

# F. W. BELL

**9000**  
SERIES  
GAUSSMETERS

# INSTRUCTION MANUAL

*EMU copy  
6/7/96*



# MODEL 9200

359200  
96/96

## 9200CE Manual Supplement

### International Electrical Symbols

*(Insert in front of page 1 of the 9200 Manual)*



Caution! Refer to this manual before using the meter.



Caution! Risk of electric shock.

## 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.



### 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.



### WARNING

Replace the battery only with a Powersonic #1220 or F.W. Bell I.N. 335635. Installing the wrong type battery could cause damage, fire or an explosion.



All input and output voltage, except line (mains), are less than 20 volts.



### CAUTION:

For continued protection replace the fuse with the same type (5 X 20mm, slow blow, 125mA at 250V for 230 volt operation or 250mA at 250V for 115 volt operation).

## EMC APPLICATION NOTE:

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

## INSTRUMENT PREPARATION: *(place behind Safety Instructions)*

### AC POWER CONNECTION



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

Figure 1.0 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.

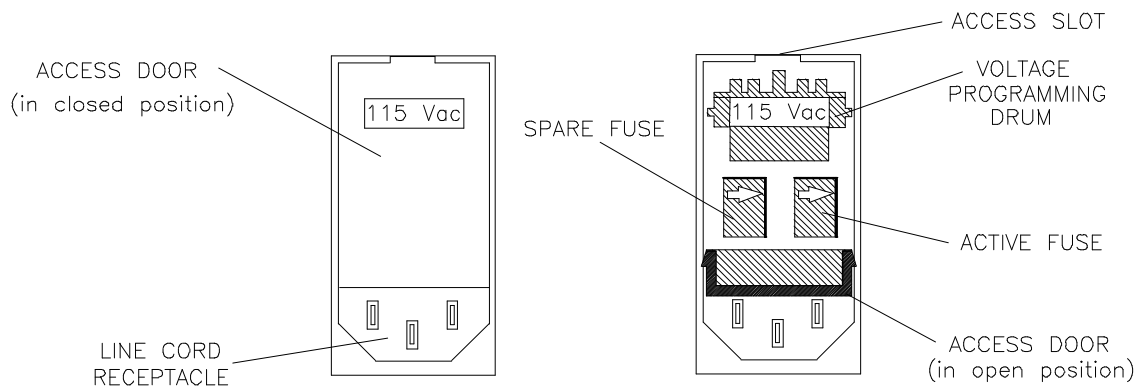


FIGURE 1.0  
POWER RECEPTACLE MODULE

## 9200CE Manual Supplement

*{Add to 9200 Specifications, insert between  
ac ACCURACY and ANALOG  
OUTPUT, page 1}*

EMC: In an RF field of 3V/m	+/- 0.5 Gauss (1x Probes)
Additional Uncertainty, ac and dc	+/- 5.0 Gauss (10x Probes)
(Displayed and Analog Output)	+/- 0.5 mG (x100 Probes)

*{Add to 9200 Specifications, insert between  
Temperature Effects and Frequency Range}*

<b>HUMIDITY RANGE</b>	0°C TO 35°C	0% RH maximum
	35°C to 50°C	50% RH maximum

<b>ALTITUDE RANGE</b>	6562 ft (2000m) maximum
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*{Change 9200 specifications, page 1}*

<b>POWER</b>	ac Volts:	105 - 125	210 - 250
	Frequency:	50 - 60 Hz	50 - 60 Hz
	Current:	250mA	125 mA

*{Change 9200 specifications, page 2}*

<b>INTERNAL BATTERY</b>	Sealed lead-acid (Power sonic PSI220 or F.W. Bell I.N. 335635)
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**SIMPLIFIED  
OPERATING  
INSTRUCTIONS  
FOR THE MODEL-  
9200 GAUSSMETER**

- 1) Check the rear panel power receptacle to insure that the voltage showing is the voltage you will be using, 115 volts ac or 230 volts ac. If it is necessary to change this setting, refer to Section II-A for further information.
- 2) Connect the probe to the connector on the front panel of the gaussmeter.
- 3) Connect power to the MODEL-9200 and turn the instrument on by locating the power switch on the front panel and depressing the side marked "1".
- 4) The Gaussmeter will initiate a self-calibration of internal circuitry. This takes about 20 seconds. Following this the phrase "CAL" will appear accompanied by a flashing "Probe Zero" Annunciator.
- 5) Insert the probe into the ZERO GAUSS CHAMBER on the front panel.
- 6) Prior to taking readings, it is necessary to zero the gaussmeter. This is done by depressing the ZERO pushbutton. The word "CAL" will disappear, and after the instrument zero's on each range the "PROBE ZERO" annunciator will disappear.
- 7) Now the Model-9200 is ready to measure magnetic fields. Allow the Gaussmeter to warm up for 30 minutes to obtain the greatest accuracy.

For complete details on any of the above procedures, consult appropriate sections within the manual. Also for information on other features, consult the table of contents to locate the proper sections.



## SECTION I

### GAUSSMETER DESCRIPTION

#### I-A INTRODUCTION

The MODEL-9200 gaussmeter is a microprocessor based instrument designed to facilitate the measurement of magnetic fields in a wide variety of applications. Either steady state (dc) or alternating (ac) fields can be measured. When matched with the appropriate F.W. Bell fourth generation probe, fields as low as 0.010 gauss (1  $\mu$  tesla) or as high as 199.9 Kilogauss (19.99 tesla), at frequencies up to 10 kHz, can be measured simply, accurately and reliably.

Primary features of the MODEL-9200 include PEAK HOLD, AUTORANGING and RELATIVE operation as well as GAUSS or TESLA readout and an optional RS-232 communications port (talker only). All information is displayed on a custom-formatted, 3 1/2 digit liquid crystal display (LCD). Unit power is derived from an internal rechargeable battery pack. Front panel pushbuttons allow easy control of all gaussmeter functions.

#### I-B FUNCTIONAL DESCRIPTION

Figures I-A and I-B depict the MODEL-9200's front and rear panels, respectively. The gaussmeter is housed in a 4.5" (11.43 cm) high x 8.8" (22.35 cm) wide x 11.0" (27.94 cm) deep case featuring an adjustable carrying handle which can also be used to support the MODEL-9200 at a variety of convenient viewing angles.

#### FRONT PANEL

- |                        |  |
|------------------------|--|
| (1) DISPLAY            | 2.5" (6.35 cm) W x 0.7" (1.78 cm) H custom formatted display with 0.4" (1.02 cm) numerals and user activated lighting.   |
| (2) POWER SWITCH       | Rocker type power switch with international legends ("0"=OFF, "1"=ON).   |
| (3) ZERO GAUSS CHAMBER | Recessed double-wall mu-metal chamber used to shield the probe from stray magnetic fields during the PROBE ZERO operation. Attenuation is 80 dB in a 300 G field.  |
| (4) ZERO PUSHBUTTON    | Momentary-contact pushbutton switch used to initiate the PROBE ZERO sequence. Probe should be inserted into the Zero Gauss Chamber before starting this sequence.  |
| (5) RANGE PUSHBUTTON   | Momentary-contact pushbutton switch used to select the desired full scale range of the MODEL-9200. On power-up, the MODEL-9200 will be in the AUTORANGE mode. Other available ranges are 20 G, 200 G, 2 kG and 20 kG using a 1x probe, or 200 G, 2 kG, 20 kG and 200 kG using a 10x probe. |

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## SECTION I continued General Description

- (6) MODE PUSHBUTTON Momentary-contact pushbutton switch used to select the desired operating mode of the MODEL-9200. On power-up, the MODEL-9200 will be in the DC-GAUSS mode. The MODE pushbutton can be used to select the AC-GAUSS, AC-TESLA, DC-GAUSS or DC-TESLA mode.
- (7) PEAK PUSHBUTTON Momentary-contact pushbutton switch used to toggle the PEAK HOLD function on or off. When the function is toggled ON, the words PEAK HOLD will appear on the display.
- (8) RELATIVE PUSHBUTTON Momentary-contact pushbutton switch used to toggle the RELATIVE measurement function on or off. When the function is activated, the words ZERO READING will appear on the display.
- (9) DISPLAY LIGHT PUSHBUTTON Momentary-contact pushbutton switch used to turn the display lights on and off.
- (10) PROBE CONNECTOR Nine pin, twist-lock, non-magnetic connector that mates with selected F.W. Bell fourth generation Hall probes.

### REAR PANEL

- (11) POWER RECEPTACLE/  
FUSE HOLDER/  
LINE VOLTAGE SWITCH This is a multi-purpose receptacle that accepts an international instrumentation 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 mechanism.
- WARNING! See SECTION II before applying power to the gaussmeter or damage may result!!**
- (12) RS-232 PORT CONNECTOR Optional 25-pin "D" type female connector for RS-232 communications (talker only).
- (13) ANALOG OUTPUT Standard BNC connector which provides a calibrated output signal which is an accurate representation of the input waveform. A full-scale input signal will be represented by a 2 volt output at this connector.
- (14) INFORMATION LABEL Label identifying the model number, serial number and line power data.

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## SECTION I continued General Description

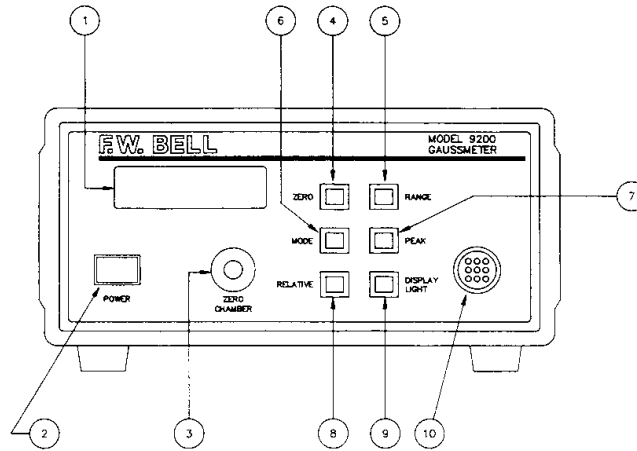


Figure I-A  
MODEL-9200 Front Panel

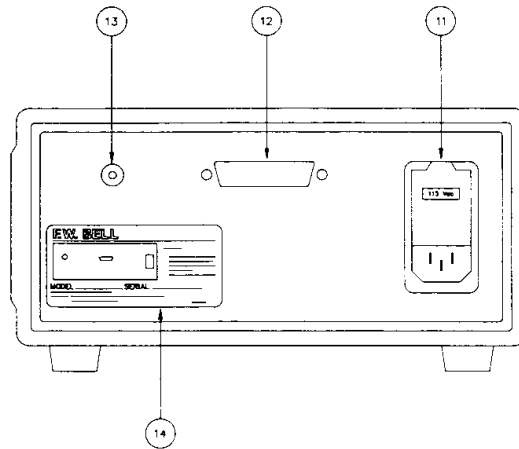


Figure I-B  
MODEL-9200 Rear Panel

## SECTION II

### MODEL-9200 GAUSSMETER PREPARATION

#### II-A POWER RECEPTACLE

##### READ THIS CAREFULLY!

The MODEL-9200 gaussmeter has been factory-configured to operate on a line voltage of 115 Vac. If operation at 230 Vac is required, perform the following steps *or damage will result*:

- (1) See Figure II-A. This is the power cord receptacle designed to accept an international instrumentation line cord. This assembly also contains the line fuse and voltage selector. Remove the line cord.
- (2) Near the top of the assembly is a slot. Insert a narrow screwdriver blade into the slot and *gently* release the access door (the door will not open unless the line cord is removed). The door will swing down.
- (3) Remove the voltage selector drum (marked "115 VAC") by pulling straight out.
- (4) Remove both fuse holders (marked with a "→") by pulling straight out. The left-hand holder is used to hold a spare fuse. The right-hand fuse holder is the actual in-circuit fuse. The gaussmeter is shipped with a 230 Vac /1/8 A fuse in the spare location, and a 115 Vac /1/4 A fuse in the active location. Reverse the positions of the holders and reinstall, making sure that the "→" points to the right.
- (5) Rotate the voltage selector drum to read "230 VAC" and reinstall.
- (6) Close access door. The "230 VAC" legend should be visible through the access door window. Reinstall the line cord.

ACCESS SLOT

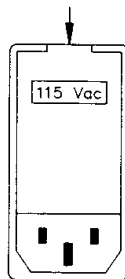


Figure II-A  
Rear Panel Power Receptacle

#### II-B PROBE INSTALLATION

Install the probe connector so that the molded keys in the connector body line up with the keyways in the front panel mating connector (Figure II-B). Push the connector in until the threaded sleeve makes contact with the receptacle. Rotate the sleeve clockwise to secure the connector to the receptacle.

## SECTION II continued Gaussmeter Preparation

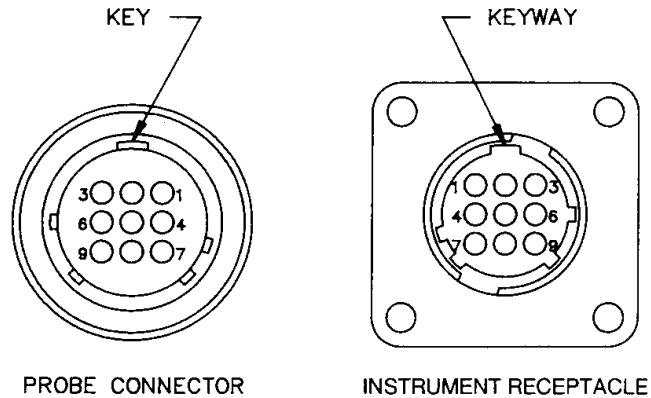


Figure II-B  
Probe Connector and Receptacle

### II-C POWER UP

Locate the power switch on the front panel and depress the side marked "1". During power on, all display segments are momentarily flashed "on" then "off". Then the display will seek a number between 1.052 and 1.817. This is an internal calibration number, determined by the probe attached. Then "CAL" and a flashing "ZERO PROBE" annunciator will appear on the display.

### II-D ZERO PROBE

Insert the probe into the zero gauss chamber in the front panel of the gaussmeter. This protects the probe from the effects of stray fields, and permits any probe offsets to be zeroed out. Depress and release the ZERO pushbutton. When the zeroing process is complete, the MODEL-9200 will display approximately 0.00. The instrument will return to the previously selected settings. At this point, the instrument control can be accomplished via the front panel pushbuttons.

SECTION III

**FIELD  
MEASUREMENT  
OPERATIONS**

III-A DISPLAY INDICATORS

The display in the MODEL-9200 provides the following information:

- (1) POLARITY: The area immediately to the left of the numerical reading indicates the polarity of the reading. No sign indicates that the North magnetic field flux lines are entering a transverse probe on the side of the probe on which the F.W. Bell logo appears, or are entering the tip of an axial probe parallel to the probe's axis. The minus sign appears for an opposite field condition.
- (2) READING: The numerical reading indicates the actual value of the dc field, the true rms value of an ac field, or, in the PEAK HOLD mode, the largest value of a dc field or the maximum rms value of an ac field, depending on the operating mode.
- (3) OVER: The OVER block is illuminated when the field being measured is greater than the instrument range setting. The readout will also display 1999. To obtain a useable reading, change the range to a higher range or to AUTORANGE.
- (4) BATTERY LOW INDICATOR: The BATT block illuminates when the internal battery voltage is insufficient for accurate measurements.
- (5) PROBE: When a probe is not plugged into the instrument, the word PROBE will blink, and the phrase "ERR" will appear.
- (6) ZERO PROBE: This indicator (ZERO PROBE) will flash when the probe is ready to be zeroed, upon power-up or whenever a probe zero operation is in progress.
- (7) ZERO READING: This feature offers the ability to suppress a large field reading so that small variations in the field can be observed. It is activated or deactivated by momentarily depressing and releasing the RELATIVE pushbutton.
- (8) AC-DC PEAK HOLD: In the dc peak hold mode, the display indicates the largest peak field measured by the probe. In the ac peak mode, the MODEL-9200 displays the maximum rms field present. This feature is activated or deactivated by momentarily pressing and releasing the PEAK pushbutton. The peak reading is held indefinitely, and is reset only when the feature is deactivated.
- (9) AUTORANGE: Indicates that the instrument is in the AUTORANGE mode.
- (10) GAUSS or K GAUSS: Indicates either k gauss or gauss depending on range.
- (11) mTESLA or TESLA: Indicates either m tesla or tesla depending on range.

## SECTION III continued Field Measurement Operations

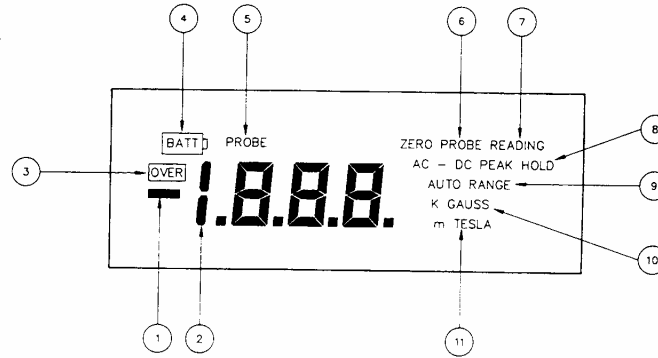


Figure III-A  
MODEL-9200 Display

### III-B ANALOG OUTPUT

A BNC connector on the rear panel provides a means for the user to display the actual magnetic field waveform. On a scope, the output level for a dc field is  $\pm 2$  volts dc for a full scale input. For a full scale ac sinusoidal field, the output waveform will be 5.657 volts peak-to-peak.

### III-C RS-232 OUTPUT OPERATION

As an option, the MODEL-9200 can be equipped with an RS-232 output port. Specifications for this port are as follows:

Baud Rate	1200
Stop Bits	1
Parity	None
Character Length	8 Bits
Connector Type	Standard, 25 pin, "D"
	Pin 2 RX (receive data)
	Pin 3 TX (transmit data)
	Pin 7 Signal ground
Typical TX Output Voltage	$\pm 3$ V to $\pm 7$ V
Minimum TX Output Load	3 k ohms
RX Input Voltage Range	$\pm 3$ V to $\pm 15$ V
Typical RX Input Impedance	3.3 k ohms
Maximum Cable Length	15 ft. (4.5 meters)

Utilization of the serial port permits the gaussmeter to control a remote terminal or printer device. This is particularly useful if the user and gaussmeter must be physically separated by some distance, or if the user wishes to have a hard copy of all gaussmeter activity.

The terminal/printer may be connected directly to the gaussmeter, or indirectly through a modem following the electrical connections described above. The RS-232 characteristics of both devices must match in order for successful communication to take place. Since the characteristics of the gaussmeter are fixed at the factory, the terminal/printer must be capable of having its characteristics adjusted to match.

**SECTION III continued**  
**Field Measurement Operations**

Whenever field measurements are taking place, the gaussmeter will transmit a continuous listing of field measurements and status in a formatted ASCII character stream as shown in Figure III-B.

Initially, a FORMFEED (FF) control character is transmitted. If a printer is connected this should cause the paper feeder to advance to the top of the next page. If a terminal is connected, this usually clears the screen. The FF is followed by CARRIAGE RETURN (CR) and a LINEFEED (LF). Then, a three-line header is printed. Each line is followed by a CR and LF. A second LF provides the blank line between data lines.

The users should be aware that the serial transmission rate is much slower than the rate at which the display is updated with new readings. In other words, the gaussmeter does not wait for a transmission to be completed before taking another reading. Readings taken during a transmission sequence may not appear in the next transmission.

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<u>Reading</u>	<u>Relative</u>	<u>Range</u>	<u>Auto</u>	<u>Peak</u>	<u>Probe</u>	<u>Type</u>	<u>Batt</u>
-1.667 kG	+55.33 G	2 kG	OFF	ON	BULK	1X	OK
-1.547 kG	+45.29 G	2 kG	OFF	ON	BULK	1X	OK
+ 245.6 G	.	200 G	ON	OFF	BULK	1X	OK
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

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<u>Reading</u>	<u>Relative</u>	<u>Range</u>	<u>Auto</u>	<u>Peak</u>	<u>Probe</u>	<u>Type</u>	<u>Batt</u>
+ 244.8 G	.	200 G	ON	OFF	BULK	1X	OK
+ 245.9 G	.	200 G	ON	OFF	BULK	1X	OK
+ 245.6 G	.	200 G	ON	OFF	BULK	1X	LOW
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

Figure III-B  
Sample Terminal Display or Printer Output



## SECTION IV

### **MODEL-9200 THEORY OF OPERATION**

#### **IV-A INTRODUCTION**

The MODEL-9200 Gaussmeter is a microprocessor controlled, dc coupled gaussmeter designed to accurately measure magnetic fields in the 10 milligauss to 20 kilogauss\* range at frequencies up to 10 kHz. The following sections and Figure IV-A describe and illustrate the theory of operation of the MODEL-9200.

\* To 200 kilogauss with a 10X probe.

#### **IV-B POWER SUPPLY**

The power supply section of the MODEL-9200 consists of a balanced, full-wave rectified, filtered power supply followed by a +5 volt regulator and a  $\pm 15$  volt converter. Also powered from the raw supply is the charging circuit for the built-in rechargeable battery. The charging circuit is designed so that as long as the unit is connected to line voltage, the battery is being "trickle" charged.

Operation from 115 Vac or 230 Vac line voltage is selected by "programming" the line voltage input receptacle on the rear panel of the gaussmeter. This reconfigures the electrical connection of the transformer to be compatible with the available line voltage. This receptacle also contains the line fuse. The center terminal of the receptacle is tied to the metal frame of the chassis.

#### **IV-C ANALOG SECTION**

The analog section of the MODEL-9200 consists of circuitry to provide a bias current for the probe, control the source of the input signal, correct probe generated offset errors, amplify the signal, switch ranges, calibrate the signal channel, accomplish the rms conversion of ac signals and convert the processed analog signal to digital form.

The bias current section provides, under processor control, either 10 mA, or 100 mA of dc bias current to the probe. Which level is provided is determined by information obtained by the processor directly from the probe itself.

When a properly biased probe is exposed to a magnetic field, a signal voltage is generated and delivered to the gaussmeter via the probe connector. This signal then enters a solid state switching circuit which connects either the probe signal or a reference signal to the amplifier stages which follow. The availability of the reference signal permits the microprocessor to generate a correction factor to compensate for any offsets which may be generated by the probe or amplifiers.

Initial amplification is provided by a preamplifier stage with a gain of approximately forty. Also present in this section is a digitally controlled offset adjusting circuit which is used to correct any probe dc offset which may have been detected during the "PROBE ZERO" operation. Following the preamplifier are the digitally controlled range switch, the remainder of the amplification and the digitally controlled calibration circuit. This latter circuit is used to fine tune the gain in the signal channel to provide the calibrated 2V full scale output. The output of the calibration control drives another digital switch which directs the signal to the true rms detector and then to the A/D converter in the ac mode or directly to the A/D converter in the dc mode.

## SECTION IV continued Theory of Operation

### IV-D DIGITAL SECTION

Communication between the analog and digital sections of the MODEL-9200 is accomplished via the I/O bus. On the digital side of the bus are connected the keyboard, its buffer and the 10 MHz 80C31 microprocessor with its support circuitry. Inputs from the front panel pushbuttons are directed to the microprocessor via the bus. Also connected to the processor are the 24K bytes of system memory, the display controller and display combination and the RS-232 port. The digital portion of the MODEL-9200 also includes a circuit to detect the presence or absence of a probe and to signal the processor accordingly.

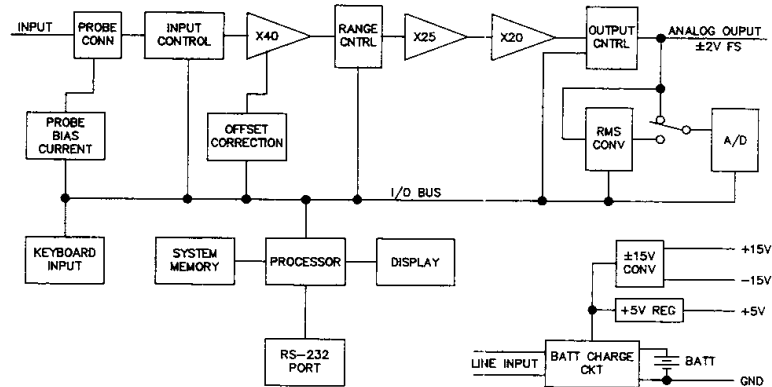


Figure IV-A  
MODEL-9200 Block Diagram

### IV-E 4TH GENERATION HALL GENERATOR PROBE

The F.W. Bell 4th generation Hall generator probes are derived from their proven 3rd generation counterparts. Each probe is terminated in a 9-pin circular, non-magnetic connector. The connector houses a 512-byte non-volatile EEPROM device programmed with the probe's calibration factor, model number information and serial number. This information is used by the gaussmeter during its calibration routine. Also included in the connector is a provision for the installation of a linearizing resistor.

Four of the connector pins interface to the Hall device itself. Another four pins interface to the EEPROM. The remaining pin is used by the processor to sense whether or not a probe is connected.

SECTION IV continued  
Theory of Operation

IV-F INSTALLATION OF RS-232 OPTION

**CAUTION:** *Disconnect cord from power before servicing.  
Do not short out internal battery terminals.*

- 1) Remove the front and rear plastic shrouds by removing the eight screws. Carefully lift off the top cover.
- 2) Remove the two screws holding the rear RS-232 filler panel.
- 3) Install the 25-position female D connector from the inside of the rear panel. Secure the connector with two screwlocks and two 4-40 X 1/4 KEPS nuts. (KEPS nuts should be mounted on the inside.)
- 4) Connect the 3-position connector to J4 connector located at the rear of the base board next to the power transformer.
- 5) Replace the top cover, then the two shrouds. Secure the shrouds with the eight screws.

# WARRANTY

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

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

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

## DAMAGE IN SHIPMENT

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

## SHIPPING INSTRUCTIONS

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

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

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