AMF Life Systems LLC
(248) 904-1344

2D HF Magnetic Field Probe Operating Manual

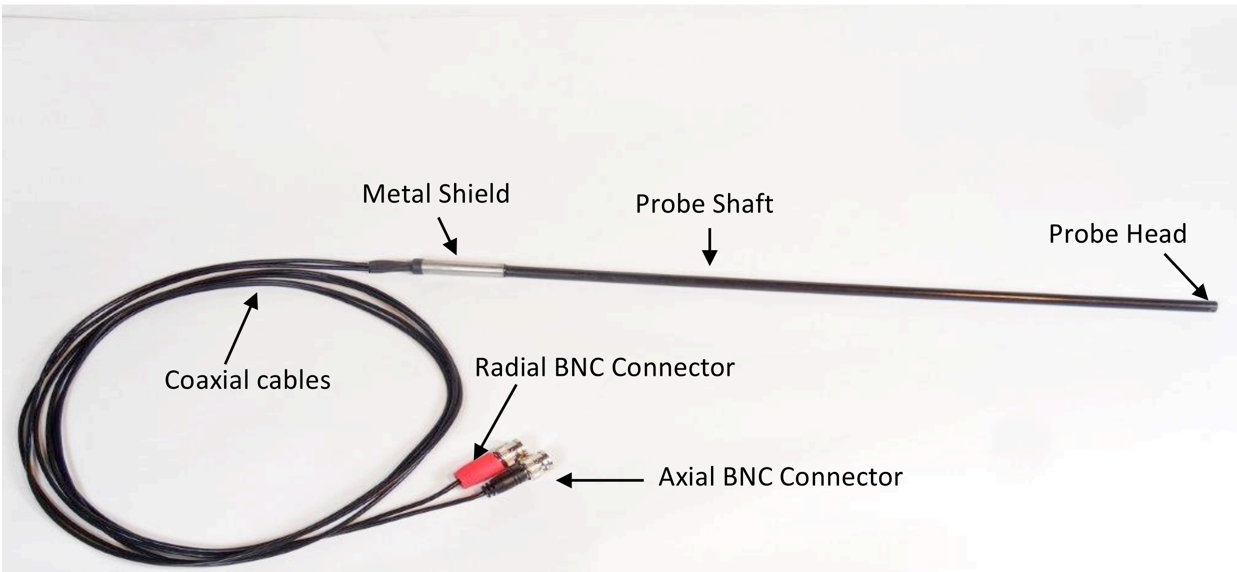

Figure 1: Image of magnetic field probe with major components labeled.

I PURPOSE:

This device is to be used for determining the strength of a high frequency magnetic field in 2 directions simultaneously.

II DESCRIPTION:

The probe is two dimensional. This means the strength of a magnetic field can be measured in two directions at a fixed position. Readings can be taken for a field axial to the length of the probe. Readings can also be taken for a field radial to the length of the probe in a specified position. There are two cables on the probe for connection to an oscilloscope. The cable with the red marking is to be used for taking radial field readings. The other cable which is completely black is to be used for taking axial readings (refer to figure 1).

III OPERATING INSTRUCTIONS:

Connecting to oscilloscope-

Connect cables to BNC inputs of oscilloscope. Keep in mind the cable with the red tag will measure radial field, the other cable will measure axial field. If oscilloscope has only one BNC input, connect one cable at a time, taking readings for one dimension of the field at a time. Set the oscilloscope input settings to AC voltage, 1:1 ratio.

Positioning probe-

To measure a certain location in a magnetic field (in an induction coil) the probe must be stable for reliable results. A holding fixture is recommended to obtain stable results at specific positions. To measure an exact location that a reading is taken from, measure from the centerline of the sensor, marked around the circumference of the probe head (refer to figure 2a).

To measure a field axial to the probe (using the unmarked, black cable), the probe rod must be aligned completely parallel to the direction of field. This relation is shown in figure 2a with the direction of the field represented by the blue arrows. If the probe is tilted at an angle from the field direction, a smaller signal will result, which is why the proper orientation is important.

To measure a field that is radial to the probe (using the red tagged cable), the direction of the field must be exactly 90° from the radial side markings on the probe end. This relation is shown in figure 2b with the direction of the field represented by the blue arrows. The radial side markings are also indicated in figure 2b. If the probe is not oriented with the field exactly 90° from the side markings, the reading will be smaller than actual. To verify if the probe is properly positioned, the shaft can be slightly twisted clockwise and then counter-clockwise until the highest reading is obtained. Field in the direction parallel to the side markings cannot be measured. The reading will be near zero at this position. Although the probe can be twisted 90° to obtain a field reading in the other radial direction.

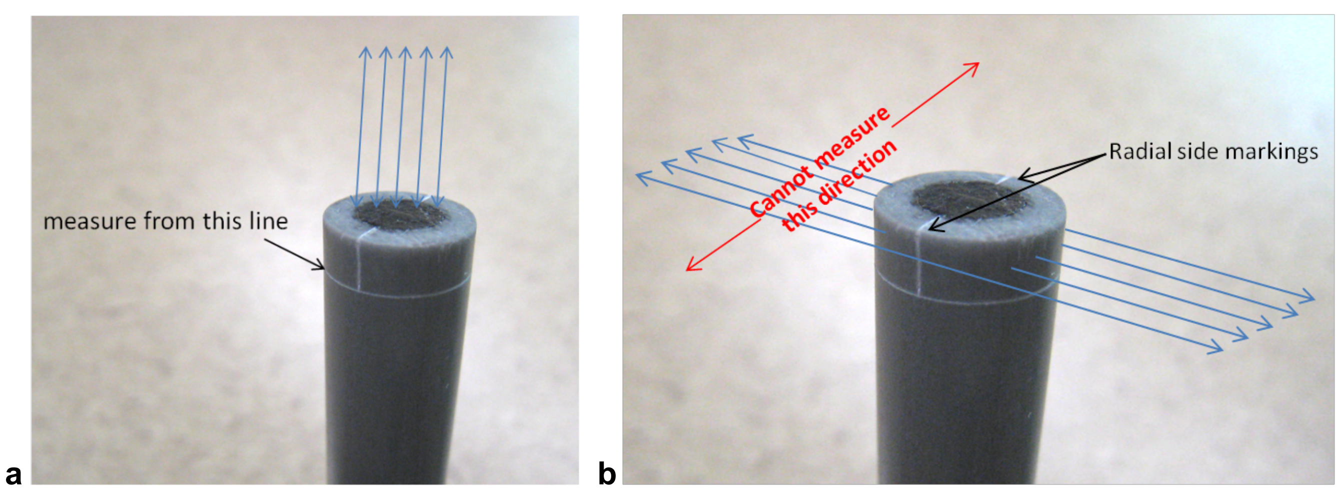

Figure 2: (a) Field direction measured by axial sensor, indicated by blue arrows. (b) Field direction measured by radial sensor, indicated by blue arrows.

IV DETERMINING MAGNETIC FLUX DENSITY (B)

To calculate the magnetic field from the voltage readings of the probe, use the following equations:

Magnetic flux density in axial direction: $B_a = \frac{U_a}{S_a * f}$

Magnetic flux density in radial direction: $B_r = \frac{U_r}{S_r * f}$

Magnitude of magnetic flux density: $B_m = \sqrt{B_a^2 + B_r^2}$

Magnetic flux density (B) is the **peak (or magnitude)** value. U is the voltage reading from the oscilloscope in **Root Mean Square (RMS)**. S is the sensitivity factor (This number is engraved on the metal portion of the probe. There is one coefficient for radial (R) and one for axial (A)), *f* is frequency in kHz, B has units of Tesla (1 T = 10,000 Gs).

V OPERATING CONDITIONS

Certain environments could interfere with the readings of the probe. The probe and oscilloscope should be positioned as far away as possible from any surrounding electronic devices or equipment during testing. If the probe is being used with an induction coil, the oscilloscope should be positioned at least four feet from the power supply.

The probe should not be submersed in any substance other than air.

Storage temperature range: -100 to 250 °F

Operating temperature range: 30 to 100 °F

The probe should be used within a certain range of signals, which is a function of B and f. The minimum combination of B and f for probe measurements to be made is displayed in figure 3, labeled as the "Recommended Min". Values below this range will not produce a significant signal which may lead to inaccuracies.

The maximum combination of B and f for an unlimited period of exposure time is also displayed in figure 3, labeled as the "Recommended Max". Beyond these values, heating may occur that could be harmful to touch or cause damage to the probe. If measurements at higher values are needed, limit the exposure time to the magnetic field. For consecutive measurements at higher values than in figure 3, it is recommended to take one reading at a time, cutting the power source and allowing the probe to cool to room temperature before each reading. The probe head (refer to figure 1) is where heating will occur at high values of B and f. To determine if the probe is overheating, carefully and abruptly touch the probe head. If it feels hot to the touch, let cool to room temperature.

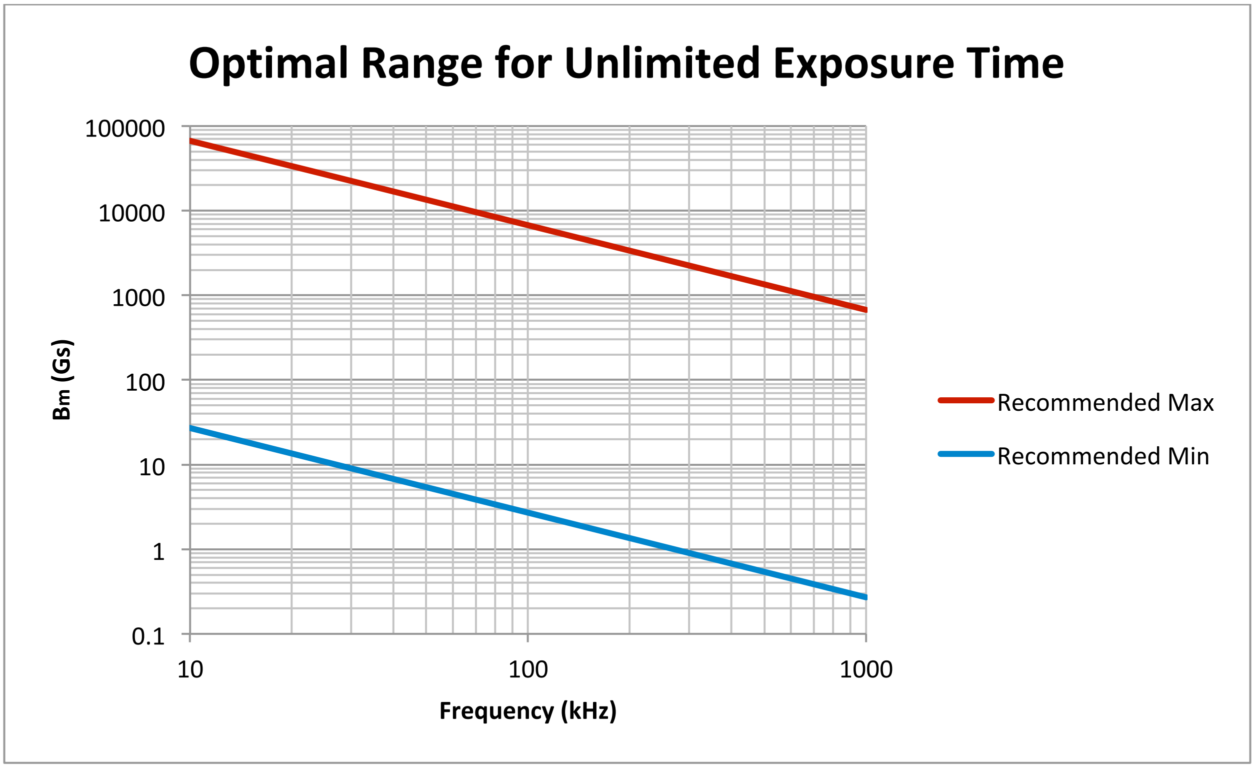

Figure 3: Optimal combination of B_m and f for probe measurements, with unlimited exposure time at ambient temperature of 70° F in air.

VI WARNINGS/CAUTIONS

The metal shield (refer to figure 1) may heat under high frequency fields. Above 100 kHz, keep shield out of fields of 20 Gs or higher. Heating will occur with exposure over time. If any metal heating is detected, immediately remove from high field area. If shield must be exposed to high fields at high frequency for testing, only do so for short intervals of time and be careful with handling.

The probe head, where the sensor is located, may heat at B and f above the recommended max in figure 3. Again, excessive heating may be avoided by limiting the exposure time of the probe to high field and frequency. Use caution when handling the probe ends during and directly following a measurement.

Before connecting the probe to an oscilloscope, determine the voltage rating of the oscilloscope. There is a risk of damaging the probe and the oscilloscope if the voltage signal of the probe exceeds the rating of the oscilloscope. Figure 4 is to be used as a guideline for the range of voltage signals (rms) that will result at various levels of B (magnitude) and frequency. This assumes a sinusoidal waveform with a consistent peak amplitude. If the amplitude of the waveform fluctuates in time, the peak voltage could exceed the rating of the equipment even if the rms value may be within the tolerance. An example of this is in figure 5. For a consistent waveform, the peak voltage is 1.4 times the rms value. If the waveform fluctuates, the maximum peak voltage could be much larger than 1.4 times the rms value and will be a higher risk for damage.

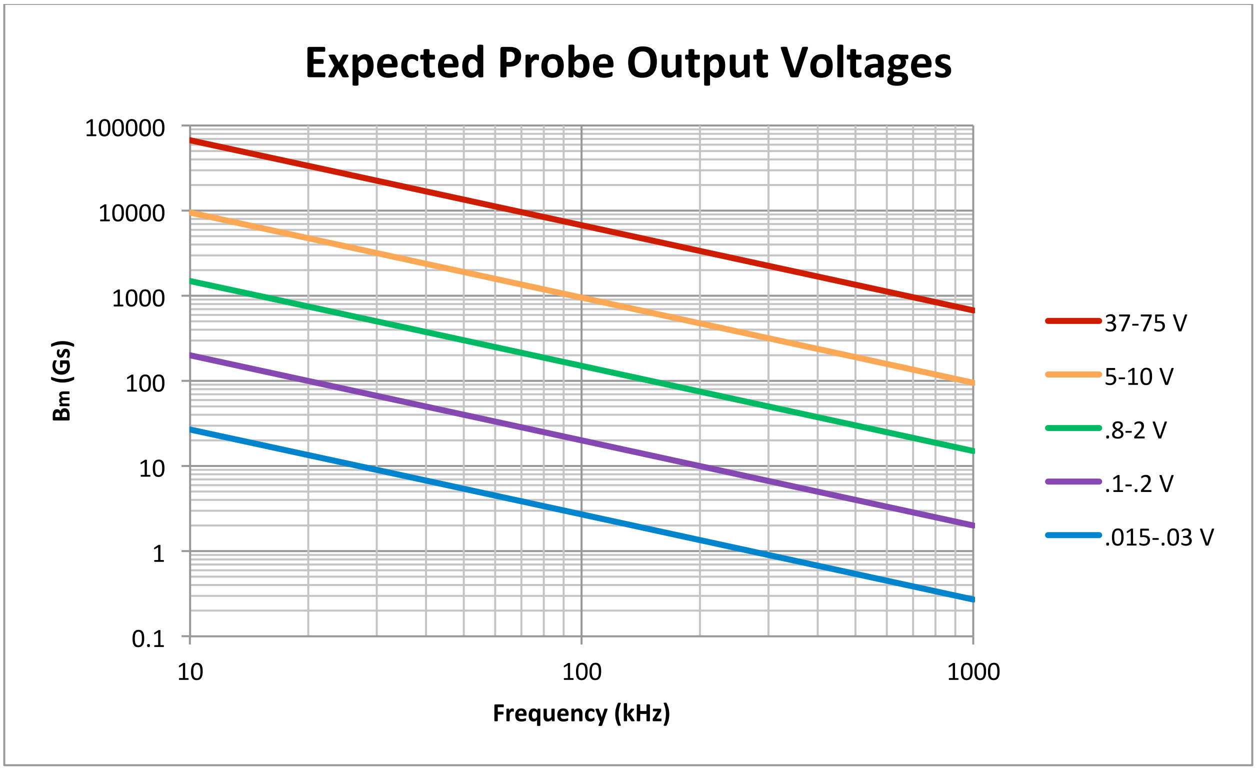

Figure 4: Expected rms voltage signals for various levels of B_m and f.

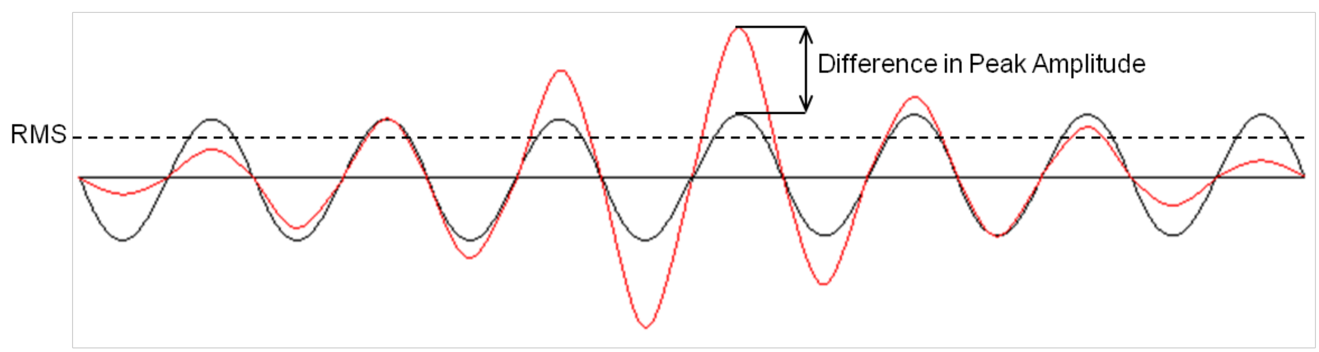

Figure 5: Example of sinusoidal waveform with a consistent peak amplitude (black) and varied peak amplitude (red).

VII MAINTENANCE

If any part of the probe becomes damaged or lost, it is recommended to return to AMF Life Systems, LLC for repair or replacement. If probe is suspected of providing false measurements, it is recommended to return to AMF Life Systems, LLC for verification and calibration.

CONTACT INFORMATION

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