VDE MAGNETIC RADIATION TESTING: CHOOSING THE MEASUREMENT RANGE TO SUIT THE PRODUCT

A better understanding of the West German VDE 0871 magnetic field strength RFI limits often eases the difficulties of achieving compliance.

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INTRODUCTION

The West German RFI regulations (VDE 0871) stipulate two sets of magnetic field strength limits according to measurement distance. The basic limit is defined at 30 meters. On an open site, the required measurement sensitivity cannot be achieved because of ambient noise and signals. VDE 0871 regulations state that alternative limits published in Vfg 1046 may be used for measurements made at the 3-meter range only. These two sets of limits are totally unrelated in their derivation.

VDE also states that because of the difficulties encountered at 30 meters, a test site may be calibrated for testing at other distances which are greater than 3-meters but less than 30 meters. In this way the 30-meter limit can be extrapolated to an intermediate distance; and then equipment can be tested on the calibrated range at that new distance. When the Vfg 1046 limit at 3 meters is compared with the 10-meter limit derived from the basic 30-meter limits, it is noteworthy that the 3-meter case represents the more stringent requirement over most of the frequency range. Obviously it is advantageous to have testing carried out at 10 meters when equipment has failed to comply with the 3-meter measurement required. Indeed, this alternative is used at the VDE test site where a failure at 3 meters is followed by a measurement at 10 meters. (See Figure 2)

DISCUSSION

Magnetic field strength decreases with distance in relation to both the distance and the wavelength involved. In general terms, the H field will obey the following:

Distance/ Wavelength	Propagation Law
<0.1	cube
0.1 - 3	square
>3	linear

This relationship will not hold true for a poor test range with proximity effects, etc. This paper describes the calibration method which is used to determine the magnetic field strength attenuation characteristic of an open field 30-meter test site. The attenuation/frequency characteristic is then used to extrapolate the VDE 0871 magnetic radiation limits to a 10-meter range, where a usable measurement signal to noise ratio can be achieved.

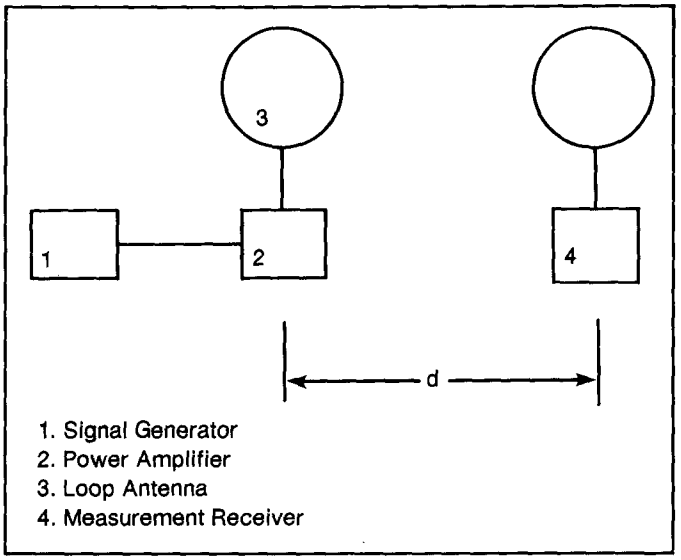

Figure 1. Range Calibration Equipment.

CALIBRATION OF SITE

Equipment Required

- Signal Generator, 9 kHz - 30 MHz
- Magnetic transmitting antenna
- Power Amplifier
- Magnetic field strength receiver, 9 kHz - 30 MHz

Method

Figure 1 shows the equipment arrangement for the calibration.

Calibration runs were made as follows.

*See advertisement on page 372.

30 Meter Range

The frequency band was first scanned on the measurement receiver to determine the frequencies where a usable ambient could be found. These frequencies were then used throughout the calibration at other distances.

The signal generator output level was adjusted to a level that ensured a 20 dB signal to noise ratio at the receiver. This level was maintained throughout the calibration at other distances.

Note: Since the site attenuation decreased with increasing frequency, at 3 MHz the transmitted output level was reduced by 9 dB to avoid feedback to the power amplifier input.

The received signal amplitude was optimized by rotating the receiving antenna, and the results obtained were recorded.

10-meter Range

The receiving system was moved to the 10-meter range position, and the measurements were repeated and recorded.

3-Meter Range

The receiving system was moved to the 3-meter range position, and the measurements were repeated and recorded.

Sources of Error

The signal generator and power amplifier must be physically separated from the transmitting loop to avoid feedback. The dynamic range of the receiver antenna/front end amplification must be determined. The measurement dynamic range is determined by the signal to noise ratio required at the 30-meter range and the maximum signal input at the 3-meter range. Transmitting loop antenna factors do not affect accuracy because the same magnitude and frequency of signal is used throughout the measurement. Normalization of results eliminates all antenna characteristics.

CONCLUSIONS

The field strength measurements recorded at the 30-, 10- and 3-meter ranges (Figure 2) were normalized to the 30-meter VDE limit values and plotted on Figure 3. The resulting extrapolated limit values show good agreement with expected values. The 10-meter extrapolated limits shown on Figure 3 can be used instead of the 3-meter Vfg 1046 limits.

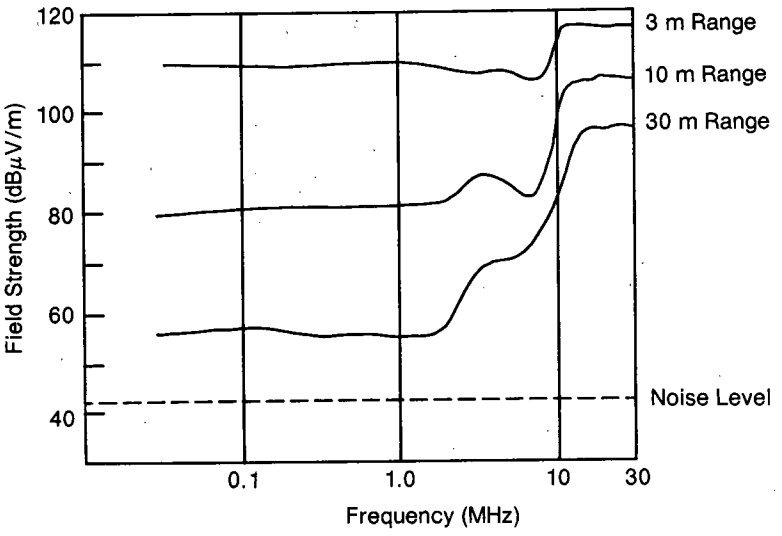

Figure 2. Field Strength Measurements, 30-Meter Range.

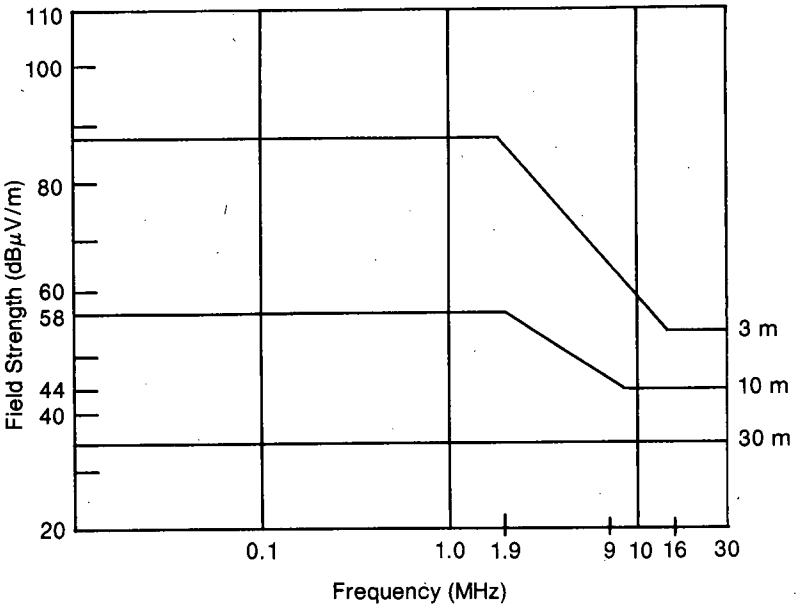

Figure 3. Range Characteristic Normalized to 30-Meter Limit.

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generator with the filter in the circuit at a given frequency.

E2 = Voltage across the signal generator with no filter in the circuit at the same frequency.

The test method is specified in MIL-STD-220. Much has been written concerning the inadequacies of MIL-STD-220; however, it remains the *only standard* by which parts may be tested and various lots compared. It should be pointed out that MS220 specifies insertion loss under load conditions between the frequencies of 100 kHz and 20.0 MHz only. Because of inductor saturation, the insertion loss specification presented by some manufacturers can be rather misleading. Seemingly insertion loss at a lower frequency is greater than the loss at a higher frequency. Actually the two frequencies were at different load conditions.

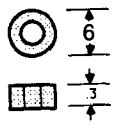
MIL-STD-461 is the standard for testing military systems for radiated and conducted emissions and susceptibility. *Filters are not tested to MIL-STD-461*, but they enable the system to meet that requirement. For accurate calculation of the insertion loss under MIL-STD-461, a low source impedance should be used with a load impedance equal to the voltage divided by current. Some fairly elaborate test circuits have been defined to simulate a MS461 insertion loss test method; however, no standard exists for this simulation, and not everyone has the capability of performing to such non-standard methods.

3.9 Temperature Rise

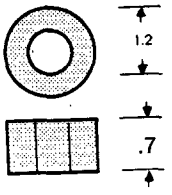
Large filters of the multi-circuit type cannot be suspended by their terminals because most terminals used cannot withstand the weight.

3.10 Overload

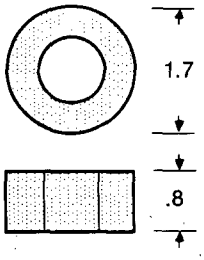
This test method specifies that filters will "be suspended by their terminals." On some multi-circuit filters, this is not possible; and the procedure should be discussed with the manufacturer.



90 μH at 1 Amp dc, 75 μH at 5 Amps dc - IP
450 μH at 1 Amp 60 Hz, 40 μH at 5 Amps 60 Hz - IP
270 μH at 1 Amp dc, 14 μH at 5 Amps dc - MP
350 μH at 1 Amp 400 MHz, 18 μH at 5 Amps 400 Hz - MP

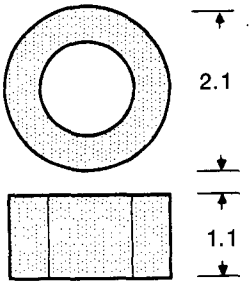


1000 μH at 1 Amp, 32 μH at 10 Amps dc - IP
4500 μH at 1 Amp, 120 μH at 10 60 Hz - IP
2600 μH at 1 Amp, 35 μH at 10 Amps dc - MP
2800 μH at 1 Amp 400 Hz, 45 μH at 10 Amps 400 Hz - MP



950 μH at 2.5 Amps dc, 30 μH at 20 Amps dc - IP
4000 μH at 2.5 Amps 60 Hz, 105 μ at 20 A 60 Hz - IP
1510 μH at 2.5 Amps dc, 25μ at 20 Amps dc - MP
1740 μH at 2.5 Amps 400 Hz, 32 μH at 20 A 400 Hz - MP

Core Material
IP - Iron Powder
MP - Molybdenum Permalloy



560 μH at 5 Amps dc, 28 μH at 30 Amps dc - IP
2000 μH at 5 Amps 60 Hz, 60 μH at 30 Amps 60 Hz - IP
8.45 μH at 5 Amps dc, 23 μH at 30 Amps dc - MP
990 μH at 5 Amps 400 Hz, 30 μH at 30 Amps 400 Hz - MP

Figure 4. Relative Inductor Size Chart.

3.11 Environmental

Resistance to soldering heat, solvents, salt spray, thermal shock and immersion, mechanical shock, and vibration should be included. Also moisture resistance, solderability and life should be specified using established military specifications. It should be noted that there are post tests, usually one or more of the "A" tests, to ensure that the part has successfully passed these environmental tests.

4.0 QUALITY ASSURANCE PROVISION

4.1 Qualification Inspection

Qualification tests are those tests performed to prove that the part is capable of meeting all of the requirements. Unless changes are made, they are usually performed only one time on a specified quantity of a given part.

4.2 Quality Conformance Inspection

Quality conformance tests are sometimes referred to as "acceptance tests" or "inspection of product for delivery". They performed by the manufacturer prior to shipping to ensure that the user receives good parts. The tests for requirements in paragraphs 3.2 through 3.8 are the same as, and are sometimes referred to as, "Group A" or simply "A" tests of MIL-F-15733. As a minimum the user should expect that these tests be done. Groups "B" and "C" tests of the military specifications are usually considered destruct tests. They are not used in production and are carried out on a smaller sample than the "A" tests. Any additional testing, such as burn-in, will usually bring additional expenses. In fact, the manufacturer should quote additional testing separately. This separate quotation will ensure that the manufacturer has not overlooked the requirement, and it gives the user a basis for comparison. If additional tests such as thermal shock or burn-in are required, they can be added to this section of the specification. The additional cost of having these tests performed should be considered. Multi-circuit filters with various voltages and current ratings can require several power supplies and loads, and considerable setup time.

5.0 Packaging

5.1 Preparation for Delivery

5.2 Marking

6.0 Notes

This paragraph may be used to add any informative or applicable notes.

CONCLUSION

A military specification format based on MIL-F-15733 and MIL-F-28861 enables buyers to define their filter needs comprehensively and concisely. The use of this format ensures buyers that filter characteristics which need definition will not be overlooked. As in any procurement activity, buyers should bear in mind that over-specification adds cost and under-specification jeopardizes performance. ■