Amphenol Spectra-Strip
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Cable Round Robin 2 Results

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Background

Cable Round Robin 2 was undertaken to determine whether different companies would achieve similar results when measuring the same samples.

Participants measured the following parameters in the frequency domain (network analyzer):

Differential Attenuation
Differential impedance ("extended distance")

Originally, seven companies agreed to participate. Three companies, for various reasons, dropped out. A fourth company provided partial data which was later withdrawn. Data is presented herein from the following companies:

Amphenol Spectra-Strip
Madison Cable Corp.
Seagate Technology

A measurement procedure was provided for the Round Robin. Key features of this procedure are included herein.

The Samples (All samples were 25 meter length)

Sample 1	Round twisted pair cable having overall shield, 28 AWG 7-36 tinned copper. Measure pairs 1, 7, and 34
Sample 2	Round twisted pair cable having overall shield, 30 AWG solid tinned copper. Measure pairs 1, 7, and 34
Sample 3	Twisted pair ribbon having no flats. Measure pairs 1, 3, and 5.
Sample 4	Twisted pair ribbon having flats at 9.95 inch intervals. Measure pairs 1, 3, and 5.

Unshielded samples (twisted pair ribbons) were to be measured while suspended from ceiling, with minimum of crossovers, keeping sample as spread out as possible (to minimize proximity effects).

(Participants reported pair "numbers" by various means. Sometimes pair numbers were reported, sometimes pair colors and positions. The author has attempted to present data as consistently as possible, while retaining the reported pair identification.)

Note concerning sample preparation: All samples were prepared for measurement at the beginning of the Round Robin. Madison Cable reports that sample preparation was different than Madison's usual practice. The way the samples were prepared may account for differences seen in Madison's data.

The Measurements

Attenuation and impedance measurements are differential, swept frequency. Attenuation is measured from 1 MHz to 1 GHz. Impedance is measured from 10 MHz to 1 GHz.

Method A – Attenuation using 2-port Network Analyzer with Balun
Use fixture described in 00-339r0 (balun with matching resistors). 120 Ohm Matching network comprised of one 68 Ω shunt and two 47 Ω series resistors (1/8 W 5% carbon).

Calibrate by storing fixture response. Then measure sample. Then "normalize" by removing fixture response.

Method B – Attenuation using 2-port Network Analyzer with Balun
Same fixture as Method A.

Full 2-port calibration. Use 121 Ω ± 1% chip resistor (Panasonic ERJ series) for "load", for "short" solder test points of fixture together, for "open" position matching resistors as will be when measurement is made. For "thru", attach both fixtures together.

Method C – Attenuation using 4-port Network Analyzer (Balun not required.)

Full 4-port calibration. Calibrate for 100 Ω environment.

Method D – Impedance using 2-Port Network Analyzer with Hybrid Junction. Seen page 3 for fixture description and measurement outline.

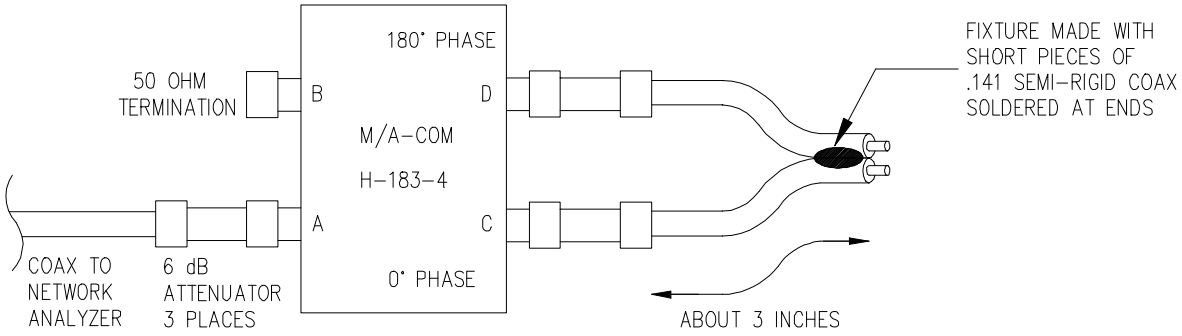
Method E – Impedance using 4-Port Network Analyzer (Hybrid Junction not required.)

	Method A Attenuation Balun Normalized	Method B Attenuation Balun 2-port Cal	Method C Attenuation 4 Port Analyzer	Method D Impedance Hybrid Junction	Method E Impedance 4 Port Analyzer
Amphenol	yes	yes		yes	
Madison			yes		yes
Seagate	yes			yes	

Method D – Impedance using 2-Port Network Analyzer with Hybrid Junction

Hybrid Junction Test Fixture

The hybrid junction converts an unbalanced 50 Ω input into two balanced 50 Ω outputs (two signals having 180° phase, 100 Ω differential). The selected hybrid junction is the M/A-COM H-183-4. This is specified from 30 MHz to 3 GHz. However, it may be used from 10 MHz to 3 GHz when used with a careful calibration.



OUTLINE for Calibration Procedure

Attach fixture to analyzer port 1. Semi-rigid coax strongly recommended.
Preset Network Analyzer to default condition. Then set analyzer to:
Power = 10 dBm Points = 401 Log Sweep preferred
Start = 10 MHz Stop = 1 GHz 30 Hz IF BW

With attenuators attached, BUT with semi-rigid fixture removed, calibrate port 1. This is accomplished using precision standards attached to the two attenuators on the right. Two sets of standards are required.

When finished calibrating port 1, attach semi-rigid coax fixture (which, having no sample attached, is an "open" circuit)

- Set analyzer to look at S11 Phase. Set phase scale to 10° per division.
- Enable port extensions
- Adjust port-1 extension for 0° across the frequency range (expected for an open circuit). This compensates for the fixture's propagation time. Above 800 MHz, it will not be possible to achieve exactly 0°. This is because the fixture is not a perfect open circuit. The attachment stubs cause small undesired parasitics. (Port extension for above fixture is about 380 ps.)
- Set the analyzer to look at S11 Set Z Reflected = On Set scale = Linear Set to read Ohms

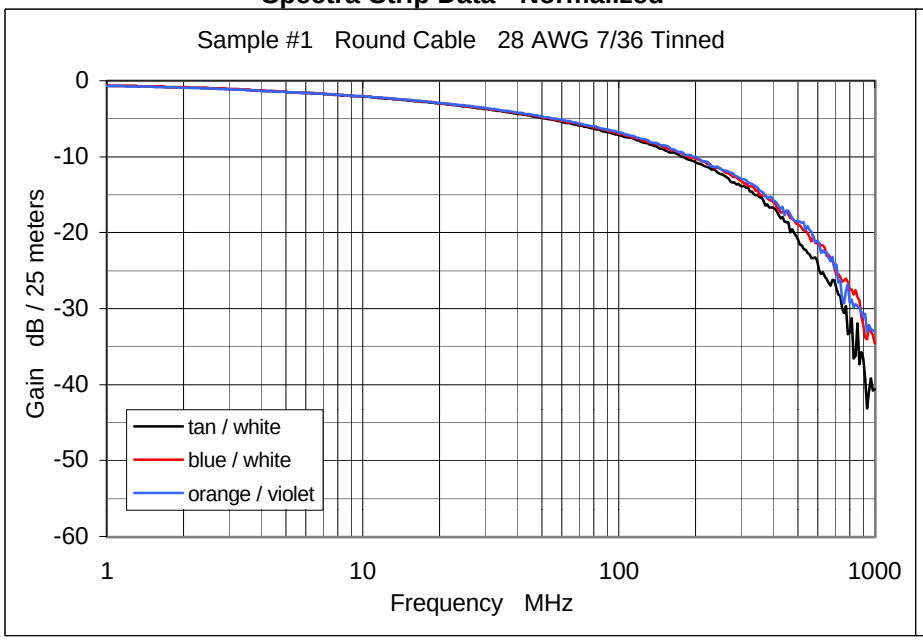
Important – The analyzer has been calibrated to 50 Ω. The actual impedance at the calibration plane was, in fact, 100 Ω differential. Multiply measurements by two for differential impedance.

Measurement using Open/Short Method

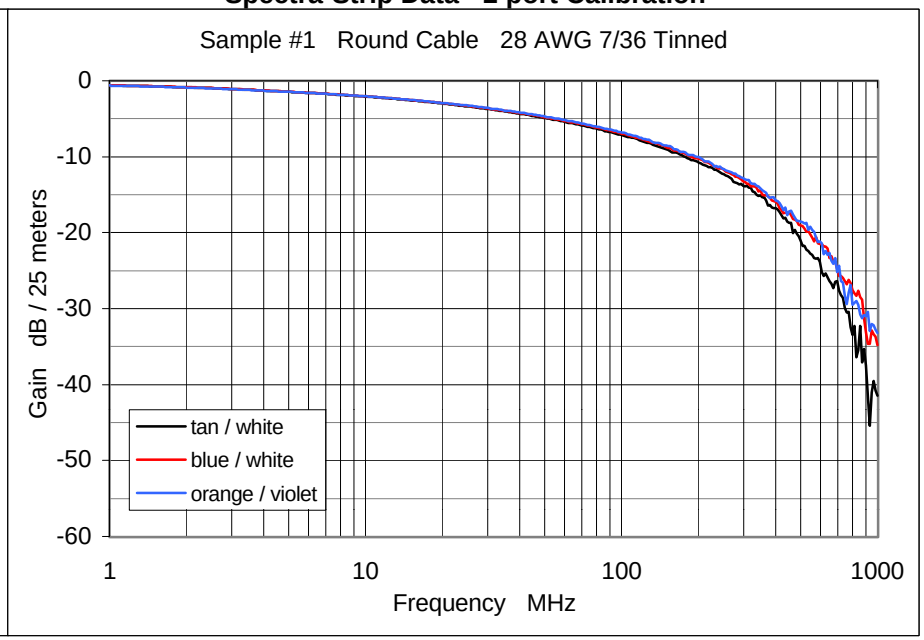
Two measurements are required for each pair that is examined. First, record the impedance of the pair with the far-end "open". Then record again with the far end "shorted". The impedance is then calculated with the following equation:

$$Z = 2 * \sqrt{(Z_{OPEN})(Z_{SHORT})}$$ (Factor of 2 because 100 Ω Differential reads as 50Ω.)

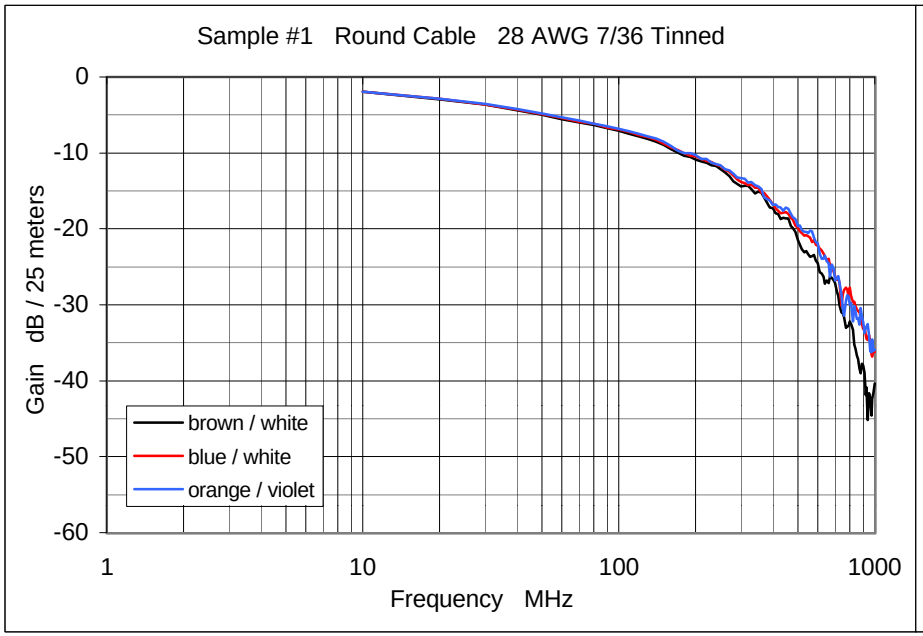
Spectra-Strip Data - Normalized



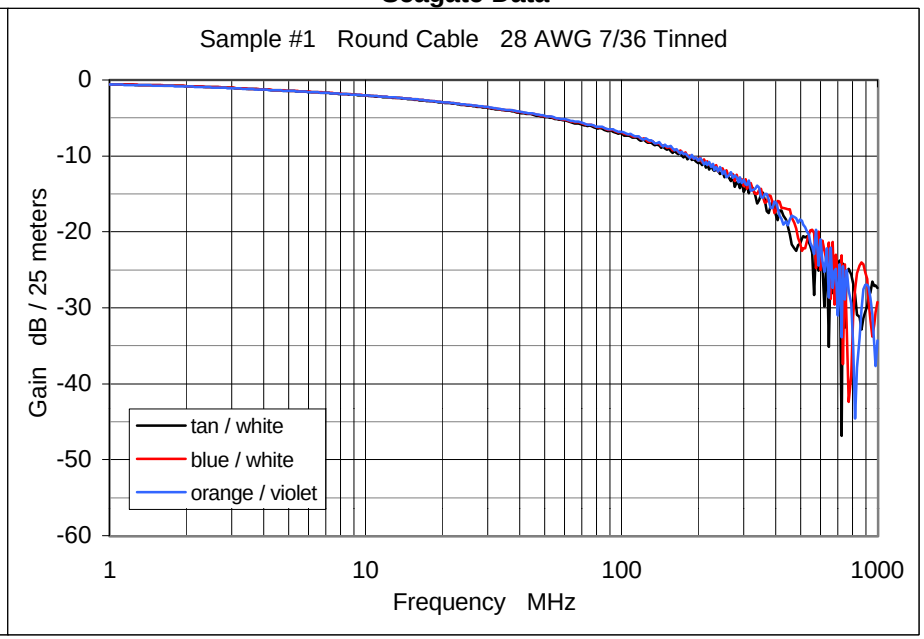
Spectra-Strip Data - 2 port Calibration



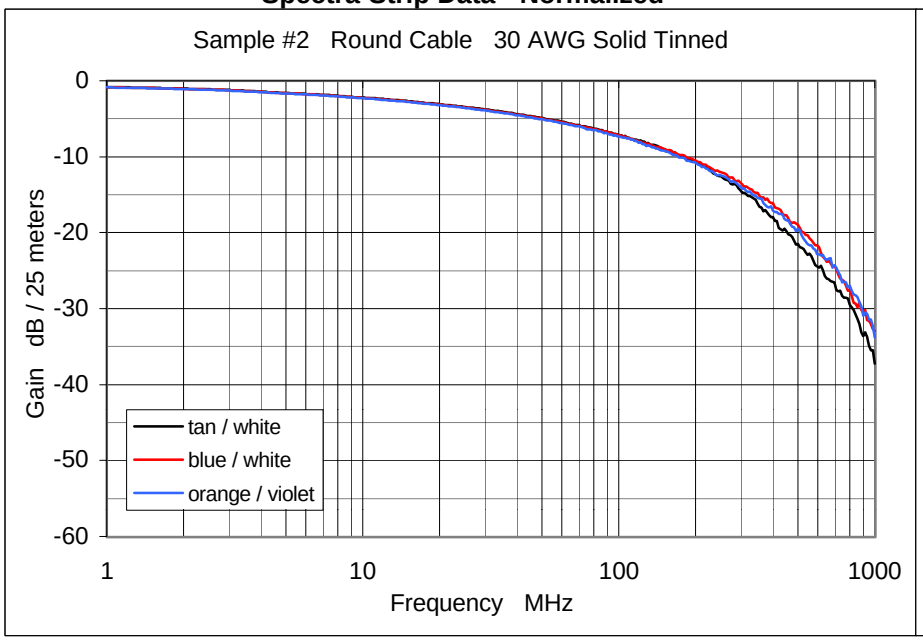
Madison Data



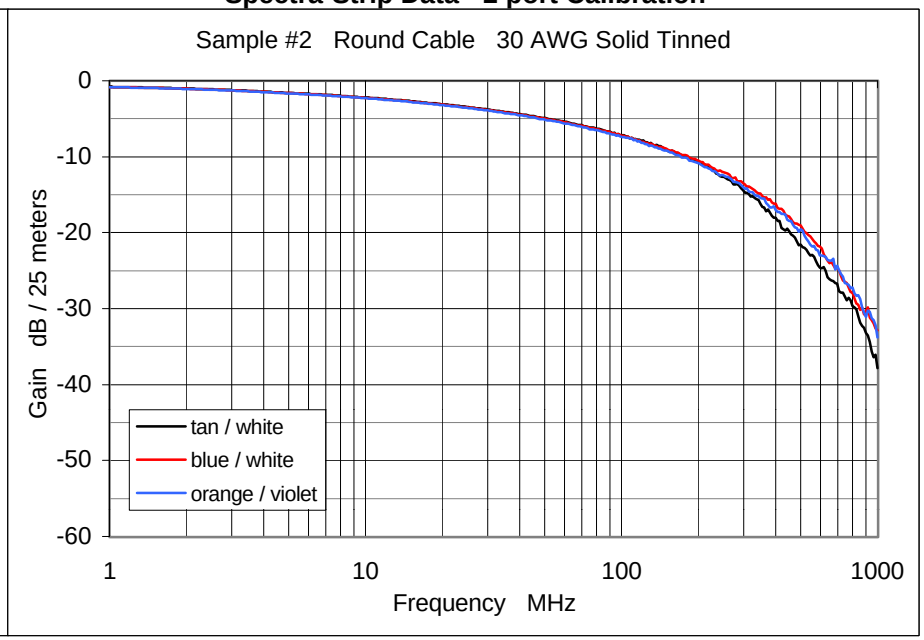
Seagate Data



Spectra-Strip Data - Normalized



Spectra-Strip Data - 2 port Calibration



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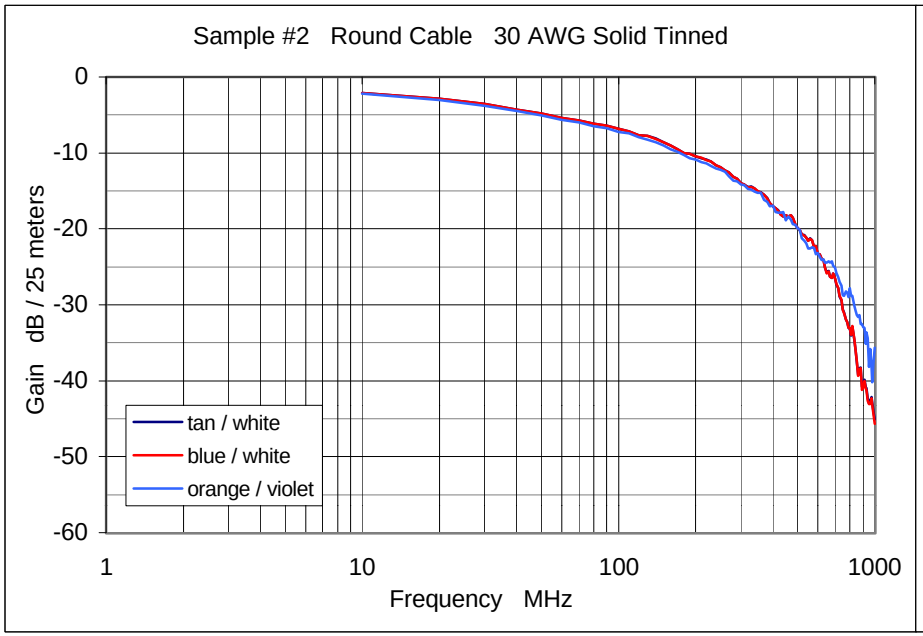

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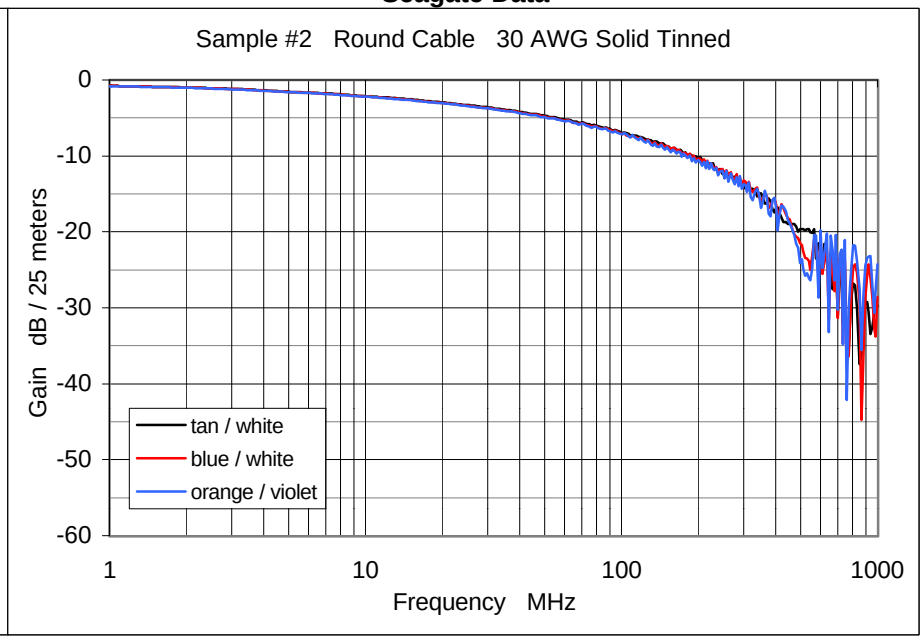

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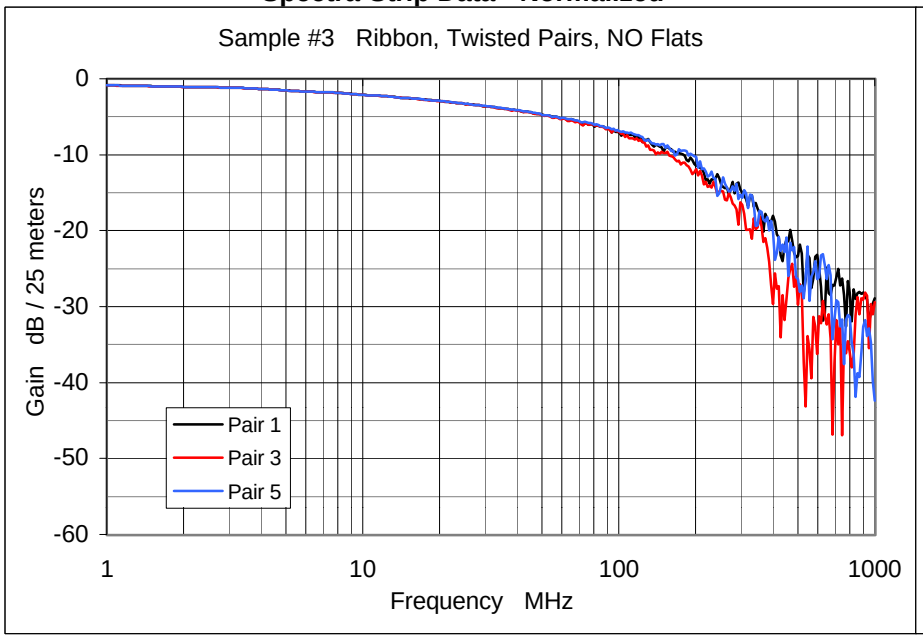

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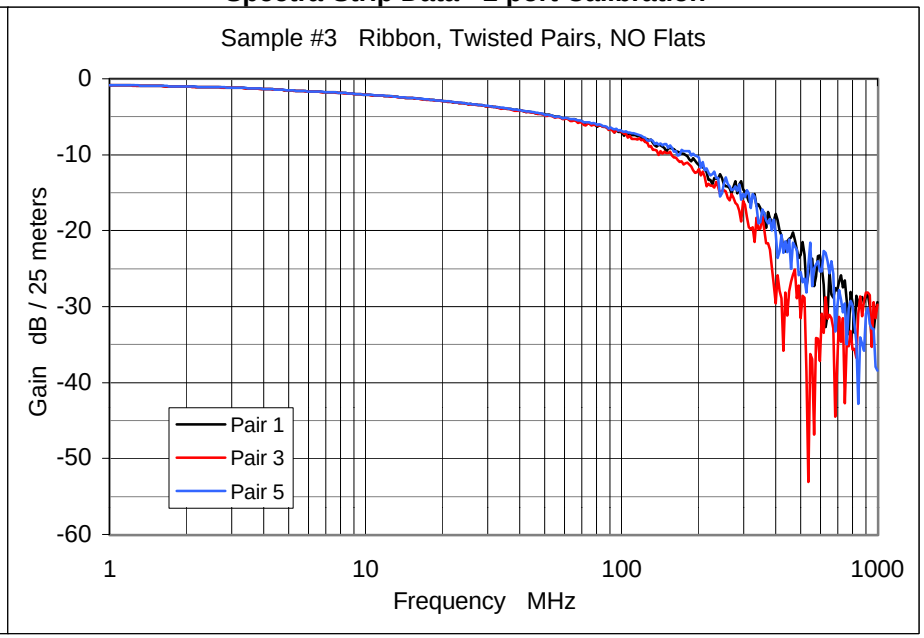

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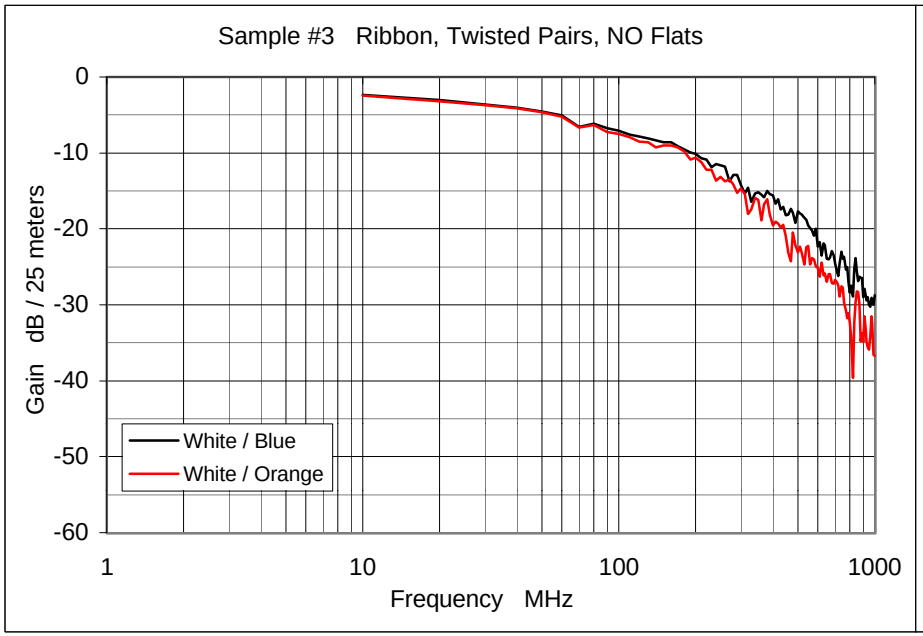

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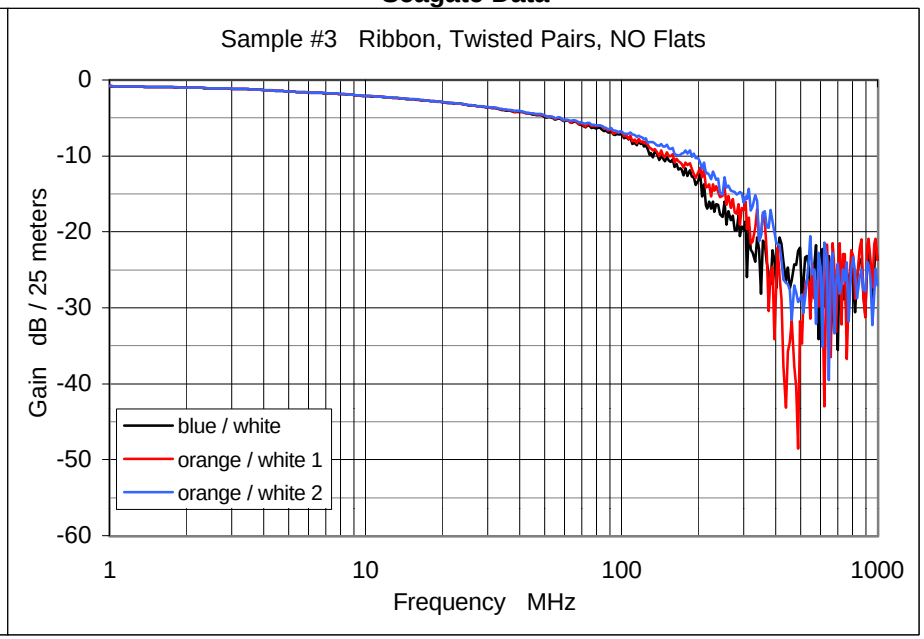
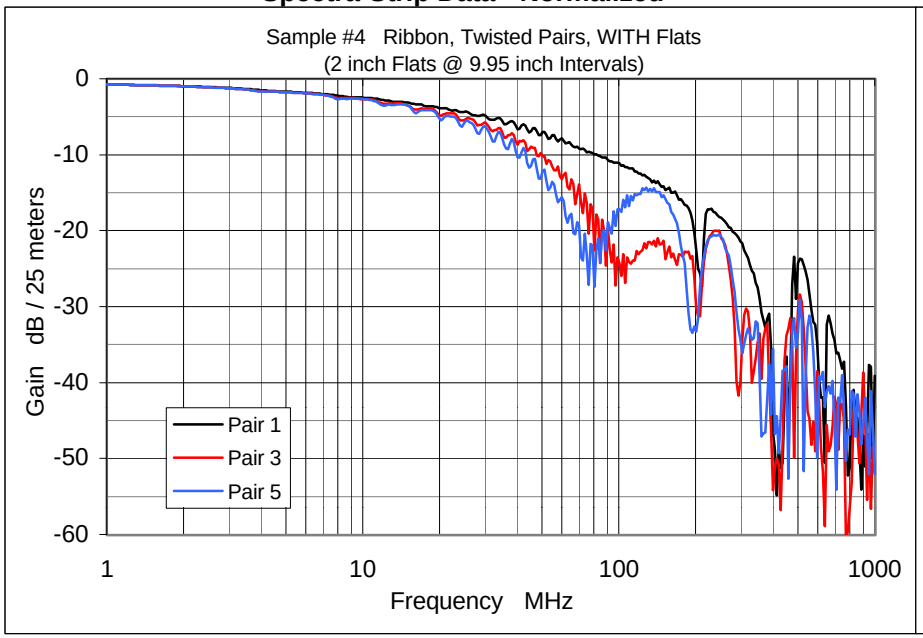
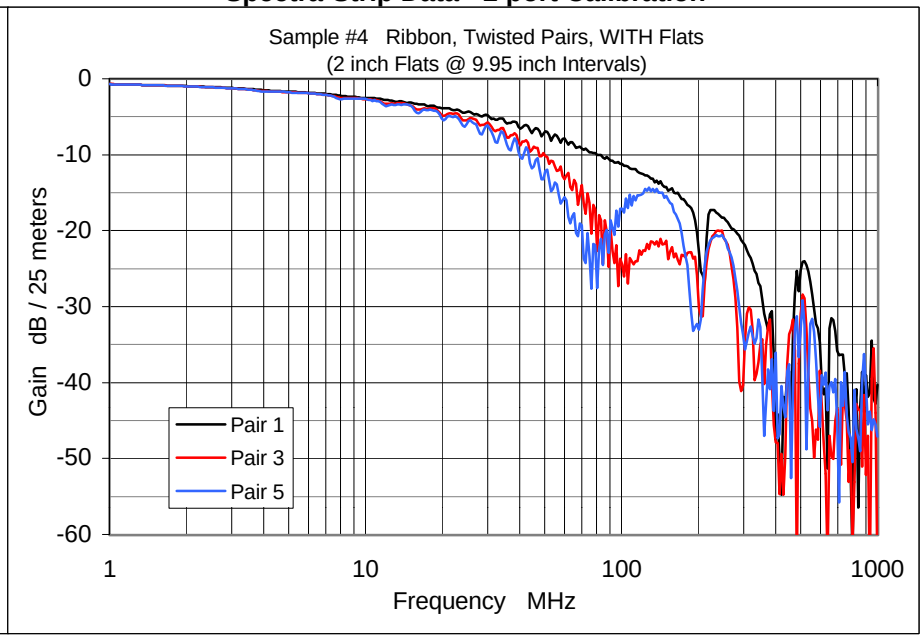


Spectra-Strip Data - Normalized



Spectra-Strip Data - 2 port Calibration



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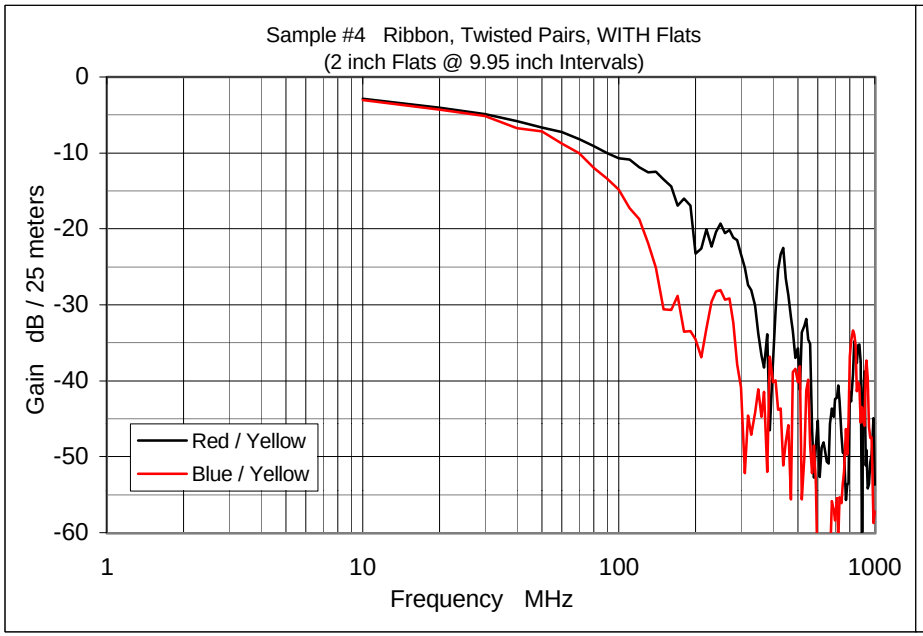

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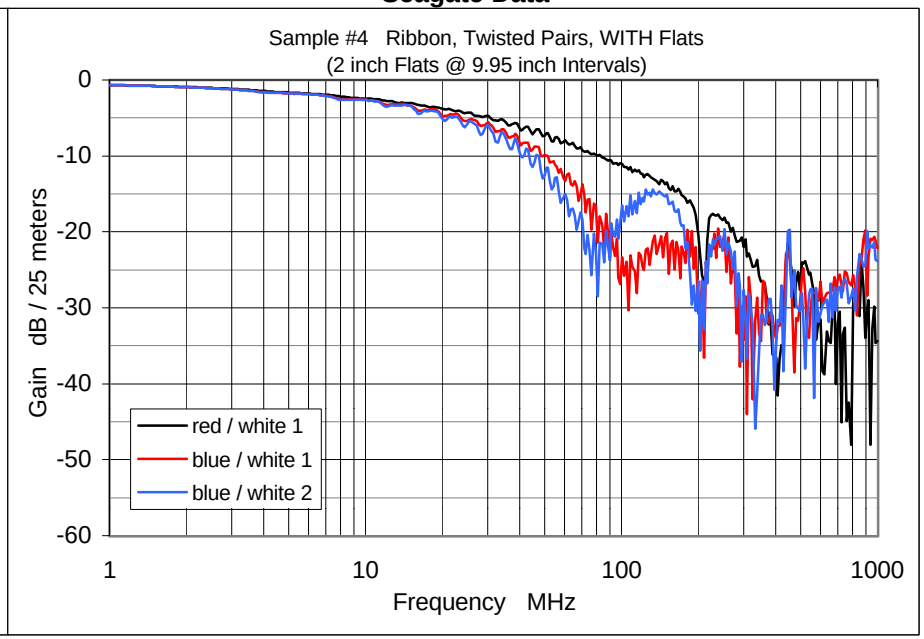


ATTENUATION at Specific Frequencies

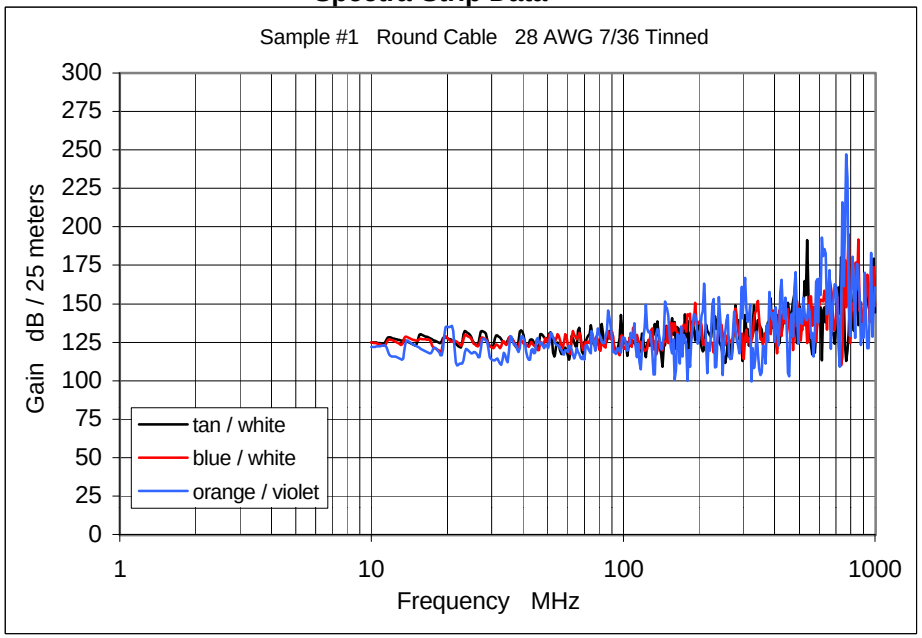
Sample #1 Round Cable 28 AWG 7/36 Tinned		80 MHz	160 MHz	200 MHz
Spectra-Strip Data	tan / white	6.30	9.41	10.76
Madison Data	Wht-Brn-Brn/Wht	6.36	9.54	10.89
Seagate Data	Tan / White	6.32	9.48	10.84
Spectra-Strip Data	blue / white	6.14	9.15	10.23
Madison Data	Wht/Blu-Blu/Wht	6.18	9.29	10.49
Seagate Data	White / Blue	6.19	9.23	10.33
Spectra-Strip Data	orange / violet	6.03	9.02	10.02
Hitachi Data	"pair 3"	6.15	9.60	11.06
Madison Data	Org/Vio-Vio/Org	6.12	9.10	10.28
Seagate Data	Orange / Violet	6.10	9.04	10.30

Sample #2 Round Cable 30 AWG Solid Tinned		80 MHz	160 MHz	200 MHz
Spectra-Strip Data	tan / white	6.29	9.29	10.79
Madison Data	Wht/Tan-Tan/Wht	6.15	9.03	10.44
Seagate Data	Tan / White	6.01	8.93	10.32
Spectra-Strip Data	blue / white	6.37	9.21	10.51
Madison Data	Wht/Blu-Blu/Wht	6.15	9.02	10.45
Seagate Data	White / Blue	6.12	8.66	10.38
Spectra-Strip Data	orange / violet	6.48	9.60	10.87
Madison Data	Org/Vio-Vio/Org	6.47	9.56	10.87
Seagate Data	Orange / Violet	6.22	9.25	10.74

Sample #3 Ribbon, Twisted Pairs, NO Flats		80 MHz	160 MHz	200 MHz
Spectra-Strip Data	pair 1	6.22	9.25	11.41
Madison Data	Wht-Blue (pair 1)	6.18	8.60	10.09
Seagate Data	Blue / White	6.37	10.87	12.84
Spectra-Strip Data	pair 3	6.09	10.21	11.98
Madison Data	Wht-Org	6.34	8.99	10.59
Seagate Data	Orange / White 1	6.07	10.24	11.98
Spectra-Strip Data	pair 5	6.01	9.49	10.29
Madison Data	-----	-----	-----	-----
Seagate Data	Orange / White 2	6.02	9.30	10.89

Sample #4 Ribbon, Twisted Pairs, WITH Flats		80 MHz	160 MHz	200 MHz
Spectra-Strip Data	pair 1	9.89	14.94	22.05
Madison Data	Red-Yel (pair 1?)	9.14	14.37	23.25
Seagate Data	Red / White	9.89	14.30	21.08
Spectra-Strip Data	pair 3	21.23	23.39	29.37
Madison Data	Blue-Yel	11.97	30.64	34.59
Seagate Data	Blue / White 1	18.35	22.84	30.52
Spectra-Strip Data	pair 5	26.02	17.40	33.20
Madison Data	-----	-----	-----	-----
Seagate Data	Blue / White 2	24.67	16.56	28.95

Spectra-Strip Data



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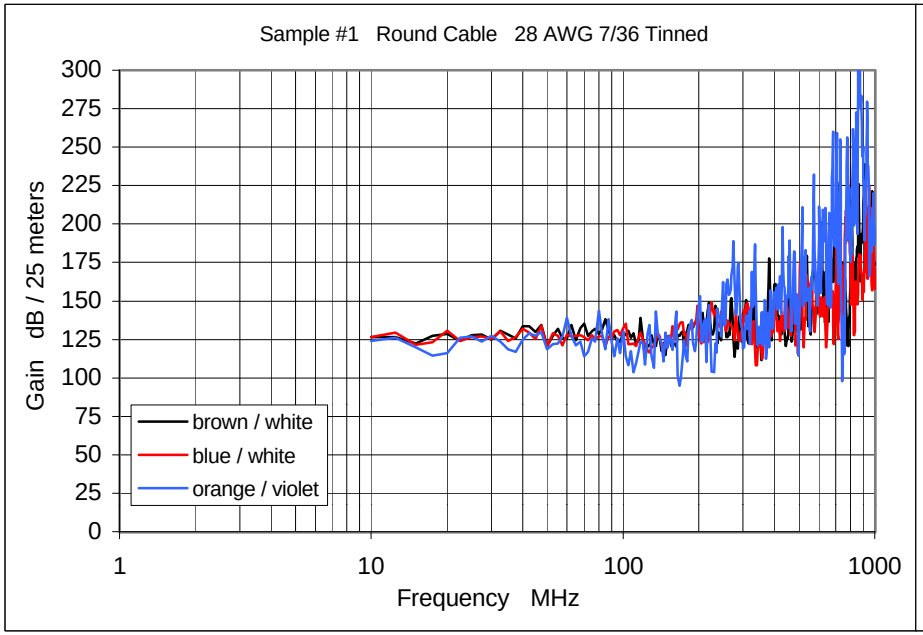

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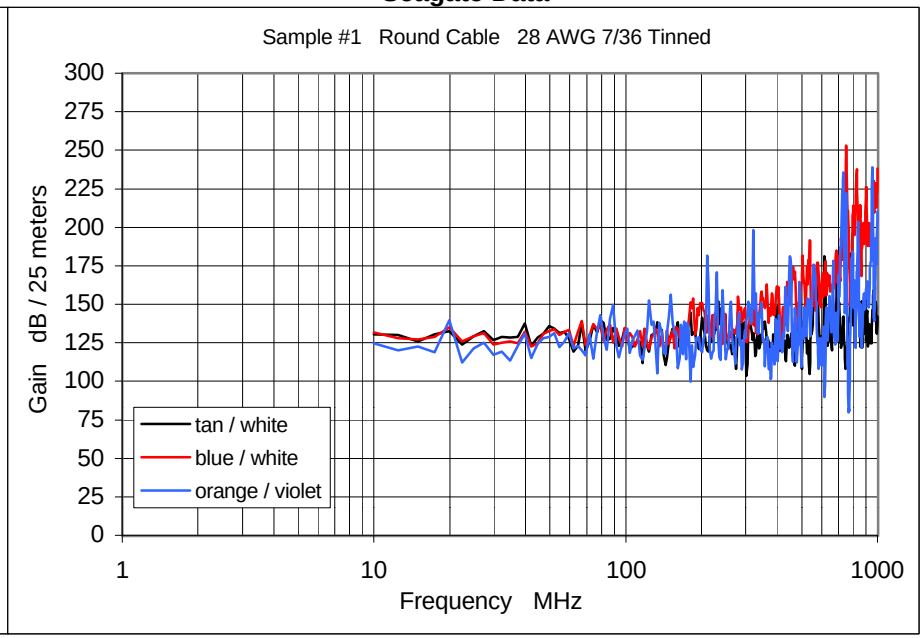

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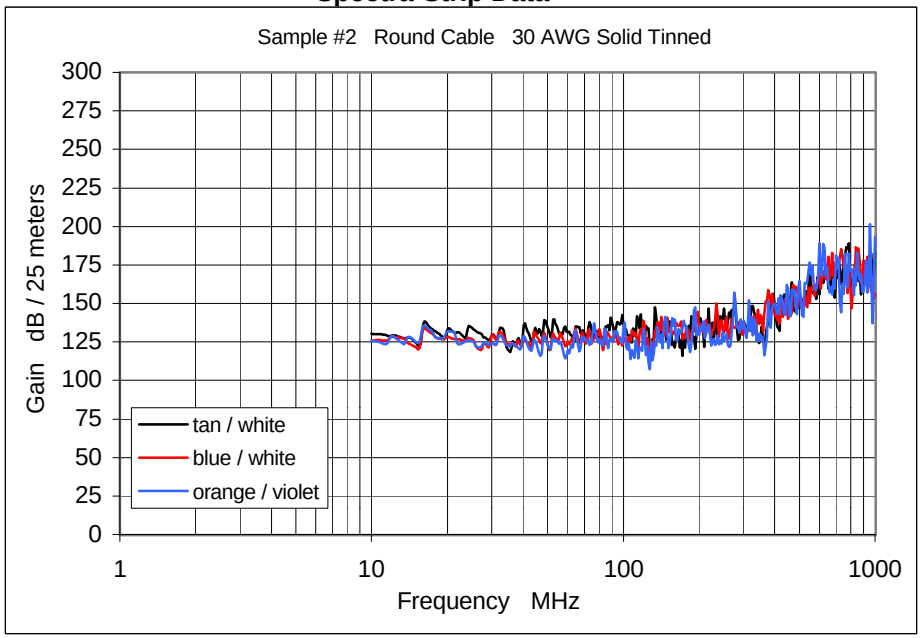

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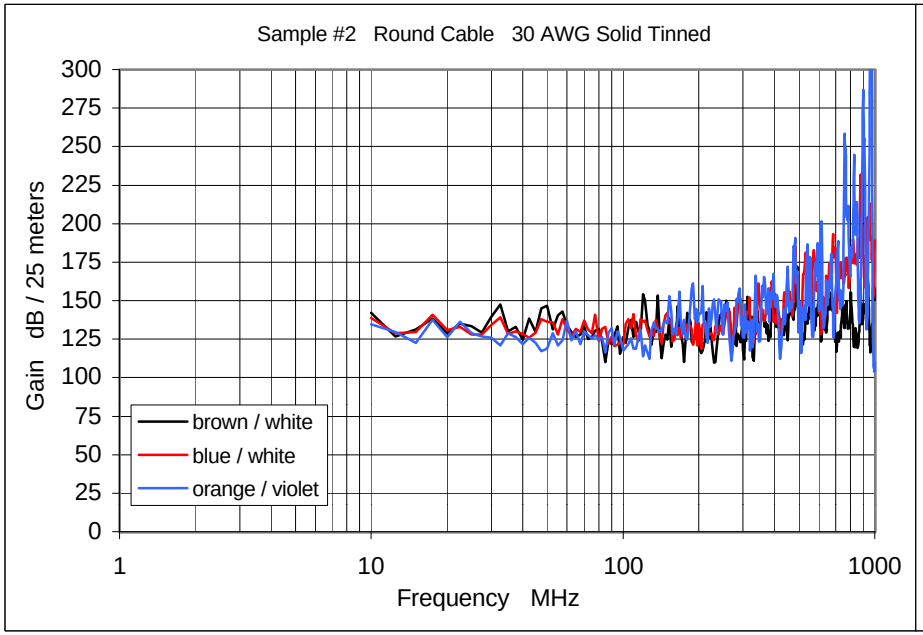

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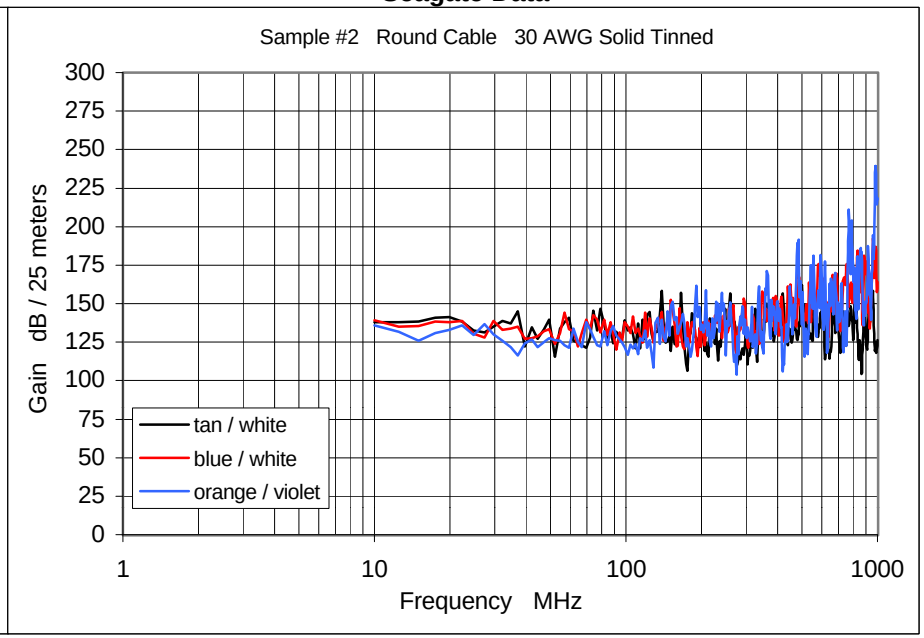

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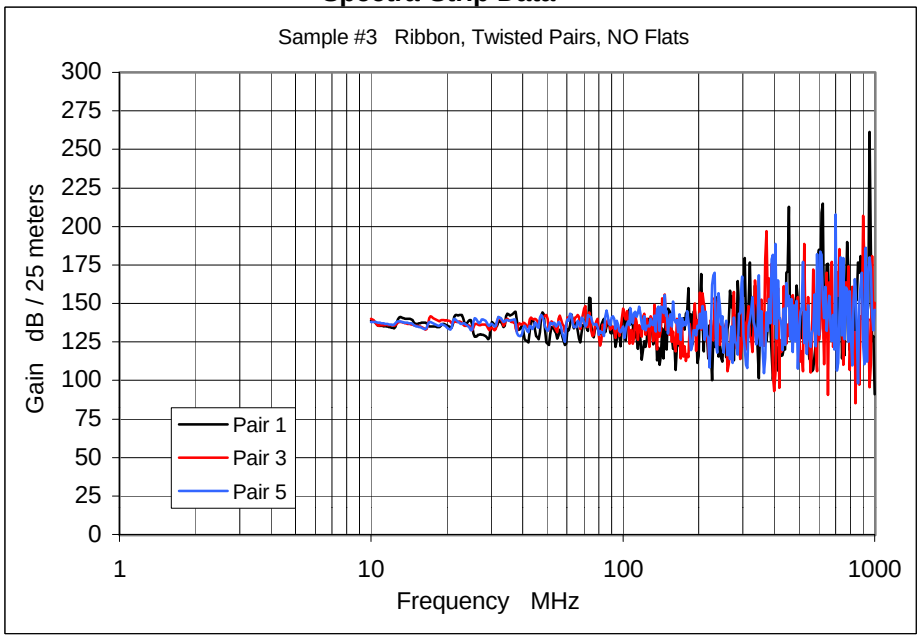

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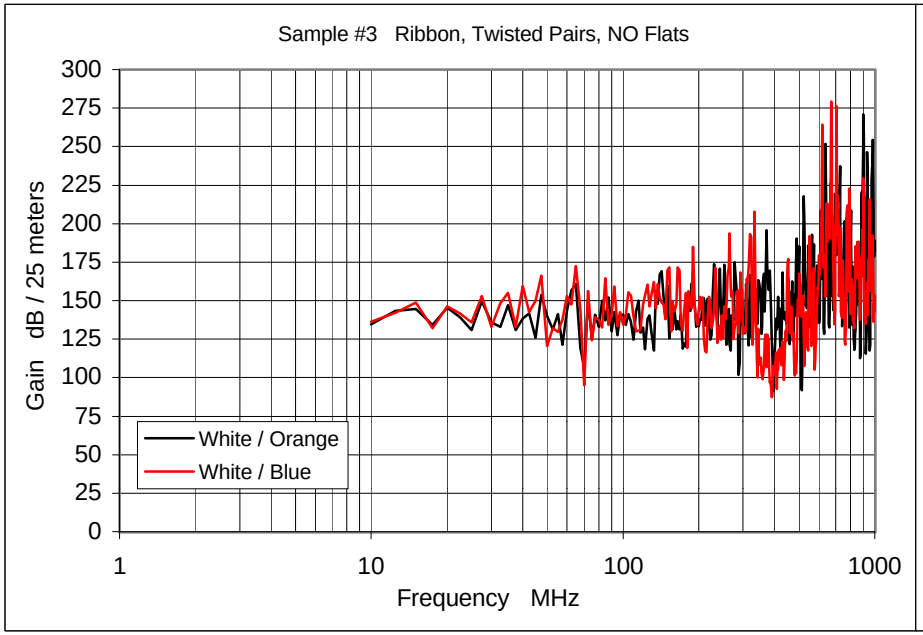

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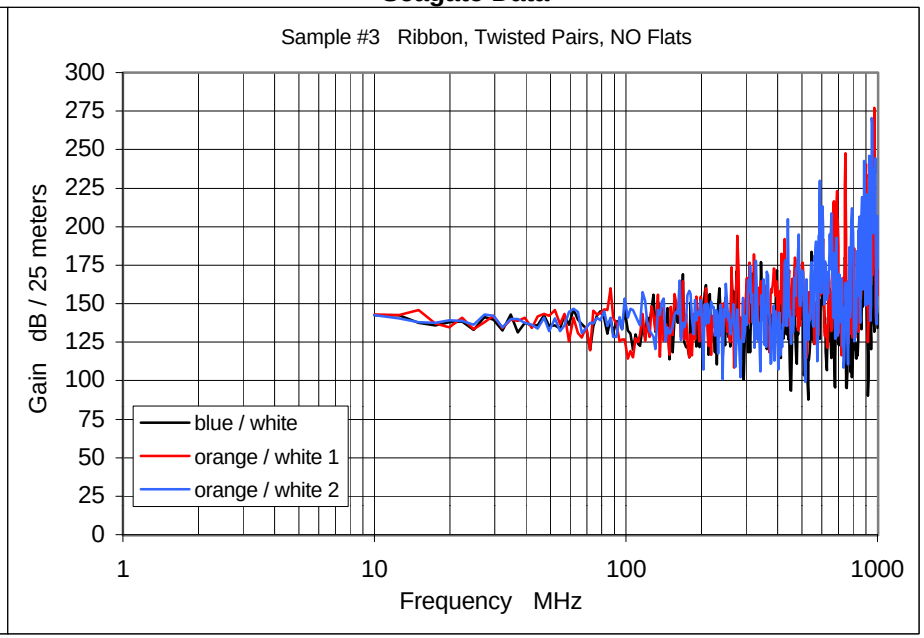

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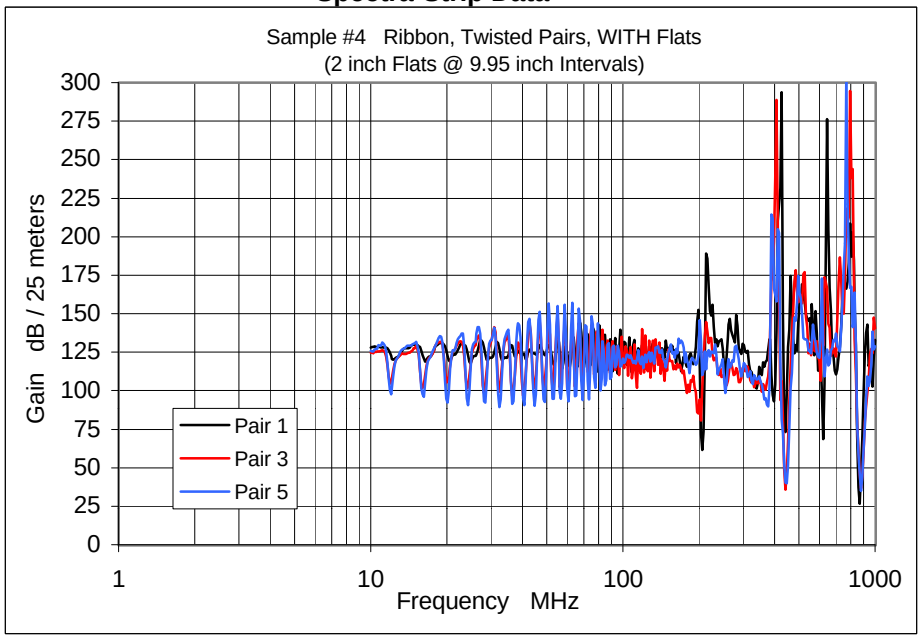

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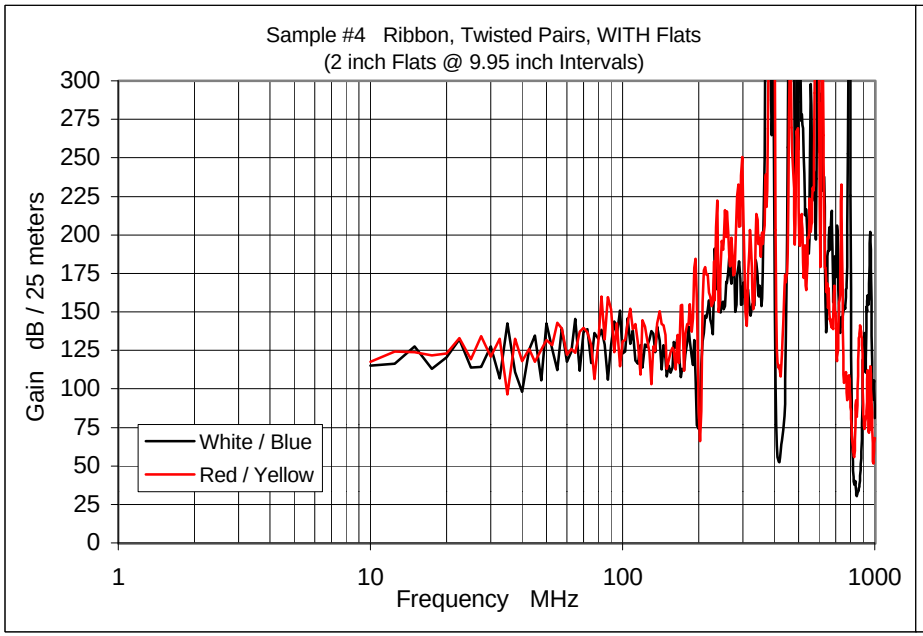

Seagate Data