001 μT)	.01X
300 mG	(30 μT)	10 μG	(0.001 μT)	.01X
3 G	(300 μT)	1 mG	(0.01 μT)	.01X, 1X
30 G	(3 mT)	10 mG	(0.1 μT)	.01X, 1X, 10X
300 G	(30 mT)	100 mG	(1 μT)	.01X, 1X, 10X
3 kG	(300 mT)	1 G	(10 μT)	.01X, 1X, 10X
30 kG	(3 T)	10 G	(100 μT)	1X, 10X
300 kG	(30 T)	10 G	(1 mT)	1X, 10X
3 MG	(300 T)	100 G	(10 mT)	10X

NOTE: The user cannot specify whether a probe is a 1X,10X OR 0.01X device. This information is retrieved from the probe itself. If the probe or interface module is not in place when programming the RANGE, the gaussmeter will assume a 1X configuration.

SECTION IV continued
Menu Operation/Gaussmeter Programming

RANGE SELECTION	3 G [30 mG]	300 uT [3 uT]
1X-10X [.01X]	30 G [300 mG]	3 mT [30 mT]
CHANNEL-1	300 G [3 G]	30 mT [300 mT]
CHANNEL-2	3 KG [30 G]	300 mT [3 mT]
CHANNEL-3	30 KG [300 G]	3 T [30 T]
HELP	300 KG [3 KG]	30 T [300 T]
MAIN MENU	3 MG	300 T
RUN	AUTO GAUSS	AUTO TESLA

Figure IV-D
RANGE SELECT Menu

One other selection in this menu is the AUTOranging mode. This feature allows the gaussmeter itself to select a range appropriate for the present intensity of the field to obtain the best resolution. Note that AUTOranging will cause a slight degradation in the system speed.

The present range setting always appears in the channel's information block in the MEASURE mode display screen as field measurements are being taken (See Figure III-D). If the AUTOranging mode is selected, the AUTO indicator will appear in the block as well.

IV-F PEAK HOLD

PEAK HOLD allows the largest absolute field measurement to be captured and held indefinitely. When engaged, the PEAK indicator will appear in the channel's information block in the MEASURE mode display screen as field measurements are being taken. (See Figure III-D.)

The presently held peak can be manually reset at any time during the measurement process by pressing and releasing the channel's respective RESET pushbutton. The PEAK indicator will flash momentarily to indicate that the reset is in progress, but a new peak will not be captured until the pushbutton is released (See Section III-H for more information).

PEAK HOLD	
CHANNEL-1	ON
CHANNEL-2	OFF
CHANNEL-3	
HELP	
MAIN MENU	
RUN	

Figure IV-E
PEAK HOLD Menu

IV-G DISPLAY FORMAT

As seen in Figure III-D, each channel's display field has a digital and a bargraph representation of the field density reading. This format can be changed using the DISPLAY FORMAT menu.

SECTION IV continued
Menu Operation/Gaussmeter Programming

Either the digital reading or the bargraph, or both, can be turned off to suit the user's requirements. By turning *both* off, the user eliminates the channel from the screen and the channel and its probe is placed in a standby position. If only the digital reading is turned off, the reading's polarity (~, or + or —) will remain on the screen as an indication of the type of field (ac or dc) being measured. This also disables the ability to gather field readings in the "SLAVE" mode of remote operation, discussed in Section V.

If ambient lighting is inadequate to clearly see the display during the measurement process, the backlight can be turned on for better visibility. This is done by choosing any of the channel selections.

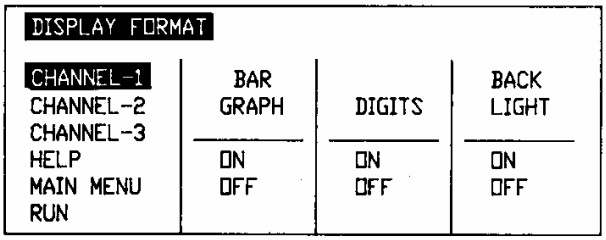


Figure IV-F
DISPLAY FORMAT Menu

IV-H SETUP SAVE-LOAD

A "SETUP" is the condition of the gaussmeter (range settings, display format, classifiers, etc.) while the instrument is operating in the MEASURE mode. The gaussmeter can permanently store up to six separate machine set-ups. The purpose of SETUP SAVE-LOAD is to allow the user to program a setup for a particular application, for instance, measuring a batch of permanent magnets. This setup can be saved and later retrieved, instantly programming the gaussmeter without the need to re-enter all of the parameters via the MENU mode each time the gaussmeter is used. It should be remembered that the present machine SETUP is saved when the instrument is powered down and will be reinitialized to that SETUP when powered up again. See Section III-I for further information.

The six SETUPs are titled "A" thru "F." When REVIEW, SAVE or LOAD is chosen, the cursor will advance to the title column. At this point the up (↑) or down (↓) pushbuttons are used to select the desired SETUP title. At the same time that title's SETUP information block will appear on the right-hand side of the screen, allowing the user to view the programming information. Similar to the three-channel MEASURE mode display screen, the top information block is for CHANNEL 1, the middle CHANNEL 2 and the lower CHANNEL 3.

The setup is then validated by the ENTER pushbutton. *In the SAVE mode the PRESENT machine setup will replace the setup that appears on the screen.* Care should be used in this mode to avoid unintentionally overwriting a setup. In the LOAD mode, the setup for the selected title *will replace the present machine setup.* REVIEW simply allows the user to view the information without affecting the setup.

SECTION IV continued
Menu Operation/Gaussmeter Programming

Note that values generated by the PROBE ZERO and PROBE RELATIVE functions are *NOT* saved or loaded. The present values (if any) remain in effect. Also, if a loaded setup's range setting is inappropriate for the type of probe presently installed, the next valid range will be selected automatically. For example, if a setup contains a CHANNEL 1 range setting of 3 G, and that setup is loaded in with a 10X probe connected to CHANNEL 1, the 30 G range will be selected (3 G is not a valid range selection with a 10X probe.)

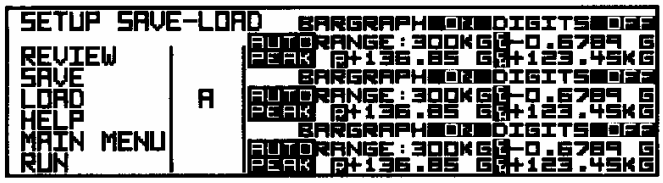


Figure IV-G
SETUP SAVE-LOAD Menu

IV-I PROBE ZERO

There are many factors that can affect the initial accuracy of a field reading. Probe offsets, circuit offsets and proximity to ferrous metals and electromagnetic fields (including the earth's) can result in field readings that are something other than zero when they should be zero.

The front panel of the gaussmeter contains a ZERO GAUSS CHAMBER which shields the probe from surrounding fields, leaving only errors due to probe and circuit offsets. With the probe placed in the zero gauss chamber, these errors can be removed by "zeroing" the probe. Unlike most other MENU operations, the PROBE ZERO function requires the presence of an interface module and a probe. The probe is zeroed only for the mode (ac or dc) that is presently programmed for the channel (via the MODE SELECTION MENU).

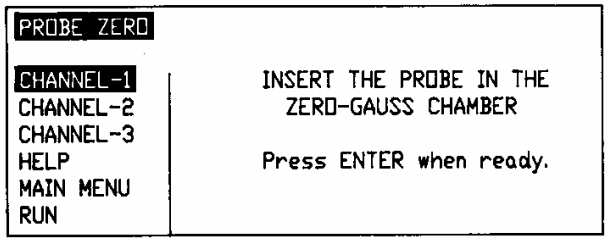


Figure IV-H
PROBE ZERO Menu

Once a channel is selected from the menu, a message will appear that states that the gaussmeter is ready to begin. Pressing the ENTER pushbutton initiates the zeroing process. (If the channel's interface module and probe are not present, an error message will appear instead. In this case, pressing the ENTER pushbutton will abort the zeroing operation.)

In the ac mode, the gaussmeter starts at the lowest valid range and zeroes the probe through each valid range. At each ac range, a digital correction factor is generated and stored.

SECTION IV continued
Menu Operation/Gaussmeter Programming

Prior to storing a digital correction factor for the lowest dc range, the Series-9900 adjusts an offset suppression voltage at the input to the first amplification stage. The unit then proceeds to generate and store a digital correction factor for each dc range. If the probe offset is considered excessive (>300 G/30 mT), or the probe is removed from the zero chamber or disconnected during the zeroing process, an error will be reported and all zero values generated to that point will be reset. In this case pressing the ENTER pushbutton will restore normal menu operations.

Internally, ac and dc zeroing differs electronically. This difference is transparent to the user, but *does* affect one aspect of machine operation. The initial probe offset for the ac mode will affect the maximum reading that can be reached in a given range. For instance, if the initial ac offset is 20.000 G and the probe is operated (after zeroing) on the 30 G range setting, an overrange condition will occur when the field reading reaches 10.000 G (30 G - 20.000 G = 10.000 G.) This limitation does not exist for the dc mode of operation.

The internal zeroing values will remain in effect until the gaussmeter is turned off or the probe is rezeroed.

NOTE: Whenever a probe is zeroed, all previously-generated relative values will be reset and the relative function will be turned off for that channel (see PROBE RELATIVE, Section IV-J).

IV-J PROBE RELATIVE

PROBE RELATIVE allows the probe to be "zeroed" in a non-zero magnetic field. This field then becomes the reference point for all future measurements. For example, if the relative field is +200.00 G and the probe is afterwards inserted in a +250.00 G field, the displayed reading will be +50.00 G. A field of +150.00 G will be displayed as -50.00 G. Thus, the RELATIVE function can be useful for observing a variance around a given field density.

Like the PROBE ZERO operation, the PROBE RELATIVE function requires the presence of an interface module and a probe. The relative values are generated *only* for the mode (ac or dc) that is presently programmed for the channel (via the MODE SELECTION menu).

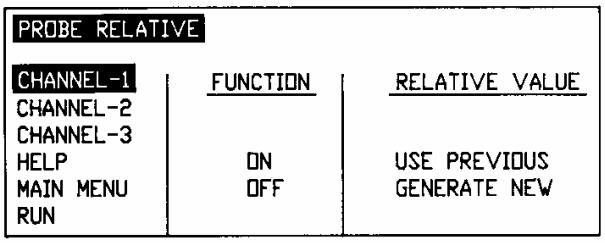


Figure IV-I
PROBE RELATIVE Menu

Once a channel is selected on the menu the user has the choice of turning the relative function ON or OFF for that channel. Selecting OFF returns the gaussmeter display to actual field readings, rather than relative readings. Selecting ON engages the RELATIVE function and allows the user to either

SECTION IV continued
Menu Operation/Gaussmeter Programming

use previously generated relative values (USE PREVIOUS) or generate new values (GENERATE NEW). If the latter is selected, the following occurs:

A message will appear that states that the gaussmeter is ready to begin. Pressing the ENTER pushbutton initiates the relative operation. (If the channel's interface module and probe are not present, an error message will appear instead. In this case, pressing the ENTER pushbutton will abort the relative operation.)

In the ac mode, the relative operation begins in the lowest valid range. If the existing field level exceeds this range, the next range is selected. This continues until a range is found that can accommodate the field level. *No relative values will be generated for those ranges that were exceeded.* At this point the relative field level reading is placed in the channel's information block preceded by a reverse-video "R," (see Figure III-D) for future reference, and relative values are generated for this and all higher ranges.

In the dc mode, the relative operation begins in the lowest valid range. If the existing field level exceeds this range, the next range is selected. This continues until a range is found that can accommodate the field level. At this point, the present field level reading is placed in the channel's information block for future reference and a relative value is generated for this range. The gaussmeter then downranges two range settings and continues the relative operation, generating a relative value for this and all higher ranges.

In either mode, if the probe is moved or disconnected during the relative operation, or if the reference field is extremely unstable, an error will be reported and all relative values generated to that point will be reset. In this case, pressing the ENTER pushbutton will restore normal menu operation.

Internally, ac and dc relative operations differ electronically. This difference is transparent to the user, but *does* affect one aspect of machine operation. The initial field for the ac mode will affect the maximum reading that can be reached in a given range. For instance, if the initial relative ac field is 100.00 G and the probe is operated on a 300 G range setting, an overrage condition will occur when the field reading reaches 200.00 G (300 G—100.00 G =200.00 G). This limitation does not exist for the dc mode of operation.

When operating in the MEASURE mode, the value of the relative field (the field that existed before the relative operation was initiated) will appear in the channel's information block preceded by a reverse-video "R." (See Figure III-D.) In the dc mode, the user can downrange *up to two ranges* to obtain better resolution of the variances around the original field. For instance, observing a 20 kG field*without* the RELATIVE function enabled, allows only a resolution of ±1 G on the 30 kG range. However, if the RELATIVE function is used, the user can downrange to observe variances as low as ±0.01 G on the 300 G range. This is valid only for the dc mode. Attempts to downrange more than two ranges will result in an overrange condition.

NOTE: The probe should be zeroed (see PROBE ZERO, Section IV-I) before performing the relative function or the relative values will also include probe and circuit offset errors. When a probe is zeroed, *all previously generated relative values will be reset and the relative function will be turned off for that channel.*

SECTION IV continued
Menu Operation/Gaussmeter Programming

IV-K CLASSIFIERS

The CLASSIFIER function allows the user to define a lower and upper limit of field density which can be used to quickly determine the status of a magnetic field. With the classifier function turned on during field measurements, the gaussmeter will indicate visually whether the field is below, within or above these limits.

Once a channel is selected on the menu the user has a choice of turning the classifier function ON or OFF. Selecting OFF returns the gaussmeter to normal operation for that channel. Selecting ON-M (ON with "Message" only) enables the classifier function and, when taking field measurements, will cause the digital reading to be replaced by the phrase "LOW" if the field density is below the lower limit, "HIGH" if above the upper limit or "ACCEPT" if within the two limits. Selecting ON-M&D (ON with Message and Digits) will cause the digital field reading and the "LOW," "HIGH" or "ACCEPT" message to alternate on the display, allowing the user to observe the actual reading as well as the classifier status.

If either of the ON selections is chosen, the user is directed to the low classifier (C/L) field containing a range setting, a polarity sign and five digits with a decimal point. The user must first choose a range for the C/L. The choices are the same as those in the RANGE SELECT menu (Section IV-E) and are made by pressing the up (↑) or down (↓) pushbuttons and validating the selection with the ENTER pushbutton. The decimal point will relocate to the appropriate position within the digits field depending on the range selected.

The next steps require that each of the five classifier digits be programmed ("0" to "9") using the up (↑) or down (↓) pushbuttons. Pressing ENTER will validate each selection. This continues until the last digit is programmed. The gaussmeter will not allow a number greater than 29999 to be programmed.

The process is then repeated for the high classifier (C/H) range. If the high classifier is mathematically less than the C/L, the classifier settings will be reversed once the final high classifier digit is entered.

There are several ways to represent the same number. For instance, a classifier of +19.374 kG can be entered as:

RANGE	SETTING	
30 kG	+19.374	or
300 kG	+019.37	or
3 MG	+0.0194	

The user should decide which is the best choice for the application.

When operating in the MEASURE mode, the values of the classifier settings will appear in the channel's information block preceded by the C/L and C/H indicators. See Figure III-D.

As an example, suppose a batch of permanent magnets is being tested for an acceptable field density of +1500 G to +1700 G. The classifier settings would be programmed for 3 kG +1.5000 and 3 kG +1.7000. Once testing commences, the gaussmeter will display (assuming the ON-M selection was made) "LOW" for all magnets below +1500 G, "HIGH" for all those above +1700 G, and "ACCEPT" for those in between.

SECTION IV continued
Menu Operation/Gaussmeter Programming

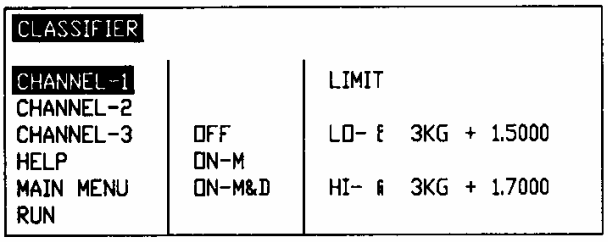


Figure IV-J
CLASSIFIER Menu

IV-L COMMUNICATIONS FORMAT

This menu allows the user to configure the communications ports.

If the IEEE-488 selection is made, the user is directed to select the device primary ADDRESS using the the up (↑) or down (↓) pushbutton. The selection is validated with the ENTER pushbutton. Legal addresses are 0 to 31 decimal. Refer to Section VI for further information on the IEEE-488 bus.

If RS-232 is selected, the user is directed to first select the PARTIY (NONE, ODD or EVEN), then the character LENGTH (5, 6, 7 or 8 bits), then the number of STOP bits (1 or 1.5 if the LENGTH is 5 bits or 1 or 2 if the LENGTH is 6, 7 or 8 bits) and finally the BAUD rate (110, 150, 300, 600, 1200, 2400, 4800, 9600 or 19200 bits/second). In each case, the up (↑) or down (↓) pushbuttons are used to select a parameter and the ENTER pushbutton validates the selection. Refer to Section VI for further information on RS-232 communications.

NOTE: Changes made to the communications ports take effect immediately.

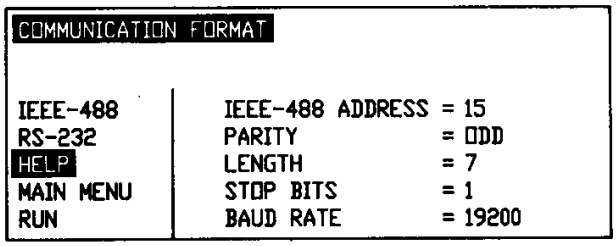


Figure IV-K
COMMUNICATIONS FORMAT Menu

IV-M MENU OPERATIONS VIA REMOTE TERMINAL

Thus far, the instructions relating to gaussmeter programming have been limited to the use of the unit's front panel display and pushbuttons. Any operation that can be programmed from the front panel can be programmed from an RS-232 terminal connected directly to the gaussmeter or indirectly through a modem. This can be useful in situations that require the user and the gaussmeter to be some distance apart.

SECTION IV continued
Menu Operation/Gaussmeter Programming

This mode of operation is called the "MASTER" mode and should not be confused with the other mode of remote operation called the "SLAVE" mode (Section V). In the "MASTER" mode the *gaussmeter is controlling* the terminal, with the terminal's screen and keyboard duplicating the gaussmeter's front panel display and pushbuttons. In the "SLAVE" mode, the *gaussmeter is being controlled* by a remote device, typically a computer. The "SLAVE" mode is accessible from either the IEEE-488 bus or the RS-232 communications port, whereas the "MASTER" mode operates only from the RS-232 port.

See Section VI for the electrical interface connections.

Only three keys are used on the terminal's keyboard; the ENTER key, the CURSOR UP (↑) key and the CURSOR DOWN (↓) key. There is a one-to-one functional correspondence between these keys and the front panel pushbuttons. Thus any reference made in previous discussions to the up (↑) pushbutton, for instance, can be replaced by the CURSOR UP (↑) on the terminal.

Some terminals may not have cursor control keys or may not generate the same ASCII codes as other terminals for the same function. Use the following table to clarify these situations. It is recommended that the user refer to the terminal's user manual for further information.

FUNCTION	ASCII	POSSIBLE KEY
ENTER	13	ENTER, RETURN, CTRL-M
UP	11/26	CURSOR UP, ↑, VTAB, CTRL-K, CTRL-Z
DOWN	10	CURSOR DOWN, ↓, LINEFEED, CTRL-J

The front panel display and pushbuttons operate in parallel with the terminal's screen and key board. Whatever is presently appearing on the gaussmeter's display will also appear on the terminal's screen though the format will be slightly different. Whether a selection is made via the front panel pushbuttons or the terminal's keyboard, both the terminal screen *and* the gaussmeter's display will be updated. It is even possible to alternate between keyboard and front panel pushbuttons to make selections.

NOTE: Since the COMMUNICATIONS FORMAT menu is accessible from the remote terminal, care should be taken not to change the RS-232 parameters without matching the new parameters on the terminal. Changes to the parameters take effect immediately so it is possible to sever communications in one keystroke. If this happens, the gaussmeter will have to be re-programmed from the front panel or the terminal's parameters will have to be modified to match the changes made.

NOTE: As discussed in Section III-H, peak readings are reset using the up (↑) and down (↓) pushbuttons. Both are pressed to reset CHANNEL-3. To accomplish a CHANNEL-3 peak reset from the remote terminal, the BACKSPACE KEY is used. (On some terminals, the RUBOUT or CURSOR LEFT (←) key may be used. The gaussmeter interprets an ASCII 08 as the backspace key).

SECTION V

REMOTE (SLAVE) MODE OPERATION

V-A OVERVIEW

The "SLAVE" mode of operation allows a remote device such as a computer system to control gaussmeter operations. Another mode of remote operation, the "MASTER" mode, in which the gaussmeter controls a remote terminal or hardcopy device, is discussed in Sections III and IV.

The "SLAVE" mode is available from either the IEEE-488 instrumentation bus or the RS-232 communications port. The operating characteristics of both ports can be programmed from the COMMUNICATIONS FORMAT menu (Section IV). The electrical interface is discussed in Section VI.

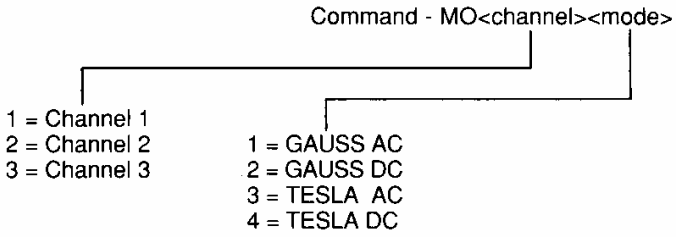
Most of the programmable aspects of the gaussmeter that are available in the MENU mode are also accessible in the SLAVE mode. Information regarding the nature of these operations can be found in Section IV. In addition, other functions are available that are not accessible in the normal manual operation of the gaussmeter.

V-B REMOTE (SLAVE) OPERATION

The master programs the gaussmeter by sending a series of ASCII character command strings and receiving a response string back from the gaussmeter.

In the following list of commands, all values within a command string are ASCII. Thus, a "3" is an ASCII '3,' which is 51 decimal, 33 hex, and not 03. The standard ASCII character set totals 128 characters, so if the RS-232 port is being used, the minimum character length must be 7 bits.

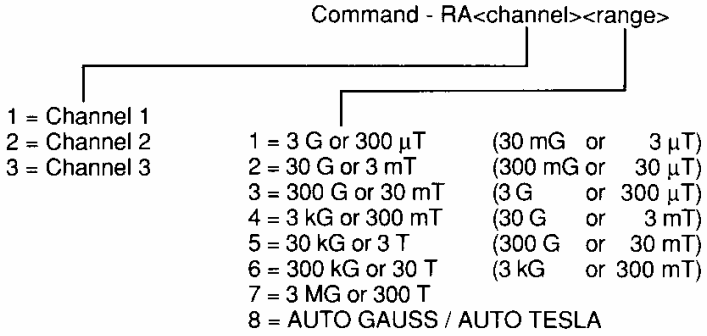
V-B(a) MODE SELECTION



EXAMPLE: "MO13" programs CHANNEL 1 for TESLA ac.

SECTION V continued
Remote (Slave) Mode Operation

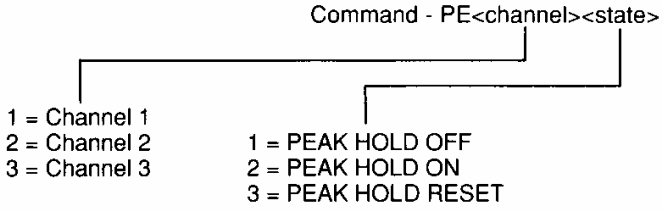
V-B(b) RANGE SELECTION



NOTE: The range units (GAUSS or TESLA) are determined by the MODE SELECTION command. The ranges shown in parenthesis ( ) are used with a 0.01X probe.

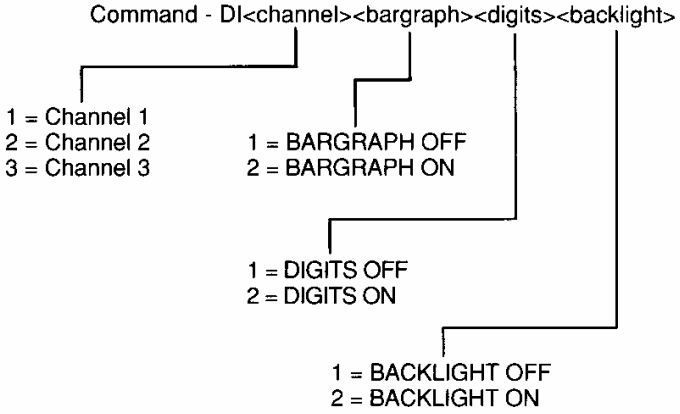
EXAMPLE: "RA35" programs CHANNEL 3 for 3 TESLA (assuming the MODE is set for TESLA with a 1X or 10X probe).

V-B(c) PEAK HOLD



EXAMPLE: "PE21" turns PEAK HOLD off for CHANNEL 2.

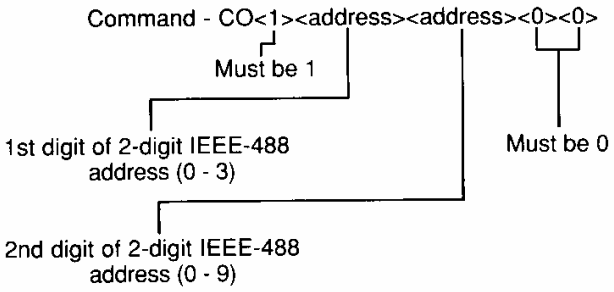
V-B(d) DISPLAY FORMAT



EXAMPLE: "DI1222" enables the bargraph and the digital reading for CHANNEL 1 and turns on the backlight.

SECTION V continued
Remote (Slave) Mode Operation

V-B(e) COMMUNICATIONS FORMAT - IEEE-488

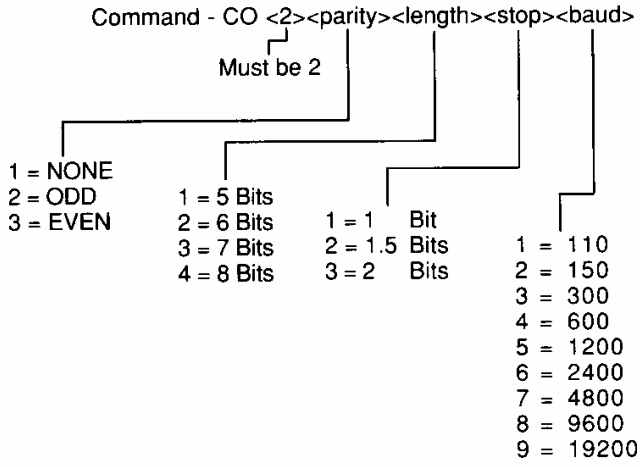


NOTE: Legal addresses are 00 - 31 (decimal).

EXAMPLE: "CO12500" sets an IEEE-488 address of 25

WARNING: Improper use of this command can terminate communications between the remote device and the gaussmeter. See Section V-E for more information.

V-B(f) COMMUNICATIONS FORMAT - RS-232



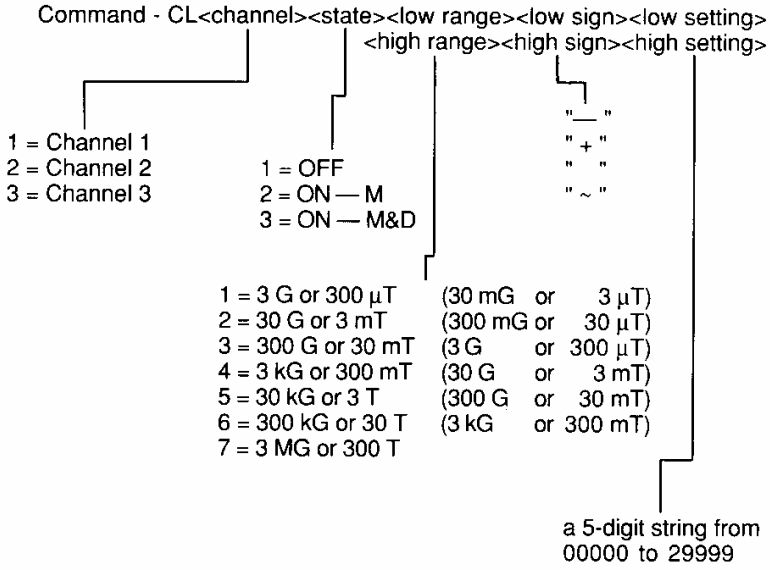
EXAMPLE: "CO21317" sets the RS-232 port for no parity, a 7-bit character, 1 stop bit and a baud rate of 4800.

NOTE: Number of stop bits for a 5-bit character can only be 1 or 1.5. For all other character lengths, choose either 1 or 2 stop bits.

WARNING: Improper use of this command can terminate communications between the remote device and the gaussmeter. See Section V-F for more information.

SECTION V continued
Remote (Slave) Mode Operation

V-B(g) CLASSIFIERS

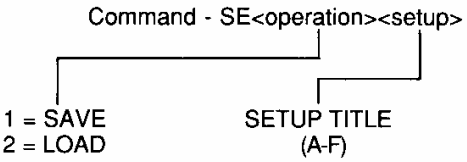


NOTE: The range units (GAUSS or TESLA) are determined by the MODE SELECTION command. If the channel has been programmed for GAUSS-AC or TELSA-AC, the 'sign' character should be a "~." The SPACE " " character should be used if the classifier setting is programmed for 00000. The ranges shown in parenthesis ( ) are used with a 0.01X probe.

NOTE: If the 'state' is set to OFF, all other digits of the command string must still be sent, but will be ignored.

EXAMPLE: "CL223-009403+01000" programs CHANNEL 2's low classifier for a -9.40 G and the high classifier for +10.00 G (assuming the mode for CHANNEL 2 is set for GAUSS-DC and the probe type 1X or 10X). The state of the classifiers in the MEASURE mode of operation will be ON with Message only.

V-B(h) SETUP SAVE LOAD



EXAMPLE: "SE1D" saves the present gaussmeter setup in SETUP "D."

SECTION V continued
Remote (Slave) Mode Operation

V-B(i) PROBE ZERO

Command - ZE<channel><status>

1 = Channel 1
2 = Channel 2
3 = Channel 3

must be '0'
(See NOTE)

NOTE: The PROBE ZERO operation will start immediately, so the probe must be placed in the ZERO GAUSS CHAMBER (or other desired zero field environment) Before this command is issued. The "status" character must be '0' in the command string. If the PROBE ZERO operation is successful, the RETURNED command string (see Section V-D) will also have the "status" character set to '0.' If an error prevented a successful zeroing of the probe, "status" will be '1.' See Section IV-I for further information on zeroing errors.

EXAMPLE: "ZE20" zeroes CHANNEL 2's probe.

V-B(j) PROBE RELATIVE

Command - RE<channel><state><select><range><sign><reading>

1 = Channel 1
2 = Channel 2
3 = Channel 3

1 = OFF
2 = ON

1 = USE PREVIOUS
2 = GENERATE NEW

Must be
'0000000'
(See NOTE)

NOTE: The PROBE RELATIVE operation will start immediately, so the probe must be placed in the desired magnetic field environment before this command is issued. The "range," "sign" and 5-digit "reading characters must be '0' in the command string. If the "USE PREVIOUS" selection is made, or if a new relative operation is invoked *and* if the PROBE RELATIVE operation is successful, the RETURNED command string (see Section V-D) will contain the following information:

RE<channel><state><select><range>< sign><reading>

1 = 3 G or 300 μT	(30 mG	or	3 μT)	"—"
2 = 30 G or 3 mT	(300 mG	or	30 μT)	"+"
3 = 300 G or 30 mT	(3 G	or	300 μT)	" "
4 = 3 kG or 300 mT	(30 G	or	3 mT)	"~"
5 = 30 kG or 3 T	(300 G	or	30 mT)	
6 = 300 kG or 30 T	(3 kG	or	300 mT)	
7 = 3 MG or 300 T				

a 5-digit string from
00000 to 29999

SECTION V continued
Remote (Slave) Mode Operation

If an error prevented a successful relative operation *or* if the OFF state was selected, "range," "sign" and "reading" will be returned to '0000000.' See Section IV-J for further information on relative operation errors.

NOTE: The range units (GAUSS or TESLA) are determined by the MODE SELECTION command. If the channel has been programmed for the ac mode, the "sign" character will be a "~." The SPACE " " character will be returned if the reading is exactly 0 in the dc mode. The ranges shown in parenthesis ( ) are used with a 0.01X probe.

EXAMPLE: "RE3220000000" starts the relative operation for CHANNEL 3. If the relative field was -23.110 mT, the returned command string will be "RE3223-23110."

EXAMPLE: "RE1110000000" disables the use of the relative offset in the MEASURE mode for CHANNEL 1. The returned command string will be the same.

V-B(k) MEASURE

Command - ME<channel><classify><range><sign><reading>

1 = Channel 1
2 = Channel 2
3 = Channel 3

Must be '00000000' (See NOTE)

This command will measure the present field density from the selected channel.

NOTE: The MEASURE operation will start immediately, so the probe must be placed in the desired magnetic field environment *before* this command is issued. The "classify," "range," "sign," and 5-digit "reading" characters must be '0' in the command string. The RETURNED command string will contain the following field information:

ME<channel><classify><range>< sign><reading>

0 = Disabled
1 = LOW
2 = HIGH
3 = ACCEPT

" − "
" + "
" "
" ~ "

1 = 3 G or 300 μT	(30 mG	or	3 μT)
2 = 30 G or 3 mT	(300 mG	or	30 μT)
3 = 300 G or 30 mT	(3 G	or	300 μT)
4 = 3 kG or 300 mT	(30 G	or	3 mT)
5 = 30 kG or 3 T	(300 G	or	30 mT)
6 = 300 kG or 30 T	(3 kG	or	300 mT)
7 = 3 MG or 300 T			

a 5-digit string from 00000 to 32767

SECTION V continued
Remote (Slave) Mode Operation

NOTE: The range units (GAUSS or TESLA) are determined by the MODE SELECTION command. If the channel has been programmed for ac mode, the "sign" character will be a "~." The SPACE " " character will be returned if the reading is exactly 00000 in the dc mode. Any reading greater than 29999 should be considered an overrange condition. If the CLASSIFIER function is enabled, the "classify" status will reflect "LOW," "HIGH" or "ACCEPT" (see Section IV-K). The ranges shown in parenthesis ( ) are used with a 0.01X probe.

EXAMPLE: "ME100000000" invokes a reading of the present field density around CHANNEL 1's probe. If the channel has been previously programmed for TESLA-AC, and a range of 3 T, the present field density is 1.2990 T, and the CLASSIFIER function has been enabled with the condition being LOW, the returned command string will be "ME115~12990."

V-B(I) LOCKOUT

Command - LO<state>
|
1 = LOCKOUT OFF
2 = LOCKOUT ON

This command allows the remote device to disable the gaussmeter's front panel pushbuttons. It has the same effect as asserting the REN (Remote Enable) control line on the IEEE-488 bus, by the system controller.

When LOCKOUT is enabled, any attempt to use the front panel pushbuttons will result in a "GAUSSMETER BEING CONTROLLED REMOTELY" message to appear on the screen, reminding the user that the gaussmeter is being controlled remotely. As long as the lockout is enabled, the gaussmeter's MASTER mode will be disabled.

The use of this command is highly recommended, otherwise the gaussmeter setup can be changed locally without the remote device knowing about it, resulting in possible erroneous computations by the remote device.

V-C COMMAND STRING ORGANIZATION

The gaussmeter can accept a command string of up to 1000 ASCII characters in length. The very first character in a command string, the "initiator," must be the ASCII ESCAPE <ESC> control character (27 decimal, 1B hex). The last character in the string, the "terminator," must be CARRIAGE RETURN <CR> (13 decimal, 0D hex).

Commands can be arranged in any order with one command following another. For example, to program the MODE of CHANNEL 1 for GAUSS-DC, the full command string would be:

<ESC>MO12<CR>

SECTION V continued
Remote (Slave) Mode Operation

To program the MODE for all three channels in one command string, the command string might appear like this:

<ESC>MO11MO23MO34<CR>

In this example, CHANNEL 1 was programmed for GAUSS-AC, CHANNEL 2 for TESLA-AC and CHANNEL 3 for TESLA-DC.

As a final example, the following command string:

<ESC>MO12RA12PE11DI1221<CR>

programs CHANNEL 1's MODE to GAUSS-DC, its RANGE to 30 G, turns its PEAK HOLD function OFF and enables both the bargraph and the digital reading on the display as well as turning off the display backlight.

V-D COMMAND EXECUTION

The gaussmeter will not execute any of the commands in the command string *until* the final terminator character <CR> has been received and the unit is triggered if being controlled on the IEEE-488 bus (see Section V-E). It is the user's responsibility to limit the entire command string to 1000 characters or less *including* the initiator and terminator characters. Characters sent in excess of this limit will be ignored until the terminator is received.

It should be noted that if an initiator <ESC> character is received in the middle of a command string, all previous characters will be ignored and the gaussmeter will start over, ready to accept another 999 characters. A transmission such as:

<ESC>MO12MO24<ESC>RA12<CR>

will be processes as through the transmitted command string was:

<ESC>RA12<CR>

Once the terminator is received (and the unit triggered if being controlled by the IEEE-488 bus) commands are executed in the order they were received. Thus a RANGE command such as:

<ESC>RA22RA14<CR>

will first program CHANNEL 2 for a range of 30 G and then CHANNEL 1 for 3 kG. A RANGE command like:

<ESC>RA22RA24<CR>

will first program CHANNEL 2 for a range of 30 G and then for 3 kG and has the same results as a command string of :

<ESC>RA24<CR>.

SECTION V continued
Remote (Slave) Mode Operation

The gaussmeter will not accept any new commands until the present commands have been executed. When the final command has been executed, *the gaussmeter will transmit the command string back to the remote device.* The echoed string will contain all received characters *except* the initiator <ESC>. Thus, if the command string sent to the gaussmeter looked like this:

<ESC>RA24<CR>

the string sent back will look like this:

RA24<CR>.

The reception of the echoed command string indicates to the remote device that all commands were executed and the gaussmeter is ready to accept a new set of commands. In some cases the contents of the returned commands will contain information pertinent to the requested operation, such as the execution status of the PROBE ZERO operation or the value of the relative field in the PROBE RELATIVE operation. See Section V-B.

The gaussmeter checks each command for validity before it is executed. If the gaussmeter detects a command containing errors, whether due to a transmission error or a programming error, *the gaussmeter will terminate the command string processing.* However, all commands previous to the one with errors will be executed. In this situation, the gaussmeter will transmit an abbreviated version of the original command string back to the remote device, ending at the point where the error was detected. This string, then, can be used to pinpoint errors in the user's program or to verify that all commands were indeed executed.

For example, the following command string contains an error:

<ESC>MO12DI1131RA16<CR>.

In the DISPLAY FORMAT command (DI1131), the "3" is not a valid selection. In this case, the gaussmeter will execute the MODE command, terminate processing and send back the following string:

MO12DI113<CR>

indicating that the MODE SELECTION command was executed but the DISPLAY FORMAT and RANGE SELECTION commands were not, due to an error in the DISPLAY FORMAT command.

V-E IEEE-488 IMPLEMENTATION

See Section VI for electrical information on the IEEE-488 bus.

When the gaussmeter is busy executing commands, performing diagnostics or recalibrating internal circuits, the serial poll register's DI01 bit will be set and all other bits reset as follows:

DI08	D107	D106	DI05	DI04	DI03	DI02	DI01
0	0	0	0	0	0	0	1

SECTION V continued
Remote (Slave) Mode Operation

The user should always wait for a "NOT BUSY" condition before issuing commands to the gaussmeter.

When the host system's bus controller sends a command string to the gaussmeter, the gaussmeter must be programmed as a listener at the gaussmeter's preprogrammed primary address (via the COMMUNICATIONS FORMAT menu). It is not necessary to assert the EOI (End or Identify) control line when the final terminator character is transmitted, but *the GET (Group Execute Trigger) command MUST be issued by the system controller before the gaussmeter will begin executing the command string.*

When the gaussmeter is ready to return the command string, it will assert the SRQ (Service Request) line. The serial poll status register will have its 'rsvl' bit (DIO7) set and all other bits reset as follows:

DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
0	1	0	0	0	0	0	0

The gaussmeter must then be programmed as a talker before it will transmit the command string back to the host. The gaussmeter *will* assert the EOI line when the final terminator character is transmitted.

When the gaussmeter is first powered on, its IEEE-488 interface will be disabled for about 40 seconds while the gaussmeter performs internal diagnostics and configuration. Assertion of the REN (Remote Enable) line by the system controller has the same effect as issuing the LOCKOUT command.

Issuing the COMMUNICATIONS FORMAT command to modify the IEEE-488 device address can have disastrous results if not properly used. If this parameter is changed, the system controller's address reference must be changed to match the new address or *the communications link can be severed!* Remember that the command string sent to the gaussmeter will not be executed until the final terminator character is received. When the COMMUNICATIONS FORMAT command is processed and executed, the change takes effect immediately. The gaussmeter will return the command string using the *new* IEEE-488 address. See Appendix for additional programming information.

V-F RS-232 IMPLEMENTATION

NOTE: It is important to remember that the gaussmeter returns to the MASTER mode once it executes a SLAVE command. This means that the gaussmeter will resume transmission of the MASTER mode data table immediately after sending back the SLAVE response. If the user's program is not prepared for this, the SLAVE response may be lost. To prevent this, issue the LOCKOUT-ON command before starting SLAVE operations. This command (Section V-B (l) terminates the MASTER mode. From this point the only information transmitted by the gaussmeter will be the SLAVE response.

Issuing the COMMUNICATIONS FORMAT command to modify the RS-232 port characteristics can have disastrous results (the loss of communications) if not properly used. If any of the parameters are changed, the host DTE's parameters must be changed to match the new characteristics *or the communications link will be severed!* Remember that the command string sent to the gaussmeter will not be executed until the final terminator character is received. When the COMMUNICATIONS FORMAT command is processed

SECTION V continued
Remote (Slave) Mode Operation

and executed, the changes take effect immediately. The gaussmeter will return the command string using the *new* RS-232 characteristics.

When the gaussmeter is first powered on, its RS-232 interface will be disabled for about 40 seconds while the gaussmeter performs internal diagnostics and configuration. During this time, the gaussmeter will not accept commands and will drop the RTS (Request To Send) and DTR (Data Terminal Ready) lines until the interface is activated.

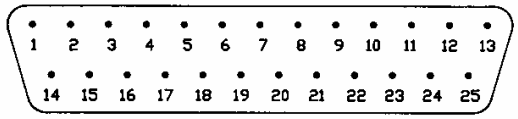
See Section VI for electrical information on the RS-232 port. See Appendix for additional programming information.

SECTION VI

COMMUNICATIONS INTERFACE

VI-A RS-232 PORT FUNCTION DESCRIPTION

The gaussmeter, like most terminals, printers and computers, is considered a DTE (Data Terminal Equipment). A modem is a DCE (Data Communications Equipment). The SERIES-9900 gaussmeter's RS-232 port is implemented on a standard 25-pin female "D" connector. Only 9 of the 25 pins are actually used, as shown in figure VI-A.



PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	EARTH GROUND	14	
2	TRANSMITTED DATA (Tx)	15	
3	RECEIVED DATA (Rx)	16	
4	REQUEST TO SEND	17	
5	CLEAR TO SEND	18	
6	DATA SET READY	19	
7	LOGIC GROUND	20	DATA TERMINAL READY
8		21	
9		22	RING INDICATOR
10		23	
11		24	
12		25	
13			

Figure VI-A
RS-232 "D" Connector

Pin-1: Earth Ground — This line connects to the gaussmeter chassis which is connected to the center terminal of the line cord power receptacle. The use of this pin is optional and is normally tied to the shield of a shielded multiconductor cable to minimize RFI/EMI radiation problems. DO NOT CONNECT THIS EARTH GROUND TO THE COMMON RETURN LINE (Pin-7)!

Pin-2: Transmit Data (TX) — This line carries serial data *from* the gaussmeter *to* the host DTE.

Pin-3: Receive Data (RX) — This line carries serial data *to* the gaussmeter *from* the host DTE.

Pin-4: Request to Send (RTS) — The gaussmeter asserts this line to indicate that it can accept data from the host DTE.

Pin-5: Clear to Send (CTS) — The host DTE asserts this line to indicate that it can accept data from the gaussmeter.

SECTION VI continued
Communications Interface

Pin-6: Data Set Ready (DSR)	The host DTE asserts this line to indicate that the DTE is operative.
Pin-7: Logic Ground (GND)	This is the common return line for all other signals *except* earth ground (Pin-1).
Pin-20: Data Terminal Ready (DTR)	The gaussmeter asserts this line to indicate that it is operative.
Pin-22: Ring Indicator (RI)	Ring Indicator is normally generated by a modem to indicate that a call-up is in progress. It is normally used by automatic answer circuits on a telephone line exchange. It is not used by the gaussmeter.

The characteristics of the serial data stream, baud rate, number of stop bits, character length and parity, are programmed from the COMMUNICATIONS FORMAT menu. See Section IV.

VI-B RS-232 ELECTRICAL INTERFACE/HANDSHAKING

On a gaussmeter-to-DCE connection, all like lines are connected together: "TX" to "TX," "RX" to "RX," "CTS" to "CTS," etc. On a gaussmeter-to-DTE connection, lines have to be "crossed" for the interface to work. Figure VI-B depicts this difference.

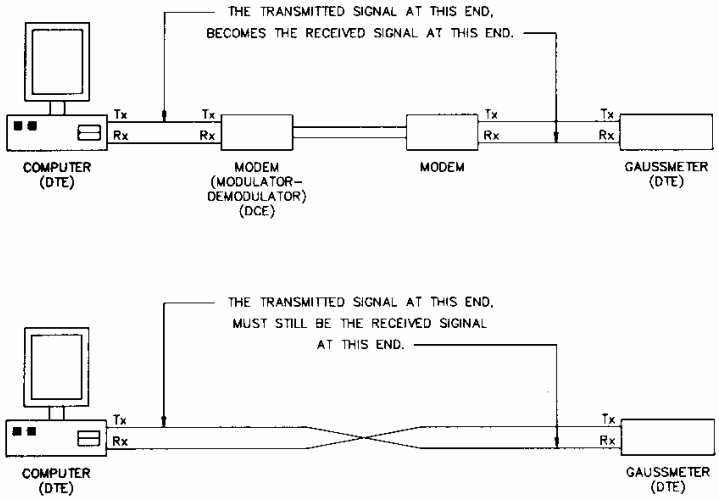


Figure VI-B
DTE and DCE Interface

In most cases, the connection will be a gaussmeter-to-DTE arrangement with the DTE being a printer or terminal in the gaussmeter's "MASTER" mode of operation or a computer in the "SLAVE" mode. These modes are discussed in Sections III and IV.

SECTION VI continued
Communications Interface

The gaussmeter supports two types of handshaking: hardware and software. Handshaking controls the flow of information between the two devices. A typical example of the need for handshaking would be a gaussmeter-to-printer connection. Usually a printer cannot print data at the rate at which it's received. Most modern printers contain a certain amount of "buffer" memory used to store incoming data. But if, for instance, data is arriving at a rate of 1000 characters per second and the printer can only print 10 characters per second, the buffer will eventually overflow. To prevent this from happening, the printer will signal the gaussmeter to stop transmitting until it has time to "catch up."

There may be instances, particularly in the gaussmeter's "SLAVE" mode, when the gaussmeter cannot respond quickly enough to incoming data from a remote computer. When this happens, the gaussmeter will signal the remote device to stop momentarily until the data can be processed.

The electrical interconnection that supports hardware handshaking is shown in Figure VI-C. Note that a connection is made to Pin-8 (Data Carrier Detect or DCD). This line is not supported on the gaussmeter, but may be on the DTE. However, making the connection at both ends makes the cable symmetrical and guarantees proper operation no matter which end is plugged into the DTE.

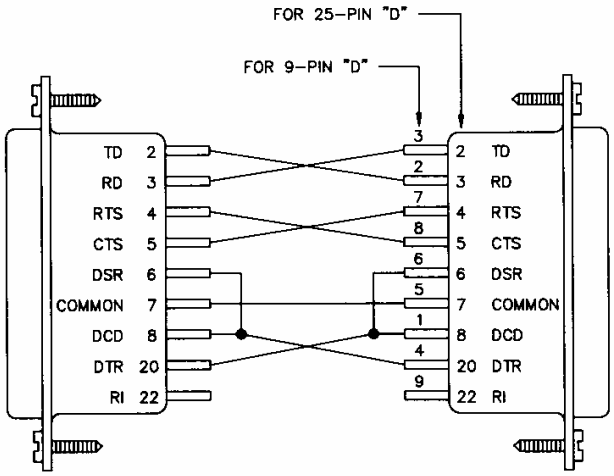


Figure VI-C
RS-232 Connection with Handshaking

For devices that implement software handshaking, or in applications where the response time of the DTE and gaussmeter are equal, the connection in Figure VI-D *must be* used.

SECTION VI continued
Communications Interface

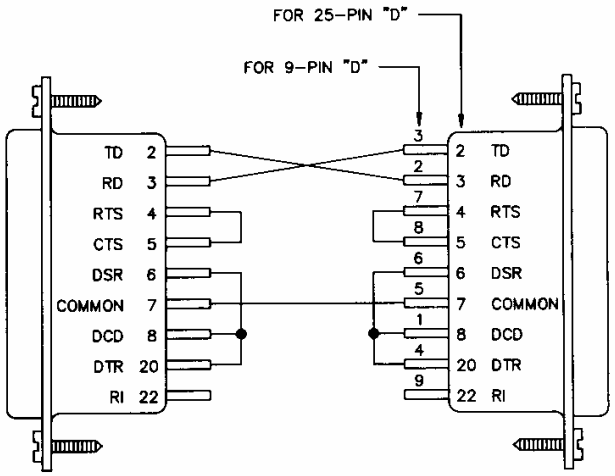


Figure VI-D
RS-232 Connection without Handshaking

Software handshaking involves the use of two ASCII control characters "XOFF" to stop a transmission, and "XON" to resume. The ASCII control code for "XOFF" is 19 decimal (13 hex) and for "XON" is 17 decimal (11 hex).

To stop an incoming transmission from the remote device, the gaussmeter will transmit an "XOFF" *and* set its RTS line FALSE. Likewise, the gaussmeter will accept an "XOFF" or FALSE CTS, or both, from the remote device to stop its own transmission. Note that if the signal to stop occurs in the middle of a character, the transmission of *that* character will finish to completion.

VI-C IEEE-488 BUS FUNCTIONAL DESCRIPTION

The IEEE-488 (GPIB) instrumentation bus follows the ANSI/IEEE 488-1978 conventions for programmable instrumentation. The IEEE-488 bus allows up to 15 instruments to be connected together in a "daisy chain" fashion and, under certain conditions, can support data transfer rates up to 1 million bytes/second.

Any device connected to the bus is capable of acting in any of three basic roles: controller, talker and listener. As a controller, the device dictates which devices act as talkers and listeners. There is only one controller at any given time, called the "system controller." As a talker, the device sends device-dependant data across the bus, but only when commanded to do so by the controller. As a listener, the device receives device-dependent data from a talker. There can be many listeners at any given time. The SERIES-9900 gaussmeter can act as a talker or a listener.

The bus is implemented on a standard 24-pin connector, as shown in Figure VI-E.

SECTION VI continued
Communications Interface

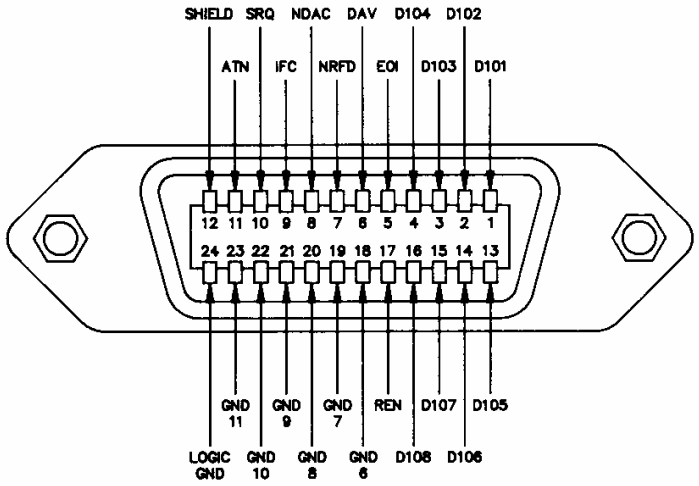


Figure VI-E
IEEE-488 Connector

Pin-1,2,3,4,13,14,15,16; Data (DIO)	These are the eight data lines DIO1 through DIO8, respectively.
Pin-5: End or Identify (EOI)	This line is normally asserted by a talker to indicate the end of a multiple byte data transfer. When EOI is asserted along with ATN (Attention), it indicates that the controller is conducting a parallel poll.
Pin-6: Data Available (DAV)	This line is asserted when a talker puts a data byte on the bus.
Pin-7: Not Ready for Data (NRFD)	This line is asserted by a listener until it is ready to accept a data byte.
Pin-8: Not Data Accepted (NDAC)	This line is asserted by a listener until it has accepted a data byte.
Pin-9: Interface Clear (IFC)	Asserted by the system controller to force all other devices to go idle.
Pin-10: Service Request (SRQ)	This line can be asserted by any device requiring service.
Pin-11: Attention (ATN)	Asserted by the controller to indicate that the byte on the data bus is an interface command.

SECTION VI continued
Communications Interface

Pin-12: Earth Ground	This line connects to the gaussmeter chassis which is connected to the center terminal of the line cord power receptacle. The use of this pin is optional and is normally tied to the shield of a shielded multi-conductor cable to minimize RFI/EMI radiation problems. DO NOT CONNECT THIS EARTH GROUND TO THE COMMON RETURN LINES (Pins -18 thru 24)!
Pin-17: Remote Enable (REN)	Asserted by the system controller to tell the systems receiving data that they can actually use the data, and that their front panel controls are locked out.
Pin-18,19, 20, 21, 22, 23, 24 Ground (GND)	These are the common return lines for all other signals *except* earth ground (Pin-12).

Each device on the system bus must be assigned a unique address ranging from 00 to 31 decimal. All devices can have one primary and another secondary address. Many devices, including the SERIES-9900, use the same address for both. The address is assigned using the COMMUNICATIONS FORMAT menu. See Section IV. Also, see Section V-E for detailed programming information.

VI-D IEEE-488 ELECTRICAL INTERFACE

The interface between each device is straightforward. Each interface line attaches to the same line on the next device (ATN to ATN, DIO1 to DIO1, etc.)

SECTION VII

DIAGNOSTIC ERROR CODES

VII-A DIAGNOSTIC OVERVIEW

Upon power-up, the gaussmeter verifies that all internal components are operating correctly before field measurements begin. This includes existing probe interface modules and their probes.

If a ***major*** error occurs, the gaussmeter will halt operations until the problem is rectified. A ***major*** error is one that prevents the gaussmeter from producing accurate field measurement results for *all* channels. A ***major*** error is usually located in the digital section or power supply area.

If a ***minor*** error occurs, the gaussmeter will inform the user, but will continue to initialize the remaining electronics and begin field measurements. A ***minor*** error is one that prevents accurate field measurements from some, but not all, existing channels, or failures in areas that do not affect field measurements such as communications, setup storage and so on.

VII-B POWER-UP SEQUENCE

When the gaussmeter is first turned on, the display's backlight will turn on and the "F.W. BELL" logo will appear. Beneath the logo will appear messages indicating the state of the power-up procedure with the first being "INTERNAL DIAGNOSTICS IN PROGRESS." At this point, three paths are possible:

1) If no errors are found, the gaussmeter will retrieve calibration data from each probe interface module and probe, initialize the internal electronics and enter the MEASURE mode of operation.

2) If a ***minor*** error is detected, the "INTERNAL DIAGNOSTICS IN PROGRESS" message will be replaced with a "MINOR DIAGNOSTIC ERROR - xxxxx" message. The "xxxxx" is a five-digit number indicating the type of failure. Refer to Section VII-C. The message will be held for a short period of time to allow the user to record the error code. The gaussmeter will then proceed as it does if no errors are found (Item-1 above).

3) If a ***major*** error is detected, the "INTERNAL DIAGNOSTICS IN PROGRESS" message will be replaced with a "MAJOR DIAGNOSTIC ERROR - xxxxx" message. The "xxxxx" is a five-digit number indicating the type of failure. Refer to Section VII-C. The gaussmeter will halt operations at this point.

Once in the MEASURE mode, the gaussmeter determines the number of probe interface modules present, and then the number of probes connected. If the module/probe combination is recognized, the interface module's red LED will light. The display screen will be formatted accordingly. (See Section III.)

The procedure just described assumes that the basic core of the gaussmeter, the processor, display and digital power supply, is operational. If a catastrophic error prevents any of these from operating, the power-up procedure will not be executed, and the MEASURE mode will not be entered. This is typically accompanied by a blank display or one that contains illegible characters and patterns.

SECTION VII continued
Diagnostic Error Codes

VII-C DIAGNOSTIC ERROR CODES

The 5-digit ***major*** and ***minor*** error codes help to pinpoint a failure within the various sections of the gaussmeter. The first digit indicates which subsection failed, with the remaining four digits providing precise information about the failure. Typically, only the first one or two digits are of any practical value to the user. The remaining information provides F.W. Bell with component-level information. *The user should not attempt to make component-level repairs.* Field repairs should be limited to subassembly replacements *only*. Returned assemblies should have with them the error code and a brief description of the problem.

VII-C(a) ERROR 0xxxx

This MAJOR error indicates a failure on the *processor card* (item #201500).

VII-C(b) ERROR 1xxxx

This MAJOR error indicates a failure of the *peripheral control card* (item #201501).

VII-C(c) ERROR 2xxxx

This MAJOR error indicates a failure on the SERIES-9900 *power supply controller card* (item #201505) or the *line voltage input transformer assembly* (item #201507).

NOTE: A failure in one of the probe interface modules can cause a failure of the power supply. Before attempting repairs on the power supply, try a systematic replacement (or removal) of each probe interface module.

VII-C(d) ERROR 31xxx

This MINOR error indicates a failure of the *processor card* (item #201500) that prevents operation of the CHANNEL 1 (left-most) probe interface module. Operation can continue with CHANNELS 2 and 3, but the *processor card* will have to be replaced to operate with all three channels.

VII-C(e) ERROR 32xxx

This MINOR error indicates a failure on the *processor card* (item #201500) that prevents operation of the CHANNEL 2 (middle) probe interface module. Operation can continue with CHANNELS 1 and 3, but the *processor card* will have to be replaced to operate with all three channels.

VII-C(f) ERROR 33xxx

This MINOR error indicates a failure on the *processor card* (item #201500) that prevents operation of the CHANNEL 3 (right-most) probe interface module. Operation can continue with CHANNELS 1 and 2, but the *processor card* will have to be replaced to operate with all three channels.

VII-C(g) ERROR 34xxx

This MINOR error indicates a failure on the *processor card* (item #201500) that prevents operation of the RS-232 communications port.

SECTION VII continued
Diagnostic Error Codes

VII-C(h) ERROR 35xxx

This MINOR error indicates a failure on the *processor card* (item #201500) that prevents operation of the IEEE-488 interface bus.

VII-C(i) ERROR 36xxx

This MINOR error indicates a failure on the *processor card* (item #201500) that prevents the gaussmeter's setup information from being stored permanently.

VII-C(j) ERROR 41xxx

This MINOR error indicates a failure on the *peripheral control card* (item #201501) that prevents operation of the CHANNEL1 (left-most) *probe interface module*. Operation can continue with CHANNELS 2 and 3, but the *peripheral control card* will have to be replaced to operate with all three channels.

VII-C(k) ERROR 42xxx

This MINOR error indicates a failure on the *peripheral control card* (item #201501) that prevents operation of the CHANNEL 2 (middle) *probe interface module*. Operation can continue with CHANNELS 1 and 3, but the *peripheral control card* will have to be replaced to operate with all three channels.

VII-C(l) ERROR 43xxx

This MINOR error indicates a failure on the *peripheral control card* (item #201501) that prevents operation of the CHANNEL3 (right-most) *probe interface module*. Operation can continue with CHANNELS1 and 2, but the *peripheral control card* will have to be replaced to operate with all three channels.

VII-C(m) ERROR 44xxx

This MINOR error indicates a failure on the *peripheral control card* (item #201501) that prevents operation of the RS-232 communications port.

VII-C(n) ERROR 45xxx

This MINOR error indicates a failure on the *peripheral control card* (item #201501) that prevents operation of the IEEE-488 interface bus.

VII-C(o) ERROR 51xxx

This MINOR error indicates a failure in the CHANNEL 1 (left-most) *probe interface module*. Replace the module.

VII-C(p) ERROR 52xxx

This MINOR error indicates a failure in the CHANNEL 2 (middle) *probe interface module*. Replace the module.

SECTION VII continued
Diagnostic Error Codes

VII-C(q) ERROR 53xxx

This MINOR error indicates a failure in the CHANNEL 3 (right-most) *probe interface module*. Replace the module.

VII-C(r) ERROR 61xxx

This MINOR error indicates a failure in the CHANNEL1 (left-most) probe . Replace the probe in CHANNEL 1.

VII-C(s) ERROR 62xxx

This MINOR error indicates a failure in the CHANNEL 2 (middle) probe . Replace the probe in CHANNEL 2.

VII-C(t) ERROR 63xxx

This MINOR error indicates a failure in the CHANNEL 3 (right-most) probe . Replace the probe in CHANNEL 3.

SECTION VIII

SERIES-9900 THEORY OF OPERATION

VIII-A OVERVIEW

The SERIES-9900 gaussmeter is housed in a standard VME-style cabinet/card cage. All cards and *probe interface modules* plug into a common, custom (non-standard) backplane via standard 32-, 64- or 96-pin DIN connectors. Also mounted on the backplane are the RS-232, IEEE-488 and ANALOG OUTPUT connectors. The backplane has no active components.

VIII-B POWER SUPPLY

Refer to the block diagram in Figure VIII-A. The power supply section of the SERIES-9900 gaussmeter consists of two electrically-isolated supplies; one for the digital section and the other for the analog (*probe interface module*) section. Each section has its own line voltage step-down transformer. The components for both supplies, with the exception of several high-current bridge rectifiers and the transformers, reside on the *power supply control card* in the card cage. Interconnection between this card and the transformer/rectifier assembly is accomplished with a multiple contact, high current connector. Power is routed to each section via the backplane.

The digital supply is used primarily by the *processor card* and *peripheral control card*, and by optocoupler components in each *probe interface module*. The supply delivers 3.0 A at +5.0 V, and is protected by overcurrent and overvoltage sense circuits.

The analog supply is used primarily by the *probe interface modules* and delivers +5.0 V at 1.5 A, ±15 V at 1.2 A each, and 24 Vac at .15 A at the line frequency. The +5 V supply is also used by the optocoupler components on the *peripheral control card*. The +5.0 V supply is protected by an overcurrent sense circuit. The +15 V supply tracks the -15 V supply.

Linear designs are used throughout to provide low ripple power to those sections responsible for conditioning the low-level signals associated with Hall devices and the high-resolution A/D converters. To reduce ground loop and ground noise problems, each module slot and digital card location has its own private power supply lines on the backplane. All return (ground) lines tie to one common point on the *power supply control card*.

Operation from 115 Vac or 230 Vac line voltage is selected by "programming" the line voltage input receptacle on the rear panel of the gaussmeter, which reconfigures the electrical arrangement of the primary side of the transformers. This receptacle also contains the line fuse. The center terminal of the receptacle is tied to the metal frame of the chassis.

VIII-C PROCESSOR CARD

On the processor card is a 10 MHz 8088 microprocessor, 128k bytes of program ROM, 256k bytes of dynamic RAM, 512 bytes of non-volatile EEPROM and the various support components required for timing and interrupt processing. The 240 x 64 dot matrix LCD is controlled by a graphics display controller under the direction of the 8088. The display controller uses an 8k byte static RAM to store screen information. Most components are of the high speed, low power CMOS type to reduce the demands on the gaussmeter's power supply.

SECTION VIII continued
Series-9900 Theory of Operation

The +5 V digital power supply is converted to ±10 Vdc for the display module and to 90 Vac/400 Hz for the display backlight. Interconnection to both the display module and the pushbutton switches is made through multiple-contact connectors on the front end of the *processor card.*

A subset of the processor's address and control buses, and the entire data bus, are brought out to the backplane through bus interface components. These are used to access the *peripheral control card.*

VIII-D PERIPHERAL CONTROL CARD

The *peripheral control card,* contains all the components necessary to access the three *probe-interface modules* as well as the communications ports. The PCC acts as an extension of the *processor card.*

The interface to the *probe-interface modules* is completely isolated using high-speed optocouplers. This reduces noise in the sensitive analog sections of the modules by separating the high-noise switching environment of the digital section from the low-noise steady state conditions in the analog sections of the module. To control the various functions on the probe modules, a bit-mapped scheme is used. Via the *peripheral control card,* the processor can access 64 individual control lines per module. Additionally, each probe module slot has a set of private backplane lines that control the transfer of serial data from the module's A/D converter. The serial data stream is converted to 16-bit wide parallel data on the PCC before being transferred to the processor. Each conversion generates a private interrupt to the processor card, one for each slot.

The RS-232 communications port is controlled by a programmable asynchronous communications element. This component generates the proper baud rate timing and line characteristics for the full duplex operation of the port. The serial data and control line logic levels are converted to the appropriate RS-232 levels by several line translation devices. The lines terminate at the 25-pin "D" connector via the backplane. The communications controller can be programmed to generate a private interrupt to the processor card for various conditions of the port.

The IEEE-488 (GPIB) bus is controlled by a programmable GPIB interface controller. The controller handles the many activity states of the IEEE-488 protocol. The data and control lines from the GPIB controller interface to the bus through several GPIB line transceivers. These lines terminate at the 24-pin IEEE-488 connector via the backplane. The controller can be programmed to generate a private interrupt to the *processor card* for various conditions on the bus.

VIII-E PROBE INTERFACE MODULE

The *probe interface module* assembly converts the low-level analog signals from the probe to high-accuracy digital information that can be manipulated by the processor section of the gaussmeter.

The processor-to-module interface is completely isolated using optocouplers to minimize noise. The logic section of the module decodes the bit-mapped information from the processor to produce individual control and status lines. The control lines are used to select amplifier range settings, magnitude and type of Hall device control current, the A/D input source, suppression (dc zeroing) network range settings, the magnitude and phase of suppression

SECTION VIII continued
Series-9900 Theory of Operation

voltage, probe input impedance matching and calibration sources. Several other lines control the flow of serial data from a monolithic 16-bit A/D converter.

All clock lines used by the module are synchronized with the master clock lines in the digital section of the gaussmeter. This reduces switching noise and prevents harmonics and beat frequencies that could deteriorate the overall performance of the gaussmeter.

Each module contains a 512-byte non-volatile EEPROM device programmed with the module's operating characteristics; frequency response, offset information, temperature coefficients, etc.

When measuring alternating (ac) fields, the module is configured to provide a constant dc current to the Hall device in the probe. The magnitude of the current depends on the type of probe being used (bulk or thin film) and the present range of the gaussmeter.

The voltage output of the Hall device is instantaneously proportional to the magnetic flux density being measured. This signal is ac-coupled into the first amplifier stages, converted to a proportional dc level by a true rms converter, and finally converted to a digital value.

When measuring steady-state (dc) fields, the module generates a 5 kHz constant ac (sinusoidal) current to the Hall device. Again the magnitude of the current depends on the type of Hall device and the present range. The voltage output from the Hall device is an amplitude-modulated sinewave proportional to the flux density being measured. This signal is ac-coupled into the first amplifier stages, converted to a proportional dc level by a synchronous demodulator and finally converted to a digital value.

The module provides a calibrated analog output to its rear-panel BNC connector. In the ac mode, the signal is the actual field density waveform calibrated to 3 Vrms full scale. In the dc mode, the signal is proportional in amplitude and polarity to the field level, calibrated to ±3 Vdc. The signal represents the raw (uncorrected) waveform produced by the Hall device.

VIII-F 4TH GENERATION HALL GENERATOR PROBE

The F.W. Bell 4th generation probe assembly consists of a Hall Generator probe element terminated by a 9-pin circular, non magnetic twist-lock connector. The connector houses a 512-byte non-volatile EEPROM device programmed with the probes operating characteristics; frequency response, field amplitude linearity, temperature response, and so on, as well as the serial number, date code and device type information for the assembly. Space is also provided to install a linearizing resistor when required.

Four of the connector pins interface to the Hall device itself. Another four control the transfer of information to the EEPROM. The remaining pin is used by the processor to sense if the probe is physically connected to the interface module.

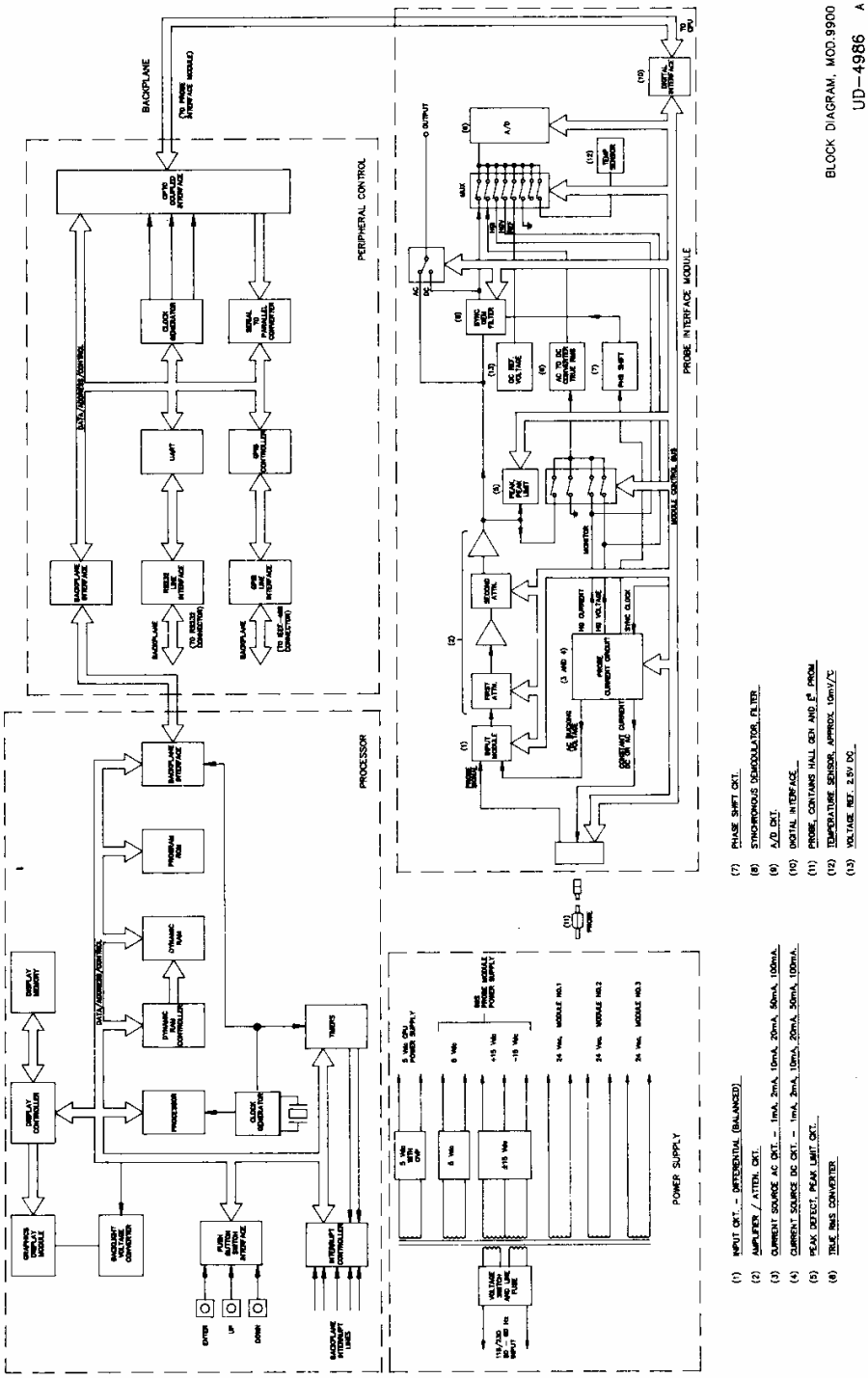


Figure VIII-A
9900 Block Diagram

SECTION IX

INSTALLATION OF OPTION

IX-A INSTALLATION OF RACK MOUNTING OPTION

The Rack Mounting Kit (Item #339192) consists of two mounting brackets with four metric flat head screws.

(1) To convert a standard bench instrument into a 19" rack mountable unit, loosen the small slotted screw on bottom of each Side Cover Plate, as shown in Figure IX-A. Remove the side cover plate.

(2) Install the Rack Mountin Brackets, using the four metric flat head screws provided.

(3) The instrument can now be mounted on a 19" wide rack or cabinet.

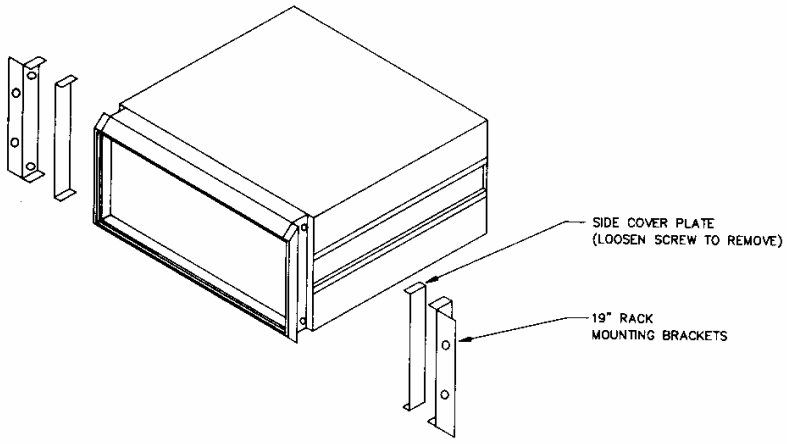


Figure IX-A
Rack Mounting Installation

APPENDIX

PROGRAMMING INFORMATION

F. W. Bell offers an optional diskette containing five programs that demonstrate the use of the RS-232 and IEEE-488 communications ports on the Series 9900 Gaussmeter. Contact the factory to obtain this diskette.

These programs were developed to provide the systems programmer with a working template that can be used as a guide when developing application progams. These programs should eliminate guesswork and allow the programmer to concentrate on the application rather than the interface. Used as a debugging tool, they can verify that the hardware interface between the gaussmeter and computer is correct and operational.

All demo programs require that the gaussmeter's internal software be at or above V1.7A. The software version number is displayed immediately after power-up.

Each program is designed to operate on an IBM PC or compatible. Three of the programs are written in BASIC and two in the "C" language:

GMRS232.BAS	--	RS-232 control (BASIC)
GMIE488M.BAS	--	IEEE-488 control (BASIC) for Metrabyte IE-488 card
GMIE488N.BAS	--	IEEE-488 control (BASIC) for National Instruments PCIIA card
GMRS232.C	--	RS-232 control ("C")
GMIE488M.C	--	IEEE-488 control ("C") for Metrabyte IE-488 card

Listed in this appendix is the BASIC program for the RS-232 port and one of the BASIC programs for the IEEE-488 port. The "C" programs are not listed due to space.

GENERAL PROGRAMMING INFORMATION

1) Always ensure that the gaussmeter is in the "RUN" mode before issuing SLAVE commands. Use the COMMUNICATIONS FORMAT menu to manually match the port characteristics to the computer's before starting. The gaussmeter permanently saves this information so you will not have to do this each time you power-up.

2) The MEASURE command does *not* trigger the gaussmeter to take a new measurement when reading fields. The gaussmeter continuously makes new measurements and updates the display independent of the communications ports. The information returned from the MEASURE command represents the latest reading. In the DC mode, the update rate is about once every 1/3 second for the 9901, once every 1/2 second for the 9902 and about every 3/4 second for the 9903. If a MEASURE command is issued at a rate faster than the update rate you will retrieve multiple identical readings. The update rate degrades slightly when using such things as AUTORANGE, PEAK HOLD, CLASSIFIERS, etc. The rate can be improved by turning off either the DIGITS or BARGRAPH, or deactivating any unused channels on a SERIES 9900 meter.

3) No specific command tells the programmer a channel is offline (deactivated from the DISPLAY FORMAT menu, missing a probe or missing an interface module on a SERIES 9900). To determine this remotely, send a "dummy" MEASURE command. A MEASURE command

APPENDIX continued
Programming Information

normally looks like <ESC>ME100000000<CR>. Replacing the "0"s with a specific ASCII character string such as <ESC>ME1abcdefgh<CR> the gaussmeter will return the command exactly as you sent it, if the channel is offline. The "abcdefg" will be replaced with the actual field information, as described in this manual, if the channel is online.

4) In any application program involving communication with external devices it is a good idea to incorporate an escape route in the event a device fails to function properly. When programming the gaussmeter's setup parameters (MODE, RANGE, etc.) allow enough time for the gaussmeter to execute the command and return the response before declaring a timeout and reissuing the command. Each setup operation can take several seconds to execute before the gaussmeter returns the response. The more operations there are in one single command string, the longer it will take to receive a response. For a single MEASURE or LOCKOUT command the gaussmeter can return a response within several milliseconds.

RS-232 PROGRAMMING INFORMATION

1) When using the RS-232 port use one of the two cable configurations depicted in this manual. The use of parity checking is highly recommended. We have found that some PCs power-up with their RS-232 handshake lines in a FALSE state. If you are using a cable with full handshaking this may present a problem unless your software makes these lines TRUE. The use of the cable *without* handshaking is suggested if in doubt. Using a cable with just TX, RX and GND will not work.

2) There is a certain amount of time that is required for the gaussmeter to return a response command. When calculating an appropriate timeout value remember to include the baud rate lag time. The time it takes to transmit each character (not each string) is:

$$\text{TIME (seconds)} = \frac{1 + D + S + P}{\text{BAUD}}$$

where: D = number of data bits
S = number of stop bits
P = 0 for no parity or
1 for odd/even parity

A single MODE command at 1200 BAUD, 7 data bits, odd parity, one stop bit will require a minimum of 50 milliseconds to transmit. *Remember, baud rate only describes the rate at which each character is transmitted and not the time it takes the computer to load each character into the transmit buffer.*

3) When issuing a ZERO or RELATIVE command the gaussmeter will transmit an XOFF (hex 13) when it first enters the operation and an XON (hex 11) when it finishes, and *then* returns the response. The gaussmeter also transmits XOFF and XON any time it performs a recalibration sequence. Your progam should be prepared for these control characters. See the section of this manual dealing with software handshaking.

IEEE-488 PROGRAMMING INFORMATION

1) When using the IEEE-488 bus, *always* read the gaussmeter's response string whether or not your wish to use it. The gaussmeter will remain idle until the response is read. Remember that a TRIGGER command is required after you output a command string to the gaussmeter.

RS-232 DEMO PROGRAM

```
100   CLS
105   PRINT "*****************************************************************************************************************"
110   PRINT "*                          F. W. BELL SERIES-9900 / MODEL-9500 GAUSSMETER                                       *"
115   PRINT "*                                  RS-232 DEMO PROGRAM                                                          *"
120   PRINT "*****************************************************************************************************************"
125   PRINT
130   PRINT "This program was written to assist users of the SERIES-9900 or                                                    "
135   PRINT "  MODEL-9500 Gaussmeters who wish to control the instrument                                                       "
140   PRINT "  remotely using the RS-232 communications port.  This program                                                    "
145   PRINT "  will work with either communications cable depicted in the                                                      "
150   PRINT "  Gaussmeter user's manual, but the cable WITHOUT handshaking is                                                  "
155   PRINT "  recommended in most applications.  The Gaussmeter must contain                                                  "
160   PRINT "  V1.7A or higher software.  V1.8 or higher is recommended.  The                                                  "
165   PRINT "  software version is displayed immediately after power-up.                                                       "
170   PRINT
175   PRINT "The intent of this program is to provide the system programmer                                                    "
180   PRINT "  with operational code that can be used during the development                                                   "
185   PRINT "  of his or her own applications software.  This program can also                                                 "
190   PRINT "  be used to verify the hardware interface between the computer                                                   "
195   PRINT "  and the Gaussmeter.                                                                                             "
200   PRINT
205   PRINT  "Press any key to continue.....                                                                                   "
210   IF INKEY$ = " " THEN 210 ELSE CLS
215   PRINT "The program is designed to operate from the PC's COM1 port, odd                                                   "
220   PRINT "  parity, 1 stop bit, 7 data bits, 9600 baud.  See the comments                                                   "
225   PRINT "  in the program to change these parameters.  At this point make                                                  "
230   PRINT "  sure that the Gaussmeter's RS-232 parameters match these by                                                     "
235   PRINT "  using the 'COMMUNICATIONS FORMAT' menu.  Place the Gaussmeter                                                   "
240   PRINT "  in the RUN mode before starting.                                                                                "
245   PRINT
250   PRINT "The program will begin by locking out the front panel and then                                                    "
255   PRINT "  programming in the Gaussmeter MODE to GAUSS-DC, RANGE to 3 kG,                                                  "
260   PRINT "  PEAK HOLD to OFF and DISPLAY DIGITS, BARGRAPH and BACKLIGHT ON,                                                 "
265   PRINT "  After this field measurements will be acquired and displayed                                                   "
270   PRINT "  until the user presses any key.  If using a SERIES-9900 only                                                   "
275   PRINT "  CHANNEL-1 will be programmed.                                                                                   "
280   PRINT
285   PRINT "Press any key to start.....                                                                                       "
290   IF INKEY4 = "" THEN 290 ELSE CLS
295   '
296   DIM RS232.IN$(255)                                    'RESPONSE INPUT BUFFER.
297   MATCH% = 1
298   '
300   '====== Open COMM PORT on PC and build demo command strings =====
305   '
315   MODE$ = "MO12"                                        'MODE = GAUSS-DC
320   RANGE$ = "RA14"                                       'RANGE = 3 KG
325   MEAS$ = "ME100000000"                                 'MEASURE (ZERO FILL)
330   PEAK$ = "PE11"                                        'PEAK HOLD = OFF
335   DISP$ = "DI1222"                                      'DISPLAY FORMAT (EVERYTHING ON)
340   LOKON$ = "LO2"                                        'LOCKOUT ON
345   LOKOFF$ = "LO1"                                       'LOCKOUT OFF
350   '
351   '=== On most PCs COM-1 is located at I/O address &H03F8 ====
352   '
```

RS-232 Demo Program continued

```
355   COMPORT1 = &H3F8                          'COM1 I/O ADDRESS
360   COMPORT1.LSR = COMPORT1 + 5               '8250 LINE STATUS REG
365   OPEN "COM1:9600,O,7,1,CS,DS,CD" AS #1     '9600 BAUD,ODD PARITY, 7 BITS
370   '
375   '===== Send LOCKOUT-ON command until MASTER mode is terminated. =====
380   '
385   PRINT "Terminating MASTER mode and locking front panel"
390   RS232.OUT$ = LOKON$: GOSUB 9000: GOSUB 8000
395   '
400   '==== Setup Gaussmeter for MODE, RANGE, PEAK HOLD and DISPLAY FORMAT ====
405   '
410   PRINT "Programming the MODE (GAUSS-DC)"
415   RS232.OUT$ = MODE$: GOSUB 9000: GOSUB 8000
420   PRINT "Programming the RANGE (3 KG)"
425   RS232.OUT$ = RANGE$: GOSUB 9000: GOSUB 8000
430   PRINT "Programming PEAK HOLD (OFF)"
435   RS232.OUT$ = PEAK$: GOSUB 9000: GOSUB 8000
440   PRINT "Programming DISPLAY FORMAT"
445   RS232.OUT$ = DISP$: GOSUB 9000: GOSUB 8000
450   '
455   '==== Take field measurements ====
460   '
462   MATCH% = 0
465   PRINT: PRINT"ACQUIRING FIELD MESUREMENTS...PRESS ANY KEY TO QUIT."
470   '
475   RS232.OUT$ = MEAS$
480   GOSUB 9000: GOSUB 8030
485   IF INKEY$ = "" THEN 480
490   '
495   '===== Send LOCKOUT-OFF command to resume MASTER mode. =====
500   '
502   MATCH% = 1
505   PRINT: PRINT "Enabling MASTER mode and unlocking front panel"
510   RS232.OUT$ = LOKOFF$: GOSUB 9000: GOSUB 8000
515   CLOSE #1: END
8000  '
8005  '*****************************************************************************************************************
8010  ' Print on screen the command string sent and the response received.
8015  '*****************************************************************************************************************
8020  PRINT"GAUSSMETER COMMAND WAS [";
8025  PRINT RIGHT$(RS232.OUT$,OUTLEN);:PRINT"]";: PRINT "  ";
8030  PRINT"GAUSSMETER RESPONSE WAS [";
8035  PRINT LEFT$(RS232.IN$,INLEN);:PRINT"]"
8040  RETURN
9000  '
9005  '*****************************************************************************************************************
9010  'THIS SUBROUTINE IS USED TO COMMUNICATE TO AND FROM THE GAUSSMETER.                                            *
9015  '                                                                                                              *
9020  'UPON ENTRY THE COMMAND STRING TO BE ISSUED TO THE GAUSSMETER MUST BE                                          *
9025  '*  IN THE "RS232.OUT$" GLOBAL BUFFER.  THE SUBROUTINE WILL TRANSMIT THE                                       *
9030  '*  COMMAND AND WAIT FOR THE GAUSSMETER TO TRANSMIT ITS RESPONSE.  IF ANY                                      *
9035  '*  OF THE FOLLOWING CONDITIONS OCCUR THE PROCESS WILL BE REPEATED:                                            *
9040  '*   1) IF 5 SECONDS HAS ELAPSED WITHOUT A RESPONSE.                                                           *
9045  '*   2) IF THE RESPONSE DID NOT CONTAIN THE  CORRECT NUMBER OF                                                 *
9050  '*         CHARACTERS.                                                                                         *
```

RS-232 Demo Program continued

```
9055  '*   3) IF THE GLOBAL VARIABLE "MATCH%" IS SET TO A NON-ZERO VALUE                                                    *
9060  '*        (MUST BE INITIALIZED BEFORE CALLING THIS ROUTINE) AND THE                                                   *
9065  '*      THE RESPONSE DID NOT EXACTLY MATCH THE COMMAND STRING.                                                        *
9070  '* UPON FOUR UNSUCCESSFUL ATTEMPTS THE PROCESS WILL BE ABORTED AND AN                                                *
9075  '* ERROR MESSAGE WILL BE PRINTED TO THE SCREEN.                                                                      *
9080  '*                                                                                                                  *
9085  '* UPON SUCCESS THE STRING RETURNED BY THE GAUSSMETER WILL BE IN THE                                                 *
9090  '* "RS232.IN$" GLOBAL BUFFER.  THE GLOBAL VARIABLES "OUTLEN" AND INLEN"                                             *
9092  '*  WILL INDICATE THE NUMBER OF CHARACTERS TRANSMITTED/RECEIVED, NOT                                                *
9100  '*  INCLUDING THE INITIATOR (ESC) OR TERMINATOR (CR) CHARACTERS.  IF ALL                                            *
9102  '*  WENT WELL THE TWO WILL BE EQUAL.                                                                               *
9105  '*****************************************************************************************************************
9110  '
9115  ON ERROR GOTO 9290
9120  RETRY = 4
9125  '
9130  '==== Send initiator <ESC>, then send command. ====
9135  '
9140  OUTLEN = LEN(RS232.OUT$)
9145  START.TIME = TIMER                                    'IF SYSTEM TIME IS APPROACHING ROLLOVER
9150  IF START.TIME > 86394! THEN 9145                      ' THEN WAIT FOR IT TO ROLLOVER
9155  RS232.IN$ = ""                                        'CLEAR INPUT BUFFER
9160  PRINT #1,CHR$(27);: PRINT #1,RS232.OUT$
9165  '
9170  '==== WAIT 5 SECONDS FOR ECHO FROM GAUSSMETER ====
9175  '
9180  IF EOF(1) <> -1 THEN 9235                             'ANY CHARACTER PENDING?
9190  IF (TIMER - START.TIME) < 5 THEN 9180
9195  RETRY = RETRY -1: IF RETRY > 0 THEN 9130
9200  '
9205  BEEP: PRINT "****** GAUSSMETER RS-232 INTERFACE FAILURE ******": PRINT
9206  PRINT   "Using the COMMUNICATIONS FORMAT menu verify that"
9207  PRINT           "the baud rate and other characteristics have been"
9208  PRINT           "correctly programmed.  Check your interface cable."
9210  CLOSE #1: END
9215  '
9220  '===== Load response string into input buffer until terminator =====
9225  '=====  character <CR> is found.                       =====
9230  '
9235  RS232.IN$ = RS232.IN$ + INPUT$(LOC(1),#1)
9240  IF(INSTR(RS232.IN$,CHR$(13))) = 0 THEN 9180
9245  '
9250  INLEN = LEN(RS232.IN$)-1
9255  IF OUTLEN <> INLEN THEN 9130
9260  IF MATCH% = 0 THEN 9270
9265  IF(INSTR(RS232.IN$,RS232.OUT$)) = 0 THEN 9130
9270  ON ERROR GOTO 0: RETURN
9275  '
9280  '==== If a receiver error clear the receiver status and continue. ====
9285  '
9290  COMM.ERROR% =INP(COMPORT1.LSR): RESUME NEXT
9295  '
```

IEEE-488 DEMO PROGRAM

```
100   CLS
105   PRINT "*****************************************************************************************************************"
110   PRINT "*          F.W. BELL SERIES-9900 / MODEL-9500 GAUSSMETER                                                        *"
115   PRINT "*                IEEE-488 DEMO PROGRAM                                                                          *"
120   PRINT "*****************************************************************************************************************"
130   PRINT
150   PRINT "This program was written to assist users of the SERIES-9900 or                                                  "
160   PRINT "  MODEL-9500 Gaussmeters who wish to control the instrument                                                     "
170   PRINT "  remotely using the IEEE-488 instrumentation bus.  The intent of                                               "
180   PRINT "  this program is to provide the system programmer with a                                                       "
185   PRINT "  template that can be used during the development of his or her                                                "
190   PRINT "  own code.  The Gaussmeter must contain V1.7A or higher soft-                                                  "
195   PRINT "  ware.  The software version is displayed immediately after                                                   "
200   PRINT "  power-up.                                                                                                     "
230   PRINT                                                                                                                  "
233   PRINT "Press any key to continue.....                                                                                  "
235   IF INKEY$ = "" THEN 235 ELSE CLS
240   PRINT "The program is designed to operate with a METRABYTE IE-488 con-                                                 "
250   PRINT "  troller card set to memory address C0000 hex, an I/O base                                                    "
260   PRINT "  address of 300 hex, DMA channel-3 and INTERRUPT-5.  The GAUSS-                                                "
265   PRINT "  METER should be set to a device address of 15 decimal using the                                              "
270   PRINT "  'COMMUNICATIONS FORMAT' menu.  To change these parameters see                                                 "
275   PRINT "  lines 1080-1090 in the program and the METRABYTE user's manual.                                               "
285   PRINT
290   PRINT "The program will begin by locking out the front panel and then                                                  "
295   PRINT "  programming the Gaussmeter MODE to GAUSS-DC, RANGE to 30 G,                                                   "
300   PRINT "  PEAK HOLD to OFF and DISPLAY DIGITS, BARGRAPH and BACKLIGHT ON.                                               "
305   PRINT "  After this field measurements will be acquired and displayed                                                 "
310   PRINT "  until the user presses any key.  If using a SERIES-9900 only                                                 "
315   PRINT "  CHANNEL-1 will be programmed.                                                                                 "
320   PRINT
350   PRINT "Press any key to start.....                                                                                     "
355   IF INKEY$ = "" THEN 355 ELSE CLS
360   '
400   '====== Open COMM PORT on PC and build demo command strings =====
1000  '
1010  MODE$ = "MO12"                                    'MODE = GAUSS-DC
1020  RANGE$ = "RA12"                                   'RANGE = 30G
1030  MEAS$ = "ME100000000"                             'MEASURE (ZERO FILL)
1040  PEAK$ = "PE11"                                    'PEAK HOLD = OFF
1050  DISP$ = "DI1222"                                  'DISPLAY FORMAT (EVERYTHING ON)
1060  LOKON$ = "LO2"                                    'LOCKOUT ON
1070  LOKOFF$ = "LO1"                                   'LOCKOUT OFF
1080  DEF SEG = &HC000: IE488 = 0: FLG% = 0: BA0% = 0: D% = 0: GM$ = "15"
1090  CMD$ = "SYSCON MAD=3,CIC=1,NOB=1,BA0=&H300": GOSUB 9070
1095  '
2000  '===== CLEAR GAUSSMETER AND LOCKOUT FRONT PANEL =====
2010  '
2015  CLS
2020  CMD$ = "CLEAR " + GM$: GOSUB 9070
2025  PRINT "PLACING GAUSSMETER IN REMOTE MODE."
2030  CMD$ = "REMOTE " + GM$: GOSUB 9070
2040  '
2050  '==== Setup Gaussmeter for MODE, RANGE, PEAK HOLD and DISPLAY FORMAT ====
```

IEEE-488 Demo Program continued

```
2060  '
2070  PRINT "Programming the MODE (GAUSS-DC)"
2080  COMMAND$ = MODE$: GOSUB 9500
2090  IF OUTLEN = INLEN THEN GOSUB 8000 ELSE GOTO 2070
2100  PRINT "Programming the RANGE (30G)"
2110  COMMAND$ = RANGE$: GOSUB 9500
2120  IF OUTLEN = INLEN THEN GOSUB 8000 ELSE GOTO 2100
2130  PRINT "Programming PEAK HOLD (OFF)"
2140  COMMAND$ = PEAK$: GOSUB 9500
2150  IF OUTLEN = INLEN THEN GOSUB 8000 ELSE GOTO 2130
2160  PRINT "Programming DISPLAY FORMAT"
2170  COMMAND$ = DISP$: GOSUB 9500
2180  IF OUTLEN = INLEN THEN GOSUB 8000 ELSE GOTO 2160
2190  '
2200  '==== Take field measurments ====
2210  '
2220  CLS
2230  PRINT " ": PRINT "TAKING FIELD MEASUREMENTS...PRESS ANY KEY TO QUIT."
2240  '
2250  IF INKEY$ <> "" THEN 2290
2260  COMMAND$ = MEAS$: GOSUB 9500
2270  IF OUTLEN = INLEN THEN GOSUB 8000 ELSE GOTO 2250
2280  GOTO 2250
2290  PRINT "PLACING GAUSSMETER IN LOCAL MODE."
2300  CMD$ = "LOCAL " + GM$: GOSUB 9070
2310  GOTO 9999
8000  '
8010  '*****************************************************************************************************************************
8020  ' Print on screen the command string sent and the response received.
8030  '*****************************************************************************************************************************
8040  PRINT"GAUSSMETER COMMAND WAS [";
8050  PRINT RIGHT$(COMMAND$,OUTLEN);:PRINT"]";: PRINT "  ";
8060  PRINT"GAUSSMETER RESPONSE WAS [";
8070  PRINT LEFT$(IEEE-488$,INLEN-1);:PRINT"]"
8080  RETURN
9000  '
9010  '***** METRABYTE IEEE-488 CARD I/O SUBROUTINE *****
9020  '
9030  CALL IE488(CMD$,IEEE488$,FLG%,BA0%)
9035  IF FLG% = &H200 THEN 9030
9040  IF FLG% = 0 THEN 9060
9050  BEEP: PRINT "IEEE-488 ERROR = &H";HEX$(FLG%)
9060  RETURN
9070  CALL IE488(CMD$,D%,FLG%,BAO%): GOTO 9040
9500  '
9510  '***** COMMAND / RESPONSE SUBROUTINE *****
9515  '
9520  '===== WAIT FOR GAUSSMETER IEEE-488 BUS TO BE IDLE =====
9503  '
9540  CMD$ = "STATUS " + GM$: GOSUB 9070: IF D% <> 0 THEN 9540
9550  '
9560  '===== CONSTRUCT COMMAND STRING AND SEND TO GAUSSMETER =====
9570  '
9580  IEEE488$ = CHR$(27) + COMMAND$ + CHR$(13)
9590  CMD$ = "OUTPUT " + GM$ + "[$]#": GOSUB 9000
```

IEEE-488 Demo Program continued

```
9600   CMD$ = "TRIGGER " + GM$: GOSUB 9070
9610   '
9660   '==== WAIT FOR GAUSSMETER TO FINISH COMMAND EXECUTION ====
9670   '
9680   CMD$ = "STATUS " + GM$: GOSUB 9070: IF D% <> &H40 THEN 9680
9690   '
9700   '==== INPUT COMMAND STRING ECHO AND DISPLAY IT =====
9710   '
9720   CMD$ = "ENTER " + GM$ + "[$]%": GOSUB 9000
9730   '
9740   '==== CALCULATE ASCII BUFFER LENGTHS ====
9750   '
9760   OUTLEN = LEN(COMMAND$) + 1:  INLEN = LEN(IEEE488$) - 1
9780   RETURN
9999   END
```

WARRANTY

F.W. BELL, INC. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to replacing any defective parts thereof (excluding batteries). This warranty covers instruments which, within one year after delivery to the original purchaser, shall be returned with transportation charges prepaid by the original purchaser, and which upon examination shall disclose to our satisfaction to be defective. If it is determined that the defect has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost after submitting an estimate to the purchaser.

F.W. BELL, INC. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of F.W. BELL, INC., and F.W. BELL, INC. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of F.W. BELL, INC. instruments.

DAMAGE IN SHIPMENT

The instrument should be examined and tested as soon as it is received. If it does not operate properly, or is damaged in any way, immediately file a claim with the carrier. The claim agent will provide report forms. A copy of the completed form should be forwarded to us. We will then make the necessary arrangements for repair or replacement. All correspondence concerning this instrument should include model and serial numbers.

SHIPPING INSTRUCTIONS

Contact the factory for Return Material Authorization number (RMA #) prior to shipping. All returns must be shipped to the factory with an RMA #.

Use the original shipping carton and inserts, if possible, or pack the instrument in a sturdy container and surround the entire instrument with two to three inches of shock-absorbing material.

Ship to:
F.W. BELL, INC. • Repair Department
6120 Hanging Moss Road • Orlando, FL 32807
Phone: 407-678-6900