8010 GAUSS / TESLA METER

Instruction Manual
This symbol appears on the instrument and probe. It refers the operator to additional information contained in this instruction manual, also identified by the same symbol.

**NOTICE:**

See Pages 4-1, 4-2, and 4-3 for **SAFETY** instructions prior to first use!

See Page 2-4 for EMC Notes concerning I/O Cables and I/O Filter Adapters
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Section 1

Introduction

OVERVIEW

The F.W. BELL model 8010 Gauss/Tesla meter incorporates the latest developments in magnetic flux density measurement technology with a modern user interface. It features a large display for easy viewing, a comprehensive keypad for control of common functions, and an easy-to-use menu system. The model 8010 features single channel, with high accuracy suitable for use in the laboratory, and enough features to be versatile in a manufacturing environment. Table 1-1 on the following page provides a list of features.

A detailed description of the 8010’s functions and features is also provided in the remaining sections.

Note: Some of the listed 8000 Gaussmeter features are currently under development and are not supported with the supplied system firmware. Visit the FW Bell web site at www.fwbell.com or contact customer support for the latest updates.
Table 1-1 Model 8010 Gauss/Tesla meter List of Features

| Flux Density Measurement | Auto Range and Zeroing Capability  
| DC and AC Field Measurement up to 50 kHz  
| Automatic Calibration  
| Units in gauss (G), tesla (T), amp/meter (A/m), or Oersted (Oe)  
| Temperature Compensated Hall Probes Available |
| User Interface | Large TFT color LCD Display with backlighting  
| Common Functions are Activated Quickly Through the Front Panel Keypad  
| Other Functions are Accessible Through Graphical Menu System  
| Mouse Supported ( future expansion via USB ) |
| Support Functions | Analog and Digital Filtering  
| Relative Feature Allows Small Fluctuations to be Observed Within a Larger Field  
| Hold Feature Includes Arithmetic Min/Max Readings Calculated by the Instrument  
| Field Classifier With Pass/Fail Outputs |
| Remote Operation and Communications | RS-232C Standard 9-pin female "D" connector  
| Baud rate: 9600  
| Protocol: IEEE-488-1987.2 (with user adapter) and SCPI-1999  
| Protocol: IEEE-802.3u Data Link Layer & TCP / IP Transport & Network Layer  
| Ethernet Standard RJ-45 Interface (10/100 MHz Ethernet Port)  
| Dual USB 2.0 Compliant Ports – Firmware Update via USB drive |
| Signal Outputs | Corrected and Uncorrected Analog Outputs  
| +/- 3V and +/- 10V Selectable Ranges  
| Either Wave Form or RMS Signals  
| Transverse and Axial |
| Probe Styles | Temperature Compensated  
| Low, Medium, and High Field  
| Standard and Heavy Duty  
| LabView Drivers under development |
| Software | On-Site Firmware Updates |
The Model 8010 gauss/tesla meter utilizes Hall effect probes to measure magnetic flux density in units of gauss (G), tesla (T), amp/meter (A/m), or oersted (Oe). Either steady-state (dc) or alternating (ac) fields may be measured. Fields as low as 10 μGauss (0.001 μT) or as high as 300k gauss (30 tesla), at frequencies up to 50 kHz, can be measured with extreme accuracy and 5-3/4 digit resolution. Each channel is calibrated and linearized independently from data stored within its probe. With a temperature compensated Hall probe, the instrument can compensate for errors due to variations in probe temperature.

**User Interface**

The instrument features a WVGA, 600 x 480 pixels, TFT Color LCD Display with backlighting. The display format may be customized by the operator.

Common functions are activated quickly through the front panel keypad. Each key has a back-light that is illuminated to indicate that it is active.

Less commonly used functions are easily accessible through the menu system.

**Auto Range**

Four measurement ranges may be selected manually or the instrument can automatically select the best range based on the present flux density level being measured.
### General Description (Continued)

**Zero**

The “zero” function allows the user to remove undesirable readings from nearby magnetic fields (including earth’s) as well as to remove initial electrical offsets in the probe and instrument. A “zero flux chamber” is included as an accessory which shields the probe from external magnetic fields during this operation.

**Hold**

When the hold function is enabled the instrument will “hold” and display the highest and/or lowest flux density readings that have been measured. Hold features include capturing peaks and valleys of rapidly changing pulses as well as arithmetically calculated max and min of slow changing signals.

**Relative**

Another feature, called “relative mode”, allows large flux readings to be suppressed so that small variations within the larger field can be observed directly.

**Update Interval**

The update interval of the reading may be adjusted. Shorter update intervals allow rapid fluctuations in flux density levels to be observed. Longer update intervals provide higher resolution and stability in the flux density reading.

**Analog Outputs**

Corrected and uncorrected analog output voltage signals are available from standard BNC connectors. The uncorrected output signal is representative of the magnetic flux density measured by the Hall probe. The corrected output signal is compensated for influences of temperature and frequency variations, as well as non-linearities inherent in the Hall probe and instrument.

The corrected output is specified with a higher accuracy than the uncorrected output. The uncorrected output is the true unprocessed analog signal which is less accurate, but also has a bandwidth up to 50kHz.
Standard full scale output ranges are 3V, 10V, 3VRMS, and 10VRMS. An adjustable full scale up to 9.9V or 9.9VRMS, in increments of 0.1V, is also available. These outputs may be connected to a voltmeter, oscilloscope, recorder, or external analog-to-digital converter.

**Analog Filters**

Several analog filter modes are available in AC mode to help reject undesired frequency content from AC field level signals. The filters affect both the displayed reading and the analog outputs.

**Field Classifiers**

The “Classifier” function allows the user to define a lower and upper limit of flux density that can be used to quickly determine the status of a magnetic field. The instrument will indicate visually whether the field is below, within, or above the pre-defined limits. The same information is provided in the form of general purpose switch closures available at a standard 15 pin “D” type female connector. This function will be available in a future firmware revision.

**Remote Operation**

Remote operation is supported through either a standard 9-pin “D” RS232 serial port connector or standard RJ-45 Ethernet connector (10/100 MHz Ethernet Port). The 8010 can be fully configured and flux density readings and other information can be acquired by a remote computer or PLC. The commands follow widely accepted protocols established by the SCPI-1999 standards.

**Accessories**

The instrument is shipped with a “zero flux chamber” used for shielding the probe from unwanted fields during zeroing.
GENERAL DESCRIPTION (Continued)

Front Panel

The front panel consists of the TFT Color LCD display, keypad, USB ports, and probe connector.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Display</td>
<td>WVGA, 600 x 480 pixels, TFT Color LCD Display with Backlighting</td>
</tr>
<tr>
<td>(2) Standby Key</td>
<td>Standby Power Indicator</td>
</tr>
<tr>
<td>(3) Menu Key</td>
<td>Menu System Navigation</td>
</tr>
<tr>
<td>(4) Enter Key</td>
<td>Menu System Navigation</td>
</tr>
<tr>
<td>(5) Range Key</td>
<td>Selects Fixed Ranges or Autorange</td>
</tr>
<tr>
<td>(6) Mode Key</td>
<td>Selects ac or dc Field Measurement</td>
</tr>
<tr>
<td>(7) Reset Key</td>
<td>Resets the Min/Max and Peak/Valley Detectors Used with the Hold Feature</td>
</tr>
<tr>
<td>(8) Zero Key</td>
<td>Starts the Zeroing Process</td>
</tr>
<tr>
<td>(9) Relative Key</td>
<td>Activates / De-activates the Relative Function</td>
</tr>
<tr>
<td>(10) Manual Key</td>
<td>Numeric Entry / Menu Navigation</td>
</tr>
<tr>
<td>(11) Probe Connector</td>
<td>12 Pin Non-Magnetic Female Connector for Hall Effect Probes</td>
</tr>
<tr>
<td>(12) Hold Key</td>
<td>Activates / Deactivates the Hold Feature</td>
</tr>
<tr>
<td>(13) USB Ports</td>
<td>Dual USB 2.0 Compliant Ports</td>
</tr>
<tr>
<td>(14) Menu Hot Keys</td>
<td>Menu Navigation and Function Selection</td>
</tr>
</tbody>
</table>

Figure 1-1 Front Panel
General Description

Rear Panel

The rear panel consists of the power inlet, fuse holder, analog signal outputs, communication ports, and the cooling fan vent.

Table 1-3 Rear Panel Description

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corrected Analog Output</td>
</tr>
<tr>
<td></td>
<td>Compensated Analog Output Voltage Signal, Standard BNC Connector.</td>
</tr>
<tr>
<td>2</td>
<td>Uncorrected Analog Output</td>
</tr>
<tr>
<td></td>
<td>Uncompensated Analog Output Voltage Signal, Standard BNC Connector.</td>
</tr>
<tr>
<td>3</td>
<td>Fuse Chart</td>
</tr>
<tr>
<td></td>
<td>Specifies the Proper Fuse Rating</td>
</tr>
<tr>
<td>4</td>
<td>Ethernet</td>
</tr>
<tr>
<td></td>
<td>Standard RJ-45 Connector (10/100 MHz Ethernet Port)</td>
</tr>
<tr>
<td>5</td>
<td>Power Receptacle</td>
</tr>
<tr>
<td></td>
<td>Accepts an International Instrumentation Power Line Cord</td>
</tr>
<tr>
<td>6</td>
<td>Cooling Vent</td>
</tr>
<tr>
<td></td>
<td>Vents for Cooling Fan (Should Remain Clear)</td>
</tr>
<tr>
<td>7</td>
<td>RS-232</td>
</tr>
<tr>
<td></td>
<td>RS-232 Serial Communication Port. Standard 9 Pin “D” Type Female Connector.</td>
</tr>
<tr>
<td>8</td>
<td>Digital I/O</td>
</tr>
<tr>
<td></td>
<td>Standard 15 Pin “D” Type Female Connector, Provides Switch Closure Points for Classifier Operation</td>
</tr>
<tr>
<td>9</td>
<td>Auxiliary Output</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Analog Voltage Output. Standard BNC Connector</td>
</tr>
</tbody>
</table>

Figure 1-2 Rear Panel
GENERAL DESCRIPTION

(Continued)

Cabinet

The cabinet is equipped with a side handle and two feet underneath the unit which serve to adjust the tilt angle of the instrument. Figure 1-3 shows the instrument in various positions.

APPLICATIONS

- Sorting or performing incoming inspection on permanent magnets, particularly multi-pole magnets.
- Testing audio speaker magnet assemblies, electric motor armatures and stators, transformer lamination stacks, cut toroidal cores, coils and solenoids.
- Determining the location of stray fields around medical diagnostic equipment.
- Determining sources of electromagnetic interference.
- Locating flaws in welded joints.
- Inspection of ferrous materials.
- 3-dimensional field mapping.
- Inspection of magnetic recording heads.
- Designing new magnetic assemblies.
Section 2  Specifications

INSTRUMENT

Full-scale ranges are shown in the Tables 2-1a – 2-1c below; listed by probe type. In all cases, the resolution is 1 part in 300,000.

<table>
<thead>
<tr>
<th>gauss (G)</th>
<th>tesla (T)</th>
<th>oersted (Oe)</th>
<th>ampere-turn/meter (A/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300.000 mG</td>
<td>30.0000 μT</td>
<td>300.000 mOe</td>
<td>23.8732 A/m</td>
</tr>
<tr>
<td>3.00000 G</td>
<td>300.000 μT</td>
<td>3.00000 Oe</td>
<td>238.732 A/m</td>
</tr>
</tbody>
</table>

Note: Low Field probe cannot be used for measurements above 2 Gauss.

<table>
<thead>
<tr>
<th>gauss (G)</th>
<th>tesla (T)</th>
<th>oersted (Oe)</th>
<th>ampere-turn/meter (A/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.0000 G</td>
<td>3.00000 mT</td>
<td>30.0000 Oe</td>
<td>2.38732 kA/m</td>
</tr>
<tr>
<td>300.000 G</td>
<td>30.0000 mT</td>
<td>300.000 Oe</td>
<td>23.8732 kA/m</td>
</tr>
<tr>
<td>3.00000 kG</td>
<td>300.000 mT</td>
<td>3.00000 kOe</td>
<td>238.732 kA/m</td>
</tr>
<tr>
<td>30.0000 kG</td>
<td>3.00000 T</td>
<td>30.0000 kOe</td>
<td>2.38732 MA/m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>gauss (G)</th>
<th>tesla (T)</th>
<th>oersted (Oe)</th>
<th>ampere-turn/meter (A/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300.000 G</td>
<td>30.0000 mT</td>
<td>300.000 Oe</td>
<td>23.8732 kA/m</td>
</tr>
<tr>
<td>3.00000 kG</td>
<td>300.000 mT</td>
<td>3.00000 kOe</td>
<td>238.732 kA/m</td>
</tr>
<tr>
<td>30.0000 kG</td>
<td>3.00000 T</td>
<td>30.0000 kOe</td>
<td>2.38732 MA/m</td>
</tr>
<tr>
<td>300.000 kG</td>
<td>3.00000 T</td>
<td>300.000 kOe</td>
<td>23.8732 MA/m</td>
</tr>
</tbody>
</table>
Table 2-2 Accuracies at 23°C ±2°C (Instrument Only *)

<table>
<thead>
<tr>
<th></th>
<th>Display and Digital Outputs (min speed)</th>
<th>Corrected Analog Output and Digital Outputs (max speed)</th>
<th>Uncorrected Analog Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>dc accuracy</strong></td>
<td>±0.05% of reading and ±0.01% of range</td>
<td>±0.15% of 3V or 10V ranges</td>
<td>3V range: 0.25% of reading ±40mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10V range: 0.25% of reading ±120mV</td>
</tr>
<tr>
<td><strong>ac accuracy</strong></td>
<td>N/A</td>
<td>2% of range dc to 100 hz</td>
<td>2% of range dc to 100Hz</td>
</tr>
<tr>
<td>in dc mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ac accuracy</strong></td>
<td>2.0% of reading ± 0.15% of range (20 Hz to 50 kHz)</td>
<td>2.0% of 3V or 10V ranges (ac 20 to 500 Hz) (ac rms (dc) 20Hz-50kHz)</td>
<td>See Figure 2-1 for Graph (Typical) ac and ac rms (dc) output</td>
</tr>
<tr>
<td>in ac mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ac peak accuracy</strong></td>
<td>5.00% of Reading</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Probes Errors Not Included*
**REFERENCE**

**Min / Max Hold Acquisition Time:**
- dc Mode: 200mS
- ac Mode: 200µS

**Peak / Valley Hold Acquisition Time:**
- dc Mode: 2ms
- ac Mode: 200µS

**Temperature Coefficient:**
- 0.02% of reading
- ±1 count/degree Celsius

**Update Rate:**
- Display: 5/s (max)
- Ethernet and RS-232 Output: 100/s (max)

**Corrected Analog Output Noise**
(3V output range with 500 Hz filter):
- All ranges: 2mVrms (35mV p-p)

**Un-Corrected Analog Output Noise**
(3V output range with 500 Hz filter):
- 300G, 3kG, 30kG ranges: 50µVrms (10mV p-p)
- 30G range: 2mVrms (20mV p-p)

**Temperature Range:**
- Operating: 0 to 70 degrees Celsius
- Storage: -20 to 60 degrees Celsius

**Humidity Range:**
- 0 to 35°C, to 80% RH at 35°C

**Analog Output Impedance:**
- <100 Ohms

**Analog Output Connector:**
- Standard female BNC

**Analog Output Scaling:**
- dc Mode: 3V or 10V standard
  - ±0.1V to ±9.9V adjustable, with increments of 0.1 V
- ac Mode: 3Vrms or 10Vrms standard
  - ±0.1Vrms to ±9.9Vrms adjustable, with increments of 0.1Vrms

**Front Panel Display:**
- WVGA, 600 x 480 pixels, TFT Color LCD Display with Backlighting.
- Dimensions: 4.7 W x 3.5 H inches
  - 119 W x 89 H millimeters

**Power:**
- Volts: 100/120 220/240
- Frequency: 50-60 Hz or 50-60 Hz
- Current: 1.0 A (max) 0.5 A (max)

**Size:**
- 11.5 W x 5.2 H x 14.5 D inches (5.85H with feet)
- 292 W x 132 H x 368 D millimeters (148.6H with feet)

**Weight:**
- Net: 11.5 lbs. / 5.3 kg
- Shipping: 17.7 lbs. / 8.1 kg

**Warm-up Time to Rated Accuracy:**
- 60 Minutes
Figure 2-1  Frequency Response of Uncorrected Analog Output (Typical)
No Probe (Instrument Only)
Communications

EMC application note

Use only high quality, double shielded cables for the RS-232 and Digital I/O connections. Keep the length of the cables less than 3 meters. Cables greater than 3 meters with insufficient EMI shielding can cause excessive emissions or may be susceptible to external interference. Adapters specified below for the RS-232 and digital I/O Classifier port connectors must be used prior to connecting the RS 232 and digital I/O cables.

<table>
<thead>
<tr>
<th>Connection</th>
<th>Description</th>
<th>Insertion Loss</th>
<th>Spectrum Control Part #</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-232</td>
<td>830pF Capacitive Type Filter, &quot;D&quot; Type 9 Pin Male to Female</td>
<td>22dB @ 100MHz, 39dB @ 1GHz</td>
<td>56-705-008, 830 pF</td>
</tr>
<tr>
<td>Digital I/O Classifier</td>
<td>1000pF Capacitive Type Filter, &quot;D&quot; Type 15 Pin Male to Female</td>
<td>20dB @ 100MHz, 40dB @ 1GHz</td>
<td>56-715-002, 1000 pF</td>
</tr>
<tr>
<td>RJ-45</td>
<td>10/100 MHz Ethernet Port</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USB</td>
<td>Dual USB 2.0 Compliant Ports</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Serial**

- Format: RS-232C
- Connector type: 9-pin "D" female
- Cable length: 3 m (9.8 ft.) maximum
- Receive input resistance: 3 kΩ minimum
- Receive voltage limit: ± 30 V maximum
- Transmit output voltage: ± 5 V min, ± 8 V typical
- Baud rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400
- Stop bits: 1, 2
- Character length: 7,8
- Parity: None, Odd, Even
- Handshaking: None, Hardware, Software
- Standards supported: SCPI-1999

**Digital I/O (available with future firmware revision)**

- Signal Type: Solid State Relay Closure
- Connector: 15-Pin "D" Female
- Switching Voltage: 100 V dc or ac Peak MAX
- Switching Current: 0.25 A dc or ac Peak MAX
- Operating Time, Including Bounce: 2 mS MAX
Classifier Connection

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>3.11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>4.12</td>
</tr>
<tr>
<td></td>
<td>GND</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>+3.3Vdc</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>+5Vdc</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: The 3.3 and 5Vdc pins are limited to 100mA maximum and intended for Classifier logic use only.

Regulatory Information:

Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

**EN 61326-1:2006**

- IEC 61000-4-2:2008 Electrostatic Discharge (ESD) Immunity
- IEC 61000-4-3:2010 Radiated Electromagnetic Field (RF) Immunity
- IEC 61000-4-6:2008 Conducted Immunity
- IEC 61000-4-8:2009 Magnetic Field Immunity
- IEC 61000-4-11:2004 Voltage Interruptions
- IEC 61000-4-11:2004 Voltage Dips

**EN 61326-1:2006 Class A**

CALIBRATION SERVICE

The instrument is calibrated at the factory prior to shipment. To maintain rated accuracy, it is recommended that the instrument be re-calibrated every 12 months.

Answers to any questions concerning the calibration of this instrument may be obtained by contacting Pacific Scientific OECO at the address below:

Pacific Scientific OECO
4607 SE International Way
Milwaukie, OR 97222

Phone: 503-659-5999

ZERO FLUX CHAMBER

Model Number:
YA-111

Cavity Dimensions:
Length: 50.8 mm (2")
Diameter: 8.7 mm (0.343")

Attenuation:
80 dB to 30 mT (300 G)

Purpose:
To shield the probe from external magnetic fields during the ZERO or RELATIVE operations.

Figure 2-3
Zero Flux Chamber
Section 3                              Probes

OVERVIEW

F.W. Bell’s 8000 series gauss/tesla meter probes are designed to meet the electrical and mechanical requirements of virtually any application. Models are available for transverse, axial, and very low field measurements. The probe style is dependent upon the measurement environment. The standard polypropylene stem is generally adequate for laboratory or light handling environments, while the heavy duty aluminum stem is recommended for harsher environments. The probe’s length, outside diameter (axial probes) or thickness and width (transverse probes) are important if there are physical constraints where the probe will be used.

In “transverse” probes the Hall generator is mounted in a thin, flat stem whereas in “axial” probes the Hall generator is mounted in a cylindrical stem. The primary difference is the axis of measurement, as shown by “+B” in Figure 3-2. Generally transverse probes are used to make measurements between two magnetic poles such as those in audio speakers, electric motors and imaging machines. Axial probes are often used to measure the magnetic field along the axis of a coil or solenoid. Either probe can be used where there are few physical space limitations, such as in geomagnetic or electromagnetic interference surveys.

The low field probe is designed for high sensitivity, volumetric measurement such as mapping variations in the earth’s magnetic field or detecting the presence of ferrous objects.

⚠️

Handle Hall probes with care. Do not bend the stem or apply pressure to the probe tip as damage may result.
PROBE VARIATIONS

A wide variety of probes are available for use with the 8010 gauss/tesla meters. The types include heavy-duty transverse and axial, standard transverse and axial, standard transverse with exposed element, flexible transverse and axial with exposed element and low field probes. All of these probes are available with or without temperature compensation. All standard probes have a 10 foot (3.04m) cable length and most are available with various stem lengths. Table 3-1 lists the maximum field measurement capabilities and resolutions.

<table>
<thead>
<tr>
<th>Probe Type</th>
<th>Maximum Field</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Field</td>
<td>2 G (200 µT)</td>
<td>1 µG (0.1 nT)</td>
</tr>
<tr>
<td>Medium Field</td>
<td>30 kG (3 T)</td>
<td>0.1 mG (0.01 µT)</td>
</tr>
<tr>
<td>High Field</td>
<td>300 kG (30 T)</td>
<td>1 mG (0.1 µT)</td>
</tr>
</tbody>
</table>

Figure 3-1 serves as an ordering guide for F.W. BELL 8000 series probes. Full electrical and mechanical specifications of all probes are available on request.

Note: Probes are not available in all part number combinations.
PROBE MEMORY

The connector of each probe contains a memory device which stores registration information (model number, serial number, date calibrated, etc.) as well as performance information for Hall generator sensitivity, linearity, frequency response and temperature response. Each probe is physically identified with model number, serial number and a maximum voltage rating of “30VRMS / 60Vdc MAX” on a durable polyester label wrapped around the cable jacket.

PROBE STEM

All probes except the low field probe are supplied with a rigid stem cover to protect the probe when not in use. It is strongly recommended to use the stem protector when storing the probe or when the probe will not be used for any length of time. If a probe stem becomes damaged it can not be repaired.

TEMPERATURE EFFECTS

All Hall probes have an initial electrical offset that will affect the accuracy of static (dc) field measurements. This offset should be canceled using the instrument’s “zero” function. However, the probe’s offset and sensitivity will change with temperature. Using temperature-compensated probes will minimize these effects.

There can be substantial errors in uncompensated probes. A typical probe’s dc offset can change by \( \pm 0.1 \text{ G} / \circ \text{C} \) (\( \pm 10 \mu \text{T} / \circ \text{C} \)). It is best to allow the probe’s temperature to stabilize before performing a “zeroing” operation. Zeroing is discussed in Section 6 – Flux Density Measurement. The probe’s sensitivity will decrease as temperature increases. Probes are calibrated at ambient temperature (\( \sim 23 \circ \text{C} \)). A typical probe may change by \( -0.05\% / \circ \text{C} \). For instance a reading of 200 mT at 23°C may drop to 197 mT at 50°C.

FIXTURING

In some applications it may be necessary to install a probe into a holding fixture to maintain a constant probe position. If this becomes necessary, do not clamp onto the probe stem as this will most likely damage the probe. Rather, clamp onto the aluminum probe body.
8000 series probes

Single Axis

Figure 3-2 Hall Probe Configurations
Section 4

SAFETY INSTRUCTIONS

⚠️ GENERAL:
For safe and correct use of this instrument 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 instrument must be made inoperative and be secured against any unintended operation. For example, safety may be impaired if the instrument fails to perform or shows visible damage.

⚠️ 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 instrument can create a dangerous condition.

⚠️ CAUTION:
For continued protection replace the fuse with the same type (IEC 127 type T).
SAFETY INSTRUCTIONS (Continued)

⚠️ ⚠️ WARNING:
The Hall probe is a non-contact measuring device. The probe is not to contact a surface which exceeds a voltage of 30Vrms (42.4V peak) or 60V dc.

![Probe Electrical Warning](image)

**Figure 4-1  Probe Electrical Warning**

⚠️ CAUTION:
This instrument may contain ferrous components which will exhibit attraction to a magnetic field. Care should be utilized when operating the instrument near large magnetic fields, as pull-in may occur.

⚠️ ⚠️ WARNING! READ THIS CAREFULLY
The 8000 Series gauss/tesla meters incorporate a universal power supply which operates from 90 to 260Vac. There are no switches or jumpers to select line voltage, but proper fuse selection is required.
LINE VOLTAGE SETTINGS / FUSE PANEL

Follow these instructions to replace a fuse or change to match the line voltage.

1) **See figure 4-2a.** This is the power cord receptacle. It is designed to accept an international instrumentation power cord. This receptacle also contains the fuse. Remove the power cord. On the right side of the receptacle is a slot. Insert a narrow screwdriver and gently release the access door (the door will not open unless power cord is removed). The door will swing out toward the right.

2) **See figure 4-2b.** Remove the fuse by pulling straight out. On the back side of the meter there is a fuse chart which specifies which fuse to use depending on your operating voltage 100/120 Vac or 220/240 Vac. There is a fuse kit which comes with the meter which includes the second fuse if needed for proper operation.
ADJUSTING THE HANDLE

See Figure 4-3

The handle on the side of the meter can easily be grasped whenever the meter needs to be carried. The meter has two feet on the bottom as shown below which can easily be extended or collapsed to adjust the viewing angle of the front panel as preferred.

CAUTION: The feet lock into place and must be pulled away from the case before folding toward the rear to prevent breaking the feet.

Figure 4-3 Adjusting the Handle and Feet
PROBE INSTALLATION / REMOVAL

See Figure 4-4

Install the probe connector so that the molded key in the connector body lines up with a similar key-way at the lower edge of the receptacle on the front panel. Push the connector in until it will travel no further. The connector will lock into place. There is no twist lock so it is not necessary to rotate any part of the connector.

To remove the connector, grab at the collar and slide back. The probe connector cannot be removed by pulling only on the rear of the connector body.

Note: You may install or remove a probe at any time, although it is not recommended to do so during the zeroing operation.

For more information on probes, see Section 3 – Probes.

Figure 4-4 Installing and Removing Probes
POWER - UP

Locate the **Standby** button on the front panel. The power switch will slowly blink a red color when the meter is in standby mode and power is applied to the line cord. The **Standby** button is shown in Figure 4-5. To turn on the instrument press the button and release. The switch color will change to blue and the boot up procedure will begin. The red LED will continue to flash during normal operation.

To shut the instrument off, press the **Standby** button and release. After a few seconds the unit will shut off and the **Standby** button will return to blinking red.

*Note: Allow at least three seconds for the instrument to be off before turning it back on again to ensure a proper boot up.*

![Figure 4-5 Power Switch / Standby Button Location](image)
POWER – UP (Continued)

Initialization

During boot up, the OE logo will appear and a status bar indicates boot up progress. See Figure 4-6. Internal diagnostics are performed first, followed by the initial formatting of the display.

Calibration data from all channels and their probes are retrieved next. The message “Reading Probe” may be displayed during this process. If no probe is connected to a channel, the message “No Probe Connected” will be displayed.

If any of the internal diagnostic tests fail, an error message will appear and the instrument will halt the power-up procedure.

Upon successful completion of the diagnostics and initial calibration, the instrument will be ready to use. Active keys on the front panel are illuminated and present flux density readings and status are displayed.

Other parameters, such as range settings, AC/DC, hold, etc. will be initialized to the same condition they were in when the instrument was last turned off. More information on saving configuration settings is presented in SECTION 5 – User Interface.

Note: It is recommended that the instrument warm-up for at least sixty (60) minutes to achieve rated accuracy
Section 5  
User Interface

OVERVIEW

Most of the features and functions of the 8000 Series Gaussmeters are activated directly from the front panel keypad. Each probe input channel has its own dedicated set of keys that control commonly used functions and the remaining functions are accessed through the menu system.

This section of the manual describes how the user interface to 8000 Series Gaussmeters is organized, including keypad layout and menu organization.

Operation and general considerations relating to flux density measurements and function operations are discussed in Section 6 – Flux Density Measurement.
FRONT PANEL

KEYPAD

There are several sets of keys on the 8000 Series Gaussmeters.

One set is associated with the menu system, these keys include; ‘Menu’, ‘Enter’ and the row of Menu Hot Keys that are aligned beside the display window. (see Figure 5-1a)

In addition for each available probe input channel there is a set of keys associated with that channel. This set includes: ‘Range’, ‘Mode’, ‘Hold’, ‘Reset’, ‘Rel’, ‘Zero’, and the ‘Manual’ adjust keys. (see Figure 5-1b)

Refer to Figure 1-1 on page 1-7 for a complete diagram of the front panel keypad layout.

Each key features a back-light that will illuminate indicating that it is active or available for user access. In some instances, certain keys will flash indicating that a particular function is enabled and or that some condition requires attention.
MENU SYSTEM

The menu system for the 8000 Series Gaussmeter is very intuitive to use. It features the use of “Hot Keys” which are linked to menu selections or functions on the display. Note the corresponding red line that link the six Menu Hot Keys to menu selections on the right-hand side of the display as shown in Figure 5-2. The current menu or sub menu is identified in the bottom block highlighted in blue.

![Figure 5-2 8000 Main Menu Example](image)

To navigate the menu system, simply press the menu hot key that corresponds to the menu selection or function desired. To return to the previously accessed menu, press the ‘Menu’ button. Pressing the ‘Menu’ button multiple times will return the display to the ‘Main’ menu.

<table>
<thead>
<tr>
<th>Key</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Keys</td>
<td>Select Menu or Feature</td>
</tr>
<tr>
<td>Menu</td>
<td>Revert One Menu Level</td>
</tr>
<tr>
<td>Enter</td>
<td>User Acceptance or Selection Verification</td>
</tr>
</tbody>
</table>

Table 5-1  
Menu Key Operation Descriptions
MENU SYSTEM
(Continued)

As the menu system is accessed each selection opens the selected menu or provides access to a list of settings for the desired function. At the point where function options are selected the current option will be highlighted in yellow as shown with the 30G range in the following example depicted in Figure 5-3.

![Figure 5-3 Menu Selections Example](image)

Note: Some menu selections differ based on the meters model number. Menu selections or paths for different models are indicated by dashed lines.

In addition, some menus have special menu screens that can be accessed. For example the Main⇒System⇒Firmware Update and the Main⇒System⇒Network Configuration menus bring up the following screens as shown in Figure 5-4.

![Figure 5-4 Special Menu Screens](image)
The complete 8000 Series Gaussmeter menu system map is shown in Figure 5-5.

Figure 5-5 8000 Gaussmeter Menu Map
Section 6  Flux Density Measurement

OVERVIEW  This section describes field measurement operations for the model 8010 gauss/tesla meter. Each of the instrument’s functions and features relating to field measurement is described in detail. This includes general considerations, technical information, and instructions on how to use each feature or function.

For a general discussion concerning the user interface, see Section 5 – User Interface.
MEASUREMENT UNITS

The measurement units selected are displayed as part of the measurement when selected. Table 6-1 lists the available units for each parameter.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flux Density</td>
<td>Gauss (G)</td>
</tr>
<tr>
<td></td>
<td>Tesla (T)</td>
</tr>
<tr>
<td></td>
<td>Oersted (Oe)</td>
</tr>
<tr>
<td></td>
<td>Ampere / meter (A / m)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Fahrenheit (°F)</td>
</tr>
<tr>
<td></td>
<td>Celsius (°C)</td>
</tr>
<tr>
<td></td>
<td>Kelvin (°K)</td>
</tr>
<tr>
<td>Time (Frequency / Period)</td>
<td>Hertz (Hz)</td>
</tr>
<tr>
<td></td>
<td>seconds (Sec)</td>
</tr>
</tbody>
</table>

Setting the Units

To change the units:

1) From the main menu, choose UNITS.
2) For each quantity, press the hot key next to the desired setting.
3) Press Menu to back out.
PRESENT FLUX DENSITY READING

The flux density reading contains five or six digits of information and includes the decimal point, polarity information, and the units of measurement; see Figure 6-1. The number of digits depends on the update interval setting. The update interval is discussed later in this section. The present flux density reading is always displayed with a larger text size than any other parameter. In the dc mode of operation, the polarity is indicated with a “+” or a “−”. The polarity information is absent when in ac mode, unless relative mode is enabled. Relative mode operation is discussed later in this section.

Note: The reading displayed in ac mode will represent the true rms value of the field waveform.

Figure 6-1 Present Flux Density Reading

MEASUREMENT MODE INDICATOR

The measurement mode is always displayed in the upper right-hand corner of the display. The range is displayed below the measurement. See Figure 6-2. It indicates the measurement range, if autorange mode is active, and whether ac or dc mode is selected. If autorange mode is active the word “Auto” is displayed.

Figure 6-2 Measurement Mode Indicator
The instrument is capable of providing flux density measurements on one of four fixed ranges, or it can be programmed to automatically select the best range for the present flux density being measured. The available ranges are listed in Section 2 – Specifications. The ranges advance in decade steps, the magnitudes available depend on the probe type. The lowest range offers the best resolution while the highest range allows higher flux density levels to be measured.

Setting the Range

Pressing the RANGE key will advance the range setting. The four ranges are followed by the autorange selection.

Autorange

In the autorange mode, the range is advanced if the reading reaches 90% full scale of the present range. The range is lowered if the present reading falls below 8% full scale of the present range.

NOTE: When the word “Auto” does not appear on the “measurement mode indicator” line, the channel is in manual ranging mode.

Overrange Condition

An overrange condition will occur when the following is true:

The instrument is in manual range mode or is in autorange mode at the highest range; and the measured flux density is 110% of the present full scale range.

When an overrange condition occurs the instrument will display the message “Over Range” in place of the flux density reading. The next highest range should be selected. If already on the highest range, then the flux density is too great to be measured with this instrument and its probe.

Note: For dc mode operation, the polarity of the flux density that caused the overrange condition will be displayed to the left of the “Over Range” message.
To Switch between ac or dc Mode

The instrument is capable of measuring either static (dc) or alternating (ac) magnetic fields. To choose the desired mode, press the AC/DC key. The “measurement mode indicator” indicates the present mode.

It is possible for the flux density signal to contain both a dc component and an ac component. In the ac mode the value displayed is the true rms value of the waveform with its dc component removed.

Frequency Measurement

When used in the ac mode, the instrument can display the frequency of an ac field. The frequency indicator line displays the measured frequency and the selected analog filter setting, see Figure 6-3. Analog filters are discussed later in this section.

Note: Depending on the selection in the UNITS menu, frequency or period may be displayed.
Frequency Compensation in ac Mode

To obtain accurate ac measurements using frequency compensation, the ac field must have a frequency greater than 10 Hz, and depending on the selected range, a minimum magnitude according to Table 6-2.

Table 6-2 Minimum Magnitudes for Rated ac Accuracy

<table>
<thead>
<tr>
<th>Range</th>
<th>Low Field Probe</th>
<th>Mid Field Probe</th>
<th>High Field Probe</th>
<th>Minimum Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mG (µT)</td>
<td>G (mT)</td>
<td>G (mT)</td>
<td></td>
</tr>
<tr>
<td>Low Field Probe</td>
<td>300.000</td>
<td>30.0000</td>
<td>300.000 G (30.000 mT)</td>
<td>20% Full Scale</td>
</tr>
<tr>
<td>Mid Field Probe</td>
<td>300.000 G (300.000 µT)</td>
<td>300.000 G (300.000 mT)</td>
<td>3.00000 kG (300.000 mT)</td>
<td>6% Full Scale</td>
</tr>
<tr>
<td>High Field Probe</td>
<td>N/A</td>
<td>3.00000 kG (300.000 mT)</td>
<td>30.0000 kG (3.00000 T)</td>
<td>4% Full Scale</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>30.0000 kG (3.00000 T)</td>
<td>300.000 kG (30.0000 T)</td>
<td>2% Full Scale</td>
</tr>
</tbody>
</table>

If the measured magnetic field is less than the “minimum magnitude” shown on Table 6-2, fourth column; the frequency of the magnetic field cannot be measured. In that case, the frequency indicator will display dashes. See Figure 6-4.

--- Hz f 10k

Figure 6-4 Indeterminate Frequency Indicator

Note: Although the flux density reading will be displayed when the frequency is indeterminate, it is not specified at rated accuracy.
AC MODE
ANALOG FILTERING

Several analog filter modes are available in AC measurement mode. The instrument can also automatically select the best filter setting based on the current flux density frequency being measured. The filters affect the displayed reading, and analog outputs.

DC MODE
OPERATION

In the dc mode, the presence of an ac component can lead to unstable readings. If the peak value of the combined ac and dc component reaches the electrical limits of the instrument, even though the average dc level is within the limits, an overrange condition will appear on the display. This situation can also lead to erratic behavior if the automatic ranging feature is being used. The presence of an ac signal can be verified by observing the analog output signal or by using the ac mode to determine the magnitude of the ac component. Analog outputs are discussed later in this section.
ZEROING

Overview

“Zeroing” the probe and instrument is one of the most important steps to obtaining accurate flux density measurements. An ideal Hall effect sensor produces zero output in the absence of a magnetic field, but actual devices are subject to variations in materials, construction and temperature. Therefore, most Hall effect sensors produce some output even in a zero field. This will be interpreted by the instrument as a magnetic field signal.

Also, the circuits within the instrument can produce a signal even when there is no signal present at the input. This will also be interpreted as a magnetic field by the instrument. Lastly, magnetic sources close to the actual field being measured, such as those from electric motors, permanent magnets and the earth’s magnetic field (roughly 0.5 gauss or 50 μT), can introduce errors in the final reading.

The zero operation is performed for both ac and dc modes of operation. While in dc mode, the zero point can be adjusted manually. When the zeroing process is initiated, the instrument performs separate zeroing sequences for ac and dc mode operation. Both sequences occur regardless of whether a channel is in ac or dc mode, and each has its own considerations.

NOTE: The process of zeroing also affects other functions such as corrected analog output signals, the hold and relative, and the field classifiers. Uncorrected analog outputs are not affected.

Zeroing

For most situations it is preferable to shield the probe from all external magnetic fields prior to zeroing. Provided with the instrument is a “zero flux chamber” which is capable of shielding against fields as high as 30 mT (300 G or 23.88 kA/m). The probe is simply inserted into the chamber before the zeroing process begins.

Handle the Hall probe with care. Do not bend the stem or apply pressure to the probe tip as damage may result.

In other situations the user may want the probe to be exposed to a specific magnetic field during the zeroing process. As an example, consider zeroing the probe when it is exposed to the earth’s magnetic field. This will cancel the effect of the earth’s magnetic field for all future readings. If a range is exceeded by the level of field while zeroing, the lower range cannot be entered by the instrument.
Zeroing

Zero Prompt

The instrument will inform the user to zero a channel by flashing the ZERO key on the front panel. The following are the conditions that will cause the instrument to prompt the user to initiate the zeroing process:

- The instrument was just turned on.
- A probe was just inserted into the instrument.
- Fifteen (15) minutes has elapsed since the instrument was turned on.
- Fifteen (15) minutes has elapsed since a probe has been inserted.
- The instrument’s internal temperature has drifted by at least 5°C.

Initiating Zeroing

To initiate the zeroing process:

1) Prepare the probe for zeroing.
2) Press the ZERO key.

The instrument will display the message “Zeroing” and a countdown indicates the approximate duration of the zeroing process. Once zeroing begins it must be allowed to complete. During this time, all controls are disabled except for the power switch. The zeroing process is approximately 2 minutes.

Manual Zero Offset for dc Mode Operation

This feature also allows the user to manually set the zero point to a value other than zero or to make a fine adjustment to the zero point after performing a zeroing operation.

To manually adjust the zero point:

1) Position the probe for zeroing.
2) Use the MANUAL ADJUST keys to adjust the zero point to the desired setting. The right MANUAL ADJUST key adds to the reading, the left MANUAL ADJUST key subtracts from the reading.

See page 1-6 for a diagram of the front panel.

This value will be added to (or subtracted from) all future dc readings. The manual offset operation affects dc offsets only, therefore it can only be used when dc mode is selected. If you wish to suppress an ac field, consider using the relative mode.

NOTE: Making a manual adjustment to the zero point only affects the current range. Adjustment may need to be repeated for other ranges.
The update interval of the reading may be adjusted. Shorter update intervals allow rapid fluctuations in flux density levels to be observed. Longer update intervals provide higher resolution, accuracy, and stability in the flux density reading. The Update Intervals are shown in Table 6-4.

<table>
<thead>
<tr>
<th>Setting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 Sec</td>
<td></td>
</tr>
<tr>
<td>0.5 Sec</td>
<td></td>
</tr>
<tr>
<td>1.0 Sec</td>
<td></td>
</tr>
<tr>
<td>2.0 Sec</td>
<td></td>
</tr>
</tbody>
</table>

Configuring the Update Interval

1) From the main menu, choose DISPLAY.
2) Select Update Rate
3) Select the desired rate.
HOLD FUNCTION

In some applications it may be desirable to “hold” a reading that is either greater than (MAX hold) or less than (MIN hold) all previous readings. The hold functions will hold their readings until reset by the user.

MIN and MAX HOLD General Description

The MIN and MAX hold functions are useful in determining the maximum or minimum value of magnetic events that occur over a period of time. The MIN and MAX use readings that are arithmetically calculated by the instrument for slow changing signals.

The MAX hold function holds the reading that is arithmetically greater than all previous readings. For instance, a reading of +125.0 is greater than +99.0 or −150.0.

The MIN hold function holds the reading that is arithmetically less than all previous readings. For instance, a reading of −125.0 is less than −99.0 or +150.0.

If the reading exceeds the limit of the selected range the MIN and MAX functions will display “Over Range” in place of minimum and maximum flux density readings.
Hold Mode Configuration

The hold functions are setup for use from the hold menu and are then activated and reset from the front panel. Any of the various hold functions may be enabled for display.

To enable / disable a hold function:

1) From the main menu, choose Channels.
2) Select the desired channel
3) Select Hold
4) Enable the desired Hold function and select Active

Using the HOLD functions

To activate / de-activate the hold functions:

1) From the measurement screen, press the HOLD key.

   The HOLD key will flash indicating that the hold function is active. Hold functions that are enabled in the HOLD menu will be displayed. Pressing the HOLD key again will de-activate the hold function.

To reset the hold function:

1) With the hold function active, press the RESET key.

Note: The hold functions are reset automatically when they are activated. (i.e. the “held” readings are not saved when the hold functions are de-activated).
RELATIVE MODE

The relative mode allows a specific flux density value to be subtracted from all future readings. Thus all future readings will be “relative” to that value. For instance if the relative value is +100.0 gauss, and the present flux density is +112.0 gauss, the actual displayed value will be +12.0 gauss. If the flux density drops to +77.0 gauss, the actual displayed value will be -23.0. Thus the relative mode allows for the direct readout of variations around a given field, whether static (dc) or alternating (ac).

There are two ways to generate a relative value. When the RELATIVE key on the front panel is pressed, the instrument uses the present flux density reading from the probe as the relative value. Alternatively, you may specify a pre-determined value from the RELATIVE menu.

There may be situations when the user may prefer to shield the probe from all external magnetic fields prior to performing a relative operation. Provided with the instrument is a “zero flux chamber” which is capable of shielding against fields as high as 30 mT (300 G or 23.88 kA/m). The probe is simply inserted into the chamber before the relative operation begins.

⚠️ Handle the Hall probe with care. Do not bend the stem or apply pressure to the probe tip as damage may result.

Relative and ac Mode Operation

In normal operation, ac readings do not indicate a polarity as they represent the true rms magnitude of the flux density reading. With the relative mode however, the polarity indicates whether the magnitude of the measured ac field is greater or less than the relative value. For example, if the relative value is 100.000 gauss ac and the measured flux density is 90.000 gauss ac, the displayed reading will be –10.000G.

Note: The relative value in ac mode is always positive, the relative reading may be positive or negative.

Note: The relative mode is cancelled if the probe is disconnected, if the instrument is turned off and back on again, or if the instrument is switched between ac and dc modes.
Section 6 – Flux Density Measurement

Relative Mode – Front Panel

In the automatic mode, the present flux density as seen by the probe is used as the relative value.

To use the present flux density as the relative value:

1) Select ac or dc mode.

2) Press the RELATIVE key.

The RELATIVE key will flash to indicate that the relative function is enabled. The “relative value indicator” displays a value that was the present flux density reading before the RELATIVE key was pressed see Figure 6-5. The present flux density reading should then display a value of zero. All readings from this point forward are “relative” and not absolute. The relative value is subtracted from all future readings. In the relative mode, a reading of zero indicates that the actual flux density being measured is equal to the relative value.

Rel +1.23456G

Figure 6-5 Relative Value Indicator

To de-activate the relative mode:

1) Press the RELATIVE key.

The RELATIVE key will discontinue to flash and the relative value indicator will disappear. All readings from this point forward are now absolute.
RELATIVE MODE
(Continued)

Relative Mode – Menu System

In some cases you may wish to set a pre-determined relative value. The relative value can be set precisely from the menu system.

To set a pre-determined relative value from the menu system:

1) Select ac or dc mode.
2) From the main menu, choose RELATIVE.
3) Select Manual or Auto

Adjusting the Relative Value from the Measurement Screen

Once the relative value is set, either from the front panel or from the RELATIVE menu, its value may be adjusted by using the MANUAL ADJUST keys. The right MANUAL ADJUST key will add to the relative value, and the left MANUAL ADJUST key will subtract from the relative value.
Corrected and uncorrected analog output voltage signal is available from standard BNC connector. The uncorrected output signal is representative of the magnetic flux density as measured by the Hall probe. The corrected output signal is compensated for influences of temperature and frequency, as well as non-linearities inherent in the Hall probe and instrument. The corrected output is specified with a higher accuracy than the uncorrected output, with a bandwidth up to 250 Hz. The uncorrected output is less accurate, but has a bandwidth of 50 kHz.

Standard full scale output ranges are $3V_{\text{RAW}}$, $10V_{\text{RAW}}$, $3V_{\text{RMS}}$, and $10V_{\text{RMS}}$. Adjustable full scale ranges up to $9.9V_{\text{RAW}}$ or $9.9V_{\text{RMS}}$, in increments of 0.1V, are also available. The raw output settings provide voltage signals that are replicas of the magnetic flux density waveforms being measured. The rms settings provide dc voltage signals that are proportional to the rms value of the ac component of a flux density signal. These outputs may be connected to a voltmeter, oscilloscope, recorder, or external analog-to-digital converter.

**Note:** With dc mode operation and rms output settings, only the ac component of the flux density is represented at the analog outputs.

**See Section 2 – Specifications**, for bandwidth and accuracy of the analog outputs.

### Flux Density Range and Output Voltage Range

Full scale of the present flux density range always corresponds to the full scale setting for the analog output voltage range. For example, if the full scale flux density range is 30 gauss and the full scale analog output voltage range is 3 volts; then a reading of 30 gauss will produce a voltage of 3 volts at the output. A reading of -20 gauss will produce a voltage of -2 volts at the output.

### Using Analog Outputs with Autorange

When using autorange and the analog output features together, the following situation can occur. Suppose the present range is 3 kG and the present reading is +2.8 kG. The analog output will be +2.8 Vdc. The signal then increases to +3.2 kG, which would force an automatic change to the 30 kG range setting. The analog output will now be +0.32 Vdc because of the range change. This can lead to problems if the analog signal is being used to make decisions, because there is no indication that a range change has occurred. In these situations it is best to select a fixed range that covers the expected flux density span.

### Configuring the Analog Outputs

1) From the main menu choose, ANALOG OUTPUTS

2) Position the “pointer” over the appropriate “selection” and press the ENTER key to advance the setting.

3) For the adjustable setting, position the “pointer” over each digit in the number and press the ENTER key to advance the setting.
CLASSIFIERS

The classifier function allows a lower and upper limit of flux density to be defined that can be quickly used to determine the status of a magnetic field. The instrument will indicate visually whether the field is above, within, or below these limits. The same information is presented in the form of general purpose switch closures available at standard 15 pin “D” type female connector. The connector is located at the rear of the instrument.

The pin assignments for the classifier connector (digital I/O) are indicated in Section 2 – Specifications. The Classifier functionality will be available with a future firmware update.

Configuring the Classifier Settings

Two flux density values are set. One value sets the upper limit and the other sets the lower limit. It does not matter which value is chosen to be the upper or lower limit, the instrument will automatically make this determination. For dc mode operation, polarity information needs to be specified. With ac mode, only positive values may be set. The instrument will retain dc polarity information when switching between ac and dc modes. The classifier function will be available with a future firmware revision.
Example Circuit for Classifier Outputs

Figure 6-6 shows an example circuit for using the classifier outputs. These outputs are in the form of general purpose switch closures available from the 15 pin “D” type connector located on the rear panel of the instrument.

See Section 2 – Specifications for pin assignments and response times of the relays.

If the measured field is within the pre-defined classifier settings, both relays are open and neither LED is illuminated. If the measured field is above the defined limits, the classifier high relay is closed causing the “High” LED to illuminate. If the measured field is below the defined limits, the classifier low relay is closed causing the “Low” LED to illuminate.
When making flux density measurements there are several conditions that can introduce errors:

1) Failure to zero the error signals from the instrument, probe, and nearby sources of magnetic interference.

2) Subjecting the probe to physical abuse.

3) One of the most common sources of error is the angular position of the probe with respect to the field being measured. A Hall Effect sensor is not only sensitive to the number of flux lines passing through it but also the angle at which they pass through it. The Hall Effect sensor produces the greatest signal when the flux lines are perpendicular to the sensor as shown in Figure 6-7.

![Figure 6-7 Probe Output versus Flux Angle](image)

Note: The probe is calibrated and specified with flux lines passing perpendicularly through the Hall effect sensor.
4) As shown in Figure 6-8 as the distance between the magnetic source and the Hall probe increases fewer flux lines will pass through the probe, causing the probe’s output to decrease.

![Figure 6-8 Probe Output versus Distance](image)

5) Flux density can vary considerably across the pole face of a permanent magnet. This can be caused by internal physical flaws such as hairline cracks or bubbles, or an inconsistent mix of materials. Generally the sensitive area of a Hall Effect sensor is much smaller than the surface area of the magnet, so the flux density variations are very apparent. Figure 6-9 illustrates this situation.

![Figure 6-9 Flux Density Variations in a Magnet](image)

6) The accuracy of the instrument and probe are affected by temperature variations. See Section 2 – Specifications. Temperature variations are greatest during the initial warm up phase after power-up (15 minutes). Allow the instrument and probe to stabilize for best accuracy.
Section 7  Remote Operation

INTRODUCTION
In 1975 the IEEE-488 standard defined the electrical and mechanical aspect for cables and connectors, as well as the handshaking, addressing and general protocol for transmitting individual bytes of information between instruments and computers. The standard was later updated and is now called IEEE 488.1-1987.

Although the standard solved the problem of how to communicate it did not specify the meaning of the bytes. Instrument manufacturers freely invented new commands as they developed new instruments. For instance a command to program a range on one manufacturer's voltmeter may not have worked with another’s. 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 488.2-1987 standard was a step toward creating a universal way to communicate with any instrument, regardless of the manufacturer or the type of instrument used. It defined a set of “common” commands that all instruments should respond to in a predictable manner. Yet it did not specify which features or commands should be implemented for a particular instrument.

Later the SCPI-1999 standard (Software Commands for Programmable Instruments) defined specific commands and responses that covered a broad range of applications. For a given measurement function such as frequency or voltage, SCPI defines a specific command set that is available for that function. The command sets are easy to learn and read. Manufacturers can still create new commands unique to their own instruments while conforming to the structure and spirit set forth by SCPI.

The 8000 Series Gauss / Tesla Meters utilize many of the IEEE-488-1987.2 “common” commands in addition to a subset of the SCPI-1999.0 commands. Due to the uniqueness of the gauss/tesla meter, there are some commands that are not specified by SCPI but conform to the rules indicated by the standard.
COMMUNICATION PORTS

RS-232 PORT

FUNCTIONAL DESCRIPTION

The instrument has been designed to interface directly to the 9-pin “D” serial connector on most personal computers using a straight-through cable. This means Pin-1 on the meter is connected to Pin-1 on the computer, Pin-2 to Pin-2, etc. Figure 7-1 shows the pin out for the 8000 Series Meter RS-232 communications port.

![Figure 7-1 RS-232 Connector](image)

RS-232 PORT

COMMUNICATIONS SETUP

The serial transmission characteristics such as baud rate, parity setting, etc. are defined in the table 7-1. These settings must be duplicated on the host computer.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud Rate</td>
<td>9600</td>
</tr>
<tr>
<td>Data Bits</td>
<td>8</td>
</tr>
<tr>
<td>Stop Bits</td>
<td>1</td>
</tr>
<tr>
<td>Parity</td>
<td>None</td>
</tr>
<tr>
<td>Handshaking</td>
<td>None</td>
</tr>
</tbody>
</table>
The 8000 Series Gaussmeters are equipped with a standard 10/100MHz Ethernet port via a RJ-45 connector on the back panel. This port supports TCP/IP communications and provides the user access to the system’s internal web based application interface. It is designed to connect directly to computer networks using a standard patch cable (T568B) as shown in Figure 7-2. Direct connection to computers using a crossover cable is not supported.

Navigating the system menu from [Main] to [System ⇒ Network Configuration] will bring up the Ethernet port network configuration screen as shown in Figure 7-3.

The meter offers two network address setup options which the user can select by pressing the [Change Addr Mode] button.

The default selection is DHCP (Dynamic Host Configuration Protocol), which sets the meter to automatically obtain an IP address from the network.

Pressing the [Change Addr Mode] button will change the system network configuration to Manual, and will bring up additional menu selections that will allow the user to specify a static IP, Netmask, Gateway, and DNS Server addresses.
ETHERNET PORT COMMUNICATIONS SETUP

(Continued)

After making changes to the network configuration pressing the [Save and Reboot] menu button will save the settings and reboot the system.

Note: While in DHCP mode the network connection must be installed prior to system boot up in order for the meter to obtain your network configuration settings from the network. If no network is detected the system will assign internal default address information.

ETHERNET PORT ACCESSING THE INTERNAL WEB APPLICATION

With the meter connected to a computer network navigate to the [Network Config] menu and determine the meter’s current IP address.

On a network computer, open a web browser application like Windows Internet Explore and enter the meter’s current IP address. For example http://10.60.43.105/

The 8000 Series Gaussmeters Web Application will open as shown below in Figure 7-4.

Note: Currently the web application is under development, check with FW Bell field applications support for future firmware updates.

![Figure 7-4 8030 Gaussmeter Web Application Screen](image-url)
The meter can also be remotely accessed using a Telnet Client such as Windows Telnet Client.

Note: The following example utilizes the windows system32 telnet.exe client as part of WindowsXP. Applications may vary based on operating system installed, please consult your application’s help files for more detailed descriptions and operating instructions.

Open the Telnet Client and at the command prompt use the open port command “open hostname [port]” where the hostname is your meters network IP address and the [port] is 5024. See Figure 7-5.

Note: Port 5024 is a registered transport protocol port number for SCPI-TELNET.

Once connected you may use the escape character to return to the command prompt and enter “status” to verify connection. Hitting “Enter” will return you to the entry prompt where you can enter SCPI commands.

Figure 7-5 Windows Telnet Example
REMOTE COMMANDS

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, tesla meter, 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 valid.

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 a decimal 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 a decimal 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.
IEEE-488.2 “COMMON” COMMANDS

**Table 7-2 Common Command Summary**

<table>
<thead>
<tr>
<th>ACRONYM</th>
<th>NAME</th>
<th>BRIEF DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>*IDN?</td>
<td>Identification query</td>
<td>Return manufacturer, model number, software version number.</td>
</tr>
</tbody>
</table>

IEEE-488.2 “COMMON” COMMANDS

*IDN? - IDENTIFICATION QUERY

Returns the following string: **F.W.BELL,80m0 GAUSS-TELSAMETER,x.x.x**.
Where m is the 8000 model (i.e. 8010 or 8030) and x.x.x is the firmware revision level.
The SCPI commands 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 valid.

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 :INPUT can be shortened to :INP.
   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 :MEASURE:TEMPERATURE? can be shortened to :MEAS:TEMP?
   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 :COUPLING2 would be shortened to :COUP2.
   f) The use of anything other than the short or long version of a command is invalid. For instance both the :MEASURE and :MEAS commands are valid, but :MEASU is not.

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

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 and means Numeric Representation format.

Many commands are channel specific, so the “#” character in these commands should be replaced with the channel number 1, 2, or 3 for multi-channel instruments such as the 8030 model. If the channel number is omitted then Channel-1 is assumed.

The gauss / tesla meter 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.

<table>
<thead>
<tr>
<th>Table 7-3a SCPI Range Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND</td>
</tr>
<tr>
<td>:SENSe#:FLUX:DC</td>
</tr>
<tr>
<td>:SENSe#:FLUX:AC</td>
</tr>
<tr>
<td>:SENSe#:FLUX:RANGe:AUTo &lt;b&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:DC:RANGe:AUTo &lt;b&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:AC:RANGe:AUTo &lt;b&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:RANGe:FIXed &lt;n&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:DC:RANGe:FIXed &lt;n&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:AC:RANGe:FIXed &lt;n&gt;</td>
</tr>
<tr>
<td>:SENSe#:FLUX:RANGe?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 7-4b SCPI Measurement Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND</td>
</tr>
<tr>
<td>:MEASure#:FLUX?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 7-4c SCPI Filter Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND</td>
</tr>
<tr>
<td>:INPut#:FILTer:BPASs &lt;n&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 7-4d SCPI Zeroing Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMAND</td>
</tr>
<tr>
<td>:CALibration#ZERo:HSENsor:INITiate</td>
</tr>
</tbody>
</table>
Table 7-4e SCPI Analog Output Commands

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>:OUTPut#:UNCorrected:MODe &lt;n&gt;</td>
<td>Set the output mode of the uncorrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:UNCorrected:MODe?</td>
<td>Query the output mode of the uncorrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:UNCorrected:SCALing &lt;n&gt;</td>
<td>Set the scaling of the uncorrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:UNCorrected:SCALing?</td>
<td>Query the scaling of the uncorrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:CORRected:MODe &lt;n&gt;</td>
<td>Set the output mode of the corrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:CORRected:MODe?</td>
<td>Query the output mode of the corrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:CORRected:SCALing &lt;n&gt;</td>
<td>Set the scaling of the corrected analog output.</td>
</tr>
<tr>
<td>:OUTPut#:CORRected:SCALing?</td>
<td>Query the scaling of the corrected analog output.</td>
</tr>
</tbody>
</table>

SCPI RANGE COMMANDS

These commands select either a fixed range or AUTO range, and specify if the measured flux density will be static (dc) or alternating (ac).

:SENSe#:FLUX:AC
:SENSe#:FLUX:DC

These commands do not alter the present range setting.

:SENSe#:FLUX:RANGe:FIXed <n>
:SENSe#:FLUX:DC:RANGe:FIXed <n>
:SENSe#:FLUX:AC:RANGe:FIXed <n>

Specifies that the measured flux density will be static (dc) or alternating (ac) while also specifying one of four fixed operating ranges for the instrument, as defined in table 7-5 shown below.

Table 7-5 Operating Ranges with Various Probes

<table>
<thead>
<tr>
<th>&lt;n&gt;</th>
<th>Maximum Flux Density Using Low Field Probe</th>
<th>Maximum Flux Density Using Mid Field (1x) Probe</th>
<th>Maximum Flux Density Using High Field (10x) Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>300 mG (30 μT)</td>
<td>30 G (3 mT)</td>
<td>300 G (30 mT)</td>
</tr>
<tr>
<td>1</td>
<td>3 G (300 μT)</td>
<td>300 G (30 mT)</td>
<td>3 kG (300 mT)</td>
</tr>
<tr>
<td>2</td>
<td>30 G (3 mT)</td>
<td>3 kG (300 mT)</td>
<td>30 kG (3 T)</td>
</tr>
<tr>
<td>3</td>
<td>300 G (30 mT)</td>
<td>30 kG (3 T)</td>
<td>300 kG (30 T)</td>
</tr>
</tbody>
</table>

SCPI :SENSe#:FLUX:RANGe:AUTo <b>
RANGE COMMANDS (Continued)

:SENSe#:FLUX:DC:RANGe:AUTo <b>
:SENSe#:FLUX:AC:RANGe:AUTo <b>

Specifies that the measured flux density will be static (dc) or alternating (ac) and AUTO ranging is turned off when <b> is “0” or on when <b> is “1”. When AUTO range is turned on the instrument determines the range that will offer the best resolution. When AUTO range is turned off the range will be fixed to the last range that was in use when the command was issued.

:SENSe:FLUX:RANGe?

Places an ASCII string in the output queue representing the present ac/dc setting, the present range and the state of the AUTO range feature.

The string will start with the phrase “AC” or “DC, followed by a comma(,). The next single digit will be the range setting, as shown in Table 7-5, and will be in the range of 0 to 3, followed by a comma(,). Next will be the phrase “OFF” or “ON, indicating the state of the AUTO range feature.

For example the string DC,2,OFF indicates that the channel is in dc mode on a fixed range setting of 2.

SCPI MEASUREMENT COMMANDS

:MEASure#:FLUX?

The latest flux density reading is placed in the output queue and will be between 0.0000000000 and ± 299999999. The meaning of this value depends upon the currently selected unit of measure (gauss, tesla, etc.). For instance the value 1.0203 could mean 1.0203 G or 1.0203 T. The rate at which flux density readings are updated is controlled by the display update rate. Issuing the MEASure:FLUX? command at a rate that is faster than this update rate will return the same reading multiple times. For instance, if the meter updates the reading once per second, and the MEASure:FLUX? command is issued 10 times per second, the same reading will be returned 10 times.

The rate at which new flux density readings can be acquired is also dependant on the speed of the communications port. Currently the RS-232 port is limited to a baud rate of 9600, if faster communication is needed use the Ethernet port.
These commands control the hardware band-pass filters while in AC mode.

:INPut#:FILTer:BPASs <n>
Selects the analog band-pass filter frequency response when in AC mode where:

- n = 0 >> High Frequency 16Hz to 50kHz
- n = 1 >> Medium Frequency 16Hz to 10kHz
- n = 2 >> Low Frequency 16Hz to 500Hz
- n = 3 >> XLow Frequency 0.5Hz to 500Hz

These commands control zeroing of the Hall probe and the instrument.

:CALibration#:ZERo:HSENsor:INITiate
This command initiates the same zeroing process as the front-panel ZERO push button for the specified channel. The Hall probe should be placed in a stable, low-flux environment such as a zero flux chamber prior to issuing this command.

:CALibration:ALL:ZERo:HSENsor:INITiate
Same as the “:CALibration#:ZERo:HSENsor:INITiate” command, but ALL channels are zero simultaneously.
The instrument provides a corrected and uncorrected analog output for each channel. These commands specify the output configuration by setting the output mode and scaling options.

```plaintext
:OUTPut#:UNCorrected:MODe <n>
:OUTPut#:CORRected:MODe <n>
```

Sets the mode of operation for the selected uncorrected or corrected analog output where:

- \( n = 0 \) >> Output Off
- \( n = 1 \) >> Output is in Waveform Output Mode
- \( n = 2 \) >> Output is in RMS Output Mode

```plaintext
:OUTPut#:UNCorrected:MODe?
:OUTPut#:CORRected:MODe?
```

Queries the mode of operation for the selected uncorrected or corrected analog output where the return value represents the following:

- 0 = Output Off
- 1 = Output is in Waveform Output Mode
- 2 = Output is in RMS Output Mode

```plaintext
:OUTPut#:UNCorrected:SCALing <NRf>
:OUTPut#:CORRected:SCALing <NRF>
```

Sets the scale value for the selected uncorrected or corrected analog output where \(<NRF>\) is the scale value from 0.0 to 10.0 in 0.1 volt increments. Setting the value to 0.0 sets the analog output mode to off.

Normally a full-scale level of 3.0 volts is used because it directly corresponds to the full-scale ranges of the instrument. For instance, if on the 300 mT range, a reading of -189.3 mT will result in an analog output of -1.893 volts. If on the 3 kG range, a reading of +2.6 kG will result in an analog output of +2.6 volts. Some data acquisition systems may require different analog input ranges. For example, assume such a system cannot accept signals greater than \( \pm 2.0 \) volts. In this case you can specify 2.0V as the full-scale range of the analog output \(<NRF> = 2.0\).

The relationship between the output voltage and the flux density reading is:

```
\text{Full scale output voltage} / \text{full scale flux density range}
```

For example, assume the full scale output voltage has been set to 2.0 volts and the present range setting is 300 mT. The relationship will be:

```
2.0 \text{ volts} / 300 \text{ mT} = 0.0067 \text{ volts / mT}
```

Thus, when the flux density reaches the maximum for the present range, the analog output voltage will reach a maximum of \( \pm 2.0 \) volts.
SCPI ANALOG OUTPUT COMMANDS (Continued)

:OUTPut#:UNCorrected:SCALing?
:OUTPut#:CORRected:SCALing?

Queries the scaling value for the selected uncorrected or corrected analog output where the return value represents the current scaling factor in volts.

SCPI 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 0001010 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.

When using the RS-232 or the Ethernet port the instrument will always send the LF (line feed) and CR (carriage return) characters every time it transmits a message to the system controller.

  Carriage Return >> ASCII code 13
  Line Feed       >> ASCII code 10
Section 8  

Firmware Update

OVERVIEW

FW Bell is dedicated to continuously provide our customers with the latest features and accessories available for the 8000 Series Gaussmeters. This section describes the procedures for updating the internal firmware of the 8000 Series Gaussmeter via either the Internet or USB flash memory device.

FIRMWARE UPDATE PROCEDURE

From the [Main] system menu, navigating to [System ⇒ Firmware Update] will open the Firmware Update screen as shown in Figure 8-1.

When this screen is accessed the meter will display the current firmware version installed and the most recent firmware versions available via the internet and/or attached USB memory device.

The user can then choose to update firmware from the USB drive or over the internet by pressing the appropriate menu button.

When one of the [Update from...] buttons are pressed the meter will confirm the operation by asking the user to press the Enter button. When the [Enter] button is pressed the meter will begin the update process and re-boot from the new firmware.

Note: If either the network or USB drive is not present before entering this menu the meter will display a message warning the user.

Note: If the network is present but the internet is unavailable the Internet version will be N/A without any other indication.

Note: Some network firewalls or network security policies block unrestricted access to the internet; please contact your network administrator for access policies.

Figure 8-1 Firmware Update Screen

PREPARING THE USB DRIVE FOR UPDATE

To prepare the USB memory device for a firmware update: Download the latest firmware release from www.fwbell.com or call your technical support representative, then save it to a USB memory device.

The file name will be fwb8000-x.x.x.bin, where the x.x.x represents the revision of the firmware.

Note: The meter will search the device for firmware files and will select the most recent version on the drive based on file name. It is best to copy the desired firmware to the root directory and remove all previous versions in order to ensure the correct version is selected.
Appendix A       Understanding Flux Density

Magnetic fields surrounding permanent magnets or electrical conductors can be visualized as a collection of magnetic flux lines; lines of force existing in the material that is being subjected to a magnetizing influence. Unlike light, which travels away from its source indefinitely, magnetic flux lines must eventually return to the source. Thus all magnetic sources are said to have two poles. Flux lines are said to emanate from the “north” pole and return to the “south” pole, as depicted in Figure A-1.

![Figure A-1](https://via.placeholder.com/150)

**Figure A-1  Flux Lines of a Permanent Magnet**

One line of flux in the cgs measurement system is called a *maxwell* (Mx), but the *weber* (Wb), which is $10^8$ lines, is more commonly used.

Flux density, also called magnetic induction, is the number of flux lines passing through a given area. It is commonly assigned the symbol “$B$” in scientific documents. In the cgs system a *gauss* (G) is one line of flux passing through a 1 cm$^2$ area. The more commonly used term is the *tesla* (T), which is 10,000 lines per cm$^2$. Thus

1 tesla = 10,000 gauss  
1 gauss = 0.0001 tesla

Magnetic field strength is a measure of force produced by an electric current or a permanent magnet. It is the ability to induce a magnetic field “$B$”. It is commonly assigned the symbol “$H$” in scientific documents. The unit of “$H$” in the cgs system is an *oersted* (Oe), but the *ampere/meter* (A/m) is more commonly used. The relationship is

1 oersted = 79.6 ampere/meter  
1 ampere/meter = 0.01256 oersted

It is important to know that magnetic field strength and magnetic flux density are not the same. The only time the two are considered equal is in free space. Only in free space is the following relationship true:

$1 \text{ G} = 1 \text{ Oe} = 0.0001 \text{ T} = 79.6 \text{ A/m}$
MEASUREMENT OF FLUX DENSITY:

A device commonly used to measure flux density is the *Hall Effect sensor*. A Hall Effect sensor is a thin slice of a semiconductor material to which four leads are attached at the midpoint of each edge, as shown in Figure A-2.

A constant current (Ic) is forced through the material. In a zero magnetic field there is no voltage difference between the other two edges. When flux lines pass through the material the path of the current bends closer to one edge, creating a voltage difference known as the Hall voltage (Vh). In an ideal Hall generator there is a linear relationship between the number of flux lines passing through the material (flux density) and the Hall voltage.

The Hall voltage is also a function of the *direction* in which the flux lines pass through the material, producing a positive voltage in one direction and a negative voltage in the other. If the same number of flux lines passes through the material in either direction, the net result is zero volts. This sensitivity to flux direction makes it possible to measure both static (dc) and alternating (ac) magnetic fields.

The Hall voltage is also a function of the *angle* at which the flux lines pass through the material. The greatest Hall voltage occurs when the flux lines pass perpendicularly through the material. Otherwise the output is related to the cosine of the difference between 90° and the actual angle.

The sensitive area of the Hall Effect sensor is generally defined as the largest circular area within the actual slice of the material. This *active area* can range in size from 0.2 mm (0.008") to 19 mm (0.75") in diameter. Often the Hall Effect sensor assembly is too fragile to use by itself so it is often mounted in a protective tube and terminated with a flexible cable and a connector. This assembly is known as a *Hall probe*. For more information on Hall Probes see Section 3 – Probes.
WARRANTY

This instrument is warranted to be free of defects in material and workmanship. Pacific Scientific OECO’s obligation under this warranty is limited to servicing or adjusting any instrument returned to the 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 Pacific Scientific OECO’s 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.

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