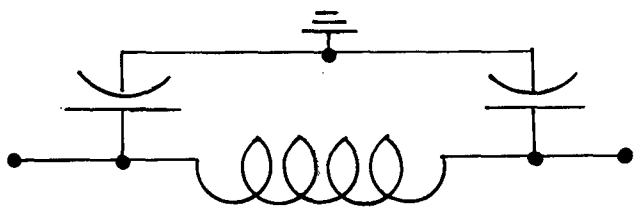
THE SHORTCOMINGS OF MIL-STD-220A

Great improvements have been made over the years in the design and manufacturing of toroidal core materials, part of the RF coil design used by the low pass power line filter industry. The core material is an intricate and essential part of the RF coil design and determines such characteristics as inductance and core saturation. Unfortunately the current military specification for testing the performance of RF power line filters, MIL-STD-220A, has not been revised to incorporate adequate testing methods to reflect these improvements in certain core materials. This situation does pose an extreme problem for technical and purchasing personnel who are responsible for the generation of specification control drawings covering power line filters.

The following filter design of a simple PI circuit filter highlights such problems.



Rating: 2.4 AMPS, 120 VAC, 60 Hz
C = 1.0 MicroFarads
L = 276 MicroHenry (No Load) Consisting of: 42 Turns of wire on a Magnetics Part No. 58930-A2 High Flux Core

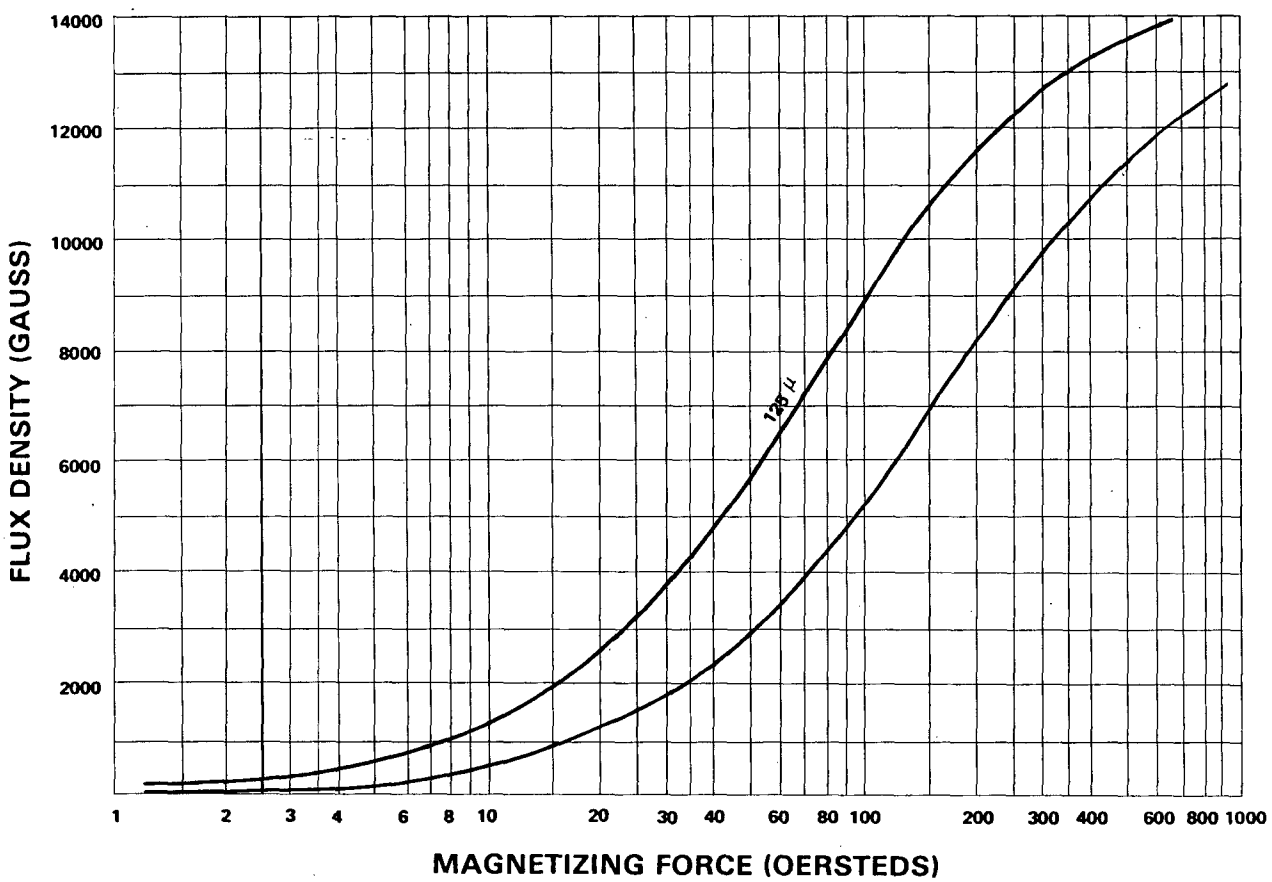


Figure 1. Normal Magnetization Curves.
High Flux Cores.

The magnetizing force in oersteds for such a winding is as follows:

$$\text{Oersteds} = \frac{0.4\ \pi\ N\ I}{\ell} = 20$$

This number is then plotted on Figure 1, using the appropriate curve for the core selected (125μ). The flux density is determined to be 2700 Gauss. This factor is applied to Figure 2, which indicates that the 125μ core offers an increase in inductance of 19%. Therefore, the inductor can offer 328 Micro-Henry at 2.4 AMPS AC. Returning to the original schematic and replacing the 276μH no-load coil with the new value of 328μH, the insertion loss of this circuit is determined to be 76 dB at 150 kHz.

An assumption is then made that this filter design was incorporated into a piece of equipment which, when tested in accordance with MIL-STD-461A, passed the conducted emission portion of the test by 2 dB at 150kHz. Generally, the next step is the preparation of a specification control draw-

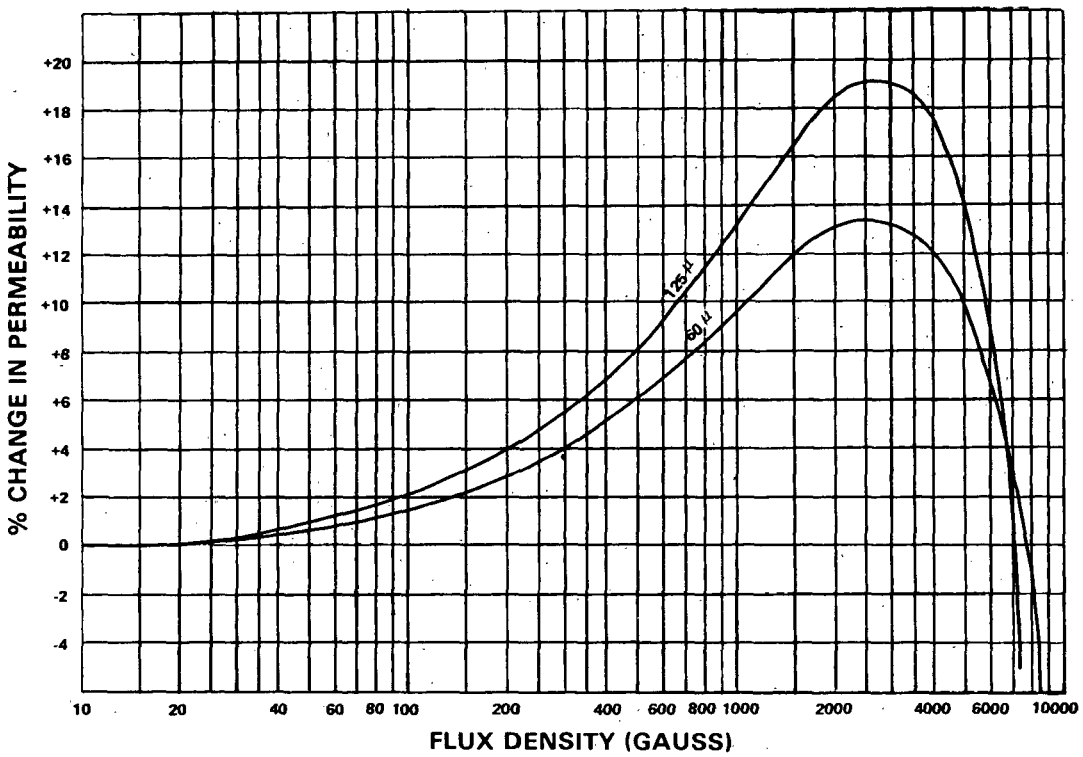


Figure 2. Permeability vs AC Flux Density (60μ - 125μ) High Flux Cores.

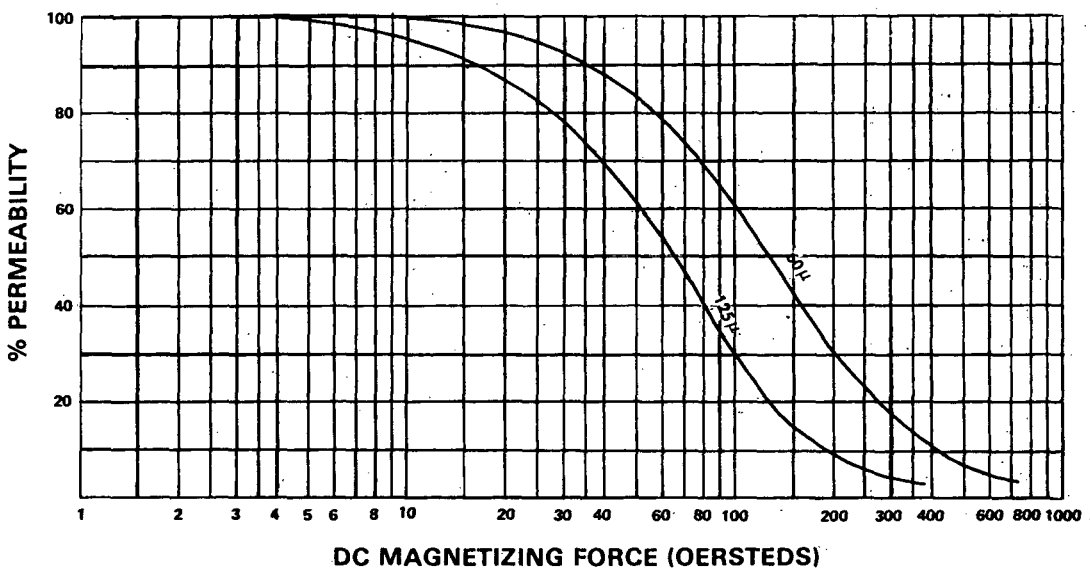


Figure 3. Permeability vs DC Bias. (60μ - 125μ) High Flux Cores.

ing for the purchasing department. A critical part of that drawing will be the insertion loss versus frequency. At this point the filter would normally be subjected to a MIL-STD-220A test to determine its insertion loss characteristics. In order to perform this testing under load, a DC current of 2.4 AMPS would be applied to the filter. However, Figure 3 indicates that applying a DC current to the filter's coil will yield an inductance of only 237μH, which will result in an insertion loss of 73dB at 150kHz.

Normal procedure in many large corporations is to request a quotation against the drawing from the prototype supplier

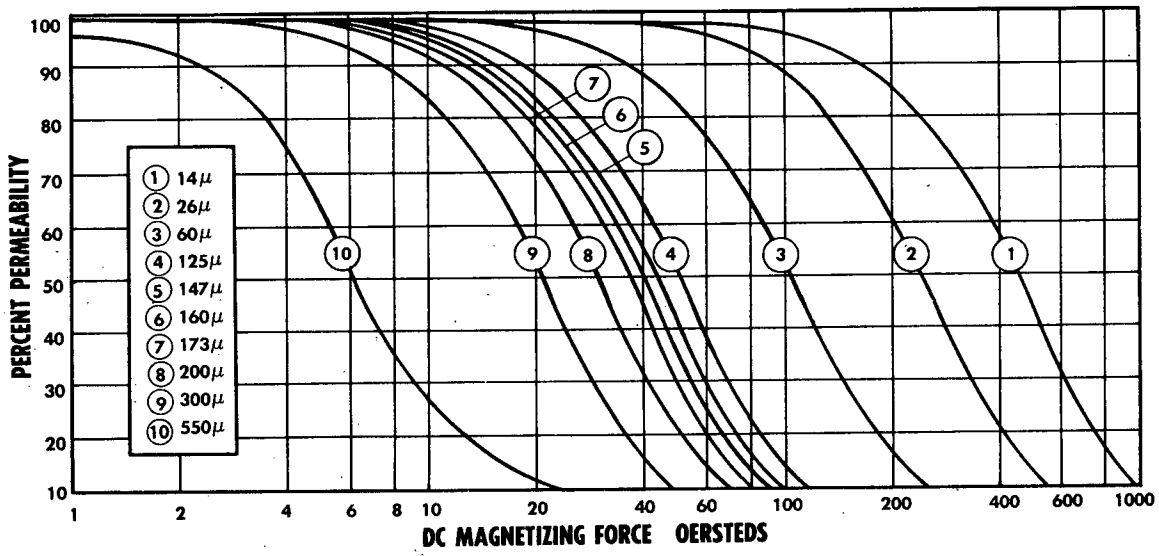


Figure 4. Permeability vs. DC Bias.

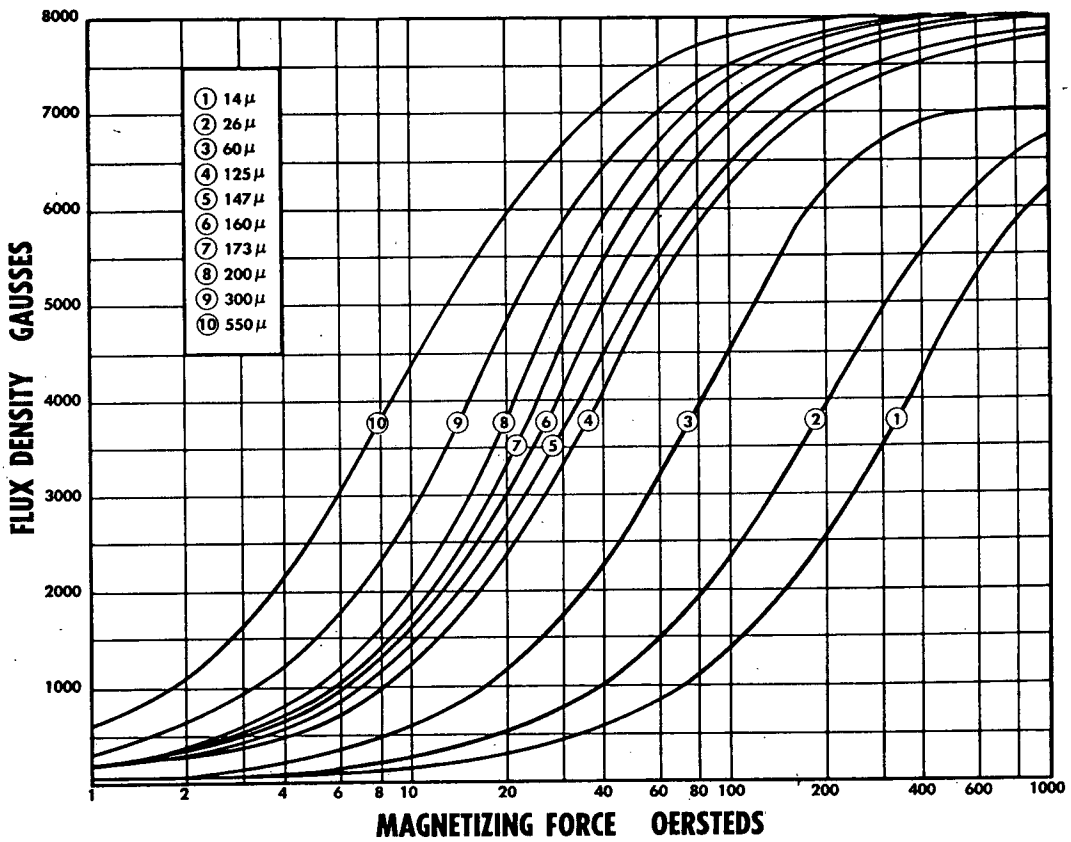


Figure 5. Normal Magnetization Curves.

as well as two other vendors. Assuming one of the other vendors decides to use Magnetics P/N 55930-A2 which is the same size and permeability as the 58930-A2 the effects on the power line filter are determined as follows:

rapidly off the chart. This difference of plus 19% permeability for the high flux core versus minus 3% for the other core will cause an out of spec condition if the EMI test is repeated.

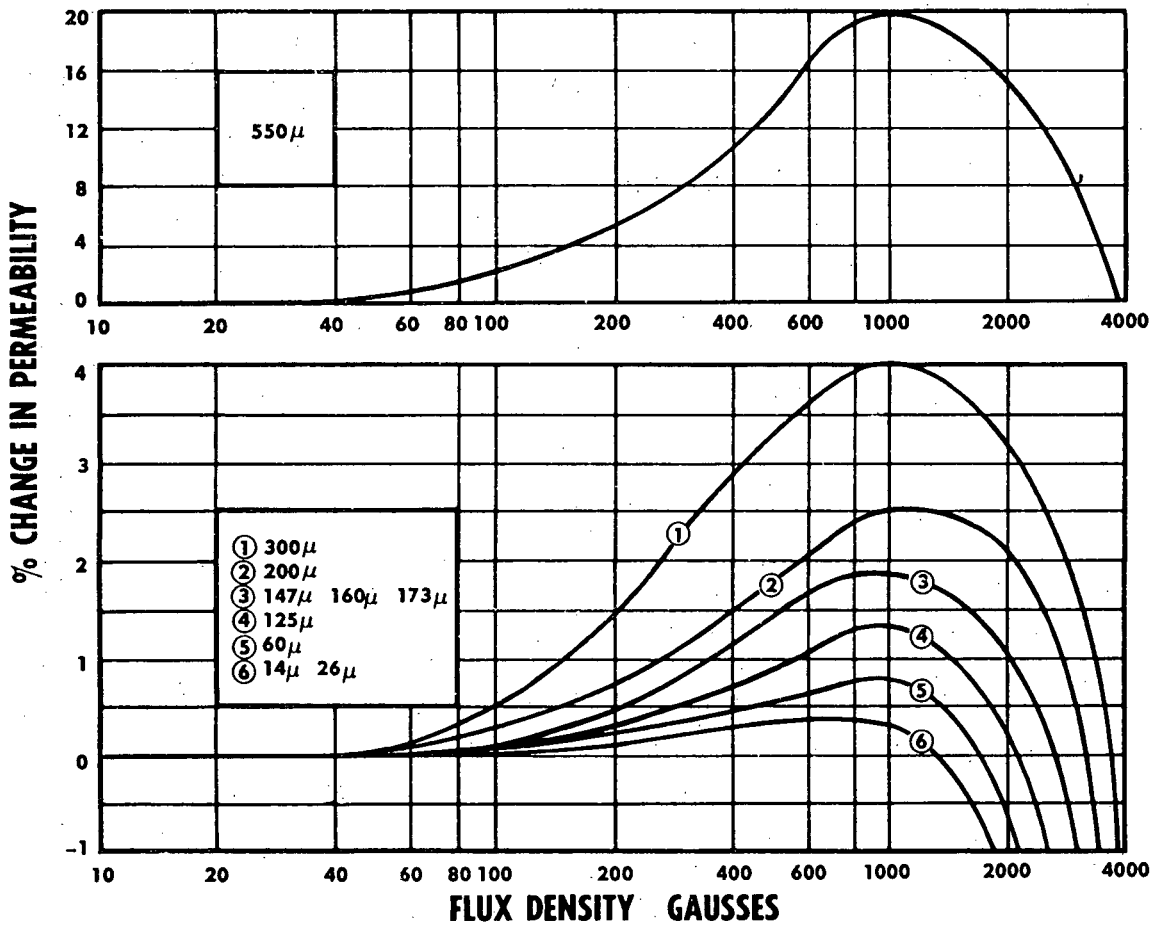


Figure 6. Permeability vs. AC Flux Density

The magnetizing force remains the same at 20 oersteds. Using Figure 4, the permeability at 2.4 AMPS Direct Current is 88% which equals 242μH. Therefore this design would meet the requirements of the specification control drawing. The problem arises if this vendor is the successful low bidder.

Plotting the normal magnetization curve of the different coil on Figure 5 shows a flux density of 2300 Gauss. Figure 6 shows that this core material at 2300 Gauss is dropping

The utilization of the MIL-STD-220A test procedures using a DC current to load the filter can cause serious problems in determining the true insertion loss of a power line filter in regards to its actual operation in an AC line. A more significant test would include the use of AC currents and impedences of the magnitude which the filter would be exposed to in actual operation. A typical test set-up would be as shown in Figure 7.

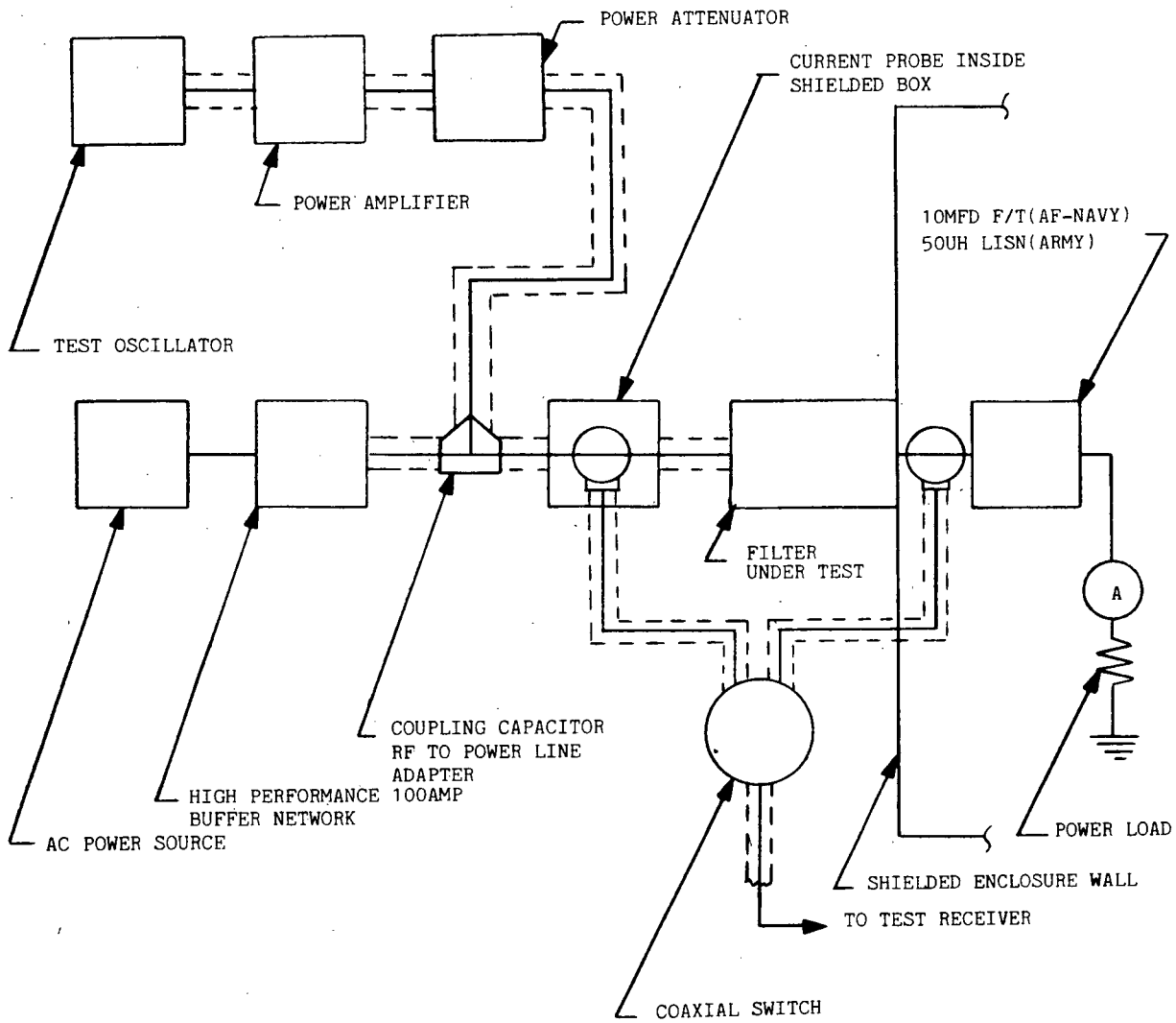


Figure 7. Test Set-up for Measurement of Filter Attenuation Under AC Rated Load.

In such a test set-up a signal can be injected onto the power lines utilizing a typical MIL-STD-461 injection device (Ref. Test Method CS02). This signal could then be measured utilizing current probes located on both the input and output filter lines as shown. With these measurements the actual insertion loss of the filter could be determined. The major advantage of such a test set-up is that the filter under test would be exposed to AC current levels which would be identical to those experienced in actual operation. The filter core material will react in the test set-up as it will in actual use, thus providing more accurate and realistic test results.

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