F.W. BELL

Division of Bell Technologies, a *SYPRIS* company

MODEL 9550

GAUSS / TESLAMETER

Instruction Manual

Manual UN-01-223
Item 359502
July, 1997
Rev. B

International Electrical Symbols


Caution! Refer to this manual before using the meter.


Caution! Risk of electric shock.

Symboles Électriques Internationaux


Attention! Consulter le manuel avant d'utiliser le gaussmèter.


Avis! Risque de choc électrique.

Internationale Elektrosymbole


Achtung! Vor Benutzung dieses Meßgerätes, bitte Handbuch lesen.


Achtung! Gefahr von Stromschlag.

Simbole Elettriche Internazionali


Attenzione! Consultare il manuale prima dell'uso.


Attenzione! Rischio scossa elettrica.

Simboles Eléctricos Internacionales


Precaucion! Consultar en manual antes de usar el instrumento.


Cautela! Riesgo sacudida eléctrica.

TABLE OF CONTENTS

SAFETY INSTRUCTIONS:

GENERAL:
For safe and correct use of this gaussmeter it is necessary that both operating and servicing personnel follow generally accepted safety procedures plus the safety cautions and warnings specified.

If it is determined that safety protection has been impaired, the gaussmeter must be made inoperative and be secured against any unintended operation. For example, safety may be impaired if the gaussmeter fails to perform or shows visible damage.

Note:
Fuses are located internally in three of the power transformer low voltage secondary windings to prevent excess heating and possible fire caused by a fault condition. **These fuses are not user replaceable**. If a failure occurs, **send the gaussmeter to a factory authorized service center for repair.**

CAUTION:
All input and output voltages, except line(mains), are less than 20V.

WARNING:
The opening of covers or removal of parts might expose live parts and accessible terminals which can be dangerous.

WARNING:
Any interruption of protective earth conductors or disconnection of the protective earth terminals inside or outside of the gaussmeter can create a dangerous condition.

WARNING:
The hall probe is a non-contact measuring device. The probe is not to contact a surface which exceeds a voltage of 30V r.m.s. (42.4V peak) or 60V d.c.

CAUTION:
For continued protection replace the Power Receptacle Module fuse with the same type (5 X 20mm, slow blow, 200mA at 250V for 230 volt operation or 400mA at 250V for 115 volt operation).

SECTION I

I-A AC POWER CONNECTION

GAUSSMETER PREPARATION

WARNING ! FOLLOW THESE INSTRUCTIONS OR DAMAGE MAY RESULT !!!

Figure I-A depicts the rear-panel power module containing the line cord receptacle, line fuse and the voltage programming drum. You can select operation from either 115 or 230 Vac service. The selected voltage will appear through the window in the module. If this does not match your service do the following:

1) Turn the power switch to the OFF (o) position and remove the line cord.

2) Insert a narrow flat screwdriver behind the access slot and gently pry open the access door. Flip the door down.

3) Grasp the voltage programming drum and pull it straight out of the module.

4) Rotate the drum to show the correct voltage, then insert the drum into the module.

5) Reverse the position of the fuses.

6) Close the access door and insert the line cord.

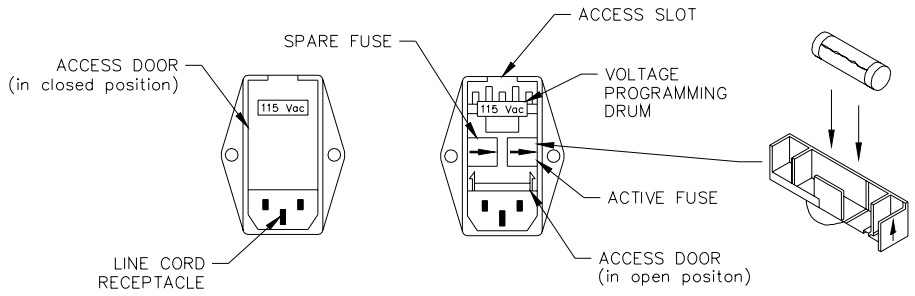


Figure I-A
Power Receptacle Module

I-B PROBE INSTALLATION

Install the probe connector so that the molded keys in the connector body line up with similar keyways in the receptacle (Figure I-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 .

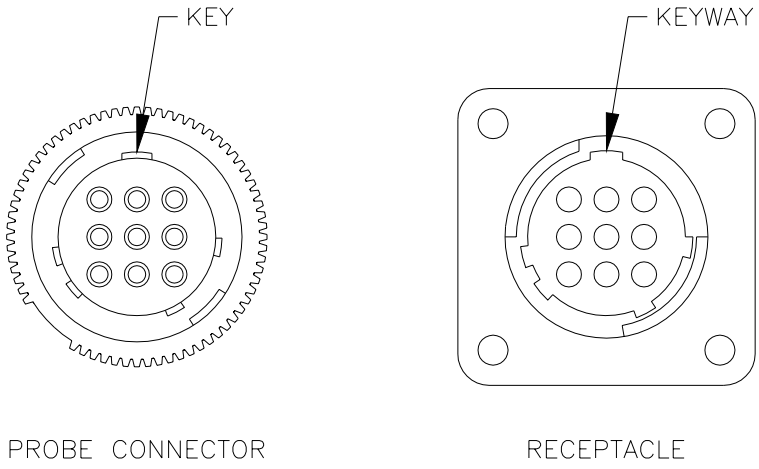


Figure I-B
Probe Connector and Receptacle

I-C POWER UP

Locate the power switch on the front panel and depress the side marked "1". The "F.W. Bell" logo will appear. Beneath the logo various messages will appear to indicate the progress of to power-up initialization. During this time the instrument's software version number will appear next to each message. Internal diagnostics are performed first, followed by retrieval of calibration data from the probe. 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 may halt the power-up procedure. See Section Vll if this occurs.

When the gaussmeter passes diagnostics, the MEASURE mode is entered and field measurements will begin. If no probe is connected, an error message will appear.

Most operating parameters, such as RANGE settings, PEAKHOLD, DISPLAY FORMAT, COMMUNICATIONS, etc. will be initialized to the same conditions present when the gaussmeter was last turned off. (See Section III-H.) When the gaussmeter is turned off again the present setup is saved for next time. The probe's zero and relative values are not saved.

SECTION II

II-A INTRODUCTION

GENERAL DESCRIPTION

The MODEL-9550 gaussmeter represents the latest developments in the science of measuring magnetic flux density using the Hall effect. 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 (0.001 μT) or as high as 299.9 Kilogauss (29.99 tesla), at frequencies up to 10 kHz, can be measured with extreme accuracy and 4-3/4 digit resolution.

The MODEL-9550 features PEAK HOLD, AUTORANGING, RELATIVE operation, CLASSIFIER, 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 enhanced 240 x 64 pixel electroluminescent display.

The gaussmeter employs a menu-driven format to allow the user to program all aspects of gaussmeter operation with ease and speed.

II-B FUNCTIONAL DESCRIPTION

Figures II-A and II-B depict the MODEL-9550 front and rear panels, respectively. The gaussmeter is housed in a standard 7.53" (19.1 cm) high x 13.47” (34.2 cm) wide x 14.21" (36.1 cm) deep cabinet featuring pop-up feet for tabletop use, (optional) brackets for rack mounting and (optional) carrying handle/bail.

FRONT PANEL

(1) DISPLAY	1920-pixel (240 x 64) dot matrix (graphics) Electroluminescent Display. Contrast is preset at the factory.
(2) " ↑ " PUSHBUTTON	Momentary-contact pushbutton switch used to advance the cursor up in the MENU mode.
(3) POWER SWITCH	Rocker type power switch with international legends ("0"=OFF, "1"=ON).
(4) "PROGRAM/ENTER" PUSHBUTTON	Dual-function momentary-contact pushbutton switch used to enter the MENU mode.
(5) "↓" /"PEAK RESET" PUSHBUTTON	Dual-function momentary-contact pushbutton switch used to reset the presently held PEAK value or advance the cursor down in the MENU mode.
(6) AUTOZERO PUSHBUTTON	Initiates an immediate probe Zero Operation. See Section IV-I for more information.
(7) PROBE CONNECTOR	Nine-pin twist-lock non-magnetic connector that mates to F.W. Bell fourth-generation Hall generator probes.

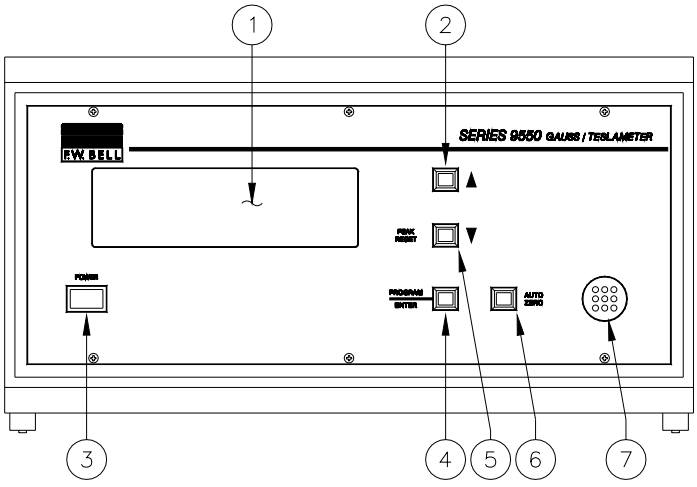


Figure II-A
MODEL-9550 Front Panel

REAR PANEL

(8) ANALOG OUTPUT	Calibrated analog output. Standard BNC connectors.
(9) IEEE-488 BUS CONNECTOR	Standard 24-pin GPIB connector for IEEE 488 bus interface.
(10) RS-232 PORT CONNECTOR	Standard 25-pin "D" type female connector for RS-232 communications.
(11) 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.
(12) INFORMATION LABEL	Label identifies the model number and serial number along with line power data.

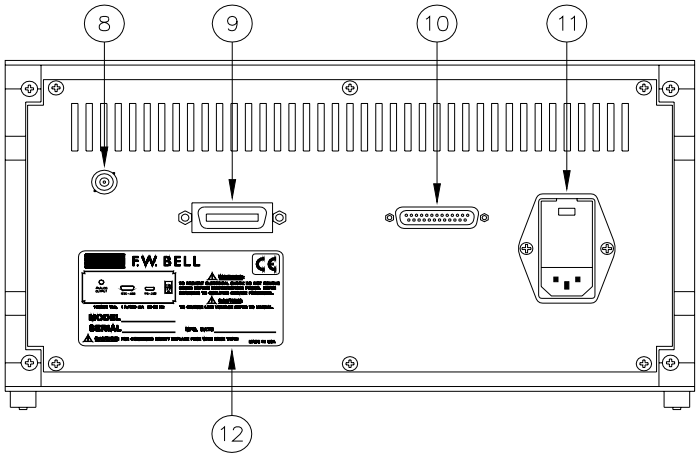


Figure II-B
MODEL-9550 Rear Panel

SECTION III

FIELD MEASUREMENT OPERATIONS

III-A DISPLAY FORMAT

In the MEASURE mode of operation the format of the display is shown in Figure III-A. The user can modify the DISPLAY FORMAT with the DISPLAY FORMAT menu. (MENU mode is discussed in Section IV.)

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.

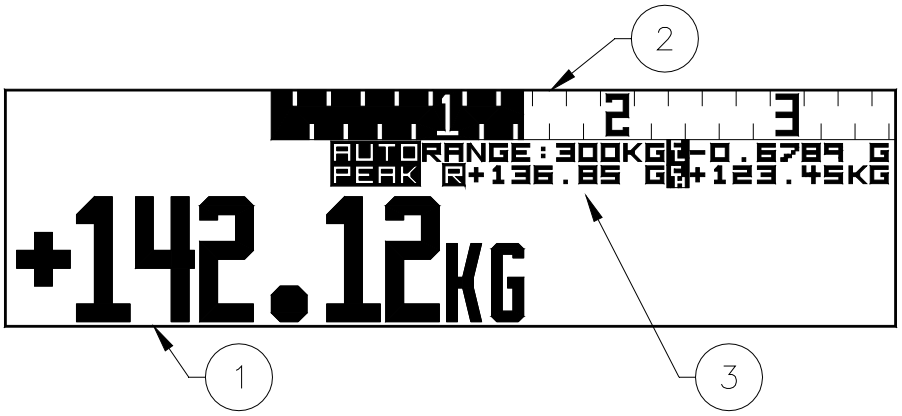


Figure III-A
Measure Mode Display Screen

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 INFORMATION BLOCK

The information block (3) contains various annunciators and information about the present state of the gaussmeter 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-F
RANGE SETTING	The present range setting for the gaussmeter.
RELATIVE OFFSET	This field contains the RELATIVE field reading that was present when the PROBE RELATIVE operation began (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-E CHANNEL DEACTIVATION

The probe can be deactivated by turning off *both* the digital reading *and* the bargraph via the DISPLAY FORMAT MENU, or by disconnecting the probe.

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

III-F 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, 2.9999 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 ripple that causes 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.

III-G 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 +200.00G reading will replace a +100.00 G reading and be held, and a -250.00 G reading will replace previously held +200.00 G reading.

The user can reset a held reading at any time by pressing *and* releasing the 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.

III-H POWER UP INITIALIZATION

The gaussmeter permanently stores the 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, GAUSS/TESLA and FILTER ON/OFF)
- RANGE SETTING (INCLUDING AUTORANGE)
- PEAK HOLD ON/OFF (LAST PEAK READING WILL NOT BE SAVED)
- DIGITS ON/OFF
- BARGRAPH ON/OFF
- CLASSIFIER SETTINGS
- 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-I 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-B. As shown, the magnetic flux lines traveling in the direction indicated by a "B" will result in a positive (+) polarity. Note the position of the "F.W. BELL" legend on the probe handle.

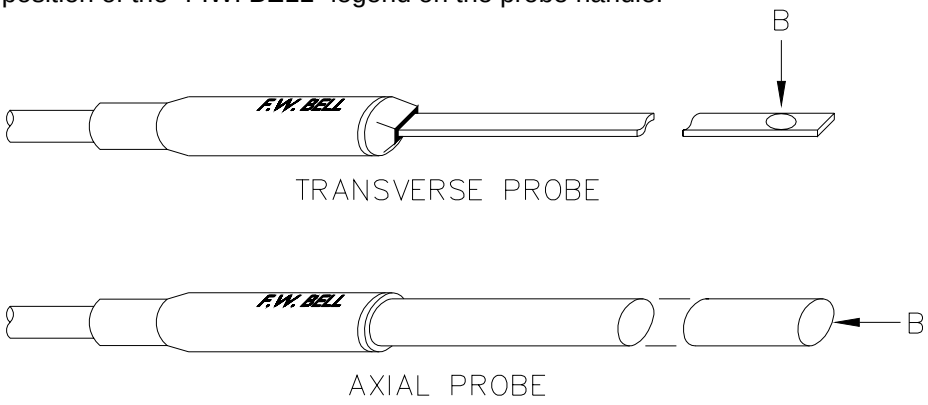


Figure III-B

Probe Orientation Versus Readout Polarity

III-J ANALOG OUTPUT

On the rear panel of the gaussmeter is a connector that, when connected to an oscilloscope, allows the user to observe the actual magnetic field waveforms.

In the ac mode, the waveform is the actual field waveform calibrated to 3 Vrms full scale. For instance, with the gaussmeter programmed for a 3 kG range setting (3000 G) a 2.000 Vrms signal correlates to a 2.000 kG field density. In the dc mode, the output is a dc level calibrated to ±3 Vdc full scale.

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

III-K INTERNAL RECALIBRATION

Occasionally, the gaussmeter will initiate an internal calibration cycle in order to maintain optimum performance. During this time, the phrase "INSTRUMENT 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.

The internal recalibration cycle can be user-controlled via the remote communications ports. See Section V for more information.

The signal present at the rear-panel analog output connector will drop to zero volts during recalibration

III-L FILTER SELECTION

The MODE SELECTION menu, discussed in Section IV-D, allows for the selection of filters.

In AC mode FILTER-ON engages a low pass filter that will reduce the high frequency content of the probe signal. Both the displayed reading and the signal available at the rear analog output jack are affected by this filter.

In DC mode FILTER-ON enhances the digital filtering scheme, resulting in greater stability of the displayed reading only (the signal available at the rear analog output jack is not affected). There will be minor reductions in the display update rate in this mode.

Refer to the SPECIFICATIONS for information relating to filter operation.

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 push-button. When this occurs all measurement operations cease and the probe is 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 "↓" push-button 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 push-button. In some menus the up "↑" or down "↓" push-buttons will be used to enter numeric values.

The 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 push-button 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.

The gaussmeter is programmed by selecting CHANGE. It is not necessary for the probe to be physically present while programming except during the PROBE ZERO or PROBE RELATIVE operations.

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 "↓" push-button is used to choose a selection, and the ENTER push-button is used to advance to the chosen operation.

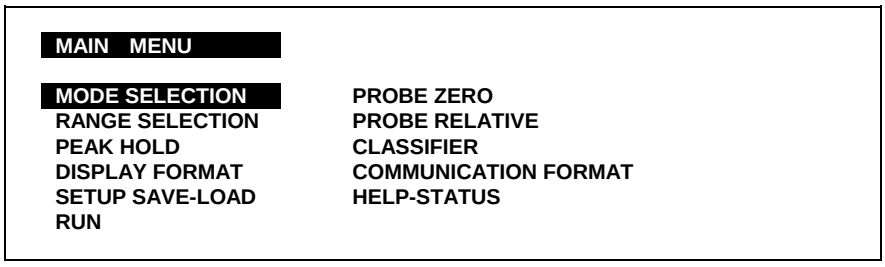


Figure IV-A
MAIN Menu

One of the selections in the MAIN MENU is "HELP-STATUS". When selected the first screen contains general information about menu operations. The next screen contains information about the probe. Displayed is the model number,

serial number and Hall device type of the probe. If no probe is connected a "NOT PRESENT" message will appear. If a probe is attached but the meter cannot identify it a "NOT DEFINED" message will appear. The latter message may indicate a problem in the probe or the meter. It may also appear when special calibration hardware is connected. The information on this screen will not be updated until the meter is returned to the RUN mode.

IV-D MODE SELECTION

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

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.

Refer to section III-M for information about filters.

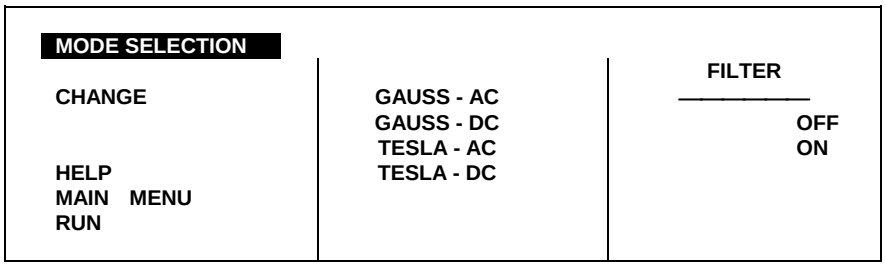


Figure IV-B
MODE SELECTION Menu

IV-E RANGE SELECTION

The choice of ranges depends upon whether the gaussmeter 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.

NOTE: The user cannot specify whether a probe is 1X, 10X, or a .01X device. This information is retrieved from the probe itself. If the probe is not physically present when programming the RANGE the gaussmeter will assume a 1X configuration .

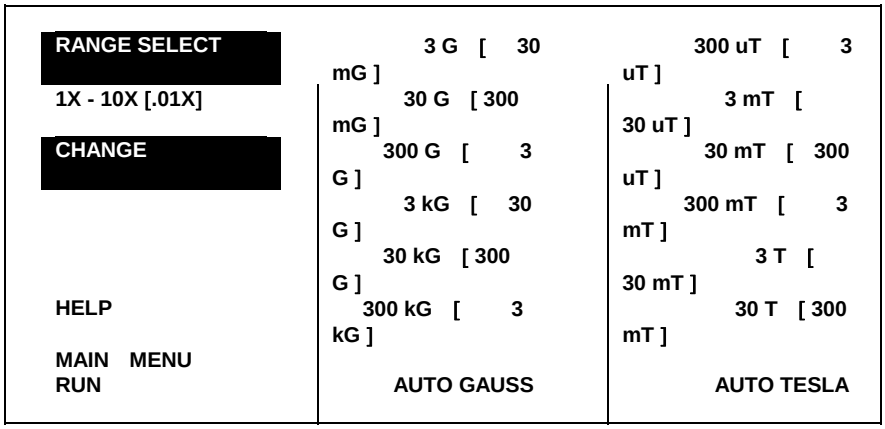


Figure IV-D
RANGE SELECT Menu

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 information block in the MEASURE mode display screen as field measurements are being taken. (See Figure III-A.) If the AUTOrange 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 information block in the MEASURE mode display screen as field measurements are being taken. (See Figure III-A.)

The presently held peak can be manually reset at any time during the measurement process by pressing *and* releasing the RESET push-button. The PEAK indicator will flash momentarily to indicate that the reset is in progress. but a new peak will not be captured until the push-button is released.

See Section III-G for more information

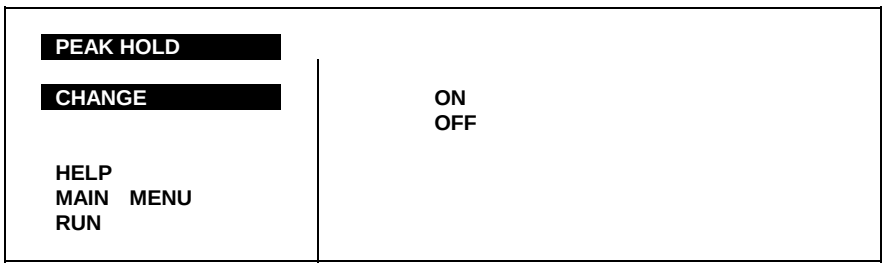


Figure IV-E
PEAK HOLD Menu

IV-G DISPLAY FORMAT

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

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 information from the screen and the probe is placed in a standby position. This also disables the ability to gather field readings in the remote mode, discussed in Section V. If only the digital reading is turned off, the reading's polarity (~, + or -) will remain on the screen as an indication of the type of field (ac or dc) being measured.

The display can be programmed for normal (orange on black) or reverse (black on orange) image.

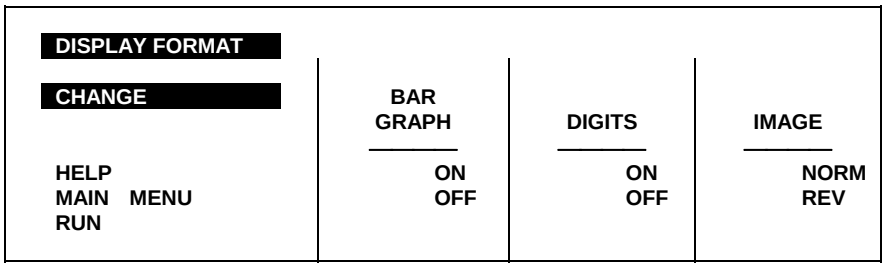


Figure IV-F
DISPLAY FORMAT Menu

IV-H SETUP SAVE-LOAD

A "SETUP" is the condition of the gaussmeter (RANGE settings, DISPLAY FORMAT, 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 set-up 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-H 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 "↑" or "↓" push-buttons are used to select the desired SETUP title. At the same time the title's SETUP information block will appear on the right-hand side of the screen, allowing the user to view the programming information.

The setup is then validated by the RETURN push-button. 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.

Note the 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 range setting of 3 G, ant that setup is loaded in with a 10X probe, the 30 G range will be selected (3 G is not a valid range selection with a 10X probe.)

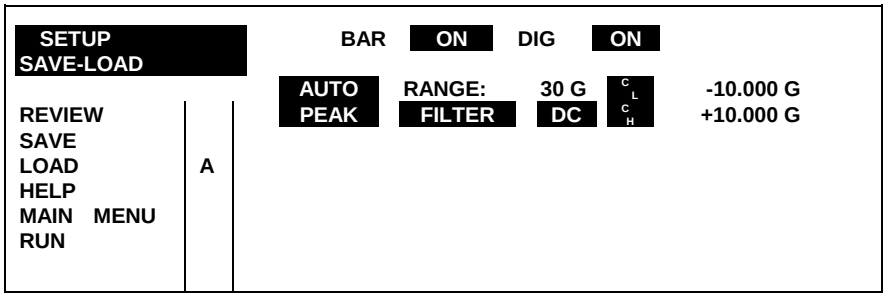


Figure IV-G
SETUP SAVE-LOAD Menu

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 use of a ZERO GAUSS CHAMBER supplied with the instrument shields the probe from surrounding field, 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 a probe. The probe is zeroed *only* for the mode (ac *or* dc) that is presently programmed for the gaussmeter (via the MODE selection menu).

Figure IV-H
PROBE ZERO Menu

Once selected, a message will appear that states that the gaussmeter is ready to begin. Pressing the ENTER push-button initiates the zeroing process. (If the probe is not present, an error message will appear instead. In this case, pressing the ENTER push-button 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 as range, a digital correction factor is generated and stored.

Prior to storing a digital correction factor for the lowest dc range, the Model 9550 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 processing, an error will be reported and all zero values generated to that point will be reset. In this case pressing the ENTER push-button will restore normal menu operations.

If the meter is able to cancel a majority of the signal but not all of it a warning message will appear but the meter will remain in its present state. In these instances the user should realize that future probe readings may not be entirely accurate because of the remaining uncancelled signal. The user should note the initial reading when returning to the RUN mode and subtract it from future readings.

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 as offset is 20.00 G and the probe is operated (after zeroing) on the 30 G range setting, an overrange condition will occur when the field reading reaches 10.00 G (30.00 G - 20.00 G = 10.00 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 removed.

NOTE: Whenever a probe is zeroed, *all previously-generated relative values will be reset and the relative function will be turned off* (See 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 +200.0 G and the probe is afterwards inserted in a +250.0 G field, the displayed reading will be +50.0 G. A field of +150.0 will be displayed as -50.0 G. Thus, the RELATIVE function can be useful for observing variances around a given field density.

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

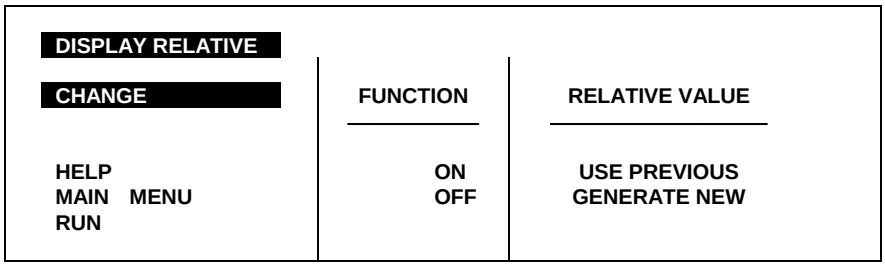


Figure IV-I
PROBE RELATIVE Menu

Once selected. the user has the choice of turning the relative function ON or OFF. 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 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 push-button initiates the relative operation. (If the probe is not present, an error message will appear instead. In this case, pressing the ENTER push-button 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-A) 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 ranges 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 push-button will restore normal menu operation.

If the meter is able to cancel a majority of the signal but not all of it a warning message will appear but the meter will remain in its present state. In these instances the user should realize that future probe readings may not be entirely accurate because of the remaining uncanceled signal. The user should note the initial reading when returning to the RUN mode and subtract it from future readings.

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 100.0 G and the probe is operated on a 300 G range setting, an overrange condition will occur when the field reading reaches 200.0 G (300.0 G-100.0 G= 200.0 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 information block preceded by a reverse-video "R." (See Figure III-A.) 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 ± 10 G on the 30 kG range. However, if the RELATIVE function is used, the user can downrange to observe variances as low as ± 0.1 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 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.

IV-K 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 "↑" or "↓" push-button. The selection is validated with the ENTER push-button. Legal addresses are 0 to 31 decimal. Refer to Section Vl for further information on the IEEE-488 bus.
If RS-232 is selected, the user is directed to first select the PARITY (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 "↑" or "↓" push-buttons are used to select a parameter and the ENTER push-button validates the selection. Refer to Section Vl for further information on RS 232 communications.

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

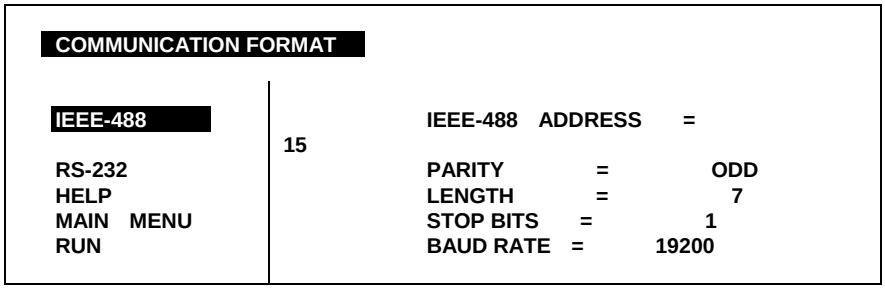


Figure IV-J

COMMUNICATIONS FORMAT Menu

IV-L CLASSIFIER MENU

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.

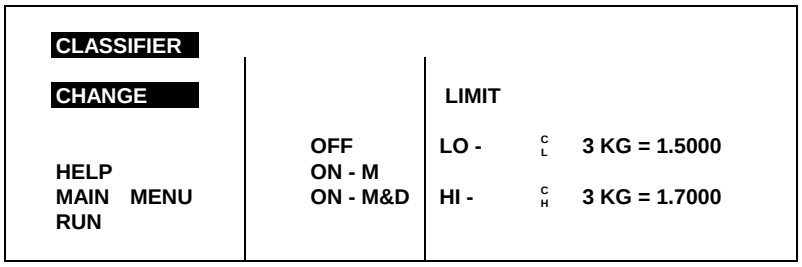


Figure IV-J
CLASSIFIER Menu

SECTION V

REMOTE COMMANDS

V-A INTRODUCTION

Prior to 1987 most instruments that featured IEEE-488 or RS-232 communications interfaces had their own unique method of exchanging information. For instance a command used to set a range on a Fluke voltmeter may not have worked with a Keithley meter. Eventually some manufacturers began offering models that recognized other manufacturer's command sets so that customers could easily switch over without making extensive changes to their programs.

The IEEE-488-1987.2 standard (also called the IEEE-488.2 standard) was one step toward creating a universal way to communicate with any instrument, regardless of the manufacturer or the type of instrument used. This was later enhanced by the SCPI-1991 standard (Software Commands for Programmable Instruments), which defined specific commands and responses that covered a broad range of applications. Though these standards were targeted for use with the IEEE-488 bus they are commonly used with serial (RS-232) interfaces as well.

The 9550 gauss/tesla meter supports the IEEE-488-1987.2 "common" commands as well as a subset of the SCPI-1991 commands.

Prior to using the IEEE-488 bus the instrument must be assigned a unique address on the bus. Prior to using the RS-232 serial port parameters such as baud rate and character length must be set to match that of the system controller. This is done with the COMMUNICATIONS FORMAT menu, discussed in Section-IV. Proper cabling is also required. This is discussed in Section-VI.

V-B IEEE-488 GENERAL BUS COMMANDS

General bus commands have the same meaning to any instrument on the IEEE-488 bus. Often the user will be using an IEEE-488 controller card, such as a Keithley KPC-488.2 or a National GPIB-PCII. Along with the card a software package is used, commonly called a Universal Language Driver (ULD) or a Universal Language Interface (ULI). This software translates the complicated lower level operations into easy-to-use commands.

The following commands assume the instrument's address has been set to 15:

COMMAND	ULI STATEMENT	BRIEF DESCRIPTION
REN	REMOTE 15	Enter remote mode, disable front panel controls.
IFC	ABORT	Clears the interface and remote mode.
LLO	LOCAL LOCKOUT	Disable front panel controls.
GTL	LOCAL 15	Cancel remote mode, restore front panel controls.
DCL	CLEAR	Cancels all commands, clears all queues, affects all instruments on the bus.
SDC	CLEAR 15	Same as DCL, except only for this instrument.
SPE, SPD	SPOLL 15	Read the serial poll byte.

Table-V-A
General command summary for IEEE-488

REN - REMOTE ENABLE

This command prepares the instrument for remote operations. All front panel controls are disabled except for the power switch.

IFC - INTERFACE CLEAR

This command cancels the remote mode and places the bus in an idle state.

LLO - LOCAL LOCKOUT

All front panel controls are disabled except for the power switch.

GTL - GO TO LOCAL

This command cancels remote mode and restores front panel operation.

DCL - DEVICE CLEAR

This command clears the bus and returns it to a known state. All devices are affected. The instrument will cancel any pending commands and clear its output buffers. Instrument settings are not affected.

SDC - SELECTIVE DEVICE CLEAR

Same as the DCL command except only for the addressed instrument.

SPE,SPD - SERIAL POLL

This command obtains the serial poll status byte, which contains important status information about the instrument. Often a serial poll is initiated when one or more devices are asserting an interface line called SRQ (service request).

V-C ERROR QUEUE AND OUTPUT QUEUE

Internally there are two buffers that accumulate messages. Errors are generated by a variety of sources, such as hardware errors or errors in the command syntax. As errors occur messages are stored in an ERROR QUEUE. They can be read by specific commands discussed later in this section.

Any time a command requests information from the instrument, such as flux density readings, instrument status or error messages, the information is placed in the OUTPUT QUEUE. They can be read by the system controller using a standard INPUT command.

V-D STATUS REGISTERS

There are four register sets that indicate the status of the instrument, such as errors or the present state of the machine. These are 16-bit registers, but in many cases not all of the bits are used. The four register sets are called

MEASUREMENT EVENT
OPERATION EVENT
STANDARD EVENT
QUESTIONABLE EVENT

There is also an 8-bit register that provides a 1-bit summary for each of the four register sets. This is called the STATUS BYTE.

Each register set consists of three individual registers, as depicted in Figure V-A.

1) The CONDITION register is a real time, read-only register that is constantly updated to reflect current operating conditions.

2) The EVENT register is fed by the CONDITION register, but operates as a latch. Whenever any bit in the CONDITION register goes to “1”, a corresponding “1” is latched into the EVENT register and remains that way until cleared by a specific command.

3) The ENABLE register is a mask register that is used to generate the single status bit for the STATUS BYTE. Setting any bit in the ENABLE register to “1” will allow a corresponding “1” in the EVENT register to set the summary bit in the STATUS BYTE.

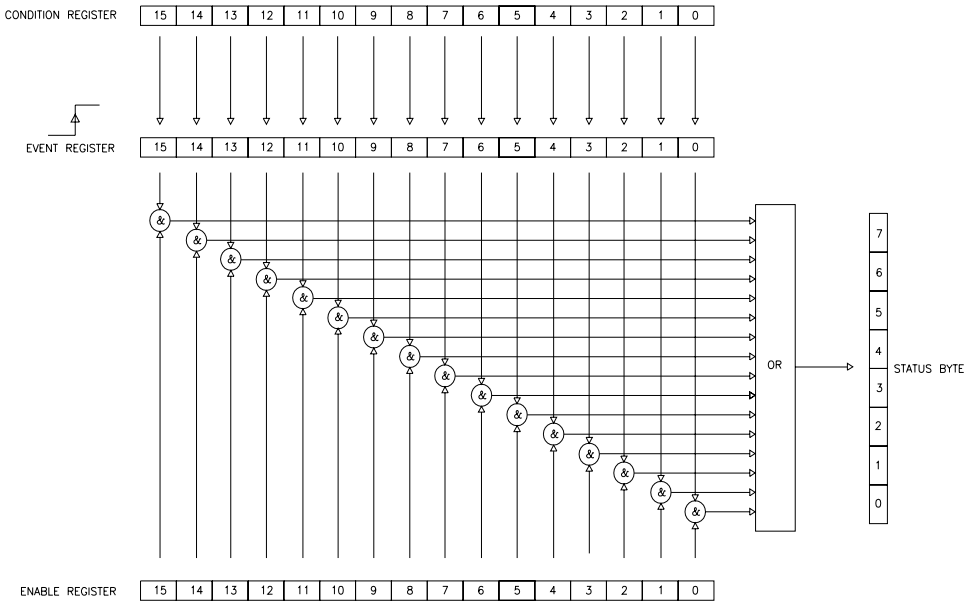


Figure V-A
Condition, event and enable registers

V-E STATUS BYTE AND SERVICE REQUEST (SRQ)

The IEEE-488 bus is a common bus linking a master controller (your computer) to one or more instruments. If an instrument requires action from the controller it must somehow get the controller's attention. A hardware line on the bus called SRQ (service request) is used to signal the controller that one or more instruments on the bus require attention. A bit in the STATUS BYTE called RQS (request for service) also sets. The master then reads the STATUS BYTE from each instrument to determine which one(s) require service.

On the RS-232 port there is no hardware method of signaling a service request, so the STATUS BYTE must be inspected ("polled") to determine if service is required.

The RQS bit can set if any of the summary bits from the MEASUREMENT EVENT, OPERATION EVENT, STANDARD EVENT or QUESTIONABLE EVENT registers are set, or if an error or output message is ready to be transmitted to the master. The SRQ ENABLE register is a mask register that is used to allow any of these conditions to set the RQS bit, and thus the SRQ line. Setting any bit in the SRQ ENABLE register to "1" will allow a corresponding "1" in the STATUS BYTE register to set the RQS bit.

These registers are depicted in Figure V-B.

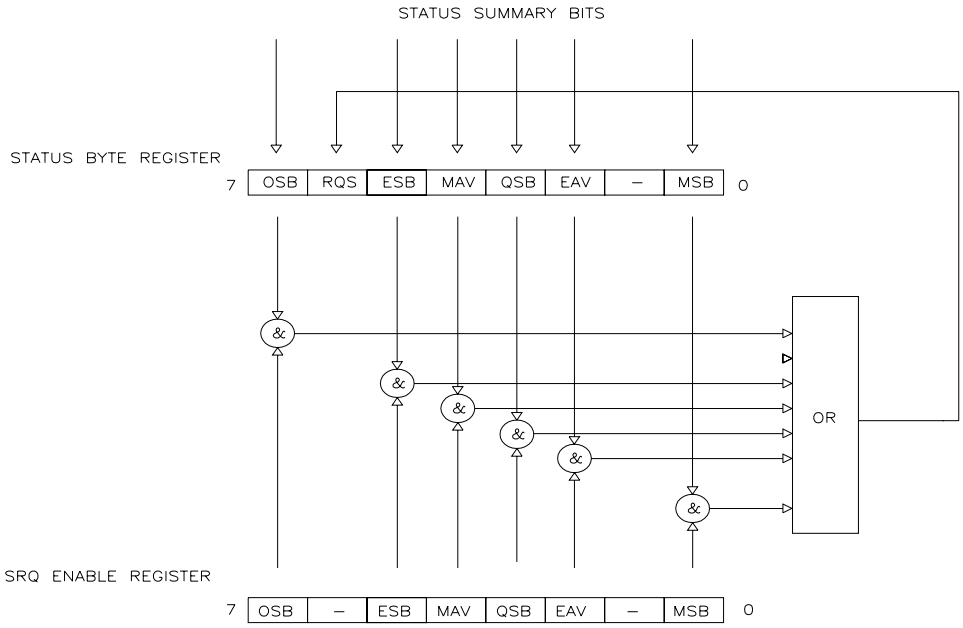


Figure V-B
Status Byte and SRQ Enable registers

OSB - Operation Summary Bit:	If any of the bits in the OPERATION EVENT register set, and their respective enable bits are set, the Operation Summary Bit (OSB) will set.
ESB - Event Summary Bit:	If any of the bits in the STANDARD EVENT register set, and their respective enable bits are set, the Event Summary Bit (ESB) will set.
QSB - Questionable Summary Bit:	If any of the bits in the QUESTIONABLE EVENT register set, and their respective enable bits are set, the Questionable Summary Bit (QSB) will set.
MSB - Measurement Summary Bit:	If any of the bits in the MEASUREMENT EVENT register set, and their respective enable bits are set, the Measurement Summary Bit (MSB) will set.
MAV - Message Available:	This bit sets any time there is a message available in the output queue.
EAV - Error Available:	This bit sets any time there is an error message available in the error queue.
RSQ - Request For Service:	If any of the other bits in the STATUS BYTE are set, and their respective enable bits are set in the SRQ ENABLE register, the Request For Service (RQS) will set, causing the SRQ interface line to be asserted if using the IEEE-488 bus.

V-F STANDARD EVENT REGISTER

If any of these bits set, and their respective enable bits are set, the Event Summary Bit (ESB) will set in the STATUS BYTE.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
–	–	–	–	–	–	–	–	PON	–	CME	EXE	DDE	QYE	–	OPC

Figure V-C
Standard Event register

PON - Power On: Indicates that the meter was turned off and on since the last communication.

CME - Command Error: Indicates that there was a syntax or spelling error in the command, or the command received is not supported.

EXE - Execution Error: Indicates that the meter detected an error while attempting to execute a command.

DDE - Device Dependent Error: Indicates that the meter did not operate properly due to some internal error.

QYE - Query Error: Indicates that an attempt was made to read an empty output queue.

OPC - Operation Complete: Indicates that all requested operations have been completed.

V-G MEASUREMENT EVENT REGISTER

If any of these bits set, and their respective enable bits are set, the Measurement Summary Bit (MSB) will set in the STATUS BYTE.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
–	–	–	–	–	–	–	–	–	–	–	–	RAV	HL	LL	ROF

Figure V-D
Measurement Event register

HL - High Limit Exceeded: When the classifier function is enabled these bits indicate that the present reading is higher than the upper limit set for the meter.

LL - Low Limit Exceeded: When the classifier function is enabled these bits indicate that the present reading is below the lower limit set for the meter.

ROF - Reading Overflow: Indicates that the present reading exceeds the present measurement range.

RAV - Reading Available: Indicates a reading was taken and processed.

V-H OPERATION EVENT REGISTER

If any of these bits set, and their respective enable bits are set, the Operation Summary Bit (OSB) will set in the STATUS BYTE.

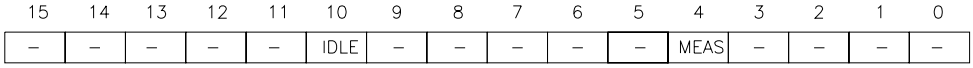


Figure V-E
Operation Event register

IDLE - Idle Mode: Indicates the meter is idle, waiting for instructions.

MEAS - Measure mode: Indicates the meter is performing a measurement.

V-I QUESTIONABLE EVENT REGISTER

If any of these bits set, and their respective enable bits are set, the Questionable Summary Bit (QSB) will set in the **STATUS BYTE**.

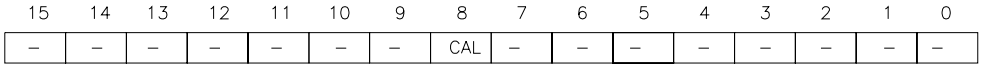


Figure V-F
Questionable Event register

CAL - Calibration summary: Indicates that an invalid calibration constant was detected during power up or when the probe was installed. The instrument will instead use a default parameter. This bit will clear once the meter and probe have been successfully calibrated.

V-J IEEE-488.2 "COMMON" COMMAND SYNTAX

The "common" commands are recognized and acted upon in a similar manner by all IEEE-488.2 instruments, whether a DVM, scope, frequency meter, gaussmeter, etc. These are the syntax rules:

1) A common command always begins with an asterisk character (*) followed by a three or four character acronym and possibly one other parameter. For instance a command to reset the instrument is *RST.

2) The commands are not case sensitive. For instance the *RST, *rst and *rSt commands are identical.

3) If there is a fourth character in the acronym it will always be a question mark (?) and indicates that information is being requested from the instrument. For instance a command to read the model number and manufacturer of the instrument is *IDN?.

4) If a parameter follows a command it must be separated from the acronym by at least one space. The parameter is the ASCII representation of an integer. For instance if the parameter to be sent is binary 1100, the actual parameter sent would be the two ASCII characters 12, since binary 1100 = decimal 12. If you were to send the four ASCII characters 1100 it would be interpreted as decimal 1100 (eleven hundred).

5) A number returned from the instrument is an ASCII representation of an integer. For instance if the instrument returns the ASCII string 345 the number is decimal 345 (three hundred forty five), which translates to 159 hex.

6) Multiple commands can be sent in one string. The commands must be separated by semicolons (;). For instance, *RST;*IDN? first resets the instrument and then requests model/manufacturer information. If more than one of the commands in the string requests information from the instrument, the instrument's response will also have semicolons separating the responses, such as 345;0;10.

V-K IEEE-488.2 "COMMON" COMMANDS

ACRONYM	NAME	BRIEF DESCRIPTION
*CLS	Clear status	Clear all event registers and error queue.
*ESE <NRf>	Program event enable	Program standard event enable register.
*ESE?	Event enable query	Read standard event enable register.
*ESR?	Event status query	Read standard event register and clear it.
*IDN?	Identification query	Return manufacturer, model number, software version number.
*OPC	Set operation complete	Set the Operation Complete bit in the standard event register after all pending commands have been executed.
*OPC?	Operation complete query	Places an ASCII "1" in the output queue after all pending commands have been executed.
*OPT?	Option identification query	Returns information about the status of the meter and probe.
*RCL <NRf>	Recall setup	Replaces the existing instrument setup with one of six stored in non-volatile memory.
*RST	Reset	Returns the instrument to a default operating condition.
*SAV <NRf>	Save setup	Save the existing instrument setup in one of six non-volatile memory locations.
*SRE <NRf>	Program SRQ enable	Program SRQ enable register.
*SRE?	SRQ enable query	Read SRQ enable register.
*STB?	Status byte query	Read status byte register.
*REN	Remote enable	Disable front panel controls
*GTL	Go to local	Enable front panel controls

NOTE: The parameter <NRf> means Numeric Representation format and is a required parameter.

Table V-B
Common command summary

*CLS - CLEAR STATUS — Clears the MEASUREMENT EVENT, OPERATION EVENT, STANDARD EVENT and QUESTIONABLE EVENT status registers, but not their enable registers. It also clears any pending error messages.

*ESE <NRf> - PROGRAM STANDARD EVENT ENABLE REGISTER	A set bit in the STANDARD EVENT ENABLE register allows its corresponding event to set the ESB (event summary bit) in the STATUS BYTE register. <NRf> is an ASCII string representing an integer mask. For instance a value of 45 decimal is the same as binary 00101101, thus setting bits 5, 3, 2 and 0 in the enable register.
*ESE? - STANDARD EVENT ENABLE REGISTER QUERY	Read the contents of the STANDARD EVENT ENABLE register. The results are placed in the output queue of the instrument.
*ESR? - STANDARD EVENT REGISTER QUERY	Read the contents of the STANDARD EVENT register. The results are placed in the output queue of the instrument. NOTE: The STANDARD EVENT register is cleared after an *ESR? command.
*IDN? - IDENTIFICATION QUERY	Returns the following string: F.W.BELL, MODEL 9550,Vx.x. The Vx.x string is the firmware revision level, where x.x is a decimal number, such as 1.1.
*OPC - SET OPERATION COMPLETE	Causes the OPC (operation complete) bit to set in the STANDARD EVENT register when all commands have been executed.
*OPC? - OPERATION COMPLETE QUERY	Places an ASCII “1” in the output queue once all command have been executed.
*OPT? - OPTION IDENTIFICATION QUERY	Indicates the existence and identity of any attached probe. The first character will always be a 1 followed by a comma (,). The string that follows the comma will be 0 if the probe is missing or the model number of the probe, such as HTF99-0608. The model number will always be 12 characters in length including spaces.
*RCL <NRf> - RECALL SETUP	The present state of the meter, called the setup, can be saved in non-volatile memory and later recalled with this command to instantly return the meter to that state. Up to six different setups can be saved. <NRf> should be a single ASCII character from “1” to “6” to specify the memory location. For more information see the discussion on the SETUP SAVE-LOAD menu (Section-IV.)

*RST - RESET	Cancels any pending commands and any response to any previously received *OPC or *OPC? commands.
*SAV <NRf> - SAVE SETUP	The present state of the meter, called the setup, can be saved in non-volatile memory and later recalled to instantly return the meter to that state. Up to six different setups can be saved. <NRf> should be a single ASCII character from "1" to "6" to specify the memory location. For more information see the discussion on the SETUP SAVE-LOAD menu (Section-IV).
*SRE <NRf> - PROGRAM SRQ ENABLE REGISTER	A set bit in the SRQ ENABLE register allows its corresponding event to set the RQS (request for service) in the STATUS BYTE register and activate the SRQ (service request) bus line. <NRf> is an ASCII string representing an integer mask. For instance a value of 45 decimal is the same as binary 00101101, thus setting bits 5, 3, 2 and 0 in the enable register.
*SRE? - SRQ ENABLE REGISTER QUERY	Read the contents of the SRQ ENABLE register. The results are placed in the output queue of the instrument.
*STB? - STATUS BYTE QUERY	Read the contents of the STATUS BYTE register. The results are placed in the output queue of the instrument. NOTE: The STATUS BYTE register is not cleared after an *STB? command. Other registers and queues must be cleared for the bits in the STATUS BYTE register to be cleared.
*REN - REMOTE ENABLE	All front panel controls are disabled except for the power switch. This command was primarily intended for use with the RS-232 port.
*GTL - GO TO LOCAL	This command cancels remote mode and restores front panel operation. This command was primarily intended for use with the RS-232 port.

V-L SCPI COMMAND SYNTAX

The SCPI commands go one step farther than IEEE-488.2 and provide a language protocol and define a standard set of commands to program every aspect of the instrument. These are the syntax rules:

1) The first character of any command string is a colon (:).

2) The commands are not case sensitive. For instance the :MEASURE, :measure and :MEASure commands are identical.

3) A question mark (?) in a command means that the command is requesting information from the instrument. This is called a query command.

4) For any command there is a short and long spelling of the command. Use the following rules for the short version:

a) If the length of the command is four letters or less, there is no short version.

b) If the command has more than four letters and the fourth letter is a vowel, drop it and all letters that follow it. For instance the command :DIGITS can be shortened to :DIG.

c) If the command has more than four letters and the fourth letter is a consonant, drop all letters that follow it. For instance the command :MEASURE can be shortened to :MEAS

d) If the command contains a question mark (?) or a non-optional parameter it must be included after the short form version. For instance a query command of :DIGITS? can be shortened to :DIG?.

e) If the command contains a number as the last character of the command follow the above rules but also include the digit. For instance the command :CALCULATE1 would be shortened to :CALC1.

f) The use of anything other than the short or long version of a command is illegal. For instance both the :MEASURE and :MEAS commands are legal, but :MEASU is not.

5) If a parameter follows a command it must be separated from the command by at least one space.

6) Multiple commands can be sent in one string. The commands must be separated by semicolons (;). For instance a legal string could be :MEAS;:DIG? Note that a colon (:) precedes each command. If more than one of the commands in the string requests information from the instrument, the instrument's response will also have semicolons separating the responses, such as 345;0;10.

V-M SCPI COMMANDS

In the following discussion the commands are written such that the short form of the command is written in UPPER CASE letters and the remainder of the command is written in lower case letters. Either form can be used.

If parameters are required they will appear within <> brackets. A <b> parameter indicates a Boolean function, either 0 or OFF, or 1 or ON. A <n> parameter is a single ASCII digit. <NRf> is usually a multiple digit number.

The gaussmeter supports a subset of the available SCPI commands. However, there are some functions that are not supported with standard SCPI commands. In these cases these special commands are patterned after other SCPI commands that are similar in function.

ERROR MESSAGE COMMANDS	DESCRIPTION
:SYSTem:ERRor?	Retrieve next error message
:SYSTem:CLEar	Clear all error messages

STATUS REGISTER COMMANDS	DESCRIPTION
:STATus:MEASurement:EVENt?	Query Measurement Event reg.
:STATus:OPERation:EVENt?	Query Operation Event reg.
:STATus:QUEStionable:EVENt?	Query Questionable Event reg.
:STATus:MEASurement:ENABle <NRf>	Program Measurement Event Enable reg.
:STATus:OPERation:ENABle <NRf>	Program Operation Event Enable reg.
:STATus:QUEStionable:ENABle <NRf>	Program Questionable Event Enable reg.
:STATus:MEASurement:ENABle?	Query Measurement Event Enable reg.
:STATus:OPERation:ENABle?	Query Operation Event Enable reg.
:STATus:QUEStionable:ENABle?	Query Questionable Event Enable reg.
:STATus:MEASurement:CONDition?	Query Measurement Condition reg.
:STATus:OPERation:CONDition?	Query Operation Condition reg.
:STATus:QUEStionable:CONDition?	Query Questionable Condition reg.
:STATus:PRESet	Clear all event registers.

MODE COMMANDS	DESCRIPTION
:UNIT:FLUX1:AC:GAUSs	Program AC Gauss mode
:UNIT:FLUX1:AC:TESLa	Program AC Tesla mode
:UNIT:FLUX1:DC:GAUSs	Program DC Gauss mode
:UNIT:FLUX1:DC:TESLa	Program DC Tesla mode
:UNIT:FLUX1?	Query mode setting

RANGE COMMANDS	DESCRIPTION
:SENSe1:FLUX:RANGe:AUTO	Program auto range
:SENSe1:FLUX:RANGe <n>	Program fixed range
:SENSe1:FLUX:RANGe?	Query range setting

FILTER COMMANDS	DESCRIPTION
:SENSe1:FLUX:AVERage:STATe <b>	Program filter setting
:SENSe1:FLUX:AVERage:STATe?	Query filter setting

PEAK HOLD COMMANDS	DESCRIPTION
:SENSe1:HOLD:STATe <b>	Program peak hold mode
:SENSe1:HOLD:STATe?	Query peak hold mode setting
:SENSe1:HOLD:RESet	Reset presently held peak value

DISPLAY FORMAT COMMANDS	DESCRIPTION
:DISPlay:ENABle <b>	Program display mode
:DISPlay:ENABle?	Query display mode
:DISPlay:FORMat1 <n>	Program display format
:DISPlay:FORMat1?	Query display format setting

CLASSIFIER COMMANDS	DESCRIPTION
:CALCulate1:LIMit:LOWer <NRf>	Program lower classifier setting
:CALCulate1:LIMit:UPPer <NRf>	Program upper classifier setting
:CALCulate1:LIMit:LOWer?	Query lower classifier setting
:CALCulate1:LIMit:UPPer?	Query upper classifier setting
:CALCulate1:LIMit:STATe <b>	Program classifier mode
:CALCulate1:LIMit:STATe?	Query classifier mode setting
:CALCulate1:LIMit:FAIL?	Query classifier pass / fail status

PROBE ZERO / RELATIVE COMMANDS	DESCRIPTION
:SYSTem:AZERo1	Initiate probe zero operation
:SYSTem:ARELative1:STATe <n>	Program probe relative mode
:SYSTem:ARELative1:STATe?	Query probe relative mode setting
:SYSTem:ARELative1:VALue?	Query relative value

MEASUREMENT COMMANDS	DESCRIPTION
:MEASure:FLUX1?	Obtain flux density value

CALIBRATION COMMANDS	DESCRIPTION
:SYSTem:CAL <n>	Program auto calibration mode
:SYSTem:CAL?	Query auto calibration mode setting

Table V-C
SCPI Command summary

V-M(a) ERROR QUEUE MESSAGES AND COMMANDS

As error messages occur, they are placed in the error queue. Each message will contain a number, a comma (,) and a brief description of the error. Negative (-) numbers are used for SCPI defined messages while positive (+) numbers relate specifically to the gaussmeter.

The error queue can hold up to 10 messages. Each time the queue is read the oldest message is presented and removed from the queue. If no errors exist the message “0, No error” will be returned. If the queue is full the message “-350, Queue Overflow” will occupy the last queue location. It is an indication that at least one, perhaps more error message(s) were lost.

There are certain error status bits that will set in the STANDARD EVENT register. These bits provide general error indications. The error queue will provide more detailed information about the errors.

The error queue can be read and cleared with the following commands:

:SYSTem:ERRor?	Either command places the oldest error message in the output queue.
:SYSTem:CLEar	Either command clears all messages in the Error queue.

V-M(b) STATUS COMMANDS

The STATUS commands control and query the MEASUREMENT EVENT, OPERATION EVENT and QUESTIONABLE EVENT registers as well as the error queue.

:STATus:MEASurement:EVENt? :STATus:OPERation:EVENt? :STATus:QUEStionable:EVENt?	Reads the contents of the specified EVENT register and places it in the output queue, then clears the register contents
:STATus:MEASurement:ENABle <NRf> :STATus:OPERation:ENABle <NRf> :STATus:QUEStionable:ENABle <NRf>	Programs the specified EVENT ENABLE register with the value <NRf>. <NRf> is an ASCII string representing an integer mask. For instance a value of 45 decimal is the same as binary 00101101, thus setting bits 5, 3, 2 and 0 in the enable register.
:STATus:MEASurement:ENABle? :STATus:OPERation:ENABle? :STATus:QUEStionable:ENABle?	Reads the contents of the specified EVENT ENABLE register and places it in the output queue.
:STATus:MEASurement:CONDition? :STATus:OPERation:CONDition? :STATus:QUEStionable:CONDition?	Reads the contents of the specified EVENT CONDITION register and places it in the output queue. The EVENT CONDITION register is a

	real-time register reflecting the state of the meter at the time of the read. Some conditions could happen very quickly and could be missed by this query. It is often better to rely on the contents of the EVENT register since it latches the event until cleared by a specific command.
:STATus:PRESet	Clears the MEASUREMENT EVENT ENABLE, OPERATION EVENT ENABLE and QUESTIONABLE EVENT ENABLE registers.

V-M(c) MODE COMMANDS

These commands select readings in either GAUSS or TESLA and flux density readings for either static fields (DC) or alternating fields (AC). For more information see the previous discussion for the MODE SELECT menu (Section-IV).

:UNIT:FLUX1:AC:GAUSs	Specifies AC flux density readings in gauss.
:UNIT:FLUX1:AC:TESLa	Specifies AC flux density readings in tesla.
:UNIT:FLUX1:DC:GAUSs	Specifies DC flux density readings in gauss.
:UNIT:FLUX1:DC:TESLa	Specifies DC flux density readings in tesla.
:UNIT:FLUX1?	Places an ASCII string in the output queue representing the present mode setting for the meter. The ASCII string can be DC GAUSS, AC GAUSS, DC TESLA or AC TESLA.

V-M(d) RANGE COMMANDS

These commands select either a fixed range or AUTO range. For more information see the previous discussion for the RANGE SELECT menu (Section-IV).

:SENSe1:FLUX:RANGe:AUTO	Selects the AUTO RANGE function.
:SENSe1:FLUX:RANGe <n>	Selects a fixed range <n>, where n = 1 for 3 G / 300 μT (30 mG / 3 μT) 2 for 30 G / 3 mT (300 mG / 30 μT) 3 for 300 G/ 30 mT (3 G / 300 μT) 4 for 3 kG / 300 mT (30 G / 3 mT) 5 for 30 kG / 3 T 6 for 300 kG / 30 T NOTE: The ranges in parenthesis () are used for 0.01X probes (Magnaprobes).
:SENSe1:FLUX:RANGe?	Places an ASCII string in the output queue representing the present range setting for the meter. The string will be a single digit indicating the present range, as follows: 1 for 3 G / 300 μT (30 mG / 3 μT) 2 for 30 G / 3 mT (300 mG / 30 μT) 3 for 300 G/ 30 mT (3 G / 300 μT) 4 for 3 kG / 300 mT (30 G / 3 mT) 5 for 30 kG / 3 T 6 for 300 kG / 30 T NOTE: The ranges in parenthesis () are used for 0.01X probes (Magnaprobes). Also, if the meter has been programmed for AUTO range operation, the range digit will be followed by a comma and the phrase “AUTO”, such a 3,AUTO;

V-M(e) FILTER COMMANDS

These commands turn on or off the filter. For more information see the previous discussion for the MODE SELECT menu (Section-IV).

:SENSe1:FLUX:AVERage:STATe <b>	The filter is turned off when <b> is 0 or OFF, or on when <b> is 1 or ON.
:SENSe1:FLUX:AVERage:STATe?	Places the on / off status of the filter in the output queue. A 0 indicates the filter is off and a 1 indicates the filter is on.

V-M(f) PEAK HOLD COMMANDS

These commands turn on or off the PEAK HOLD function. For more information see the previous discussion for the PEAK HOLD menu (Section-IV).

:SENSe1:HOLD:STATe <b>	The peak hold function is turned off when <b> is 0 or OFF, or on when <b> is 1 or ON.
:SENSe1:HOLD:STATe?	Places the on / off status of the peak hold function in the output queue. A 0 indicates peak hold is off and a 1 indicates peak hold is on.
:SENSe1:HOLD:RESet	When peak hold is turned on this command resets the presently held value. This allows a new peak reading to be acquired on subsequent measurement cycles.

V-M(g) DISPLAY FORMAT COMMANDS

These commands control the format of the display. For more information see the previous discussion for the DISPLAY FORMAT menu (Section-IV).

:DISPlay:ENABle <b>	The display is turned off when <n> is 0 or OFF, or on when <n> is 1 or ON. The instrument operates at a higher speed when the display is turned off. In this state a single message GAUSSMETER BEING CONTROLLED REMOTELY will appear on the display.
:DISPlay:ENABle?	Places the on / off status of the display enable status in the output queue. A 0 indicates the display is turned off and a 1 indicates it is on.
:DISPlay:FORMat1 <n>	When <n> is 0 both the digital reading and the analog bargraph will appear on the display. When <n> is 1 only the digital reading will appear on the display. When <n> is 2 only the analog bargraph will appear on the display. When <n> is 3 the meter is deactivated and no information will appear on the display.
:DISPlay:FORMat1?	Places the display format status in the output queue. A 0 indicates both the digital reading and the analog bargraph appear on the display. A 1 indicates only the digital reading appears on the display. A 2 indicates only the analog bargraph appears on the display. A 3 indicates the meter is deactivated and no information appears on the display.

V-M(h) CLASSIFIER COMMANDS

These commands control the CLASSIFIER function. For more information see the previous discussion for the CLASSIFIER menu (Section-IV).

:CALCulate1:LIMit:LOWer <NRf> :CALCulate1:LIMit:UPPer <NRf>	<NRf> is a signed decimal number that sets the lower and upper classifier limits. <NRf> must be between 0.000000000 and ± 299999. The meaning of the limit depends upon the currently selected unit of measure (gauss or tesla). For instance the value 1.02 could mean 1.02 G or 1.02 T. If a lower limit is specified that is arithmetically larger than the upper limit, the two limits will be swapped internally. The sign of the limit has no meaning in the AC measurement mode.
:CALCulate1:LIMit:LOWer? :CALCulate1:LIMit:UPPer?	The requested classifier limit is placed in the output queue. The limit will be between 0.000000000 and ± 299999. The meaning of the limit depends upon the currently selected unit of measure (gauss or tesla). For instance the value 1.02 could mean 1.02 G or 1.02 T.
:CALCulate1:LIMit:STATe <b>	The classifier function is turned on when <b> is 1 or ON, or turned off when <b> is 0 or OFF.
:CALCulate1:LIMit:STATe?	The state of the classifier function is placed in the output queue. A 0 indicates the classifier function is turned off, a 1 means it is turned on.
:CALCulate1:LIMit:FAIL?	The pass/fail status of the classifier test is placed in the output queue. A 1 indicates that the measured value falls between the lower and upper limit. A 0 indicates that the measured value either falls below the lower limit or above the higher limit. To determine which limit was exceeded inspect the contents of the MEASUREMENT EVENT register.

V-M(i) PROBE ZERO COMMANDS

These commands control the PROBE ZERO function. For more information see the previous discussion for the PROBE ZERO menu (Section-IV).

:SYSTem:AZERo1	Automatic probe zeroing is initiated upon receipt of this

command.

V-M(j) PROBE RELATIVE COMMANDS

These commands control the PROBE RELATIVE function. For more information see the previous discussion for the PROBE RELATIVE menu (Section-IV).

:SYSTem:ARELative1:STATe <n>	The probe relative function is turned off when <n> is 0. When <n> is 1 the probe relative function is turned on and the automatic probe relative operation is initiated. When <n> is 2 the probe relative function is turned on and the previously-generated relative value is reestablished.
:SYSTem:ARELative1:STATe?	The on / off state of the relative function is placed in the output queue. A 0 indicates the probe relative function is turned off. A 1 indicates the probe relative function is turned on.
:SYSTem:ARELative1:VALue?	The requested relative value is placed in the output queue. The relative value will be between 0.000000000 and ± 299999. The meaning of the value depends upon the currently selected unit of measure (gauss or tesla). For instance the value 14.78 could mean 14.78 G or 14.78 T. The relative value is the level of the magnetic field prior to initiating a probe relative operation.

V-M(k) MEASUREMENT COMMANDS

NOTE: The meter continuously acquires new readings and places the results in internal holding registers. The contents of these registers can be retrieved using the following commands. These commands do not cause new readings to be acquired, rather they retrieve the results of the last readings that were processed. Since there is a finite time between each update it is possible to read the same result more than once. It is highly advisable to use the MEASUREMENT EVENT register to determine when a new reading is available. Refer to Section V-G and V-M(b).

:MEASure:FLUX1?	These commands acquire the latest flux density reading. The returned string will contain a signed real number, a unit indicator (G or T), a comma(,) and a 1, as follows: ±17345.0G,1 If in the AC mode the ± sign will not appear in the reading. The range of possible readings, depending on the type of probe used, is 0.00001G to 299999.0G,

or 0.000000001T to 29.99T.

V-M(I) SELF CALIBRATION COMMANDS

These commands control the internal self calibration cycle. As mentioned in Section III the internal recalibration cycle guarantees optimum performance and is initiated shortly after power-up, any time a probe is connected or any time the internal temperature of the instrument varies by more than 5 °C.

The possibility of an unexpected recalibration cycle (triggered by a temperature change) might be disruptive to some users. These commands allow this situation to be controlled.

:SYSTem:CAL <n>	When <n> is 0 the instrument ignores the internal temperature. Recalibration will still occur upon power-up or any time a probe is connected. When <n> is 1 the instrument returns to the normal calibration mode, monitoring temperature and recalibrating if the internal temperature varies by more than 5 °C. When <n> is 2 the gaussmeter will be forced to recalibrate once it has finished executing the present command string. After this the instrument will return to the previously defined calibration mode, either monitoring temperature (<n> = 1) or ignoring it (<n> = 0).
:SYSTem:CAL?	The state of the self recalibration mode is placed in the output queue. A 0 indicates the meter is ignoring the internal temperature. A 1 indicates the internal temperature is being monitored.

V-N INTERMIXING “COMMON” AND SCPI COMMANDS

As mentioned earlier a string sent to the instrument can contain more than one command as long as the commands are separated by semicolons(;). “Common” and SCPI commands can be intermixed. For instance the string

*CLS;:UNIT:FLUX1:DC:TESLA;:MEASure:FLUX1?

is valid, first clearing the instrument, then programming it supply readings in tesla in the dc mode and requesting a new measurement.

V-O MESSAGE TERMINATORS

When transmitting a string to the instrument the message must be "terminated" properly to notify the instrument that the message is complete. One way is to append an ASCII line feed (LF) character as the final character in the string, which is a 0A hex or 00001010 binary. Note that 0A hex is equivalent to 10 decimal, but sending the two ASCII characters "10" will not work. It must be the single byte representation of the LF control character.

If using the IEEE-488 bus the second way to terminate a message is to assert the End-or-Identify (EOI) bus line at the same time the final character is sent to the instrument.

It is also acceptable to send the LF character and assert EOI with that character. In most cases sending the LF character and/or asserting the EOI line is a function of the IEEE-488 controller card being used, and can be specified when the card's configuration program is run. Usually the user has the option to automatically append the LF character and/or assert the EOI line with every transmission to the instrument. If not it is the programmer's task to append the LF character to each string and/or make sure the EOI line is asserted with the last character transmitted.

When using the RS-232 port the instrument will always send the LF character every time it transmits a message to the system controller.

When using the IEEE-488 bus the instrument will send the LF character and assert the EOI line every time it transmits a message to the system controller.

V-P SAMPLE PROGRAMS

Of the many programming languages available such as C, Pascal, Fortran, BASIC, etc., BASIC is probably the best known and understood by the most people. For this reason the following example programs were written in Microsoft® MS-DOS Q-BASIC for 80x86 style personal computers.

These programs are provided as guides for programmers who wish to develop their own programs. Thus they were written for clarity and are not necessarily the most efficient in terms of speed or size. Not all of the commands are demonstrated, but enough are to serve as a general guide for using the other commands.

These programs were designed for either the multiple channel 9950 gauss / tesla meter or the single channel 9550 meter. The 9550 and "Channel-1" on the 9950 are considered to be the same thing.

V-P(a) IEEE-488 PROGRAM

There are a variety of IEEE-488 (GPIB) controller cards available for the PC. One of the most popular is made by National Instruments, the GPIB-PCIIA card. This program was written for and tested with this card. Though this card requires specific hardware choices about the base address, interrupt and DMA, there is nothing in this program relating to those parameters. However, prior to running this program you must do two things: (1) Set the meter's IEEE-488 address to 15 via the COMMUNICATIONS FORMAT menu, and (2) run the National-supplied program called ULI.COM.

The first part of the program declares subroutines and variables, and introduces starting instructions to the user.

```
DECLARE SUB METER.I.O (expect.response%)
DIM SHARED METER.CMD$, METER.RESP$, METER.ERROR%
DIM CHAN$(3), PROBE$(3), MODE$(3), RANGE$(3), FILTER$(3)
DIM HOLD$(3), CLASS$(3), LOCLASS$(3), HICLASS$(3), REL$(3)
DIM G.T$(3), GAUSS$(8), TESLA$(8)

GAUSS$(1) = "3 G":      TESLA$(1) = "300 uT"
GAUSS$(2) = "30 G":     TESLA$(2) = "3 mT"
GAUSS$(3) = "300 G":    TESLA$(3) = "30 mT"
GAUSS$(4) = "3 KG":     TESLA$(4) = "300 mT"
GAUSS$(5) = "30 KG":    TESLA$(5) = "3 T"
GAUSS$(6) = "300 KG":   TESLA$(6) = "30 T"
GAUSS$(7) = "3 MG":     TESLA$(7) = "300 T"

CLS
    PRINT "************************************************************************"
    PRINT "                    IEEE-488 DEMONSTRATION PROGRAM FOR"
    PRINT "               F.W.BELL 9950 / 9550 GAUSS / TESLA METERS"
    PRINT "************************************************************************"
    PRINT "This program demonstrates the use of the IEEE-488 bus on an"
    PRINT " F.W.BELL 9950 or 9550 gauss / tesla meter.  This Q-BASIC program"
    PRINT " was intended for use on any 80x86 PC using a National Instruments"
    PRINT " GPIB-PCIIA card."
    PRINT
    PRINT " This program can be used to verify the connection between the"
    PRINT " meter and computer as well as provide a template for system"
    PRINT " programmers who wish to create their own programs."
    PRINT
    PRINT "The National card comes with a program called ULI.COM that should "
    PRINT " be executed prior to starting this program.  This program was "
    PRINT " tested with the National GPIB-PCIIA card set to base address 2E1,"
    PRINT " DMA Channel-1 and interrupt-7 (IRQ-7).  The meter's IEEE-488 "
    PRINT " address should be set to 15 using the COMMUNICATIONS FORMAT menu."
    PRINT
    PRINT "When executed this program will obtain and display the present"
    PRINT " setup of the instrument, and then will acquire flux readings on"
    PRINT " a continuous basis."
    PRINT
    PRINT "Place the meter in the RUN mode and press any key to continue...";
```

```
    DO
    LOOP UNTIL INKEY$ <> "":   CLS
```

Note: The IEEE-488 controller is initialized. Since all command strings must end with a line feed character, the card is instructed to append a LF character to each outgoing message and to expect one on each incoming message.

```
    PRINT "Initializing IEEE-488 controller..."
    OPEN "GPIB0" FOR OUTPUT AS #1
    OPEN "GPIB0" FOR INPUT AS #2
    PRINT #1, "ABORT"
    PRINT #1, "RESET"
    PRINT #1, "GPIBEOS LF"                  'Terminate all bus activity
    PRINT #1, "LANGEOS CR LF"          ' and put the meter in
    PRINT #1, "REMOTE 15"                   ' remote mode.
```

Note: The meter is asked to provide its I.D. information. The meter's I.D. is displayed and any information about the probes is saved for later.

```
    '=======================================
    'Request meter and probe I.D. information.
    '=======================================
RESTART:
    CLS
    PRINT "Retrieving meter I.D. information...": PRINT
    METER.CMD$ = "*IDN?;*OPT?": CALL METER.I.O(1)

    IF METER.ERROR% = 1 THEN
        PRINT "Meter did not respond as requested.   Please check your"
        PRINT " interface cable.   Verify that the meter is set for"
        PRINT " an IEEE-488 address of 15. Make sure the meter is in the "
        PRINT " RUN mode."
        END
    END IF

    '==============================
    'Display meter I.D. information.
    '==============================
    POS2% = INSTR(METER.RESP$, ";")
    PRINT "Meter I.D. = "; LEFT$(METER.RESP$, POS2% - 1)
    MODEL% = 9950
    IF INSTR(METER.RESP$, "9550") <> 0 THEN MODEL% = 9550

    '=======================================
    'Save the status of each channel and probe.
    '=======================================

    FOR X% = 0 TO 2
        POS1% = INSTR(POS2% + 1, METER.RESP$, ",")
        CHAN$(X%) = MID$(METER.RESP$, POS1% - 1, 1)
        POS2% = INSTR(POS1% + 1, METER.RESP$, ",")
        IF POS2% = 0 THEN POS2% = INSTR(POS1% + 1, METER.RESP$, ";")
        PROBE$(X%) = MID$(METER.RESP$, POS1% + 1, (POS2% - POS1% - 1))
        IF MODEL% = 9550 THEN EXIT FOR
```

```
NEXT X%
```

Note: The meter is asked to provide information about its present setup such as range, mode, classifiers, etc. This information is then displayed in a table.

```
'=====================================================
'Obtain and display the present setup of each channel
' in a table format.
'=====================================================
LOCATE 10, 1: PRINT "PROBE";
LOCATE 11, 1: PRINT "MODE";
LOCATE 12, 1: PRINT "RANGE";
LOCATE 13, 1: PRINT "FILTER";
LOCATE 14, 1: PRINT "PEAK HOLD";
LOCATE 15, 1: PRINT "CLASSIFIER";
LOCATE 16, 1: PRINT "LO CLASS LIMIT";
LOCATE 17, 1: PRINT "HI CLASS LIMIT";
LOCATE 18, 1: PRINT "RELATIVE VALUE";
LOCATE 19, 1: PRINT "PRESENT READING";
LOCATE 23, 1
PRINT "Flux readings will be updated until any key is pressed."

FOR X% = 0 TO 2
    CH$ = RIGHT$(STR$(X% + 1), 1)
    SCREEN.COL = 20 * (X% + 1)

    '=====================================================
    'If this is a 9950 then display the status of the next
    ' channel and probe.  If this is a 9550, display the
    ' status of the probe only.
    '=====================================================

    IF MODEL% = 9950 THEN
        LOCATE 7, SCREEN.COL: PRINT "    CHANNEL-" + CH$;
        LOCATE 8, SCREEN.COL: PRINT "----------"
        IF CHAN$(X%) = "0" THEN
            LOCATE 9, SCREEN.COL: PRINT " NOT INSTALLED"
        END IF
    ELSE
        LOCATE 7, SCREEN.COL: PRINT "     STATUS"
        LOCATE 8, SCREEN.COL: PRINT "----------"
    END IF

    IF CHAN$(X%) = "0" THEN
        GOTO CONT.TABLE
    ELSE
        LOCATE 10, SCREEN.COL
        IF PROBE$(X%) = "0" THEN
            PRINT "NOT INSTALLED"
        ELSE
            PRINT PROBE$(X%)
        END IF
    END IF
```

```
'====================================
'Obtain and display the present mode.
'====================================
METER.CMD$ = ":UNIT:FLUX" + CH$ + "?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
MODE$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 11, SCREEN.COL: PRINT MODE$(X%)
IF INSTR(MODE$(X%), "GAUSS") <> 0 THEN
    G.T$(X%) = " G"
ELSE
    G.T$(X%) = " T"
END IF
```

```
'====================================
'Obtain and display the present range.
'====================================
METER.CMD$ = ":SENSE" + CH$ + ":FLUX:RANGE?": CALL METER.I.O(1)
RANGE$(X%) = LEFT$(METER.RESP$, 1)
POS1% = VAL(RANGE$(X%))
LOCATE 12, SCREEN.COL
IF G.T$(X%) = " G" THEN
    PRINT GAUSS$(POS1%)
ELSE
    PRINT TESLA$(POS1%)
END IF

'================================================
'Obtain and display the present state of the filter.
'================================================
METER.CMD$ = ":SENSE" + CH$ + ":FLUX:AVER:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
FILTER$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 13, SCREEN.COL
IF FILTER$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

'============================================================
'Obtain and display the present state of the peak hold function.
'============================================================
METER.CMD$ = ":SENSE" + CH$ + ":HOLD:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
HOLD$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 14, SCREEN.COL
IF HOLD$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

'============================================================
'Obtain and display the present state of the classifier function.
'============================================================
METER.CMD$ = ":CALC" + CH$ + ":LIM:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
CLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 15, SCREEN.COL
IF CLASS$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

METER.CMD$ = ":CALC" + CH$ + ":LIM:LOW?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
```

```
        LOCLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 16, SCREEN.COL
        PRINT LOCLASS$(X%); G.T$(X%)

        METER.CMD$ = ":CALC" + CH$ + ":LIM:UPP?": CALL METER.I.O(1)
        POS1% = INSTR(METER.RESP$, ";")
        HICLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 17, SCREEN.COL
        PRINT HICLASS$(X%); G.T$(X%)

        '============================================================
        'Obtain and display the present state of the relative function.
        '============================================================
        METER.CMD$ = ":SYST:AREL" + CH$ + ":STAT?": CALL METER.I.O(1)
        POS1% = INSTR(METER.RESP$, ";")
        REL$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 18, SCREEN.COL
        IF REL$(X%) = "0" THEN
            PRINT "OFF"
        ELSE
            METER.CMD$ = ":SYST:AREL" + CH$ + ":VAL?": CALL METER.I.O(1)
            POS1% = INSTR(METER.RESP$, ";")
            REL$(X%) = LEFT$(METER.RESP$, POS1% - 1)
            LOCATE 18, SCREEN.COL
            PRINT REL$(X%); G.T$(X%)
        END IF

CONT.TABLE:
        IF MODEL% = 9550 THEN EXIT FOR
    NEXT X%
```

Note: From this point on the meter is asked to provide flux density information for all probes. This information is displayed on a continuous basis until the user presses a key. The meter is first instructed to enable the “reading available” status bits in the MEASUREMENT EVENT register so that the “measurement event” status bit will set in the STATUS BYTE whenever a reading is available. It is also instructed to set the “request for service” bit in the STATUS byte when this happens. The program performs a serial poll operation to read the STATUS BYTE rather than responding to an srq (service request) interrupt.

The 9550 is considered to be the same as “Channel-1” on the 9950. Although the program inspects the status of all three channels regardless of the model, there will never be a “reading available” status from Channel-2 and 3 on the 9550.

```
'=============================================================
'Clear error and status registers. Enable the "message available"
' bits in the measurement event register and the "measurement
' summary" bit in the status byte.   Obtain and display the
' flux readings on a continuous basis until user presses a key.
'=============================================================
METER.CMD$ = ":SYST:CLEAR;:STATUS:PRESET": CALL METER.I.O(0)
METER.CMD$ = ":STAT:MEAS:ENABLE 56;*SRE 1": CALL METER.I.O(0)

DO
    DO
PRINT #1, "SPOLL 15"                'Wait for MEASUREMENT SUMMARY
        INPUT #2, X%                                ' bit to set.
    LOOP WHILE (X% AND 1)   = 0

    METER.CMD$ = ":STAT:MEAS:EVENT?": CALL METER.I.O(1)
    X% = VAL(METER.RESP$)

    '=============================================================
    'If Channel-1 is ready with a new reading, obtain and display it.
    '=============================================================
    IF (X% AND 8) <> 0 THEN
        IF PROBE$(0) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX1?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
        ELSE
            POS1% = INSTR(METER.RESP$, ",")
            LOCATE 19, 20: PRINT LEFT$(METER.RESP$, POS1% - 1);
        END IF
    END IF

    '=============================================================
    'If Channel-2 is ready with a new reading, obtain and display it.
    '=============================================================
    IF (X% AND 16) <> 0 THEN
        IF PROBE$(1) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX2?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
        ELSE
            POS1% = INSTR(METER.RESP$, ",")
            LOCATE 19, 40: PRINT LEFT$(METER.RESP$, POS1% - 1);
        END IF
    END IF

    '=============================================================
    'If Channel-3 is ready with a new reading, obtain and display it.
    '=============================================================
    IF (X% AND 32) <> 0 THEN
        IF PROBE$(2) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX3?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
```

```
            ELSE
                POS1% = INSTR(METER.RESP$, ",")
                LOCATE 19, 60: PRINT LEFT$(METER.RESP$, POS1% - 1);
            END IF
        END IF

    LOOP UNTIL INKEY$ <> ""
    METER.CMD$ = "*GTL": CALL METER.I.O(0)

    END

SUB METER.I.O (expect.response%)
    ' ============================================================
    '                                   METER INPUT / OUTPUT SUBROUTINE
    ' ============================================================
    ' This subroutine transmits the contents of the global buffer
    ' <METER.CMD$> to the meter.
    '
    ' If the variable <expect.response%> is non-zero, the subroutine will
    ' wait for a response from the meter and store it in the global buffer
    ' <METER.RESP$>.   If no response occurs within 5 seconds the global
    ' variable <METER.ERROR%> will be set to 1.
    '============================================================
    METER.ERROR% = 0                                    'Clear error flag.

    PRINT #1, "OUTPUT 15;" + METER.CMD$       'Send command string.

    IF expect.response% = 0 THEN EXIT SUB       'Done if no response expected.
    METER.RESP$ = ""                                      'Null response buffer.

    PRINT #1, "ENTER 15"                                ‘Get response from meter.
    LINE INPUT #2, METER.RESP$
    END SUB
```

V-P(b) RS-232 PROGRAM

Since most PCs have RS-232 ports already built in to them the only additional item needed is the interface cable. Though the IEEE-488.2 and SCPI commands are widely used with the IEEE-488 bus they are also usable with the RS-232 serial port, with a few exceptions.

First, any device connected to an IEEE-488 bus can get the attention of ("interrupt") the master controller by asserting a particular bus line. The event registers can be utilized to generate specific interrupts, such as when an error occurs or when a reading is available. Thus the computer does not have to be tied up continually reading ("polling") status registers to determine when these conditions occur. There are no interrupt provisions with RS-232, so polling of the status registers is necessary. One command that is particularly useful with RS-232 is the *OPC? command. Once this is issued the meter will always transmit the character "1" after every command string. The computer can be configured to generate an interrupt when the character arrives in the receiver buffer, allowing the computer to do other work while waiting for the meter to execute a command.

Second, there are no dedicated command lines on the RS-232 port, so none of general bus commands shown in Table V-A can be issued. However, there are several commands in the "common command" list (Table V-B) that can be used to obtain similar results.

Prior to running the following RS-232 program you must: (1) Set the meter's RS-232 parameters to 9600 baud, 7 character bits, 1 stop bit and odd parity via the COMMUNICATIONS FORMAT menu. (2) Use one of the two cables shown in Section-VI and connect it to the COM1 port of your computer (or change the program to work with COM2). The cable <u>without</u> handshaking is best.

The first part of the program declares subroutines and variables, and introduces starting instructions to the user.

```
DECLARE SUB METER.I.O (expect.response%)
DIM SHARED METER.CMD$, METER.RESP$, METER.ERROR%
DIM CHAN$(3), PROBE$(3), MODE$(3), RANGE$(3), FILTER$(3)
DIM HOLD$(3), CLASS$(3), LOCLASS$(3), HICLASS$(3), REL$(3)
DIM G.T$(3), GAUSS$(8), TESLA$(8)

GAUSS$(1) = "3 G":       TESLA$(1) = "300 uT"
GAUSS$(2) = "30 G":      TESLA$(2) = "3 mT"
GAUSS$(3) = "300 G":     TESLA$(3) = "30 mT"
GAUSS$(4) = "3 KG":      TESLA$(4) = "300 mT"
GAUSS$(5) = "30 KG":     TESLA$(5) = "3 T"
GAUSS$(6) = "300 KG":    TESLA$(6) = "30 T"
GAUSS$(7) = "3 MG":      TESLA$(7) = "300 T"
```

```
    CLS
     PRINT "*************************************************************************"
     PRINT "                      RS-232 DEMONSTRATION PROGRAM FOR"
     PRINT "                F.W.BELL 9950 / 9550 GAUSS / TESLA METERS"
     PRINT "*************************************************************************"
     PRINT "This program demonstrates the use of the RS-232 serial port on an"
     PRINT " F.W.BELL 9950 or 9550 gauss / tesla meter.   This Q-BASIC program"
     PRINT " was intended for use on any 80x86 PC using the COM-1 serial port."
     PRINT " This program can be used to verify the connection between the"
     PRINT " meter and computer as well as provide a template for system"
     PRINT " programmers who wish to create their own programs."
     PRINT
     PRINT "It is important to use the proper interface cable.   A straight-"
     PRINT " through cable will not work.   See Section-VI of the user's manual"
     PRINT " for suggestions.   The cable without handshaking is recommended."
     PRINT
     PRINT "The meter's RS-232 communications parameters should be set using"
     PRINT " the COMMUNICATIONS FORMAT menu to"
     PRINT
     PRINT "             9600 baud, 1 stop bit, 7 data bits and odd parity."
     PRINT
     PRINT "When executed this program will obtain and display the present"
     PRINT " setup of the instrument, and then will acquire flux readings on"
     PRINT " a continuous basis."
     PRINT
     PRINT "Place the meter in the RUN mode and press any key to continue...";

     DO
     LOOP UNTIL INKEY$ <> "":   CLS
```

Note: The COM1 port is initialized. The meter is then asked to provide its I.D. information. The meter's I.D. is displayed and any information about the probes is saved for later.

```
     PRINT "Initializing COM1 port..."
     OPEN "COM1:9600,O,7,1,CS,DS,CD" FOR RANDOM AS #1

     '=======================================
     'Request meter and probe I.D. information.
     '=======================================
RESTART:
     CLS
     PRINT "Retrieving meter I.D. information...": PRINT
     METER.CMD$ = "*IDN?;*OPT?": CALL METER.I.O(1)

     IF METER.ERROR% = 1 THEN
          PRINT "Meter did not respond as requested.   Please check your"
          PRINT " interface cable.   Make sure it is connected to the COM1"
          PRINT " port on your computer.   Verify that the meter is set for"
          PRINT " the proper baud rate, character length, etc.   Make sure"
          PRINT " the meter is in the RUN mode."
          END
     END IF
```

```
'==============================
'Display meter I.D. information.
'==============================
POS2% = INSTR(METER.RESP$, ";")
PRINT "Meter I.D. = "; LEFT$(METER.RESP$, POS2% - 1)
MODEL% = 9950
IF INSTR(METER.RESP$, "9550") <> 0 THEN MODEL% = 9550

'========================================
'Save the status of each channel and probe.
'========================================

FOR X% = 0 TO 2
    POS1% = INSTR(POS2% + 1, METER.RESP$, ",")
    CHAN$(X%) = MID$(METER.RESP$, POS1% - 1, 1)
    POS2% = INSTR(POS1% + 1, METER.RESP$, ",")
    IF POS2% = 0 THEN POS2% = INSTR(POS1% + 1, METER.RESP$, ";")
    PROBE$(X%) = MID$(METER.RESP$, POS1% + 1, (POS2% - POS1% - 1))
    IF MODEL% = 9550 THEN EXIT FOR
NEXT X%
```

Note: The meter is asked to provide information about its present setup such as range, mode, classifiers, etc. This information is then displayed in a table.

```
'================================================
'Obtain and display the present setup of each channel
' in a table format.
'================================================
LOCATE 10, 1: PRINT "PROBE";
LOCATE 11, 1: PRINT "MODE";
LOCATE 12, 1: PRINT "RANGE";
LOCATE 13, 1: PRINT "FILTER";
LOCATE 14, 1: PRINT "PEAK HOLD";
LOCATE 15, 1: PRINT "CLASSIFIER";
LOCATE 16, 1: PRINT "LO CLASS LIMIT";
LOCATE 17, 1: PRINT "HI CLASS LIMIT";
LOCATE 18, 1: PRINT "RELATIVE VALUE";
LOCATE 19, 1: PRINT "PRESENT READING";
LOCATE 23, 1
PRINT "Flux readings will be updated until any key is pressed."
```

```
FOR X% = 0 TO 2
    CH$ = RIGHT$(STR$(X% + 1), 1)
    SCREEN.COL = 20 * (X% + 1)

    '=====================================================
    'If this is a 9950 then display the status of the next
    ' channel and probe.   If this is a 9550, display the
    ' status of the probe only.
    '=====================================================

    IF MODEL% = 9950 THEN
        LOCATE 7, SCREEN.COL: PRINT "     CHANNEL-" + CH$;
        LOCATE 8, SCREEN.COL: PRINT "----------"
        IF CHAN$(X%) = "0" THEN
            LOCATE 9, SCREEN.COL: PRINT " NOT INSTALLED"
        END IF
    ELSE
        LOCATE 7, SCREEN.COL: PRINT "      STATUS"
        LOCATE 8, SCREEN.COL: PRINT "----------"
    END IF

    IF CHAN$(X%) = "0" THEN
        GOTO CONT.TABLE
    ELSE
        LOCATE 10, SCREEN.COL
        IF PROBE$(X%) = "0" THEN
            PRINT "NOT INSTALLED"
        ELSE
            PRINT PROBE$(X%)
        END IF
    END IF

    '==================================
    'Obtain and display the present mode.
    '==================================
    METER.CMD$ = ":UNIT:FLUX" + CH$ + "?": CALL METER.I.O(1)
    POS1% = INSTR(METER.RESP$, ";")
    MODE$(X%) = LEFT$(METER.RESP$, POS1% - 1)
    LOCATE 11, SCREEN.COL: PRINT MODE$(X%)
    IF INSTR(MODE$(X%), "GAUSS") <> 0 THEN
        G.T$(X%) = " G"
    ELSE
        G.T$(X%) = " T"
    END IF
```

```
'====================================
'Obtain and display the present range.
'====================================
METER.CMD$ = ":SENSE" + CH$ + ":FLUX:RANGE?": CALL METER.I.O(1)
RANGE$(X%) = LEFT$(METER.RESP$, 1)
POS1% = VAL(RANGE$(X%))
LOCATE 12, SCREEN.COL
IF G.T$(X%) = " G" THEN
    PRINT GAUSS$(POS1%)
ELSE
    PRINT TESLA$(POS1%)
END IF

'================================================
'Obtain and display the present state of the filter.
'================================================
METER.CMD$ = ":SENSE" + CH$ + ":FLUX:AVER:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
FILTER$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 13, SCREEN.COL
IF FILTER$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

'============================================================
'Obtain and display the present state of the peak hold function.
'============================================================
METER.CMD$ = ":SENSE" + CH$ + ":HOLD:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
HOLD$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 14, SCREEN.COL
IF HOLD$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

'============================================================
'Obtain and display the present state of the classifier function.
'============================================================
METER.CMD$ = ":CALC" + CH$ + ":LIM:STAT?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
CLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
LOCATE 15, SCREEN.COL
IF CLASS$(X%) = "0" THEN
    PRINT "OFF"
ELSE
    PRINT "ON"
END IF

METER.CMD$ = ":CALC" + CH$ + ":LIM:LOW?": CALL METER.I.O(1)
POS1% = INSTR(METER.RESP$, ";")
```

```
        LOCLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 16, SCREEN.COL
        PRINT LOCLASS$(X%); G.T$(X%)

        METER.CMD$ = ":CALC" + CH$ + ":LIM:UPP?": CALL METER.I.O(1)
        POS1% = INSTR(METER.RESP$, ";")
        HICLASS$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 17, SCREEN.COL
        PRINT HICLASS$(X%); G.T$(X%)

        '============================================================
        'Obtain and display the present state of the relative function.
        '============================================================
        METER.CMD$ = ":SYST:AREL" + CH$ + ":STAT?": CALL METER.I.O(1)
        POS1% = INSTR(METER.RESP$, ";")
        REL$(X%) = LEFT$(METER.RESP$, POS1% - 1)
        LOCATE 18, SCREEN.COL
        IF REL$(X%) = "0" THEN
            PRINT "OFF"
        ELSE
            METER.CMD$ = ":SYST:AREL" + CH$ + ":VAL?": CALL METER.I.O(1)
            POS1% = INSTR(METER.RESP$, ";")
            REL$(X%) = LEFT$(METER.RESP$, POS1% - 1)
            LOCATE 18, SCREEN.COL
            PRINT REL$(X%); G.T$(X%)
        END IF

CONT.TABLE:
        IF MODEL% = 9550 THEN EXIT FOR
    NEXT X%
```

Note: From this point on the meter is asked to provide flux density information for all probes. This information is displayed on a continuous basis until the user presses a key. The MEASUREMENT EVENT register is polled to determine if any of the “reading available” status bits are set. If so, the readings are acquired and displayed.

The 9550 is considered to be the same as “Channel-1” on the 9950. Although the program inspects the status of all three channels regardless of the model, there will never be a “reading available” status from Channel-2 and 3 on the 9550.

```
'============================================================
'Clear error and status registers, lockout front panel.
' Obtain and display the flux readings on a continuous basis
' until user presses a key.
'============================================================
METER.CMD$ = "*REN;:SYST:CLEAR;:STATUS:PRESET;*OPC?": CALL METER.I.O(1)

DO
    METER.CMD$ = ":STAT:MEAS:EVENT?": CALL METER.I.O(1)
    X% = VAL(METER.RESP$)

    '================================================================
    'If Channel-1 is ready with a new reading, obtain and display it.
    '================================================================
    IF (X% AND 8) <> 0 THEN
        IF PROBE$(0) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX1?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
        ELSE
            POS1% = INSTR(METER.RESP$, ",")
            LOCATE 19, 20: PRINT LEFT$(METER.RESP$, POS1% - 1);
        END IF
    END IF

    '================================================================
    'If Channel-2 is ready with a new reading, obtain and display it.
    '================================================================
    IF (X% AND 16) <> 0 THEN
        IF PROBE$(1) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX2?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
        ELSE
            POS1% = INSTR(METER.RESP$, ",")
            LOCATE 19, 40: PRINT LEFT$(METER.RESP$, POS1% - 1);
        END IF
    END IF

    '================================================================
    'If Channel-3 is ready with a new reading, obtain and display it.
    '================================================================
    IF (X% AND 32) <> 0 THEN
        IF PROBE$(2) = "0" THEN GOTO RESTART
        METER.CMD$ = ":MEAS:FLUX3?": CALL METER.I.O(1)
        IF INSTR(METER.RESP$, "ERR") <> 0 THEN
            GOTO RESTART
        ELSE
            POS1% = INSTR(METER.RESP$, ",")
            LOCATE 19, 60: PRINT LEFT$(METER.RESP$, POS1% - 1);
        END IF
    END IF

LOOP UNTIL INKEY$ <> ""
```

```
    METER.CMD$ = "*GTL": CALL METER.I.O(0)

    END

SUB METER.I.O (expect.response%)
    '============================================================
    '                    METER INPUT / OUTPUT SUBROUTINE
    '============================================================
    ' This subroutine transmits the contents of the global buffer
    ' <METER.CMD$> to the meter, followed by the line feed terminator.
    '
    ' If the variable <expect.response%> is non-zero, the subroutine will
    ' wait for a response from the meter and store it in the global buffer
    ' <METER.RESP$>.   If no response occurs within 5 seconds the global
    ' variable <METER.ERROR%> will be set to 1.
    '============================================================
    METER.ERROR% = 0                                    'Clear error flag.
    DO UNTIL EOF(1) = -1
        METER.RESP$ = INPUT$(LOC(1), #1)      'Remove any garbage from
    LOOP                                        ' input buffer.

    PRINT #1, METER.CMD$ + CHR$(10);          'Send command string followed
                                                        ' by a line feed.

    IF expect.response% = 0 THEN EXIT SUB     'Done if no response expected.
    METER.RESP$ = ""                                    'Null response buffer.

    'Get present time, but if it is approaching the rollover point,
    ' wait for it to rollover and then continue.

RESET.TIMER:
    START.TIME = TIMER
    IF START.TIME > 86394! THEN GOTO RESET.TIMER

   'Store as many characters as are in the input buffer.   If
    ' one of them is the line feed character, return to caller.
    ' If no response is received within 5 seconds, report an error.
```

```
LOOK.FOR.INPUT:
      IF EOF(1) = -1 THEN
           IF (TIMER - START.TIME) > 5 THEN
                METER.ERROR% = 1
                EXIT SUB
           ELSE
                GOTO LOOK.FOR.INPUT
           END IF

      ELSE
           METER.RESP$ = METER.RESP$ + INPUT$(LOC(1), #1)
           IF (INSTR(METER.RESP$, CHR$(10))) = 0 THEN GOTO RESET.TIMER
           EXIT SUB
      END IF

      END SUB
```

SECTION VI

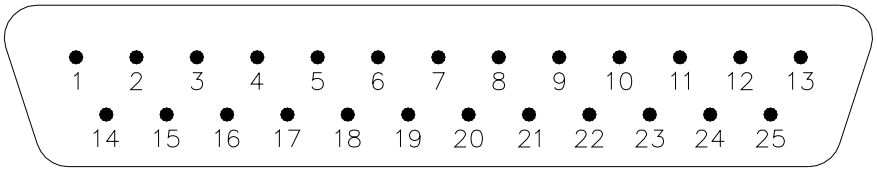
COMMUNICATIONS INTERFACE

EMC APPLICATION NOTE:

Use only high quality, double shielded cables for RS-232 and IEEE-488 connection. Keep the length of the cables less than 3 meters. Long cables (>3m) with insufficient EMI shielding can cause excessive emissions or may be susceptible to external interference.

VI-A RS-232 PORT FUNCTIONAL 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 MODEL-9550 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	6	DATA SET READY
2	TRANSMITTED DATA (Tx)	7	LOGIC GROUND
3	RECEIVED DATA (Rx)	20	DATA TERMINAL READY
4	REQUEST TO SEND	22	RING INDICATOR
5	CLEAR TO SEND		

Figure VI-A
RS-232 "D" Connector

Pin-l: 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.
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)	This pin is implemented in hardware but is not used for any function.

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.

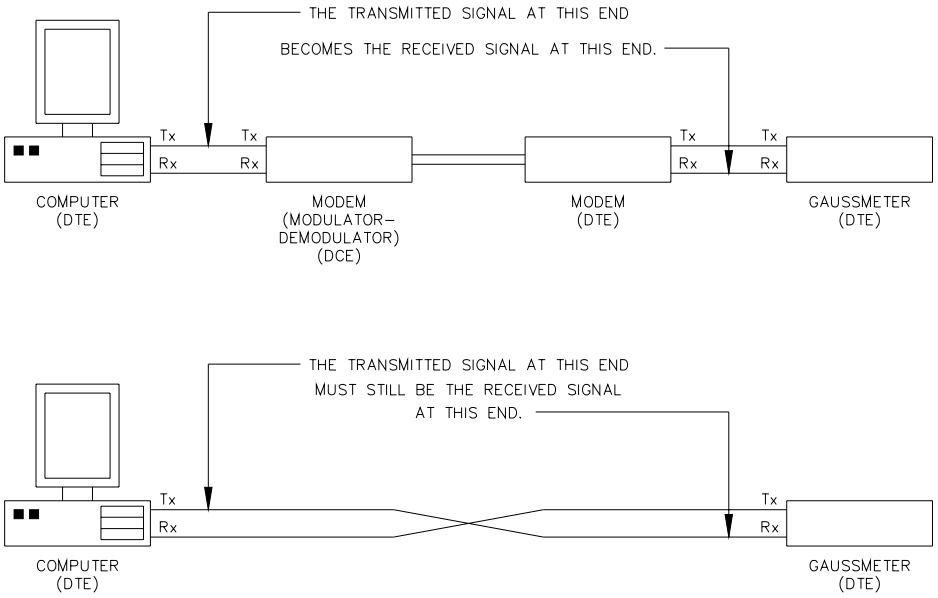


Figure VI-B
DTE and DCE Interface

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 computer-to-printer connection. Usually a printer can not print data at the rate at which it is 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 computer to stop transmitting until it has time to "catch up."

There may be instances 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 IV-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 computer. Making the connection at both ends makes the cable symmetrical and guarantees proper operation no matter which end is plugged into the computer.

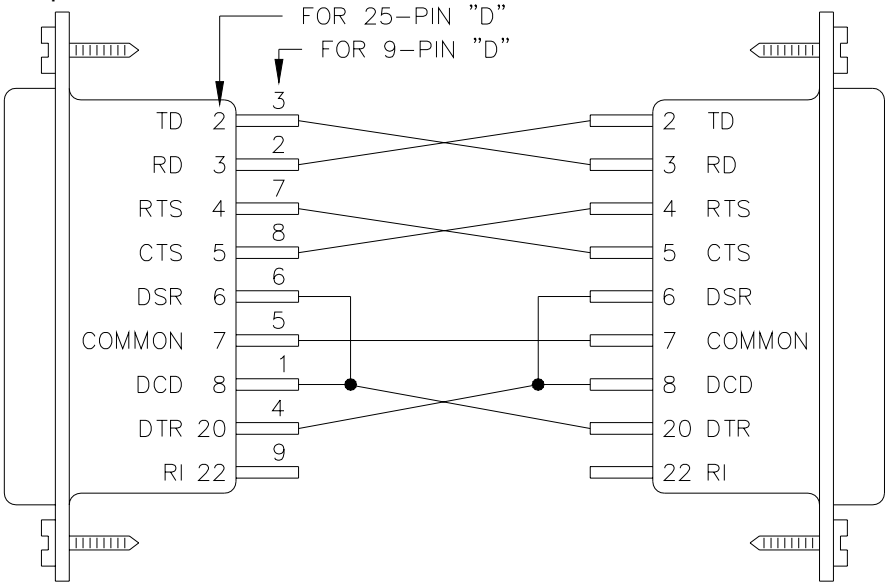


Figure VI-C
RS-232 Connection With Handshaking

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 should be used.

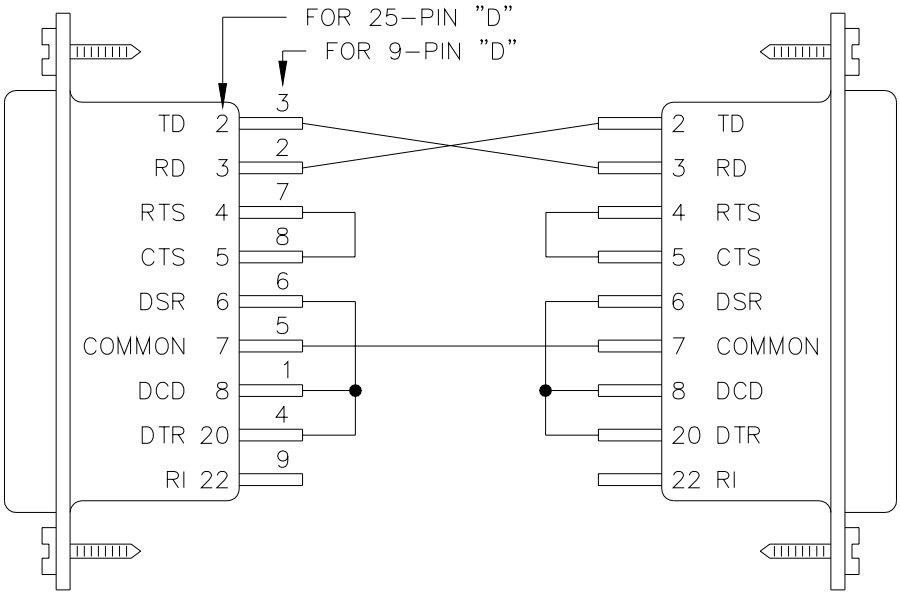


Figure VI-D
RS-232 Connection Without Handshaking

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 that 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 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-dependent 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 MODEL-9550 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.

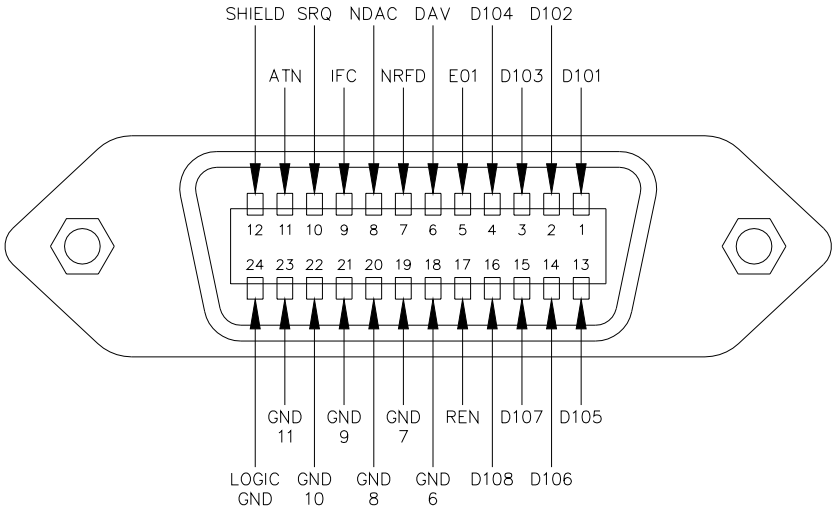


Figure VI-E
IEEE-488 Connector

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 (EIO)	The 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
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/EMIradiation 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 MODEL-9550, use the same address for both. The address is assigned using the COMMUNICATIONS FORMAT menu. See Section IV.

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

VII-A DIAGNOSTIC OVERVIEW

DIAGNOSTIC CODES

Upon power-up, the gaussmeter verifies that all internal components are operating correctly before field measurements begin. This includes the probe. **ERROR**

If a ***major*** error occurs, the gaussmeter may halt operations until the problem is rectified. A ***major*** error is one that prevents the gaussmeter from producing accurate field measurements.

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 does not affect field measurements, such as a failure in communications, setup storage and so on.

VII-B POWER-UP SEQUENCE

When the gaussmeter is first turned on, 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 the 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 may halt operations at this point.

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.

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, ERROR 1xxxx

This MAJOR errors indicate a failure on the PROCESSOR CARD.

VII-C(b) ERROR 2xxxx

This MAJOR error indicates a failure of the SERIES-9550 POWER SUPPLY CONTROLLER CARD or the LINE VOLTAGE INPUT TRANSFORMER ASSEMBLY.

VII-C(c) ERROR 34xxx

This MINOR error indicates a failure on the PROCESSOR CARD that prevents operation of the RS-232 communications port.

VII-C(d) ERROR 35xxx

This MINOR error indicates a failure on the PROCESSOR that prevents operation of the IEEE-488 interface bus.

VII-C(e) ERROR 36xxx

This MINOR error indicates a failure on the PROCESSOR CARD that prevents the gaussmeter's setup information from being stored permanently.

VII-C (f) ERROR 44xxx

This MINOR error indicates a failure on the RS-232 Control Card that prevents operation of the RS-232 communications port.

VII-C(g) ERROR 45xxx

This MINOR error indicates a failure on the IEEE-488 Control Card that prevents operation of the IEEE-488 interface bus.

VII-C(h) ERROR 51xxx

This MINOR error indicates a failure in the Analog Subsection.

VII-C(i) ERROR 61xxx
This MINOR error indicates a failure in the probe. Replace the probe.

SECTION VIII

INSTALLATION OF OPTIONS

VIII-A INSTALLATION OF RACK MOUNTING OPTION

The Rack Mounting Kit (Item #119510) consists of two mounting brackets with four metric flat head screws and an adapter plate with two 1/4-20 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 VIII-A. Remove the Side Cover Plate.

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

3) Attach the Adapter Plate to either the left or right side Rack Mounting Bracket.

4) The instrument can now be mounted in a 19" wide rack or cabinet.

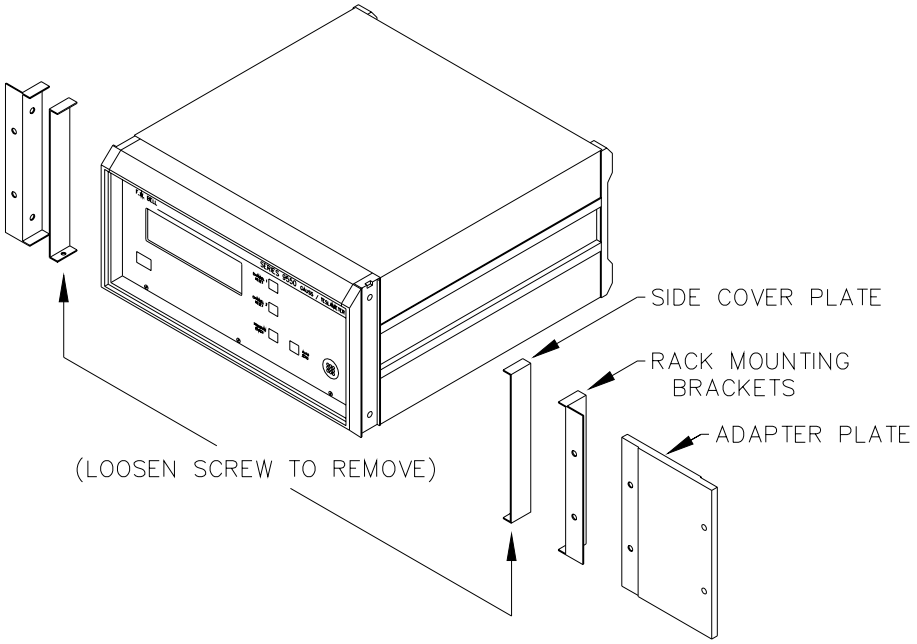


Figure VIII-A
Rack Mounting Installation

SERIES-9550 SPECIFICATIONS

RANGES/RESOLUTION

.01X PROBE

RANGES		RESOLUTION	
GAUSS	**TESLA**	**GAUSS**	**TESLA**
30 mG	3 μT	10 μG	0.001 μT
300 mG	30 μT	10 μT	0.001 μT
3 G	300 μT	100 μG	0.01 μT

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

1X PROBE

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

10X PROBE

RANGES		RESOLUTION	
GAUSS	**TESLA**	**GAUSS**	**TESLA**
30 G	3 mT	10 mG	1 μT
300 G	30 mT	10 mG	1 μT
3 kG	300 mT	100 mG	10 μT
30 kG	3T	1 G	100 μT
300 kG	30T	10G	1 mT

dc ACCURACY

Range	±% of Reading	±Number of Counts
30 mG to 30 G (3 μT to 3mT)	.075	14
300 G to 300 kG (30mT to 30T)	.075	6

Additional Influences:

Temperature Coefficient: <±(0.02% of Reading, ± 3 Counts) / °C
From 0 °C to +50 °C

dc Calibration Reference: ± 0.1 % of Reading
1 year; 23 °C, ±5 °C

ac Accuracy		**Ranges**		
Filter Off		30 mG to 30 G	300 G to 300 KG	
Frequency(Hz)	**±% of Reading**	**±Number of Counts**	**±% of Reading**	**±Number of Counts**
20-49	3.6	500	3.6	75
50-99	1.7	500	1.7	75
100-499	1.0	500	1.0	75
500-10K	0.5	500	0.5	75

ac Accuracy		**Ranges**		
Filter On		30 mG to 30 G	300 G to 300 KG	
Frequency(Hz)	**% of Reading**	**±Number of Counts**	**% of Reading**	**±Number of Counts**
20-49	±3.6	500	±3.6	75
50-99	±1.7	500	±1.7	75
100-499	-10.0	500	-10.0	75
500-10K	-30.0	500	-30.0	75

Additional Influences:
Temperature Coefficient:< ±(0.04% of Reading, +5 Counts) /°C From 0°C to +50°C
ac Calibration Reference: ±1.0% of Reading
Sinewave input: >10% of Full Scale
1 Year; 23°C, ±5°C

NOTES: dc and ac accuracy is for the corrected, displayed reading and the digital information sent out on the RS-232 port or the IEEE-488 bus.

Accuracies do not include probe errors.

FREQUENCY RANGE:

DC Mode	dc
AC Mode (Filter on)	20 Hz to 1 KHz
AC Mode (Filter off)	20 Hz to 10 KHz

FREQUENCY RANGE ANALOG OUTPUT

DC Mode	dc TO 400 Hz
AC Mode (Filter on)	20 Hz to 1 KHz
AC Mode (Filter off)	20 Hz to 10 KHz

TEMPERATURE RANGE:

Operating: 0°C to 50°C
Storage: -20°C to 70°C

HUMIDITY RANGE:

0°C TO 35°C 80% RH
35°C TO 50°C 70% RH

ALTITUDE RANGE:

6562 ft. (2000 m) Maximum

FRONT PANEL DISPLAY:

Type: 240 x 64 pixel electroluminescent
Viewing Area: 5.2 in (13.2 cm) wide, 1.6 in (4.1 cm) high

POWER:

Volts:	103-127	or	207-253
Frequency:	50-60 Hz		50-60 Hz
Current:	400 mA		200 mA

SIZE:

13.47 in (34.2 cm) wide
7.53 in (19.1 cm) high (including feet)
14.12 in (36.1 cm) deep

WEIGHT: (Maximum)

Net: 18.5 lbs (8.4 Kg)
Shipping: 26.0 lbs (11.8 Kg)

COMMUNICATIONS PORTS:

RS-232: Standard 25 pin "D" connector
IEEE-488: Standard 24 pin GPIB connector

WARM UP TIME:

1 Hour to rated specifications

ANALOG OUTPUT:

Output Voltage: 3.0 volts Full Scale
Source impedance: <100 ohms
Termination: Standard BNC connector

DC ANALOG OUTPUT ACCURACY:

For output >10% of Full Scale
1 Year 23°C + 5°C

RANGE	±% Reading	±% Full Scale
30 mG to 3 G	.3	4.0
30 G	.3	.3
300 G to 300 KG	.3	.1

Temperature Coefficient < + (.03% of Reading + .005% FS) /°C
From 0°C to 50°C

NOTE: THE DC MODE ANALOG OUTPUT IS INSTANTANEOUSLY PROPORTIONAL TO THE FIELD IN MAGNITUDE AND POLARITY FROM DC TO 400 Hz.

AC ANALOG OUTPUT ACCURACY

Filter Off **RANGES**

	30mG to 30 G		300 G to 300 KG	
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
500-10K	5	2.0	5	0.25

AC ANALOG OUTPUT ACCURACY

Filter On **RANGES**

	30mG to 30 G		300 G to 300 KG	
Frequency(Hz)	±% of Reading	% of Full Scale	% of Reading	±% of Full Scale
20-39	-36	2.0	-36	0.25
49-79	-17	2.0	-17	0.25
80-159	±5	2.0	±5	0.25
160-319	±5	2.0	±5	0.25
320-639	-17	2.0	-17	0.25
640-1280	-36	2.0	-36	0.25

1 Year; 23°C, ± 5°C
Sinewave input, >10% of Full Scale

Additional Influences:

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

Frequency Range: dc Mode: dc to 400 Hz
(Analog Output) ac Mode: 20 HZ to 10 kHz

Output Noise, ac Mode:

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

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 from 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 a 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
Repair Department
6120 Hanging Moss Road
Orlando, FL 32807

Phone: 407-678-6900

WARRANTY

F.W. Bell 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 replace any defective parts thereof. 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 reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

THE ABOVE WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED AND ALL OTHER OBLIGATIONS AND LIABILITIES ON THE PART OF F.W. BELL, AND NO PERSON INCLUDING ANY DISTRIBUTOR, AGENT OR REPRESENTATIVE OF F.W. BELL IS AUTHORIZED TO ASSUME FOR F.W. BELL ANY LIABILITY ON ITS BEHALF OR ITS NAME, EXCEPT TO REFER THE PURCHASER TO THIS WARRANTY. THE ABOVE EXPRESS WARRANTY IS THE ONLY WARRANTY MADE BY F.W. BELL. F.W. BELL DOES NOT MAKE AND EXPRESSLY DISCLAIMS ANY OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITING THE FOREGOING, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ARISING BY STATUE OR OTHERWISE IN LAW OR FROM A COURSE OF DEALING OR USAGE OR TRADE. THE EXPRESS WARRANTY STATED ABOVE IS MADE IN LIEU OF ALL LIABILITIES FOR DAMAGES, INCLUDING BUT NOT LIMITED TO CONSEQUENTIAL DAMAGES, LOST PROFITS OR THE LIKE ARISING OUT OF OR IN CONNECTION WITH THE SALE, DELIVERY, USE OR PERFORMANCE OF THE GOODS. IN NO EVENT WILL F.W. BELL BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES EVEN IF F.W. BELL HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

Answers to any questions concerning the use of and authorized repair of this product may be obtained by writing F.W. Bell at the address below.

F.W. Bell
6120 Hanging Moss Road
Orlando, FL 32807

Phone: 407-678-6900