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DELTA Test Report

TEST Reg. no. 19

Performance testing of data communication cable, Category 5E with copper plated aluminium conductors

Performed by DELTA EC Cabling

DANAK-19J2197
Project no.: N312708P

20 January 2010

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Title	Testing of data communication cable
Product description	Unshielded communication cable, Category 5E
Product identification	Category 5E with copper plated aluminium conductors
Report no.	DANAK-19J2197
Project no.	N312708P
Test object received	17 December 2010
Test period	January 2010
Specification	ISO/IEC 11801 ed. 2
Results	Compliance with specifications is not verified
Prepared by	Claude Videt
Reviewed by	Erik Bech
Date	20 January 2010
Responsible	Erik Bech _____ Erik Bech, Test Manager DELTA LAN Components and Systems Testing

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1. Summary

An unshielded communication cable has been subjected to a test programme for compliance with generic cabling standards.

The cable for this test was sent to DELTA by the customer.

The testing has been performed under laboratory conditions at the EC Cabling Group of DELTA.

This report firstly informs on the conclusion. Then the test results are reported. The results are compared with the requirements. At last the applied standards and test procedures are listed and described.

2. Conclusion

The tested sample did not comply with the applied requirements:

1. Cable breaking strength. The measured breaking strength is 333 N. Limit > 400 N

2. Conductor diameter. Measured 0.47 mm. Limit > 0.5 mm

3. Loop resistance. The measured resistance is 29 Ω. Limit < 19 Ω (see table 7)

4. Balanced mode attenuation. The limit is exceeded at lower frequencies (see page 10)[1]

5. Return loss and characteristic impedance. The limit is exceeded (see page 13-14)

6. Material for conductors. The cable standard IEC 61156 requires copper conductors.

The test results are only applicable for the tested sample.

[1] This small deviation does not mean anything for the application

3. Test results, reel #1

3.1 Cable marking

Table 1 Cable marking, reel #1

Characteristic	Result
Type of printing	Jet Ink
Colour of text	Black
Text	UTP CAT.5E 4P 24AWG SOLID ISO/IEC 11801 AND TIA/EIA 568 08/08/2009 (meter mark)

3.2 Mechanical and environmental tests

3.2.1 Mechanical characteristics of complete cable

Table 2 Cable breaking strength, reel #1

Parameter	Test Result	Requirement	Compliance
Breaking strength [N]	333	> 400 N	NO

Equipment:

Tensile testing machine, Lloyd, type LRX plus Instrument no.: 31166
Load cell Lloyd, LRX-2500-A1 Instrument no.: 31168

3.2.2 Mechanical characteristics of conducting materials

Table 3 Conductor diameter, reel #1

Pair	Colour	Diameter [mm]	Requirement	Compliance
1	White/Blue	0.48	0.5 - 0.65 mm	NO
	Blue	0.48		NO
2	White/Orange	0.48		NO
	Orange	0.48		NO
3	White/Green	0.47		NO
	Green	0.48		NO

Pair	Colour	Diameter [mm]	Requirement	Compliance
4	White/Brown	0.47		NO
	Brown	0.47		NO

Equipment:

Micrometer screw, Mitutoyo type No. 293-501N Instrument no.: 31031

Table 4 Conductor tensile strength and elongation reel #1

Parameter	Test result	Requirement	Compliance
Tensile strength minimum [MPa]	126	No requirement	NA
Tensile strength average [MPa]	129		NA
Elongation minimum [%]	17	>8%	YES
Elongation average [%]	21		YES

Equipment:

Tensile testing machine, Lloyd, type LRX plus Instrument no.: 31166
Load cell Lloyd, LRX-2500-A1 Instrument no.: 31168

3.3 Electrical tests

3.3.1 Capacitive properties

Table 5 Mutual capacitance, reel #1

Pair	Capacitance [nF/km]	Requirement
1	47.0	No requirement
2	77.8	
3	46.8	
4	48.7	

Table 6 Capacitive unbalance, reel #1

Pair	C unbalance [pF/km]	Requirement	Compliance
1	360	< 1600 pF/km	YES
2	20		YES
3	240		YES
4	420		YES

Equipment:

LCZ meter Hewlett Packard, type 4276A Instrument no.: 80137

3.3.2 Resistance properties

Table 7 DC loop resistance, reel #1

Pair	Resistance [Ohm]	Requirement	Compliance
1	28.3	< 19	NO
2	29.1		NO
3	28.9		NO
4	29.4		NO

Table 8 DC resistance unbalance, reel #1

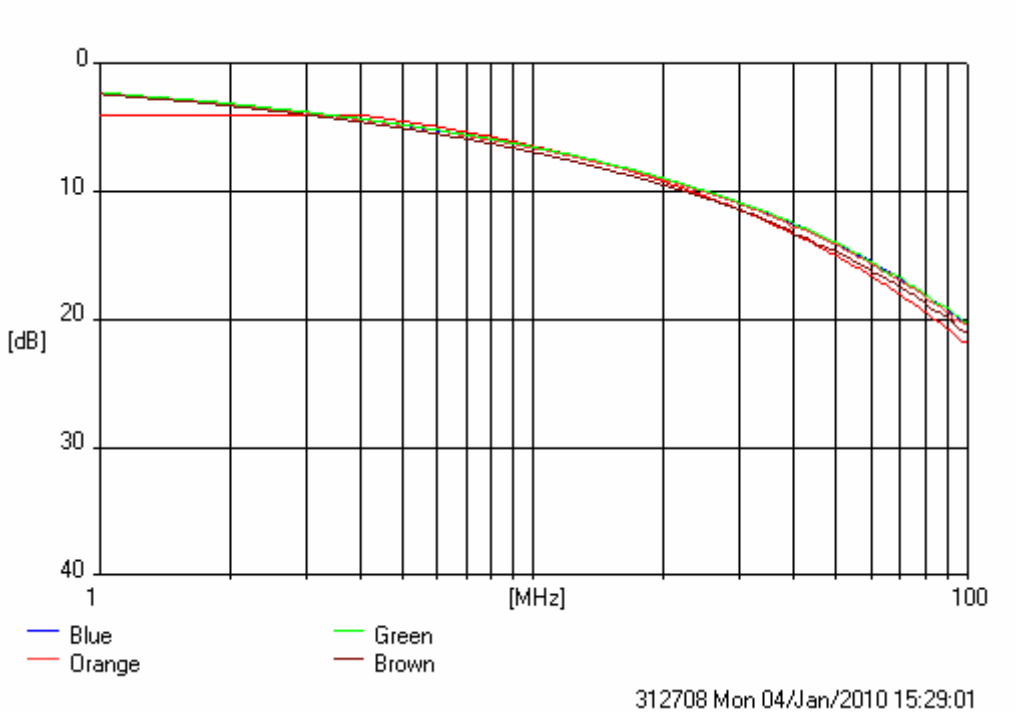
Pair	R unbalance [%]	Requirement	Compliance
1	0.1	< 2%	YES
2	0.9		YES
3	0.0		YES
4	0.5		YES

Equipment:

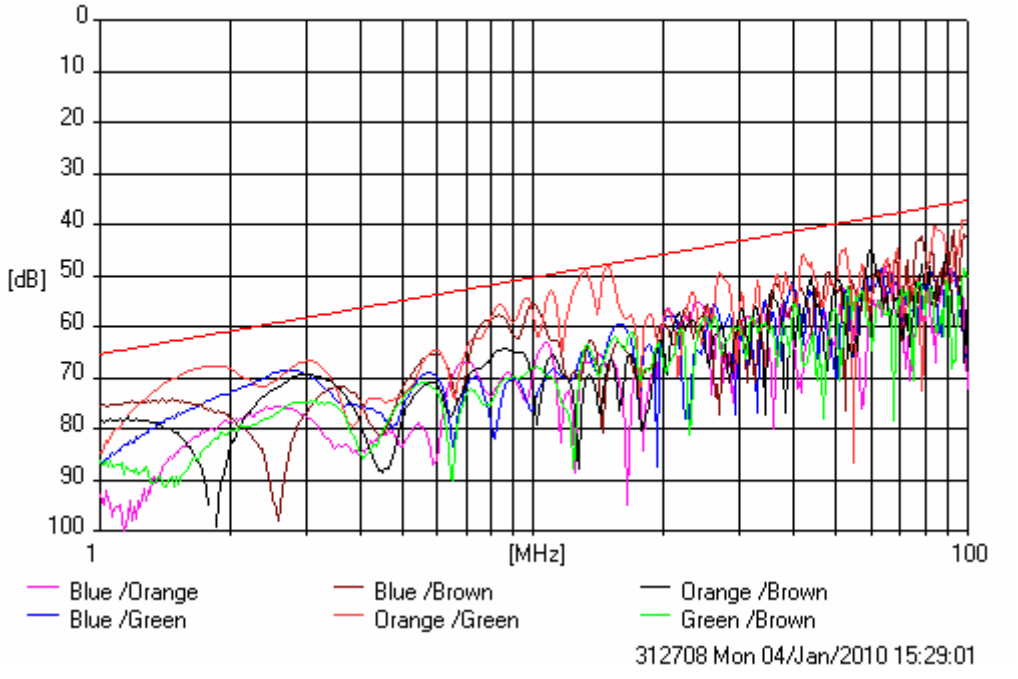
Micro-Ohmmeter Keithley, type 2000 Instrument no.: 31092

3.4 High frequency transmission test results, reel #1

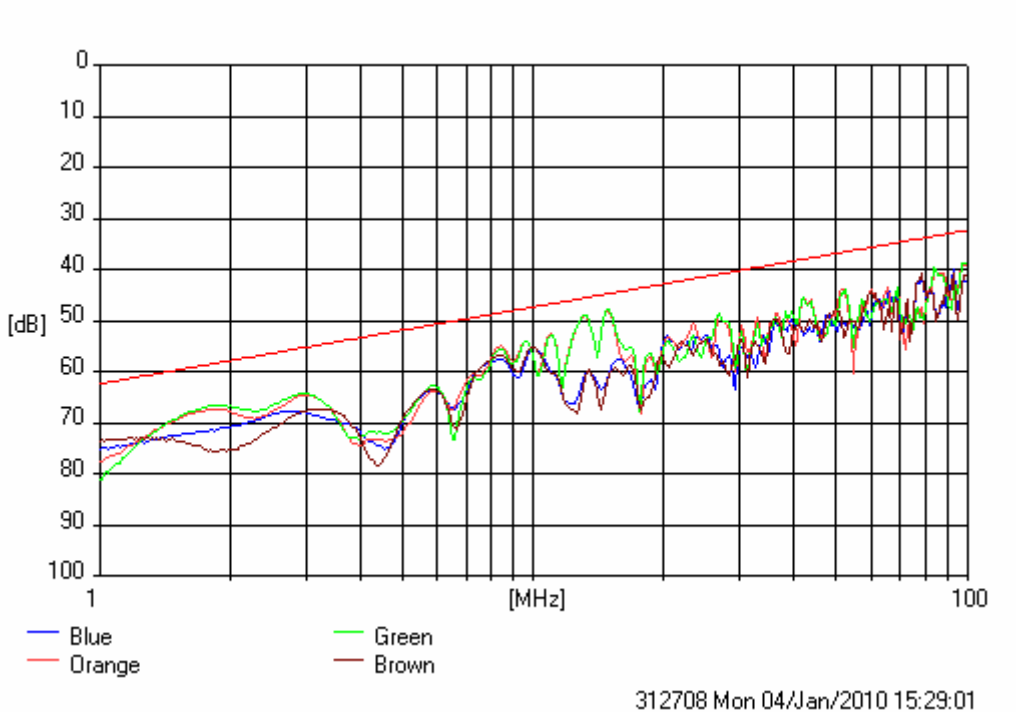
BALANCED MODE ATTENUATION
Data series #1 Room temperature



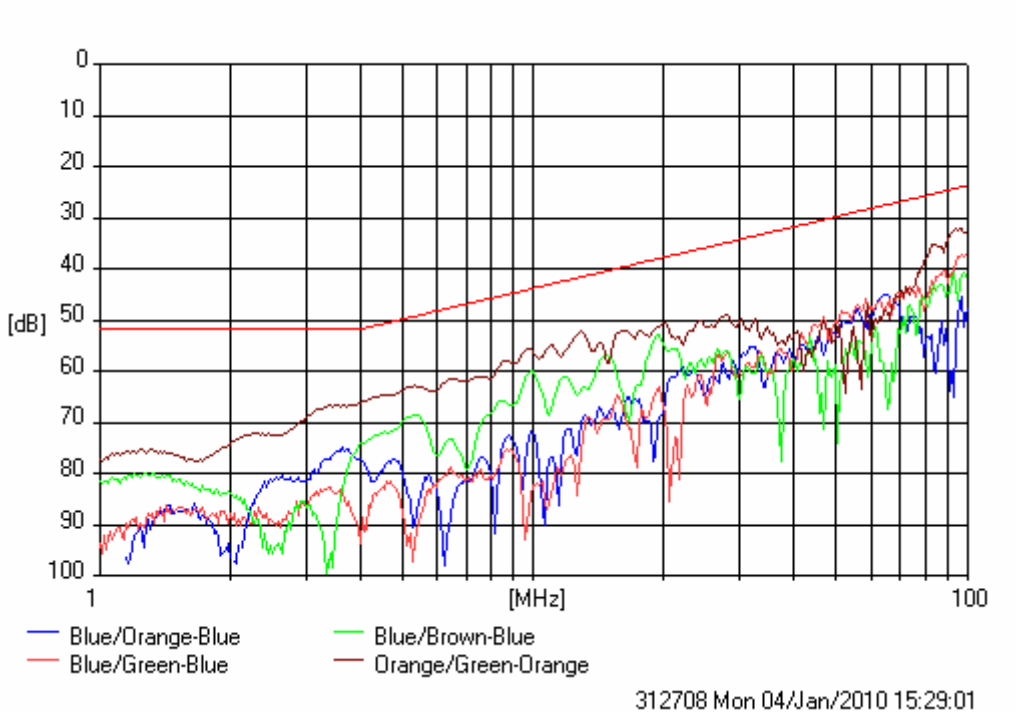
NEAR END CROSSTALK (NEXT)
Data series #1



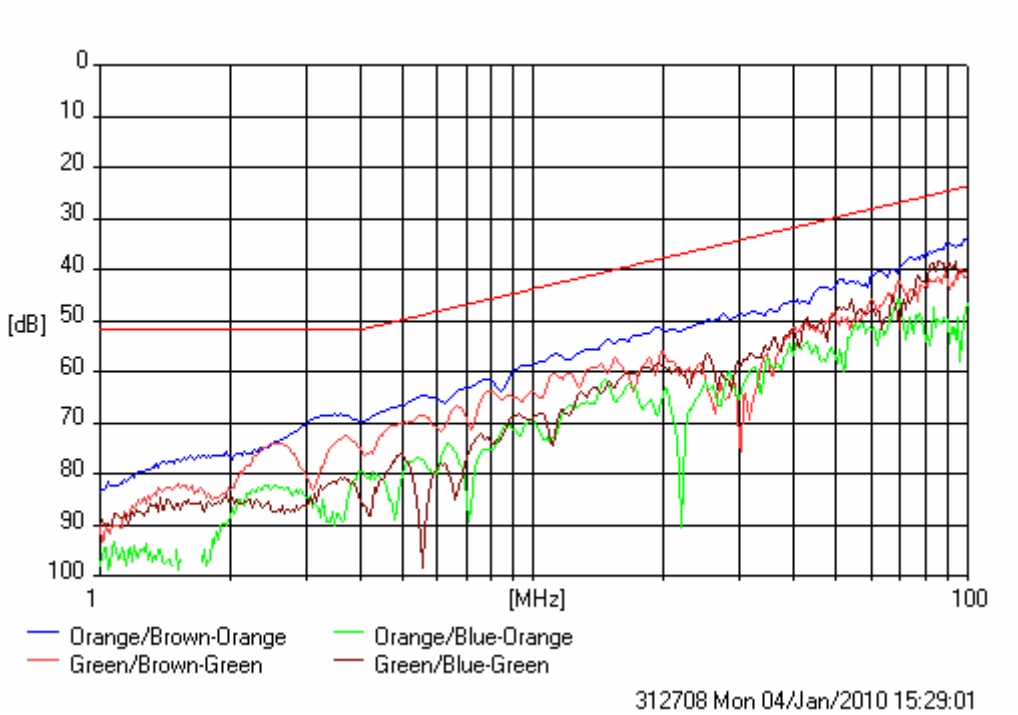
NEAR END CROSSTALK POWERSUM (PSNEXT)
Data series #1



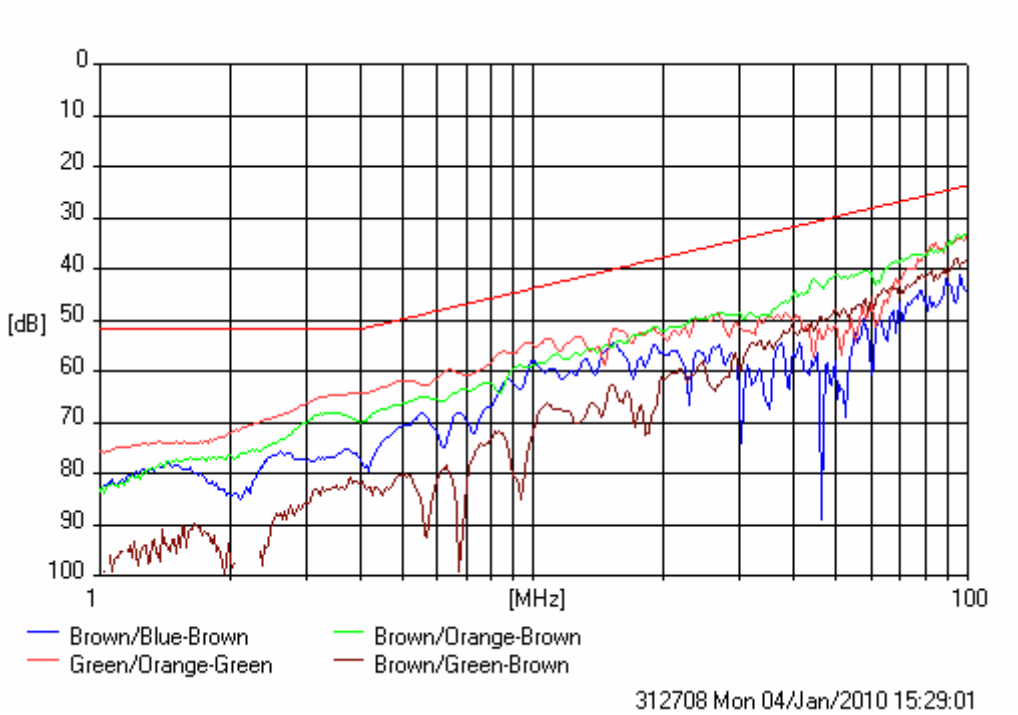
ATTENUATION TO CROSSTALK LOSS RATIO - FAR (ACR-F)
Data series #1



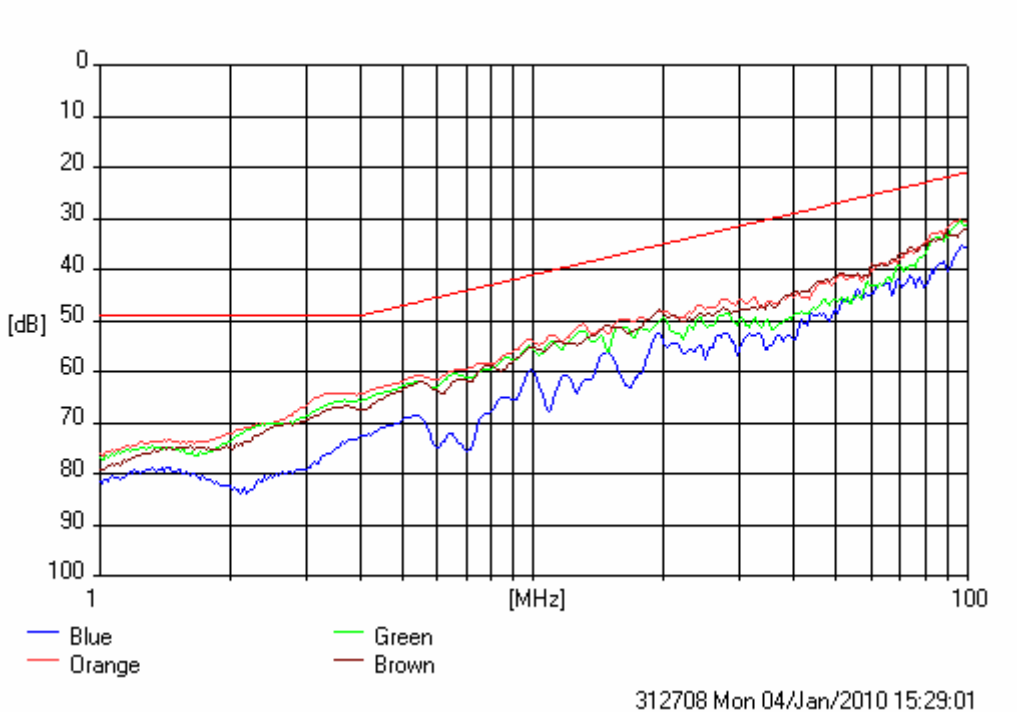
ATTENUATION TO CROSSTALK LOSS RATIO - FAR (ACR-F)
Data series #1



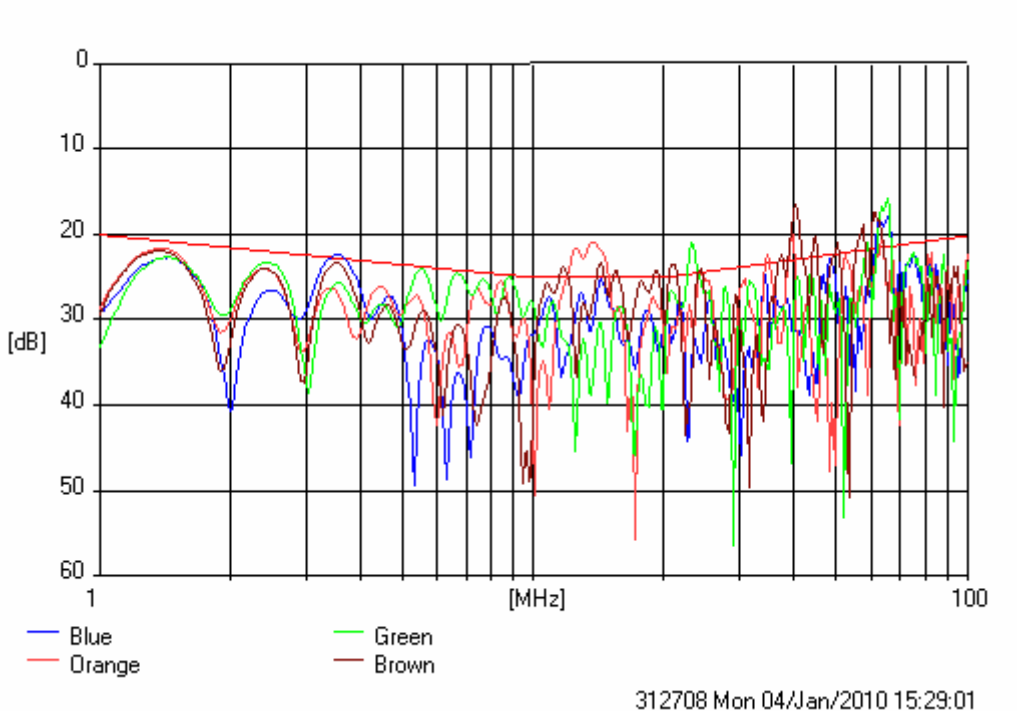
ATTENUATION TO CROSSTALK LOSS RATIO - FAR (ACR-F)
Data series #1



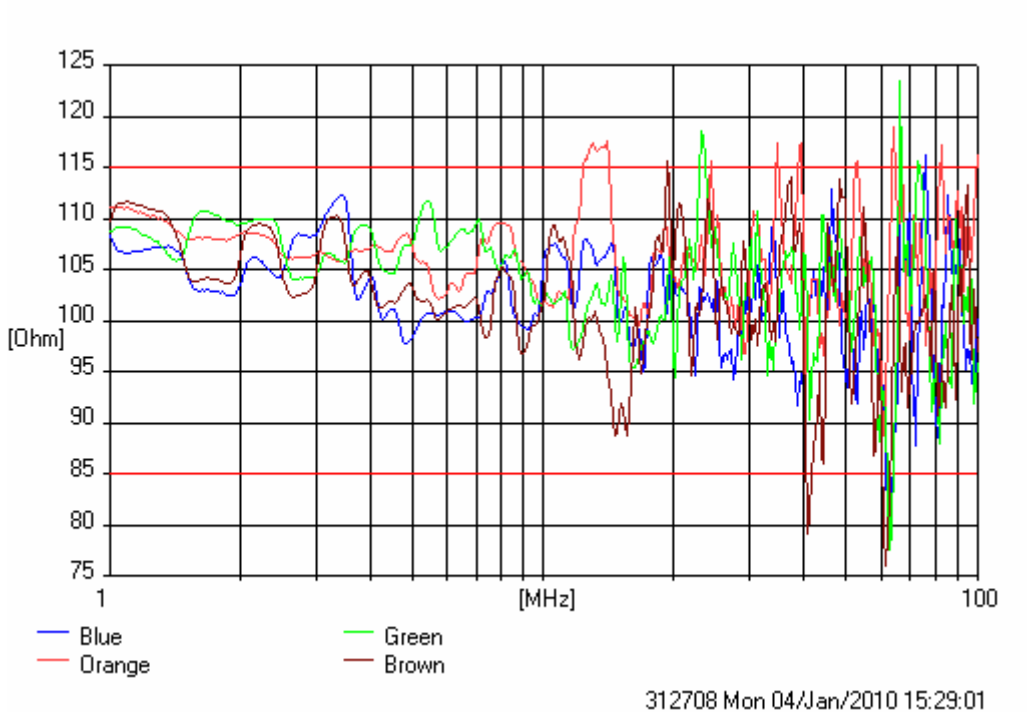
POWER SUM ATTENUATION TO CROSSTALK LOSS RATIO - FAR (PSACR-F)
Data series #1



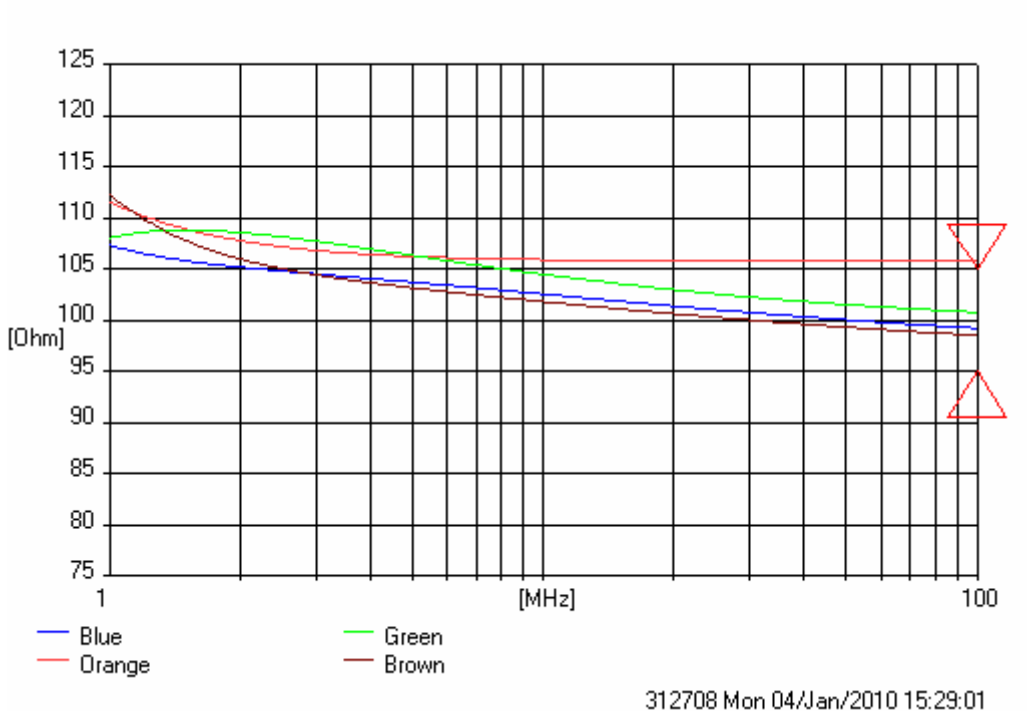
RETURN LOSS
Data series #1



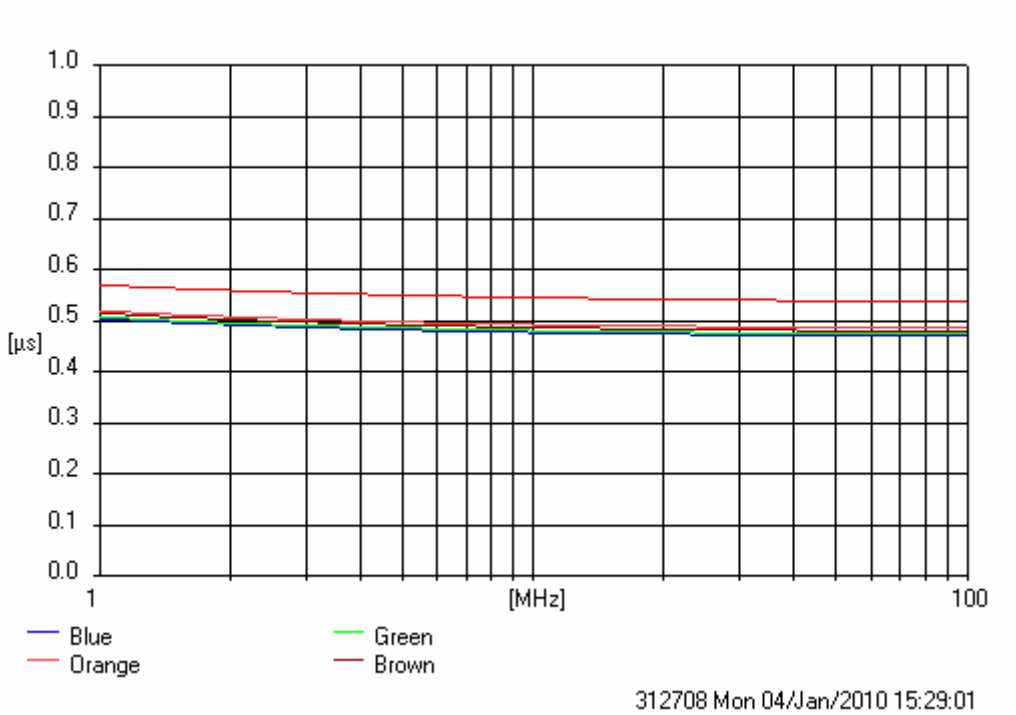
CHARACTERISTIC IMPEDANCE
Data series #1



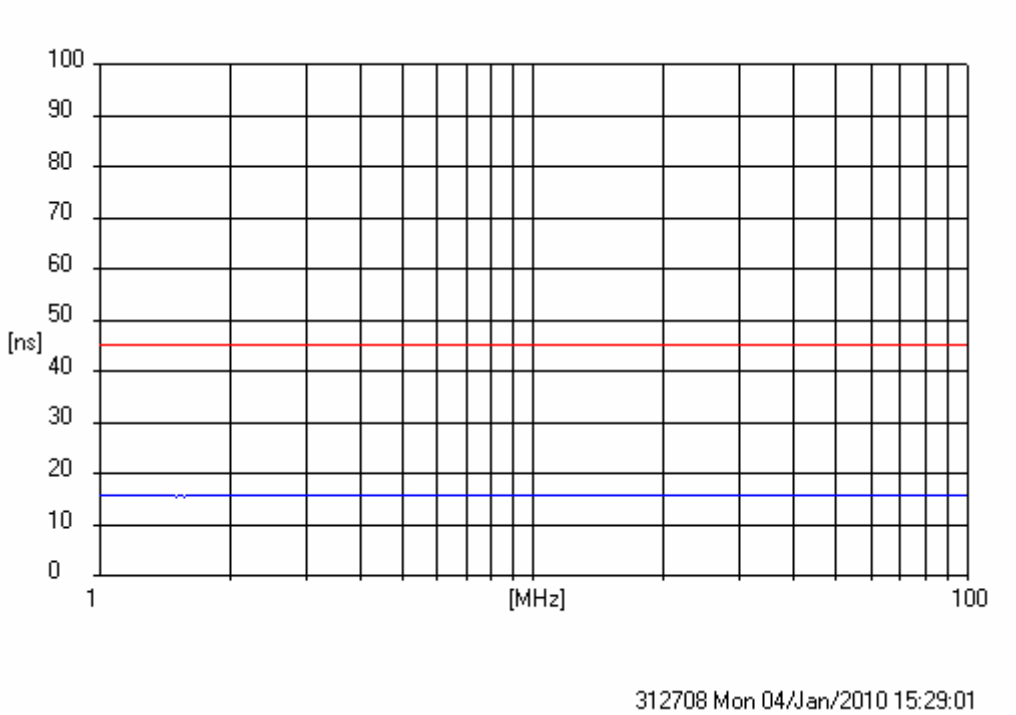
MEAN IMPEDANCE
Data series #1



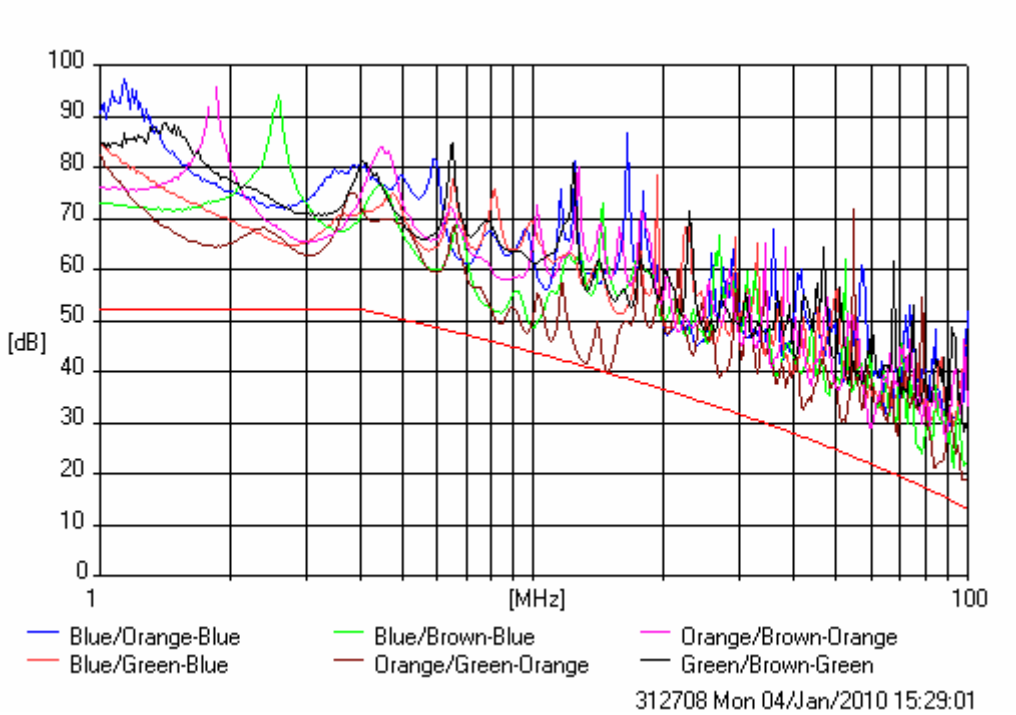
PROPAGATION DELAY
Data series #1



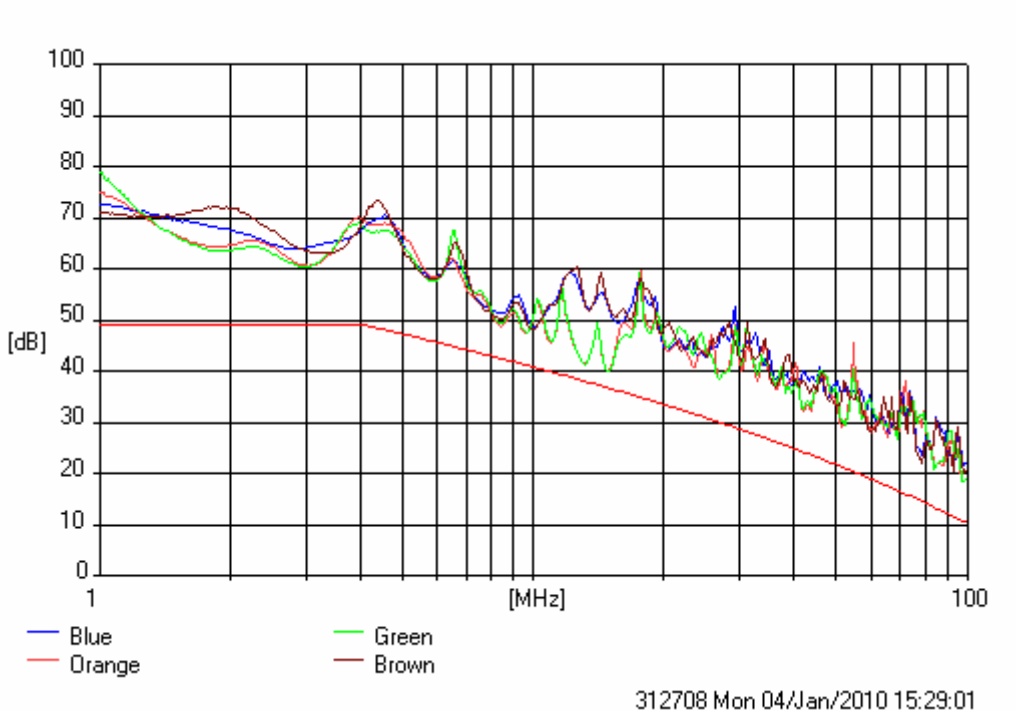
DELAY SKEW
Data series #1



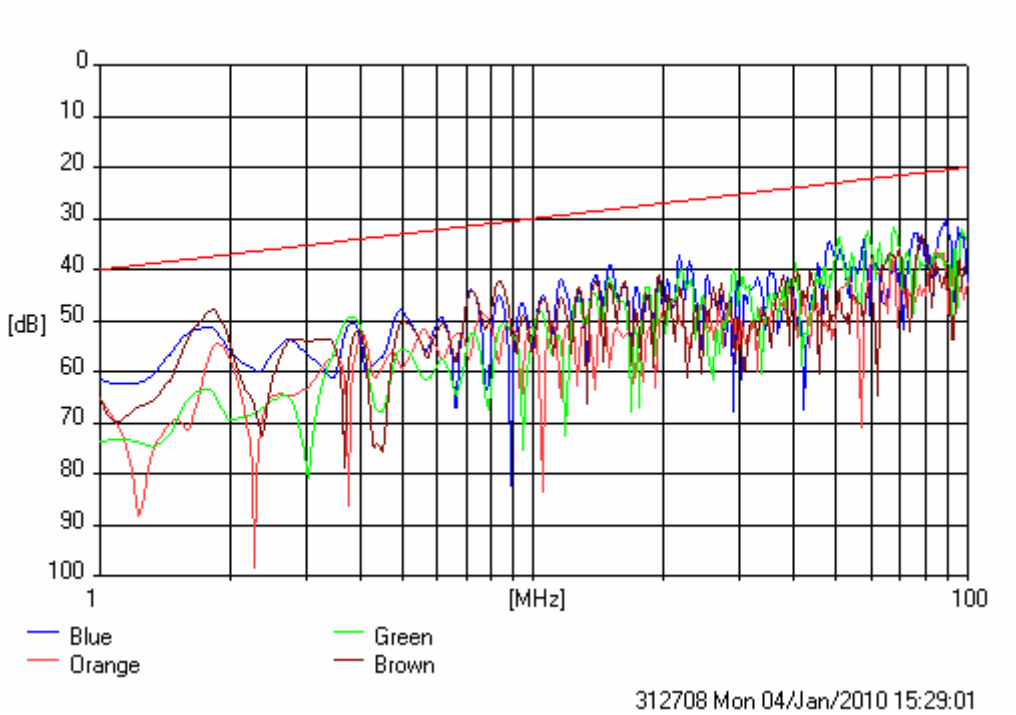
ATTENUATION TO CROSSTALK LOSS RATIO, NEAR END (ACR-N)
Data series #1 Room temperature



ATTENUATION TO CROSSTALK LOSS RATIO POWERSUM, NEAR END (PSACR-N)
Data series #1 Room temperature



TRANSVERSE CONVERSION LOSS (TCL)
Data series #1



****** CURVE ERRORS ******

Measurement (ATT, reel 1) exceeding limit for pair no. 1.
Measurement (ATT, reel 1) exceeding limit for pair no. 2.
Measurement (ATT, reel 1) exceeding limit for pair no. 3.
Measurement (ATT, reel 1) exceeding limit for pair no. 4.
Measurement (RETURNLOSS, reel 1) exceeding limit for pair no. 1.
Measurement (RETURNLOSS, reel 1) exceeding limit for pair no. 2.
Measurement (RETURNLOSS, reel 1) exceeding limit for pair no. 3.
Measurement (RETURNLOSS, reel 1) exceeding limit for pair no. 4.
Measurement (IMP, reel 1) exceeding limit for pair no. 1.
Measurement (IMP, reel 1) exceeding limit for pair no. 2.
Measurement (IMP, reel 1) exceeding limit for pair no. 3.
Measurement (IMP, reel 1) exceeding limit for pair no. 4.

Equipment:

Network Analyser Hewlett Packard, type 8753D	Instrument no.: 31094
Relay box DELTA	Instrument no.: 31113

4. Reference to applicable standards and documents

Test of the cable under test is performed with reference to the following standards:

4.1 Generic cabling standards

ISO/IEC 11801, 2nd edition:2002
Information Technology, Generic cabling for customer premises.
(This standard covers all cabling classes up to Category 7).

CENELEC EN 50173-1:2007
Information Technology-Generic cabling systems Part 1: General requirements.
(This standard covers all cabling classes up to class 7).

ANSI/TIA-568-C.2
Balanced Twisted-Pair Telecommunications Cabling and Components Standard
(This standard provides requirements for category 3, category 5e, category 6 and category 6A cabling and components).

4.2 Cable standards

IEC 61156-5 Edition 2.0:2009-02
Symmetrical pair/quad cables for digital communication with transmission characteristics up to 1000 MHz - Horizontal floor wiring - Sectional specification.
(This standard is for cables up to Category 7A).

CENELEC EN 50288-1, 2003.
Generic specification for multi-element metallic cables used in analogue and digital communication and control.

CENELEC EN 50288-3-1, 2003.
Multi-element metallic cables used in analogue and digital communication and control.
Part 3: Sectional specification for unscreened cables characterised up to 100 MHz.
Section 1: Horizontal and building backbone cables.

5. Test procedures

The tests carried out on the cable under test are performed according to the standard: IEC 61156-1 Multicore and symmetrical pair/quad cables for digital communication-Part 1: Generic specification.

The test methods are detailed in test procedures worked out by DELTA and approved by DANAK. In this section the procedures are described briefly.

5.1 Constructional tests

5.1.1 Mechanical characteristics of conducting materials

The diameters of conductors are measured. The measurement uncertainty for diameter measurements is ±0.03 mm.

5.1.2 Properties of conducting materials

The following parameters are measured: Tensile strength and elongation of conductors. The complete cable is tested for breaking strength.

The measurement uncertainty for tensile strength is ±14%.
The measurement uncertainty for elongation is ±11%.
The measurement uncertainty for breaking strength is ±10%.

5.2 Electrical tests

The electrical tests on the cable under test are performed according to the procedures described in this section. Measurements of attenuation, characteristic impedance, near end cross talk, and balance are performed on 100 m of the cable under test, cut and stretched on a non-conductive surface. Measurements of capacitive properties are performed on 100 m of the cable in on-reel condition.

5.2.1 Capacitive properties

The capacitive properties, mutual capacity, and capacitive unbalance are measured.

Mutual capacitance is measured for each pair as the capacitance between the conductors of the pair. Mutual capacitance is expressed in nF/km.

Capacitive unbalance is measured as the difference of the capacitance of each conductor in a pair to all the other conductors connected together. Capacitive unbalance is expressed in pF/km.

The measurement uncertainty for mutual capacitance is ±1.4 %.
The measurement uncertainty for capacitive unbalance is ±1% ±2.5 pF.

5.2.2 DC resistance

The DC resistance is measured at a length of 100 m of the cable under test. The measured value is corrected for the temperature of the test object in order to obtain the resistance at 20°C.

The measurement uncertainty for DC resistance is ±1.4%.

5.2.3 Attenuation (Att)

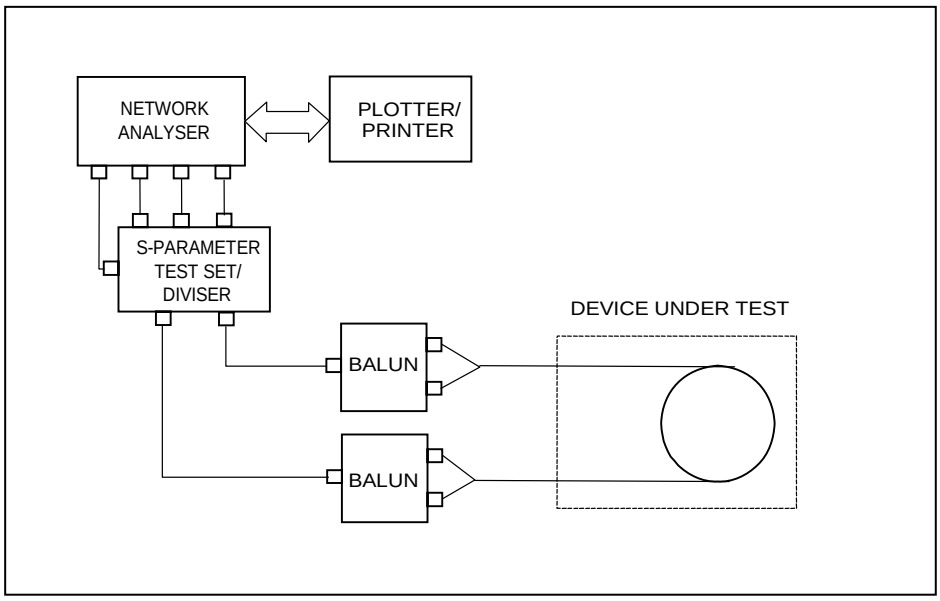


Figure 1 Test set-up for attenuation measurements.

The attenuation of the cable under test is measured by the network analyser and corrected for the length of the cable, in order to express the attenuation in dB/100 m.

The measurement uncertainty for attenuation is ±0.15 dB for attenuation up to 40 dB and ±0.5 dB for attenuation up to 60 dB.

5.2.4 Characteristic impedance and return loss

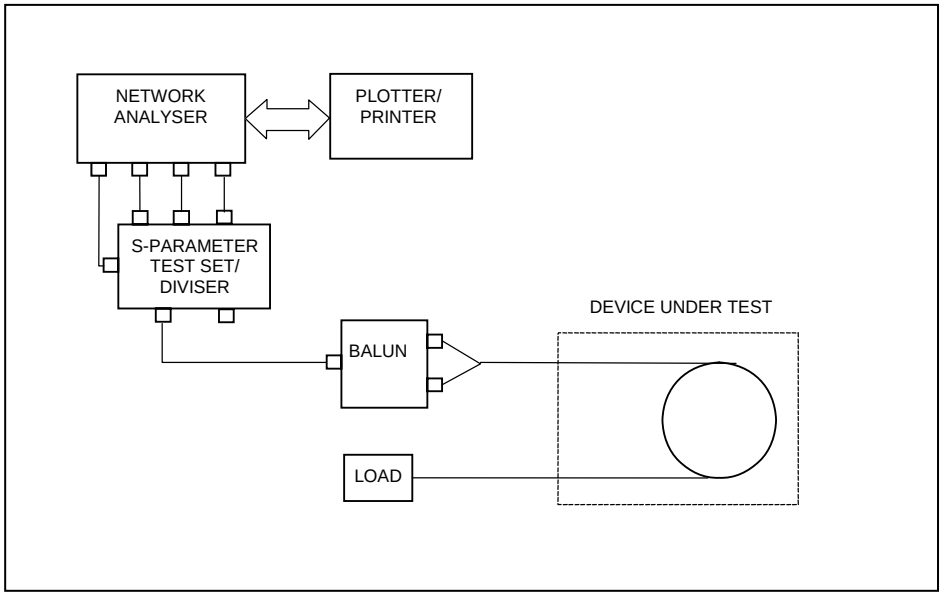


Figure 2 Test set-up for impedance and return loss measurements.

The input impedance of the component under test is measured by taking two measurements, one for the far end shorted and one for the far end open. The impedance is then calculated as the square root of the product of the measured values.
The return loss of the cable under test is measured in the applied frequency range with the far end terminated with a resistance of the quoted characteristic impedance of the component under test.

The measurement uncertainty for impedance is ±1% at 100 MHz.
The measurement uncertainty for return loss is dependant of the measured return loss value. The error band is specified in the table below:

Measured return loss	Error band
5 dB	$4.8 \leq RL \langle 5.2$
10 dB	$9.7 \leq RL \langle 10.3$
15 dB	$14.5 \leq RL \langle 15.5$
20 dB	$19.2 \leq RL \langle 20.9$
25 dB	$23.6 \leq RL \langle 26.7$
30 dB	$27.6 \leq RL \langle 33.3$
40 dB	$34 \leq RL \langle \infty$

At frequencies above 500 MHz add ±3 dB to the uncertainty.

5.2.5 Mean Impedance

Mean impedance is determined by calculating the fitted impedance according to IEC 61156-1 Multicore and symmetrical pair/quad cables for digital communication. Part 1: Generic specification, clause 3.3.6.3. The fitted impedance is shown in graphical form in this report.

The mean impedance is the fitted impedance at high frequencies. The value at 100 MHz is used for this parameter.

5.2.6 Near end crosstalk (NEXT)

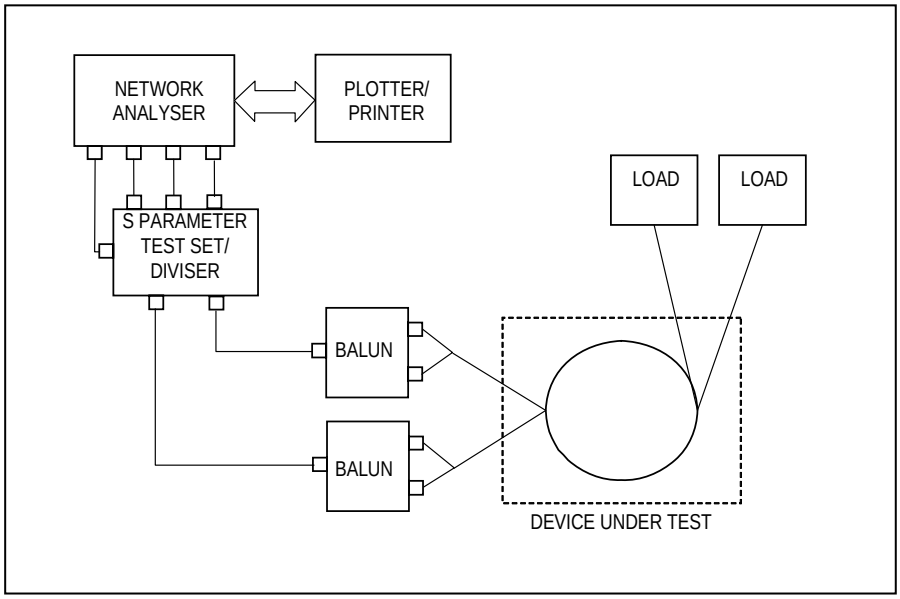


Figure 3 Test set-up for near end crosstalk measurements.

Near end crosstalk, NEXT, is measured as the attenuation from one pair to the others and these measurements are repeated for all pair combinations. In the far end all pairs are terminated with a resistor with a value of the quoted characteristic impedance of the component under test.

The measurement uncertainty for NEXT is dependant of the level of measured NEXT. The uncertainty is shown in the table below:

Measured NEXT	Uncertainty
40 dB	±0.5 dB
60 dB	±0.6 dB
70 dB	±0.8 dB
80 dB	±1.7 dB

5.2.7 Powersum near end crosstalk (PSNEXT)

PSNEXT is calculated for each pair according to the formula:

$$PSNEXT = -10\,log(10^{-x1/10} + 10^{-x2/10} + 10^{-x3/10})$$

where x1, x2, x3 are the pair-to-pair crosstalk measurements in dB between the selected pair and the other three pairs.

The measurement uncertainty is the same as for NEXT measurements.

5.2.8 Attenuation to crosstalk loss ratio (ACR-N)

Attenuation to Crosstalk Ratio near end, ACR-N is calculated for each pair considering the minimum near end crosstalk, NEXT measured for the six pair combinations.

The measurement uncertainty is the same as for NEXT measurements.

5.2.9 Power sum ACR (PSACR-N)

PSACR_N is calculated according to the formula:

$$PSACR - N = -10\log(10^{-x1/10} + 10^{-x2/10} + 10^{-x3/10} + 10^{-x4/10})$$

Where x1, x2, x3, and x4 are the ACR-N values in dB for each pair.

The measurement uncertainty is the same as for NEXT measurements.

5.2.10 Attenuation to crosstalk ratio-far end (ACR-F)

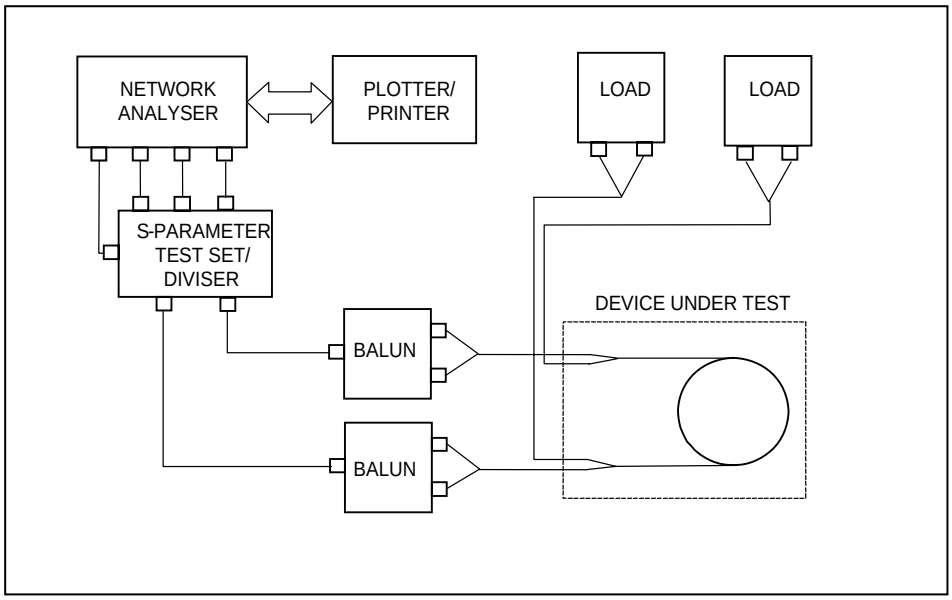


Figure 4 Test set-up for far end crosstalk measurements.

ACR-F is calculated from the measured values of far end cross talk, FEXT, and attenuation, ATT of the disturbed pair.

ACR-F = FEXT - ATT

The measurement uncertainty is the same as for NEXT measurements.

5.2.11 Power sum attenuation to crosstalk ratio far end (PSACR-F)

PSACR-F is calculated for each pair according to the equation:

$$PSACR - F = PSFEXT - ATTENUATION$$

$$PSFEXT = -10\log(10^{-x1/10} + 10^{-x2/10} + 10^{-x3/10})$$

Where x1, x2, x3 are the pair-to-pair crosstalk measurements in dB between the selected pair and the other three pairs.

5.2.12 Attenuation unbalance, near end (Transverse conversion loss, TCL)

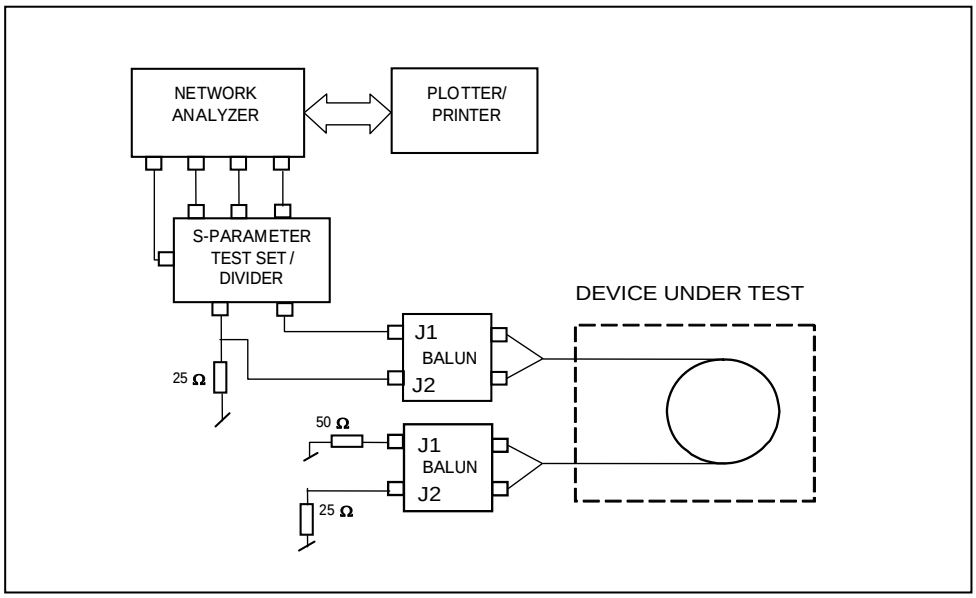


Figure 5 Test set-up for balance characteristics measurements.

Balance characteristics, transverse conversion loss, is measured as the signal attenuation between the common mode and the differential mode port of the test balun.
The test set-up is calibrated by imposing a known unbalance, consisting of a 50 Ohm resistor from one of the balance output terminals to ground. The instrument is adjusted for a reading of 16 dB for this unbalance. All pairs are terminated for differential and common mode signals during the test.

The measurement uncertainty for balance measurements is dependant of the level of balance. The uncertainty is shown in the table below:

Measured TCL	Uncertainty
20 dB	±0.3 dB
30 dB	±1 dB
40 dB	±3 dB

5.2.13 Propagation delay

Propagation delay is measured by determining the phase delay of a signal transmitted through the cable.

$$\delta = \frac{\varphi}{2\pi \times f}$$

where φ is the phase delay. f is the frequency in Hertz.

The measurement uncertainty for delay is ±1%.

5.2.14 Delay skew

Delay skew is calculated as the difference between the maximum and minimum propagation delay over the four pairs at each frequency.

The measurement uncertainty for skew is ±10%.

5.3 Test software

Test software according to information in the table below is used for the conducted tests.

Software name	**Function**	**File name**	**Version**	**Date**
Cablingtotal	Electrical cable tests	Cabltot	3.98	081113
ECCalculate	Calculated parameters	ECCalculate	7	060904
ECReport	Report	Xreport	28	090505
Report programme	Report	Rapgen.xls	1.19	090421
DELTA Automatic Reporting Program	Automatic word processing	Rapport	1.6	091111
Cable report 2002	Cable report generation	Cable report	3.8	091111