SHIELDING EFFECTIVENESS TEST DATA

Vermillion is currently working with the Air Force Research Laboratory at Wright-Patterson Air Force Base to complete an exhaustive shielding and shielding combination testing analysis to determine expanded capabilities for Vermalloy® and other shielding materials.

Upon the completion of this testing program, we will update this section of our Engineering Manual.

4754 South Palisade
Wichita, KS 67217
P.O. Box 12147 (67227)
ph. 316.524.3100 fax 316.524.2011
www.vermillioninc.com

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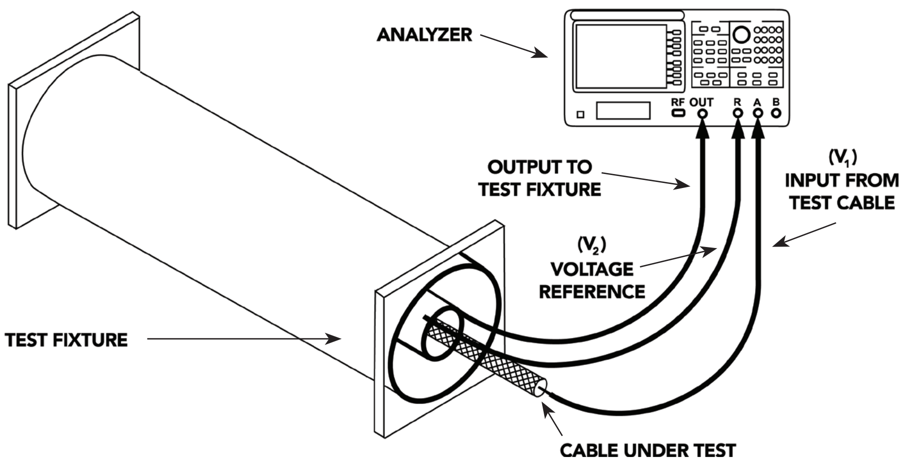
CALCULATION OF SHIELDING EFFECTIVENESS



$$\text{Shielding Effectiveness (dB)} = 20 \log \frac{(V_1)}{(V_2)}$$

Our test procedure utilizes the HP8715A Network Analyzer to measure frequency and dependent electrical field shielding effectiveness of the cable under test. The cable is mounted in a special quadraxial test fixture designed by Vermillion and based on MIL-STD-1857.

A test signal is injected into the inner conductor of the test fixture which shares a common ground plane with the shield of the cable under test. The resulting induced signal is then read from the center conductor of the test cable and utilized to calculate the shielding effectiveness (dB) as a function of frequency. Measurements are for E-field only.

SHIELDING EFFECTIVENESS TEST DATA ELECTRICAL (E-FIELD)

NOTES:

- All cables tested have a 90% coverage on the braided shields.
- All curves are plotted using the HP8751 Network Analyzer and special test fixture. Description of the test setup and test procedure follows the curve data.
- Curves plotted from 60Hz to 10MHz band width. Data for the other portions of the frequency spectrum can be provided upon request.
- Readings at selected frequencies are also printed out underneath plotted data to assist in the interpretation of the data.

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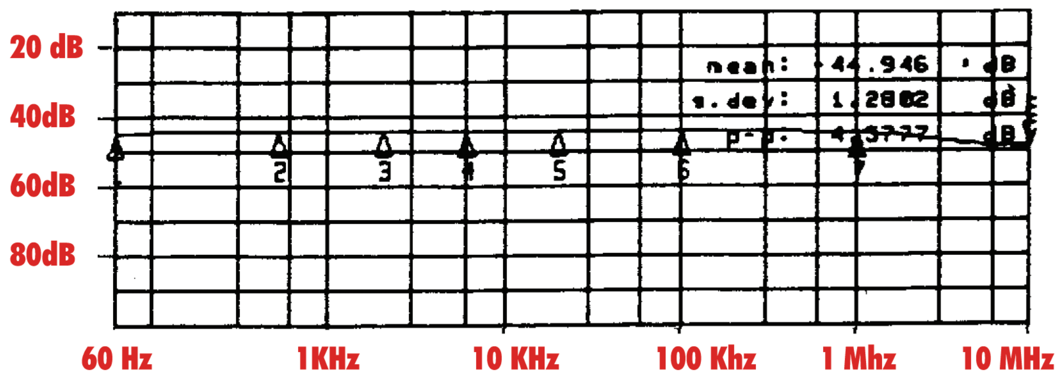
FIG. 1. RIBBON COPPER — LIGHTWEIGHT SINGLE SHIELD LAYER

This lightweight shield shows a fairly constant attenuation curve of 45 dB in the low frequency range for tinned ribbon (flattened) copper. Weight savings of 60% in shielding material is realized over conventional tinned copper material.



FREQUENCY		
1	60 Hz	-44.815 dB
2	500 Hz	-44.269 dB
3	2 kHz	-44.235 dB
4	6 kHz	-44.214 dB
5	20 kHz	-44.232 dB
6	100 kHz	-44.41 dB
7	1 MHz	-45.104 dB
8	10 MHz	-48.735 dB

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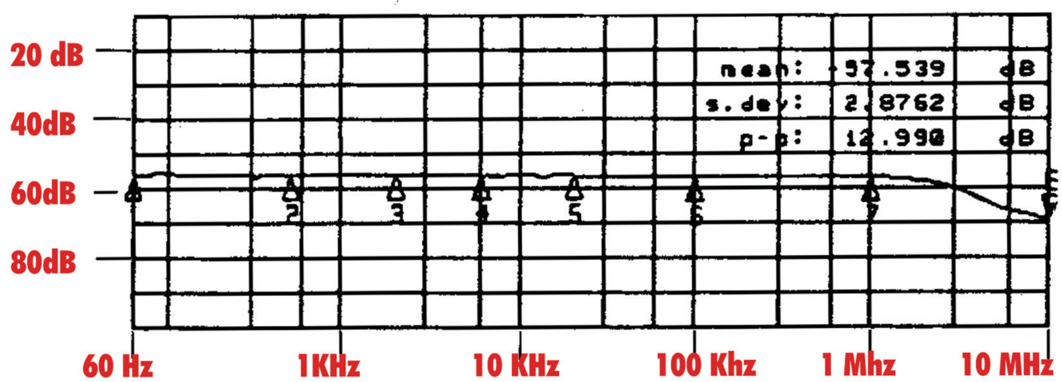
FIG. 2. TINNED COPPER SINGLE SHIELD LAYER

Use of standard tinned copper results in an improvement of 11 dB to 56 dB, over the ribbon copper.



FREQUENCY		
1	60 Hz	-56.333 dB
2	500Hz	-56.302 dB
3	2kHz	-56.32 dB
4	6kHz	-56.562 dB
5	2OkHz	-56.562 dB
6	100kHz	-56.602 dB
7	1MHz	-56.980 dB
8	10MHz	-68.832 dB

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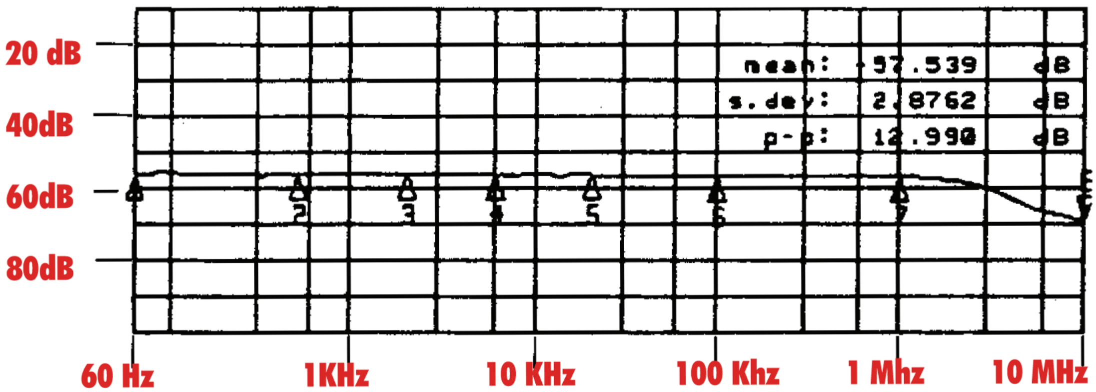
FIG. 3. TINNED COPPER, TINNED COPPER DOUBLE SHIELD.
Use of dual tinned copper shielding layers results in 62 dB mean attenuation and flat response in the overall frequency range. Compare with single tinned copper shield and with Vermalloy® 622/tinned copper combination for good comparison of relative shielding effectiveness.



FREQUENCY		
1	60 Hz	-61.053 dB
2	500Hz	-61.714 dB
3	2kHz	-62.446 dB
4	6kHz	-62.486 dB
5	20kHz	-62.476 dB
6	100kHz	-62.513 dB
7	1MHz	-62.882 dB
8	10MHz	-61.016 dB

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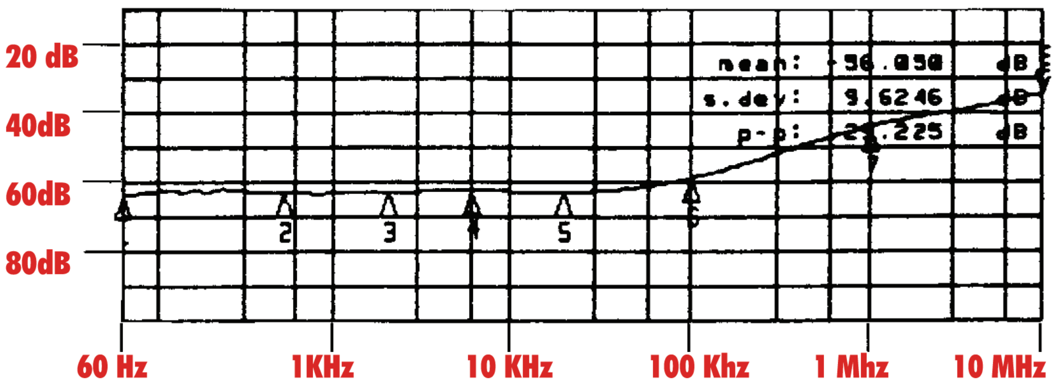
FIG. 4. VERMALLOY® 3948 LIGHTWEIGHT SINGLE SHIELD LAYER

Use of Vermalloy® 3948 improves attenuation to 63 dB in the audible portion of the frequency range, although some degradation occurs in the higher frequencies shown. This is characteristic of Vermalloy® when used alone in shielding applications. Mean attenuation is 56 dB over the total frequency range shown. There is the additional benefit of the magnetic characteristics of all Vermalloy® materials. Weight savings of 45%-58% may be realized in the shielding material over conventional tinned copper or Vermalloy® 622 material.

Vermalloy® 3948 exceeds the attenuation provided by two layers of tinned copper shielding up to about 40 kHz. This would result in weight savings of 73%-80%.



FREQUENCY		
1	60 Hz	-63.618 dB
2	500Hz	-63.265 dB
3	2kHz	-63.189 dB
4	6kHz	-62.665 dB
5	20kHz	-63.137 dB
6	100kHz	-58.949 dB
7	1 MHz	-44.101 dB
8	10MHz	-34.603 dB

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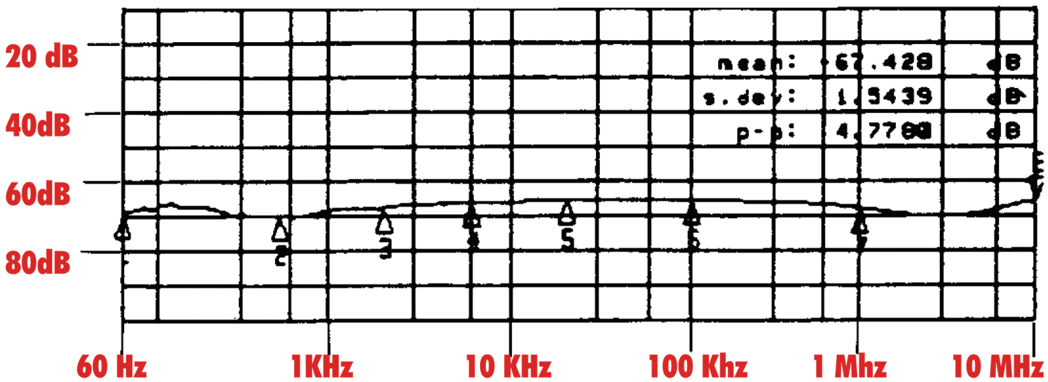
FIG. 5. VERMALLOY® 3948 (FLATTENED) & RIBBON COPPER LIGHTWEIGHT, DOUBLE SHIELD

This is an excellent combination of lightweight shielding materials with the benefit of high attenuation. Use of two layers of ribbon shielding, one Vermalloy® and one tinned copper, shows improvement both in:

I) overall attenuation (mean is 67 dB) and:

2) performance in the overall frequency range compared with a single layer of Vermalloy® 3948. Weight savings of up to 80% is realized in the shielding material over a double shield of conventional round material.



FREQUENCY

1	60 Hz -69.128 dB
2	500Hz -69.875 dB
3	2kHz -67.814 d8
4	6kHz -66.384 dB
5	20kHz -65.707 dB
6	100kHz -65.817 dB
7	1MHz -67.923 dB
8	10MHz -65.727 dB

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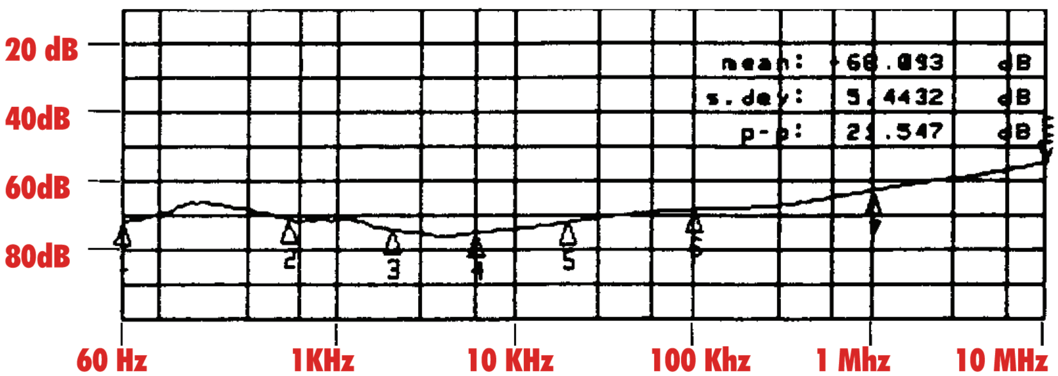
FIG. 6. VERMALLOY 622 SINGLE SHIELD LAYER
Use of Vermalloy® 622 boosts attenuation in the audible frequency range to 74 dB and mean attenuation in the overall frequency range to 68 dB. The effect of higher frequency on Vermalloy shielding levels is also seen here. The full benefit of the magnetic absorption characteristic of Vermalloy® is realized in 622 material.



FREQUENCY

1	60 Hz	-72.041 dB
2	500Hz	-70.997 dB
3	2kHz	-74.183 dB
4	6kHz	-74.979 dB
5	20kHz	-72.124 dB
6	100kHz	-68.432 dB
7	1MHz	-62.820 dB
8	10MHz	-54.866 dB

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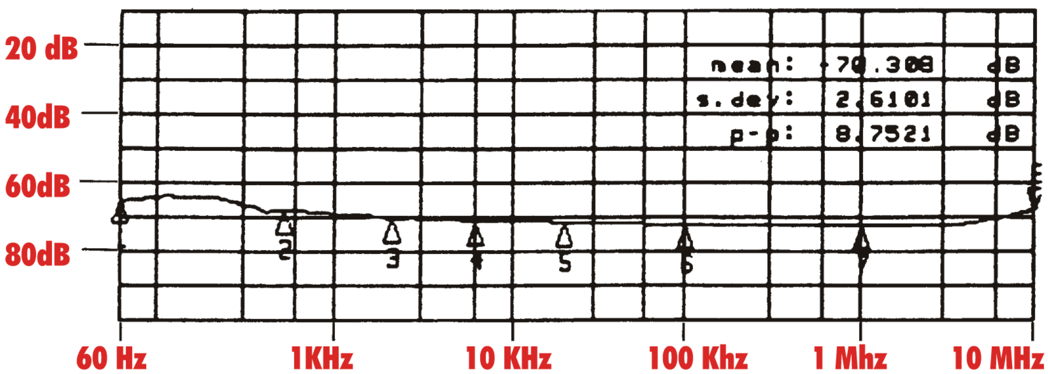
FIG. 7. VERMALLOY® 622, TINNED COPPER - DOUBLE SHIELD
Use of two stranded layers of shielding, Vermalloy® 622 and tinned copper, shows further improvement to 70 dB mean attenuation level and continued flat performance in the overall frequency range. Compare this performance with that of either Vermalloy® 622 or tinned copper alone and the advantage of combining shielding types and layers becomes apparent.

The full benefit of the magnetic characteristics of Vermalloy® is realized in this shielding combination.



FREQUENCY		
1	60 Hz	-65.192 dB
2	500Hz	-68.314 dB
3	2kHz	-70.654 d8
4	6kHz	-70.996 dB
5	20kHz	-71.609 dB
6	100kHz	-72.346 dB
7	1MHz	-72.409 dB
8	10MHz	-68.217 dB

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