QUALIFICATION TESTING OF UNSCREENED CATEGORY 6 ISO/IEC, EN & TIA/EIA CONNECTING HARDWARE ACCORDING TO REQUIREMENTS OF 2ND EDITION ISO/IEC 11801, CENELEC EN 50173-1, ANSI/TIA/EIA-568-B.2-1 AND IEC 60603-7-4

Produced by
Telebox Industries Corp.

Unscreened Keystone Jack, Category 6, RJ 45
Telebox Industries Corp. Identification, P/N TA8761Ux

Prepared by Poul Villien

Project No. 1071660 2007.10.22

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1. IDENTIFICATION

Project No.:	1071660
Subject:	Qualification Testing of Unscreened Category 6 ISO/IEC, EN & TIA/EIA Connecting Hardware according to Requirements of 2nd Edition ISO/IEC 11801, CENELEC EN 50173-1, ANSI/TIA/EIA-568-B.2-1 and IEC 60603-7-4
Connecting Hardware:	Unscreened, Category 6, RJ 45, Keystone Jack
Manufacturer:	Telebox Industries Corp. 4F, No. 306, Tatung Road, Sec. 1 Hsichih-Taipei 221 Taiwan R.O.C.
Telebox Industries Corp. Identification:	P/N TA8761Ux
PCB Marking:	001-87604 C6 A01 1F00
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2. SURVEY OF THE WORK

3P has performed qualification testing on samples of unscreened Category 6 keystone jack from Telebox Industries Corp., P/N TA8761Ux. Samples of the keystone jack have been supplied for testing at 3P by Telebox Industries Corp. in August 2007.

Qualification testing of the supplied samples was carried out in September and October, 2007.

Testing has included a verification of performance according to all relevant international standards. This means that the following specifications stating electrical transmission requirements are covered by the present testing:

- ISO/IEC 2nd Edition 11801, Cat. 6
- CENELEC EN 50173-1, Cat. 6
- ANSI/TIA/EIA-568-B.2-1, Cat. 6
- IEC 60603-7-4, Cat. 6

The transmission performance of the unscreened Category 6 ISO/IEC, EN & TIA/EIA keystone jack from Telebox Industries Corp., P/N TA8761Ux, having PC board marking 001-87604 C6 A01 1F00, does in every respect comply with all specified requirements.

The positive conclusion of the testing covers all unscreened products from the qualified production line of Telebox Industries Corp. having identical PCB circuitry. Presently this only includes Telebox Industries Corp. keystone jack,

- P/N TA8761Ux

The company

Telebox Industries Corp.
4F, No. 306, Tatung Road, Sec. 1
Hsichih-Taipei 221
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is qualified at their Hsichih site to produce the connecting hardware in question with a 3P rating as Unscreened Category 6 ISO/IEC, EN & TIA/EIA Connecting Hardware.

The qualification will be valid until failure to pass one of the maintenance of qualification test programmes, which will be performed at 12 months intervals.

The present testing does not include the reliability test programmes specified in ISO/IEC, CENELEC, ANSI/TIA/EIA and IEC standards. Only the transmission performance is covered by the 3P testing. It is assumed that the reliability of the applied RJ 45 jacks is adequate to secure safe interconnection to the patch cords throughout a lifetime of normal application of the connecting hardware.

3. APPLIED SPECIFICATIONS

The transmission performance requirements of the following specifications have been covered by the connecting hardware testing:

- ISO/IEC 2nd Edition Generic Cabling Standard 11801, Cat. 6
- CENELEC Generic Cabling Standard EN 50173-1, Cat. 6
- ANSI/TIA/EIA Generic Cabling Standard 568-B.2-1, Cat. 6
- IEC Connecting Hardware Standard 60603-7-4, Cat. 6

4. CONDITIONS OF TESTING

4.1 Connecting Hardware Types covered by the Qualification Testing

The qualification testing has been carried out on supplied samples of unscreened Category 6 keystone jack from Telebox Industries Corp., P/N TA8761Ux.

The positive conclusion of the testing covers all unscreened products from the qualified production line of Telebox Industries Corp. having identical PCB circuitry. Presently this only includes Telebox Industries Corp. keystone jack,

- P/N TA8761Ux

The marking of the PC boards was 001-87604 C6 A01 1F00.

4.2 Electrical Measurements

The following electrical transmission parameters have been measured for all pairs or combination of pairs for the tested connecting hardware samples:

- Return loss from 1 MHz - 250 MHz, measured from both sides of the connecting hardware
- Attenuation from 1 MHz - 250 MHz
- Pair-pair near end crosstalk from 1 MHz - 250 MHz, measured from both sides of the connecting hardware
- Pair-pair far end crosstalk from 1 MHz - 250 MHz, measured for all 2×6 combinations of pairs
- DC resistance
- DC resistance unbalance
- Current carrying capacity
- Propagation delay from 1 MHz - 250 MHz
- Delay skew from 1 MHz - 250 MHz
- Coupling attenuation and EMC performance from 30 MHz - 1 GHz, recorded as both near and far end measurements
- Common mode balance from 1 MHz - 250 MHz, measured as TCL from both sides of the connecting hardware
- Insulation resistance
- Voltage proof

The following instruments were applied for the electrical measurements:

- HP Network Analyzer, type 8753ES with Internal S-Parameter Test Set
- BH Electronics Baluns, type 040-0093
- 3P Baluns, type 3P-250-Cat6-C
- 3P Balun, type 3P-600-Cat7
- Rohde & Schwarz Absorbing Clamp, type MDS-21
- HP Milliohmmeter, type 4338A
- HP LCR Meter, type 4263A
- HP High Resistance Meter, type 4339A
- Danbridge Insulation Tester, type JP12A

5. FACTORY INSPECTION

The quality assurance and production facilities of the Hsichih site of Telebox Industries Corp. have been approved by 3P during the inspection visit 20 June 2007. It is concluded by 3P that generally quality assurance, working procedures, capabilities, production facilities and extent of end product testing should be acceptable to secure a continous production of a high quality Unscreened Category 6 ISO/IEC, EN & TIA/EIA Connecting Hardware.

However, three minor observations have been found:

- Quality assurance depatment is organised under the vice president of production. This might cause a downgrading risk of quality if production optimisation is conflicting with quality issues. Also it is a tradition that quality and production are separate functions in the organisation.

- The marking of the printed wiring boards does not always include the latest design version. Traceability is done by the printed production date on the boards, which makes conclusion of design version possible, but potentially misleading and more difficult than necessary. Also it is a tradition to specify design version of the printed wiring boards on the boards in question.

- No documented sampling procedure for internal testing at Telebox Industries Corp. is present. Very extensive testing is carried out, but is subject to subjective evaluation of the testing operators.

These minor observations, which will be corrected during the production, do not affect the suitability of the production of connecting hardware.

The results of the factory inspection is described in the following 4 sections.

5.1 Company Organization

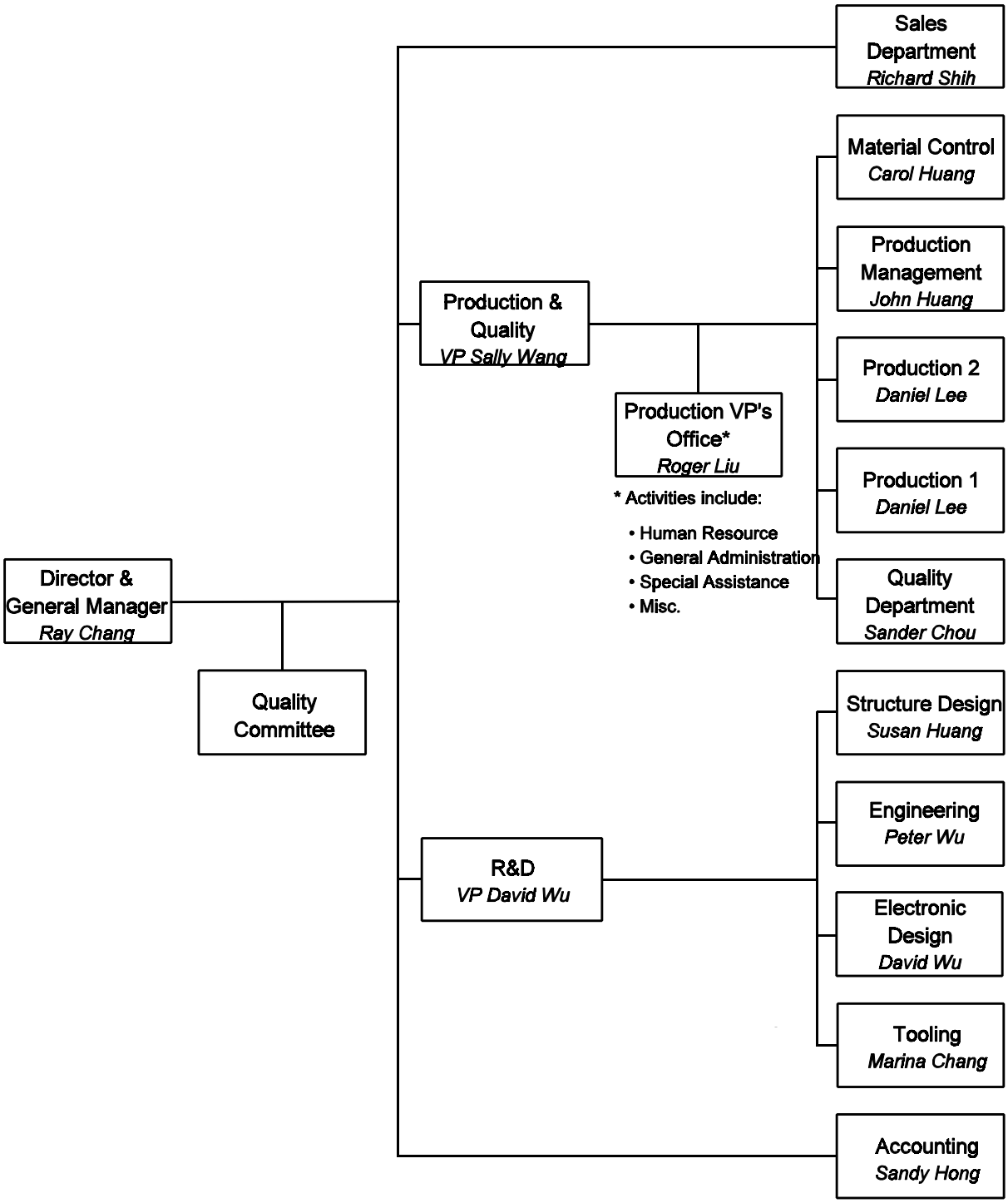
The overall company organisation plan of Telebox Industries Corp. is presented in page 8.

The following key management positions apply at Telebox Industries Corp.:

- Director and General Manager: Ray Chang
- Quality Manager: Sander Chou
- Production Manager: Sally Wang
- Research & Development Manager: David Wu
- Leader of Quality Department: Sander Chou
- Leader of Electronic Design Department: David Wu
- Leader of Engineering Department: Peter Tu

It is concluded that quality assurance and production is in the same level in organisation. **Both quality assurance and production are managed by the same vice president.**

Company Organization Plan for Telebox Industries Corp.



5.2 Quality Assurance

Quality manager of Telebox Industries Corp. is Sander Chou.

All major quality issues are discussed in the quality committee, which consists of the department managers. The quality committee meets on a monthly basis under leadership of the vice president for production and quality. The quality committee is the forum in which general discussions and final conclusion of quality issues are taken.

Telebox Industries Corp. has quality assurance approved according to ISO 9001:2000. Approval was granted by TÜV CERT Certification Body of TÜV Rheinland Group", Certificate No. 01 100 043836 dated 2006.02.07. Next update of approval is scheduled before 4th January 2009.

The quality manual was inspected by 3P during the visit without giving cause to remarks, except for the above discussed co-location of quality and production in the organisation plan.

Traceability of connecting hardware performance applies at Telebox Industries Corp. by the production date printed on the printed wiring board.The quality assurance system at Telebox Industries Corp. is recognized by the following companies and organisations:

- TÜV Rheinland
- 3P

A quality record of subsuppliers is kept and maintained by Telebox Industries Corp. All supplied printed wiring boards are identified by design version and with producer code and production time. **Latest design version of the printed wiring board is not always updated on the printed wiring board.**

Plated wires are supplied with certificates for plating thicknesses.

All measuring and test equipment were properly identified with a tag showing instrument number and calibration expiration date. Calibration data were properly filed. Calibration is carried out by external source (company IPE).

11 persons (15 % of total staff) and equipment operators are working with quality assurance and quality control at Telebox Industries Corp.

5.3 Production Facilities

All production of connecting hardware is carried out at the Hsichih factory of Telebox Industries Corp. External sub-suppliers are only used for plated contact wires and some non-critical connector parts.

Incoming control

Supplier records of quality and delivery time are used and maintained. Plated contact wires and IDC contacts are delivered with certificates for plating and materials, and are containing test data for gold and nickel thicknesses and base metal composition.

Telebox Industries Corp. has two different printed wiring board suppliers. Incoming inspection and approval of printed wiring boards includes dimensional measurements and testing of hole diameters. Furthermore two samples are mounted with components, soldered and measured for near end crosstalk performance. The printed wiring board delivery is approved after passing of visual, dimensional and electrical requirements.

Internally produced pressure moulded and stamped components are also included in the incoming inspection system.

Traceability of incoming components is possible by order number.

A first-in /first-out principle applies at Telebox Industries Corp.

Production

Pressure moulding of plastic parts and stamping of metallic parts are applied at Telebox Industries Corp. Dimensional measurements and visual control are carried by the operator on samples from the running production.

Telebox Industries Corp. has manual assembly line for both keystone jacks and patch panels. A sequence of mounting, soldering and visual inspection of each individual type of contact and connector part is applied. Operator training, and detailed, illustrated instruction guides are applied for each production process. dc resistance testing of each port of all finished connectors is applied.

Keystone jacks are only produced using hand mounting and soldering. Patch panels are produced using hand mounting of components, wave soldering of contacts at 275°C and hand soldering of screen contacts.

A lead free soldering process is applied.

Telebox Industries Corp. is planning to implement pressure fit mounting of components instead of soldering.

5.4 Final Testing

Telebox Industries Corp. has very extensive electrical high frequency testing of produced connecting hardware, which is documented as either pass/fail result or with recording of tested electrical parameters in the full specified frequency range. Failing components are offered to the customer with documented performance data.

Frequency of testing depends on component type and experience, but **no documented sampling procedure is present at Telebox Industries Corp.**

The following data for final testing at Telebox Industries Corp. has been concluded by 3P:

- Visual inspection: 100 %
- Continuity (dc) testing: 100 %
- Testing for Shorts: 100 %
- Near End Crosstalk measurements: 10 % - 100 % (most of the sampling is only recorded as fail/pass)
- Insertion Loss, Return Loss and Far End Crosstalk measurements: Type testing
- High Voltage testing and Insulation Resistance Measurements: Type testing

Test results are stored in the quality department for three years.

The following instruments were applied at Telebox Industries Corp. for performing the ongoing quality assurance testing:

High Frequency Testing:

- HP Network Analyzer, type 8753E
- Agilent ENA Network Analyzer, type E5062A
- BH Electronics Baluns, types 040-0092 and 040-0093
- North Hills Baluns, type 0322 BFX
- 3P Baluns, type 3P-250-Cat6-C

dc Resistance and Short Circuit Testing:

- Microtest dc test equipment, type CT-8768
- Microtest dc test equipment, type CT-8681
- Wayne Kerr LCR Meter, type 4273
- Chen Hwa Milliohmmeter, type 502AC
- Instek AC/DC Withstand Voltage / Insulation Tester, type GPI-735

6. SUMMARISED TEST RESULTS

The qualification testing has been carried out on samples of unscreened Category 6 keystone jack from Telebox Industries Corp., P/N TA8761Ux. Measurements have been made to 250 MHz.

Summarised test results are presented in the following clauses, while recordings of electrical performance versus frequency are found in the appendix. The tables in the present section generally inform about the headroom to a specified worst case limiting function which is specified under the table concerned. The various recordings of electrical performance versus frequency in the appendix contains, in red colour, this limiting function specified for the parameter in question.

The transmission measurements have been carried out using the test configurations specified in the ISO/IEC, CENELEC, ANSI/TIA/EIA and IEC standards. This means that the following three conditions are covered by the testing:

1. All noise parameters are measured from both the plug and connecting block sides (for far end crosstalk with signal injection and receiving on each pair of a specific pair combination). For reasons of simplification only the worst case recordings of these two measurements are presented in the appendix. The summarised results of all bi-directional measurements are presented in the tables of the relevant sub-clause.

2. All electrical high frequency parameters have been measured using "common and differential mode" (Y-term.) termination.

3. The measurements of near end crosstalk has been carried out using all of the specified low, central and high limit de-embedded NEXT plugs. The worst case recordings in question are presented in the appendix. All summarised results of all low, central and high limit plug measurements are presented in the tables of clause 6.4.

The low limit plug is in the present report understood to be the plug having the lowest numerical de-embedded NEXT value, i.e. the "worst" NEXT performance, while the high limit plug is understood to be the plug having the highest numerical de-embedded NEXT value, i.e. the "best" NEXT performance. Both phase angle and absolute value of the applied plugs are in compliance with the requirements of all ISO/IEC, CENELEC, ANSI/TIA/EIA and IEC standards. However, only the measured low, central and high absolute de-embedded NEXT values at 100 MHz are presented in table 6.1.

6.1 De-Embedded NEXT Values of Applied RJ 45 Plugs

Summarised results of testing of the applied low, central and high limit plugs are found in table 6.1, and include all six pair combinations measured for absolute value at 100 MHz, as this is the spot frequency for which de-embedded NEXT performance is traditionally reported. Both absolute value and phase angle have been measured from 1 MHz to 250 MHz and comply with the specified limits in the full frequency range for all six pair combinations for all applied plugs.

However, for simplification these test data are neither presented in table 6.1 nor as recordings in the appendix.

Table 6.1 Summarised Results of De-Embedded NEXT Measurements of Absolute Value for Applied RJ 45 Plugs at 100 MHz

COMBINATION OF PAIRS	DE-EMBEDDED NEXT AT 100 MHz (dB)			
	Absolute Value for Low Limit Plugs	*Absolute Value for Central Limit Plug*	*Absolute Value for High Limit Plugs*	*Specified Covered Range*
1/2 - 3/6	46,5	-	49,5	46,5 - 49,5
1/2 - 4/5	57,0	-	70,0	57,0 - 70,0
1/2 - 7/8	60,0	-	-	Max. 60,0
3/6 - 4/5	36,4	-	37,6	36,4 - 37,6
3/6 - 4/5	-	37,0	-	36,8 - 37,2
3/6 - 7/8	46,5	-	49,5	46,5 - 49,5
4/5 - 7/8	57,0	-	70,0	57,0 - 70,0

It is concluded from table 6.1 and testing performed at 3P that the performance of the applied test plugs complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz.

6.2 Return Loss

Summarised results of the testing are found in table 6.2, and include all four tested pairs measured from both sides of the connecting hardware. Worst case recordings of return loss versus frequency from both sides of the connecting hardware are found in page 23 of the appendix.

Table 6.2 Summarised Results of Return Loss Measurements from 1 MHz to 250 MHz

PAIR	RETURN LOSS MARGIN TO LIMIT (dB)[1,2]
1/2	8,2 (7,4)
3/6	4,5 (3,5)
4/5	7,1 (3,6)
7/8	9,8 (8,0)

[1]: Return Loss requirements are defined by the function:

64-20log(f) dB,

where f is frequency in MHz. Calculated requirements below 30 dB are equaled to this value.

[2]: The first value is measurement from the RJ 45 plug side, while the corresponding measurement from the connecting block side is presented in brackets.

It is concluded from table 6.2 and return loss recordings in page 23 that return loss complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz for both sides of the connecting hardware.

6.3 Attenuation

Summarised results of the testing are found in table 6.3, and include all four tested pairs measured from one side of the connecting hardware. Recordings of attenuation versus frequency are found in page 24 of the appendix.

Table 6.3 Summarised Results of Attenuation Measurements from 1 MHz to 250 MHz

PAIR	MAX. ATTENUATION (dB)[1]					ATTENUATION MARGIN TO LIMIT (%)[1]
	1 MHz	10 MHz	100 MHz	200 MHz	250 MHz	1 - 250 MHz
1/2	0,00	0,00	0,03	0,07	0,07	70
3/6	0,00	0,00	0,05	0,10	0,11	59
4/5	0,00	0,00	0,05	0,12	0,12	55
7/8	0,00	0,00	0,03	0,07	0,06	69
Specified	0,10	0,10	0,20	0,28	0,32	0

[1]: Attenuation requirements are defined by the function:

$0{,}02\sqrt{f}$ dB,

where f is frequency in MHz. Calculated requirements below 0,1 dB are equaled to this value.

It is concluded from table 6.3 and attenuation recordings in page 24 that attenuation complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz.

6.4 Near End Crosstalk

Summarised results of the testing are found in table 6.4, and include all six combinations of the four tested pairs measured from both sides of the connecting hardware. Worst case recordings of pair - pair near end crosstalk versus frequency for both low, central and high limit plug measurements, each covering both sides of the connecting hardware, are found in pages 25 - 31 of the appendix.

Table 6.4 Summarised Results of Pair - Pair Near End Crosstalk Measurements from 1 MHz to 250 MHz

COMBINATION OF PAIRS	PAIR - PAIR NEXT MARGIN TO LIMIT (dB)[1,2]		
	Low Limit Plug	*Central limit plug*	*High Limit Plug*
1/2 - 3/6	5,0 (4,1)	- (-)	3,9 (4,4)
1/2 - 4/5	6,4 (10,3)	- (-)	6,9 (5,6)
1/2 - 7/8	7,4 (5,1)	- (-)	- (-)
3/6 - 4/5	5,0 (4,8)	5,4 (14,5)	3,5 (8,7)
3/6 - 7/8	7,2 (7,6)	- (-)	3,8 (6,6)
4/5 - 7/8	1,9 (3,2)	- (-)	6,6 (9,3)

[1]: Pair - Pair Near End Crosstalk requirements are defined by the functions:

For all pair combinations except 3/6 - 4/5, low and high limit plugs: 94,0-20log(f) dB
For 3/6 - 4/5, low and high limit plugs: 92,5-20log(f) dB,

where f is frequency in MHz. Calculated requirements more strict than 80 dB are equaled to this value.

[2]: The first value is measurement from the RJ 45 plug side, while the corresponding measurement from the connecting block side is presented in brackets. For pair combinations 1/2-3/6, 1/2-4/5, 1/2-7/8, 3/6-7/8 and 4/5-7/8 the central limit plug measurements are not specified. For pair combination 1/2-7/8 the high limit plug measurement is not specified.

It is concluded from table 6.4 and pair - pair near end crosstalk recordings in pages 25 - 31 that pair - pair near end crosstalk complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz for all six combinations of plug performance limit and sides of connecting hardware.

The documentation of power sum near end crosstalk has not been included in the present testing as only informative limits are proposed in ISO/IEC 11801, and ANSI/TIA/EIA-568-B.2-1 does not specify this parameter.

6.5 Far End Crosstalk

Summarised results of the testing are found in table 6.5 for pair - pair far end crosstalk and include all 2×6 combinations of the four tested pairs. Worst case recordings of pair - pair far end crosstalk versus frequency covering all 2×6 combinations of the four tested pairs are found in page 32 of the appendix.

Table 6.5 Summarised Results of Pair - Pair Far End Crosstalk Measurements from 1 MHz to 250 MHz

COMBINATION OF PAIRS	PAIR - PAIR FEXT MARGIN TO LIMIT (dB)[1,2]
1/2 - 3/6	25,7 (27,2)
1/2 - 4/5	6,6 (7,5)
1/2 - 7/8	13,6 (13,8)
3/6 - 4/5	2,7 (2,9)
3/6 - 7/8	22,9 (22,4)
4/5 - 7/8	15,4 (15,8)

[1]: Pair - Pair Far End Crosstalk requirements are defined by the function:

83,1-20log(f) dB,

where f is frequency in MHz. Calculated requirements more strict than 75 dB are equaled to this value.

[2]: The first value is measurement with signal injection on the first of the listed pairs, while the corresponding measurement with signal injection on the second of the listed pairs is presented in brackets.

It is concluded from table 6.5 and pair - pair far end crosstalk recordings in page 32 that pair - pair far end crosstalk complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz for all 2×6 pair combinations.

The documentation of power sum far end crosstalk has not been included in the present testing as only informative limits are proposed in ISO/IEC 11801, and ANSI/TIA/EIA-568-B.2-1 does not specify this parameter.

6.6 Input to Output Resistance

Results of the testing are found in table 6.6, and include all 8 tested conductors measured from one side of the connecting hardware.

Table 6.6 Results of Input to Output Resistance Measurements

CONDUCTOR PATH	INPUT TO OUTPUT RESISTANCE (mΩ)
1	40
2	38
3	60
6	49
4	50
5	60
7	45
8	59
Specified	Max. 200

It is concluded from table 6.6 that input to output resistance complies with the specified Category 6 requirements.

6.7 Input to Output Resistance Unbalance

The worst case value of input to output resistance unbalance between any conductors is 22 mΩ, which is in compliance with the specified max. 50 mΩ.

It is concluded that input to output resistance unbalance complies with the specified Category 6 requirements.

6.8 Current Carrying Capacity

Current carrying capacity has been measured by subjecting each conductor to a simultaneous exposure of 0,75 A at 60°C for 30 minutes.

The increase in temperature was 4°C, which is in compliance with the specified max. 30°C. Continuity of conductor paths was maintained. No degradation of connecting hardware was observed after the testing.

It is concluded that current carrying capacity complies with the specifiedCategory 6 requirements.

6.9 Propagation Delay

Summarised results of the testing are found in table 6.9, and include all four tested pairs measured from one side of the connecting hardware.

Table 6.9 Summarised Results of Propagation Delay Measurements from 1 MHz to 250 MHz

PAIR	PROPAGATION DELAY (nsec)
1/2	Max. 0,6
3/6	Max. 0,7
4/5	Max. 0,8
7/8	Max. 0,6
Specified	Max. 2,5

It is concluded from table 6.9 that propagation delay complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz.

6.10 Delay Skew

Summarised results of the testing are found in table 6.10, and include all six combinations of the four tested pairs measured from one side of the connecting hardware.

Table 6.10 Summarised Results of Delay Skew Measurements from 1 MHz to 250 MHz

COMBINATION OF PAIRS	DELAY SKEW (nsec)
1/2 - 3/6	Max. 0,06
1/2 - 4/5	Max. 0,13
1/2 - 7/8	Max. 0,02
3/6 - 4/5	Max. 0,07
3/6 - 7/8	Max. 0,08
4/5 - 7/8	Max. 0,15
Specified	Max. 1,25

It is concluded from table 6.10 that delay skew complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz.

6.11 Electromagnetic Performance

Summarised results of coupling attenuation measurements are found in table 6.11, and include all four tested pairs recorded as both near and far end measurements. The connecting hardware is connected with unscreened horizontal cable and RJ 45 plug terminated unscreened horizontal cable. Worst case recording of electromagnetic performance is found in page 33 of the appendix.

Table 6.11 Summarised Results of Coupling Attenuation Measurements

PAIR	COUPLING ATTENUATION MARGIN TO LIMIT (dB)[1,2]
1/2	16 (23)
3/6	10 (12)
4/5	21 (12)
7/8	20 (18)

[1]: Coupling attenuation requirements are defined by the functions:

35 dB between 30 MHz and 100 MHz

$35-20\log(\frac{f}{100})$ dB between 100 MHz and 1 GHz,

where f is frequency in MHz.

[2]: The first value is measurement from near end, while the corresponding measurement from far end is presented in brackets.

It is concluded from table 6.11 and coupling attenuation recordings in page 33 that coupling attenuation complies with the specified Category 6 requirements when recorded as both near and far end measurement.

6.12 Balance Measured as Transverse Conversion Loss (TCL)

Summarised results of the testing are found in table 6.12 for balance measured as TCL, and include all four tested pairs measured from both sides of the connecting hardware. Worst case recordings of TCL versus frequency from both sides of the connecting hardware are found in page 34 of the appendix.

Table 6.12 Summarised Results of Balance (TCL) Measurements from 1 MHz to 250 MHz

PAIR	BALANCE (TCL) MARGIN TO LIMIT (dB)[1,2]
1/2	10,4 (15,1)
3/6	6,4 (5,9)
4/5	15,6 (13,4)
7/8	16,5 (16,1)

[1]: Requirements to Balance, measured as TCL, are defined by the function:

68 - 20log(f) dB,

where f is frequency in MHz. Calculated requirements more strict than 60 dB are equaled to this value.

[2]: The first value is measurement from the RJ 45 plug side, while the corresponding measurement from the connecting block side is presented in brackets.

It is concluded from table 6.12 and the TCL recordings in page 34 that transverse conversion loss (near end balance) complies with the specified Category 6 requirements in the complete frequency range from 1 MHz to 250 MHz for both sides of connecting hardware.

6.13 Insulation Resistance

The worst case insulation resistance between any combination of conductors is 12.000.000 MΩ, which is in compliance with the specified min. 100 MΩ. The applied test voltage was 500 Vdc.

It is concluded that insulation resistance complies with the specified Category 6 requirements.

6.14 Voltage Proof

No flash-over, breakdown or other deterioration was found by application of 1000 Vdc between any combination of conductors.

It is concluded that the voltage proof performance complies with the specified Category 6 requirements.

7. CONCLUSION

Samples of unscreened Category 6 keystone jack from Telebox Industries Corp. have been subjected to qualification testing according to 3P requirements for Unscreened Category 6 ISO/IEC, EN & TIA/EIA Connecting Hardware.

The transmission performance of the unscreened Category 6 keystone jack from Telebox Industries Corp., P/N TA8761Ux having PC board marking 001-87604 C6 A01 1F00, does in every respect comply with the requirements of the following international standards:

- ISO/IEC 2nd Edition 11801, Cat. 6
- CENELEC EN 50173-1, Cat. 6
- ANSI/TIA/EIA-568-B.2-1, Cat. 6
- IEC 60603-7-4, Cat. 6

The positive conclusion of the testing covers all unscreened products from the qualified production line of Telebox Industries Corp. having identical PCB circuitry. Presently this only includes Telebox Industries Corp. keystone jack,

- P/N TA8761Ux

The company

Telebox Industries Corp.
4F, No. 306, Tatung Road, Sec. 1
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is qualified at their Hsichih site to produce the connecting hardware in question with a 3P rating as Unscreened Category 6 ISO/IEC, EN & TIA/EIA Connecting Hardware.

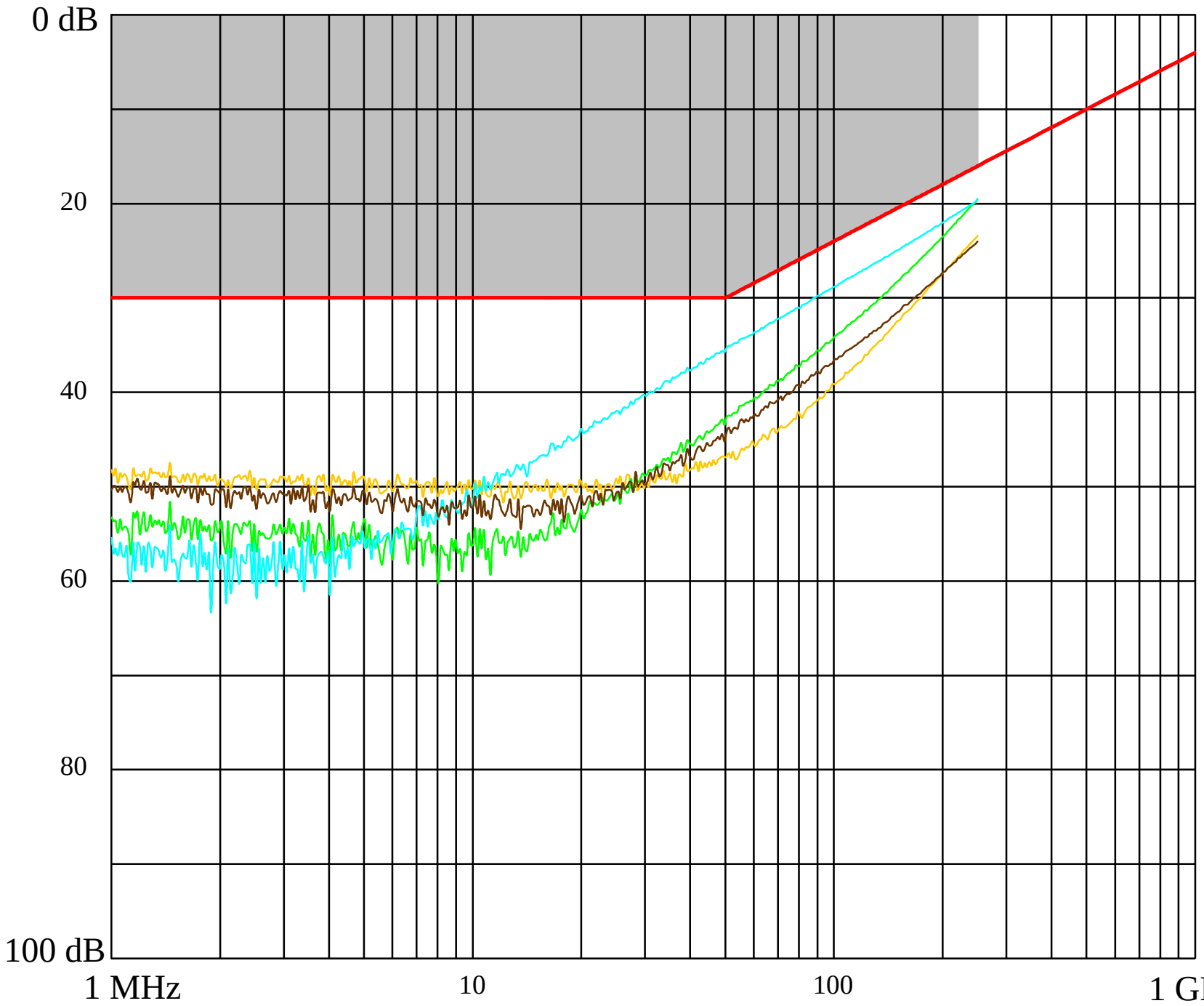
The qualification will be valid until failure to pass one of the maintenance of qualification test programmes, which will be performed at 12 months intervals.

The present testing does not include the reliability test programmes specified in ISO/IEC, CENELEC, ANSI/TIA/EIA and IEC standards. Only the transmission performance is covered by the 3P testing. It is assumed that the reliability of the applied RJ 45 jacks is adequate to secure safe interconnection to the patch cords throughout a lifetime of normal application of the connecting hardware.

8. APPENDIX: Data Sheets of Transmission Performance versus Frequency

All characteristic and most critical recordings of transmission performance are presented in the following way:

Page 23	Worst case recordings of return loss for all four pairs between 1 MHz and 250 MHz.
Page 24	Recordings of attenuation for all four pairs between 1 MHz and 250 MHz.
Pages 25 - 31	Worst case recordings of pair - pair near end crosstalk for all six combinations of pairs between 1 MHz and 250 MHz. Each page includes recordings of one specific pair combination measured using low and, if applicable, high limit plugs. For pair combination 3/6 - 4/5 the worst case central limit plug recording is presented in a separate page due to the different mated pair performance limits specified for low/high and central limit plugs.
Page 32	Worst case recordings of pair - pair far end crosstalk for all 2×6 combinations of pairs between 1 MHz and 250 MHz.
Page 33	Worst case recording of electromagnetic performance between 30 MHz and 1 GHz.
Page 34	Worst case recordings of balance measured as TCL for all four pairs between 1 MHz and 250 MHz.



Worst case recordings of Return Loss for all four pairs from 1 MHz to 250 MHz.

Date: 2007.09.07

Pair 1/2:
Worst case is measurement from connecting block side.

Pair 3/6:
Worst case is measurement from connecting block side.

Pair 4/5:
Worst case is measurement from connecting block side.

Pair 7/8:
Worst case is measurement from connecting block side.

Limiting function:
Category 6 limit:

The worst case of Return Loss for all four pairs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

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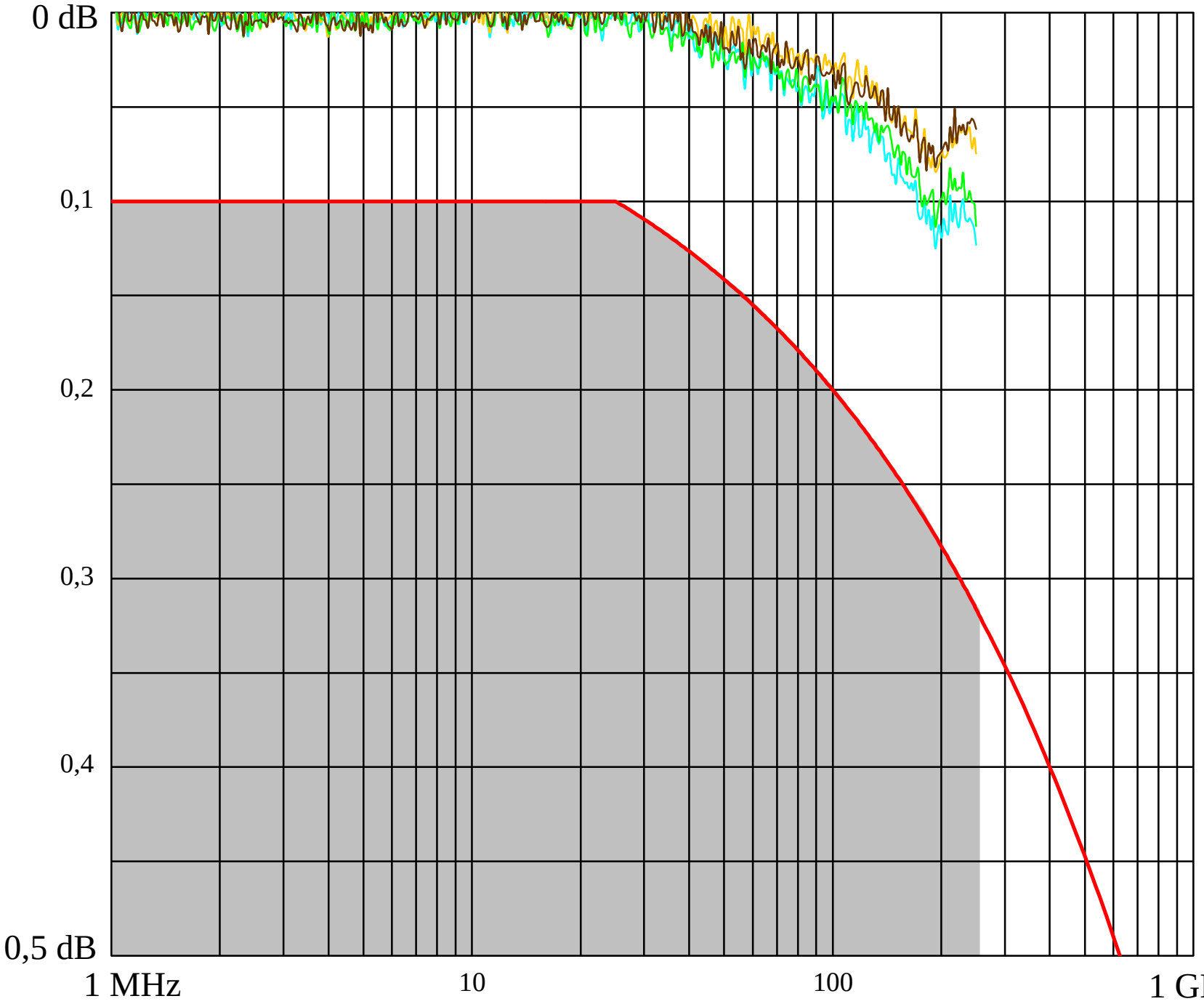


Recordings of Attenuation for all four pairs from 1 MHz to 250 MHz.

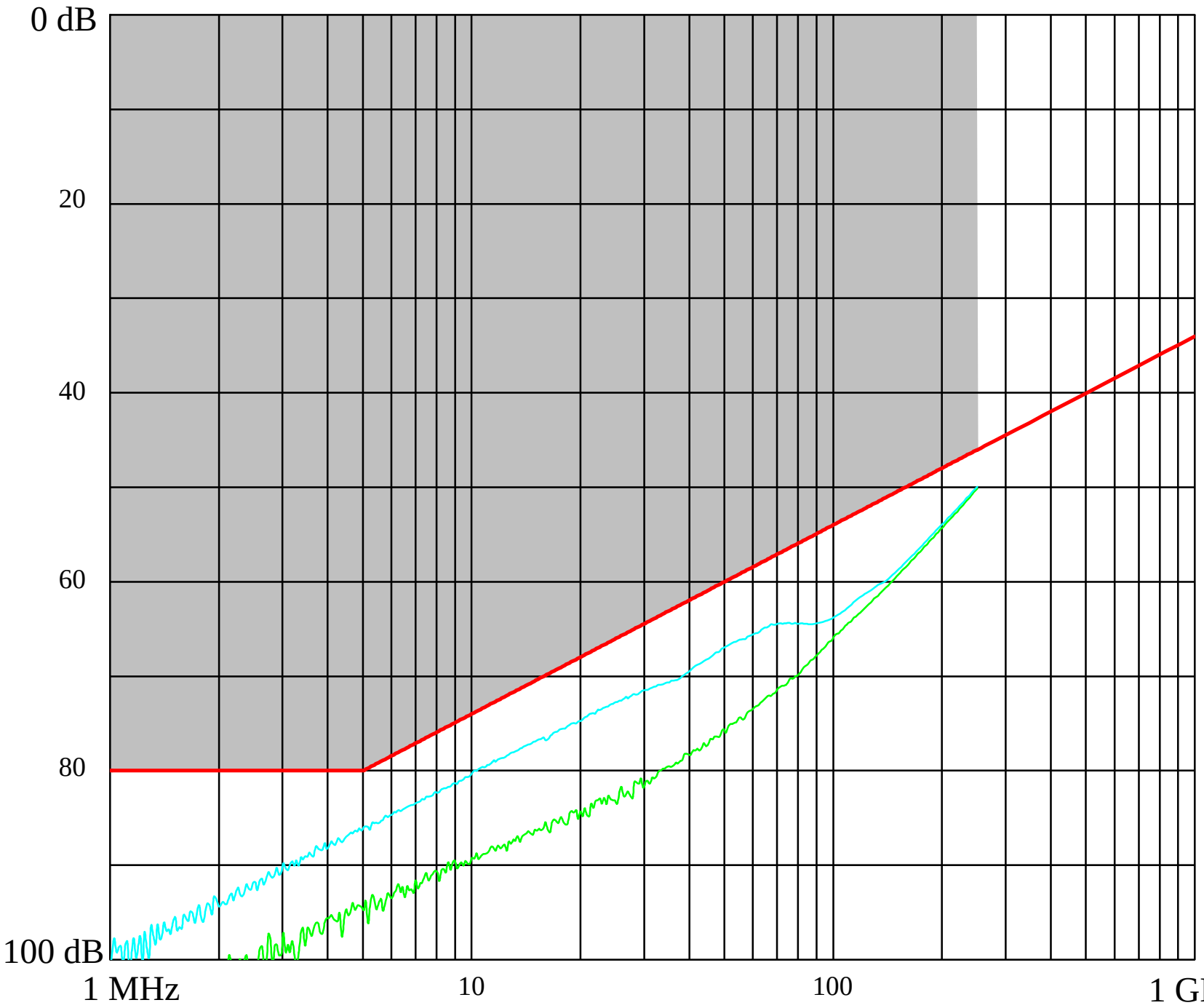
Date: 2007.09.19

Pair 1/2:
Pair 3/6:
Pair 4/5:
Pair 7/8:

Limiting function:
Category 6 limit:

The Attenuation for all four pairs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Near End Crosstalk for pair combination 1/2 - 3/6 measured with low and high limit plugs from 1 MHz to 250 MHz.

Date: 2007.09.07

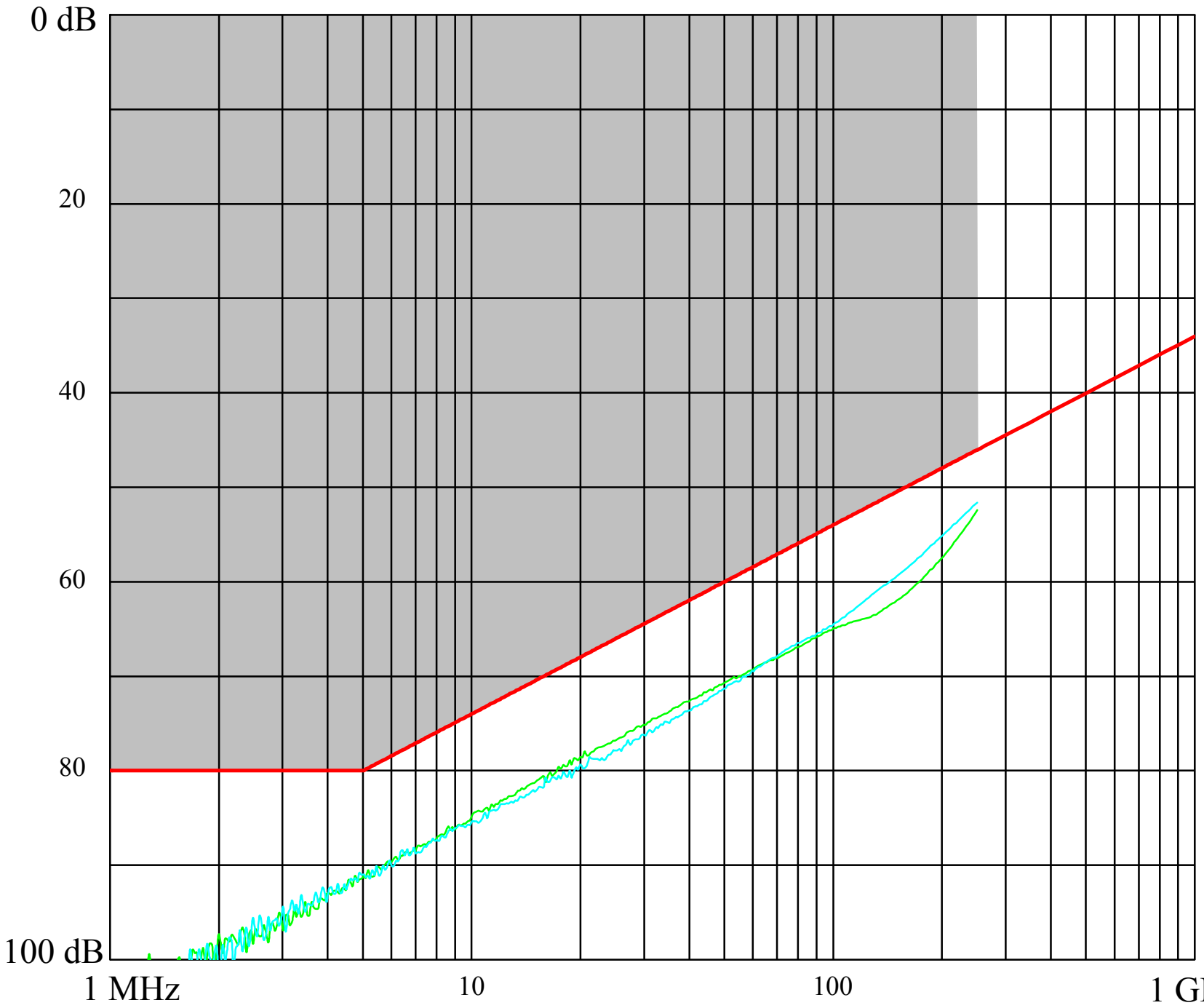
Low limit plug [46,5 dB]:
Worst case is measurement from connecting block side.

High limit plug [49,5 dB]:
Worst case is measurement from plug side.

Limiting function:
Category 6 limit:

The worst case of Near End Crosstalk for pair combination 1/2 – 3/6 measured with both low and high limit plugs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Near End Crosstalk for pair combination 1/2 - 4/5 measured with low and high limit plugs from 1 MHz to 250 MHz.

Date: 2007.09.07

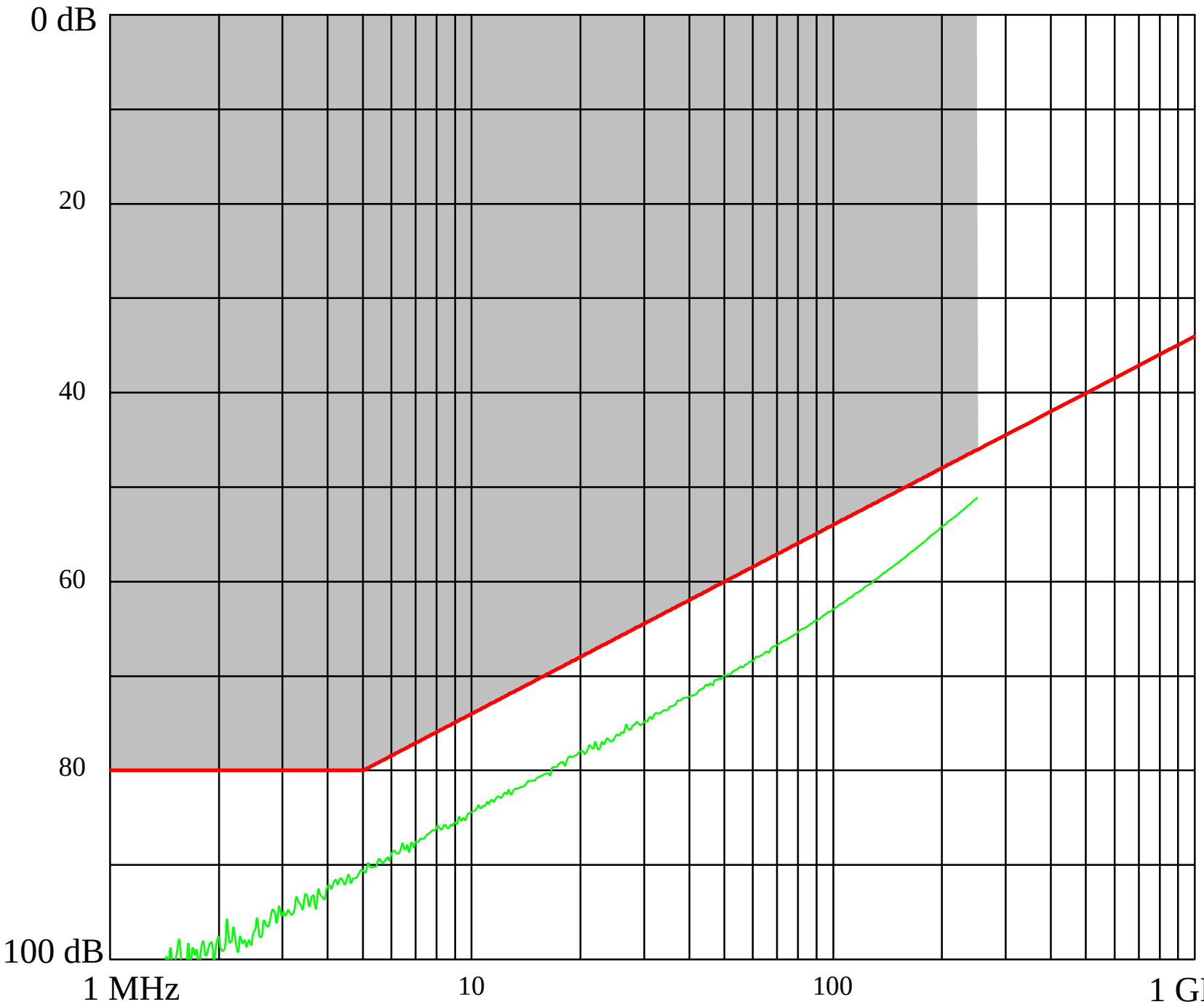
Low limit plug [57,0 dB]:
Worst case is measurement from plug side.

High limit plug [70,0 dB]:
Worst case is measurement from connecting block side.

Limiting function:
Category 6 limit:

The worst case of Near End Cross-talk for pair combination 1/2 – 4/5 measured with both low and high limit plugs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recording of Near End Crosstalk for pair combination 1/2 - 7/8 measured with low limit plug from 1 MHz to 250 MHz.

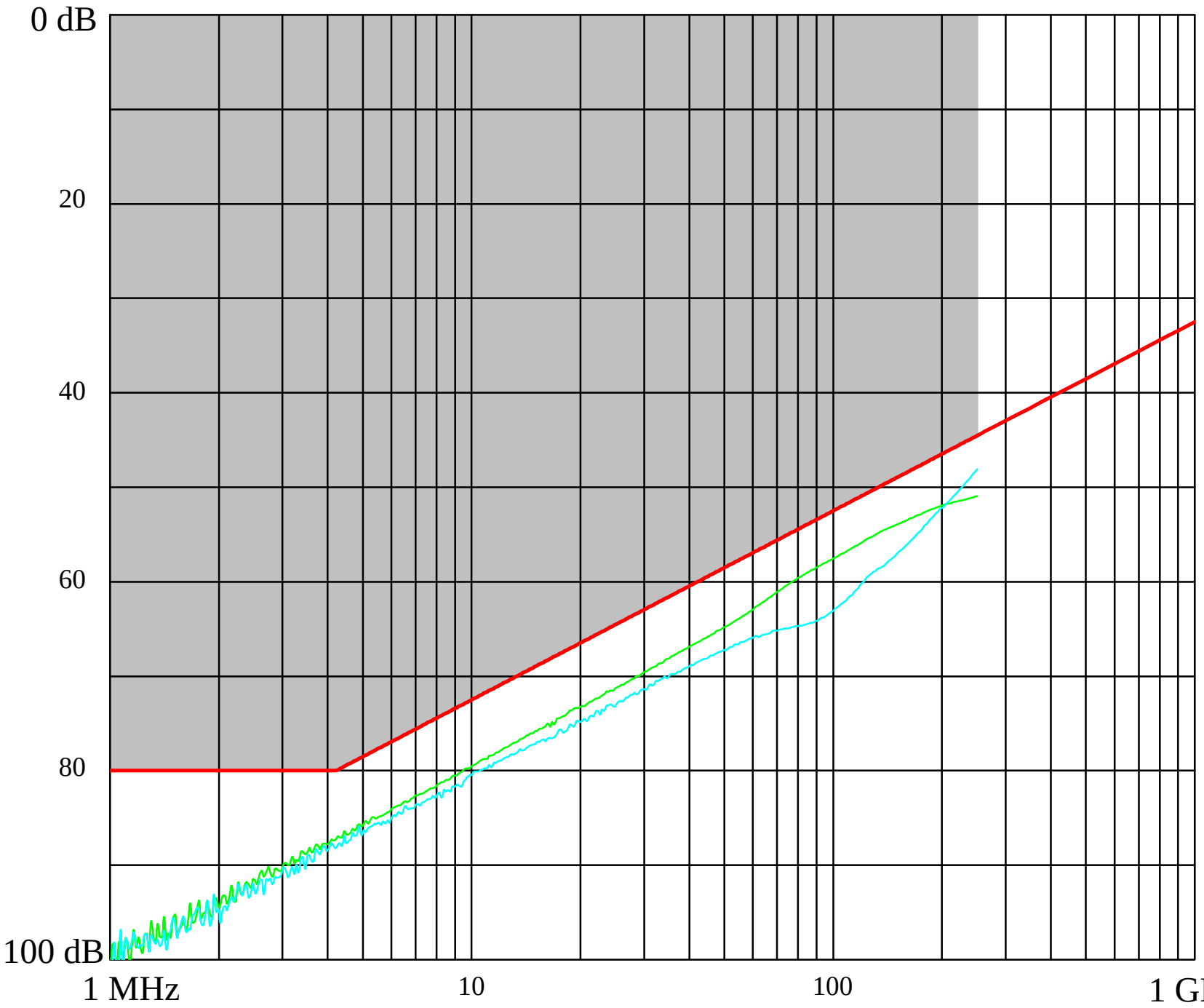
Date: 2007.09.07

Low limit plug [60,0 dB]:
Worst case is measurement from connecting block side.

Limiting function:
Category 6 limit:

The worst case of Near End Crosstalk for pair combination 1/2 – 7/8 measured with low limit plug complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Near End Crosstalk for pair combination 3/6 - 4/5 measured with low and high limit plugs from 1 MHz to 250 MHz.

Date: 2007.09.07

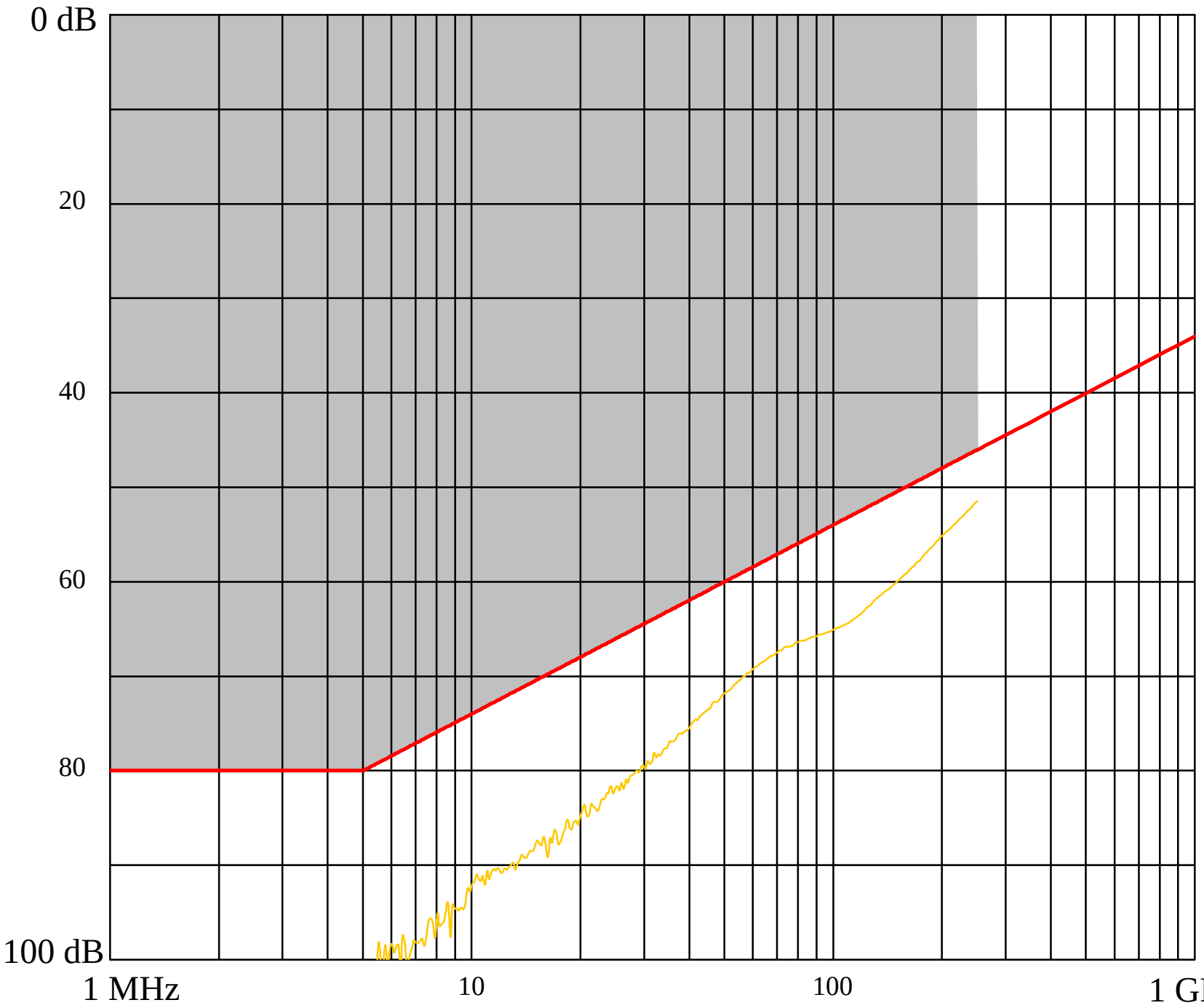
Low limit plug [36,4 dB]:
Worst case is measurement from connecting block side.

High limit plug [37,6 dB]:
Worst case is measurement from plug side.

Limiting function:
Category 6 limit:

The worst case of Near End Cross-talk for pair combination 3/6 – 4/5 measured with both low and high limit plugs complies with the specifi-ed Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recording of Near End Crosstalk for pair combination 3/6 - 4/5 measured with central limit plug from 1 MHz to 250 MHz.

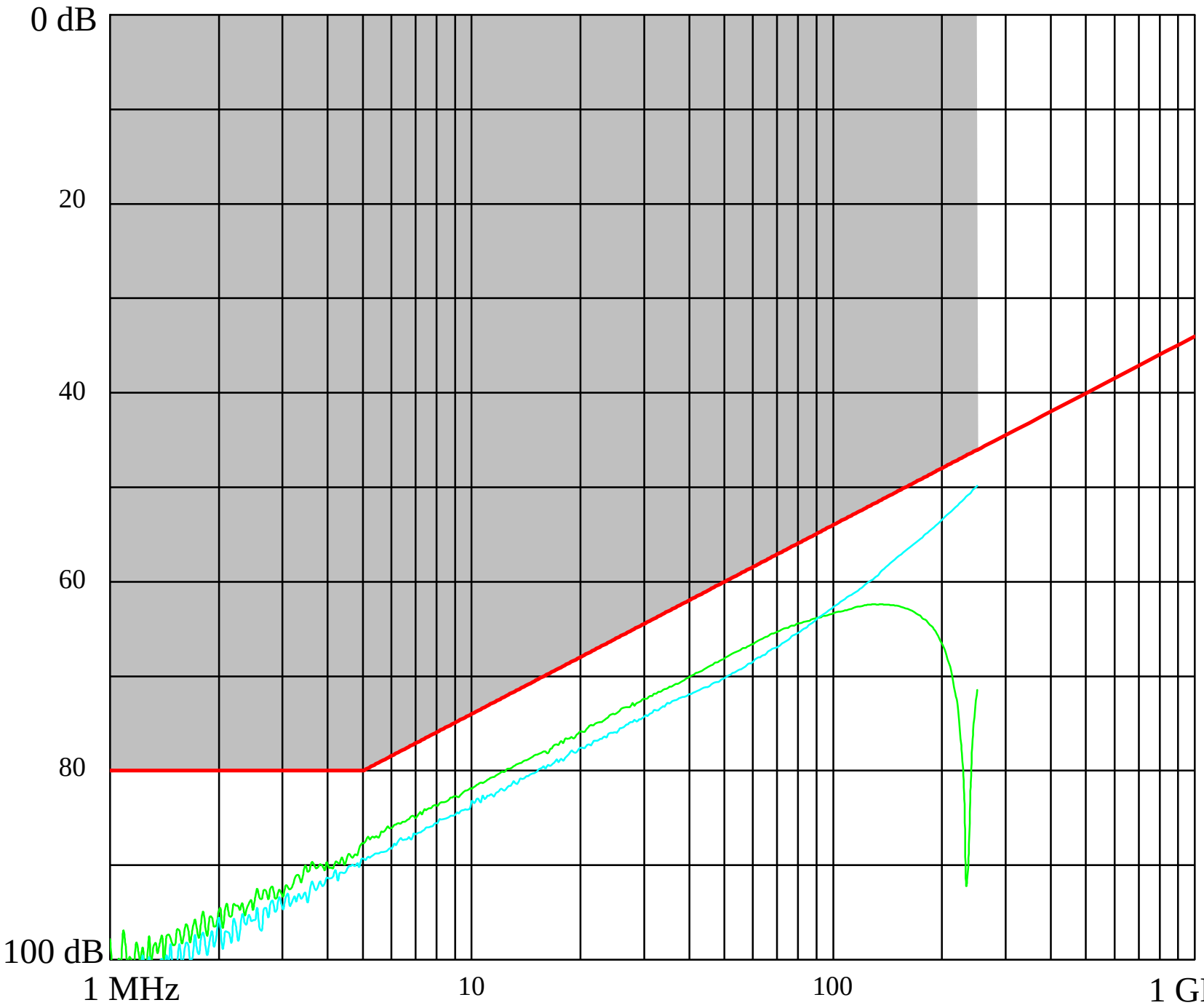
Date: 2007.09.07

Central limit plug [37,0 dB]:
Worst case is measurement from plug side.

Limiting function:
Category 6 limit:

The worst case of Near End Crosstalk for pair combination 3/6 – 4/5 measured with central limit plug complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Near End Crosstalk for pair combination 3/6 - 7/8 measured with low and high limit plugs from 1 MHz to 250 MHz.

Date: 2007.09.07

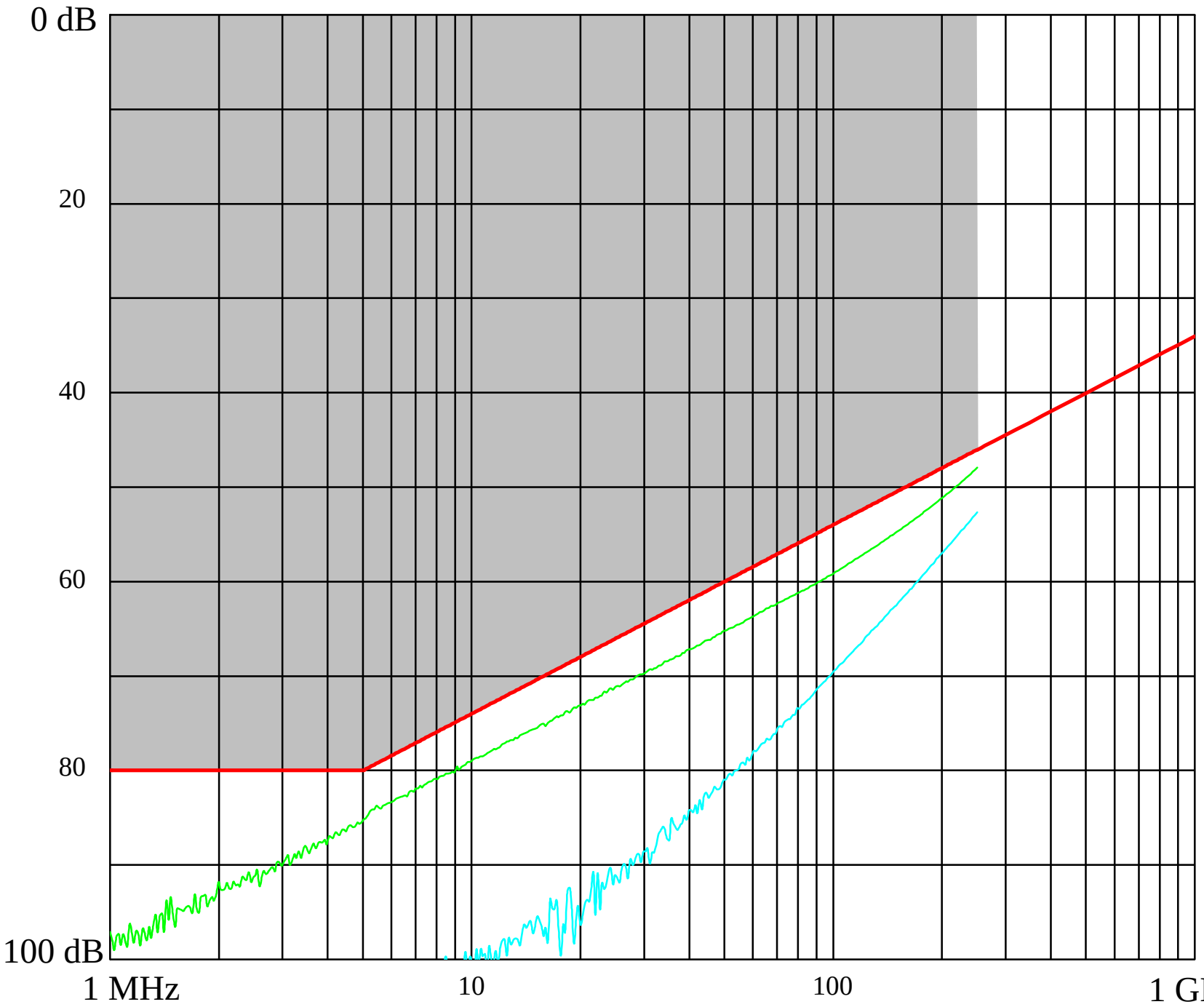
Low limit plug [46,5 dB]:
Worst case is measurement from plug side.

High limit plug [49,5 dB]:
Worst case is measurement from plug side.

Limiting function:
Category 6 limit:

The worst case of Near End Crosstalk for pair combination 3/6 – 7/8 measured with both low and high limit plugs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Near End Crosstalk for pair combination 4/5 - 7/8 measured with low and high limit plugs from 1 MHz to 250 MHz.

Date: 2007.09.07

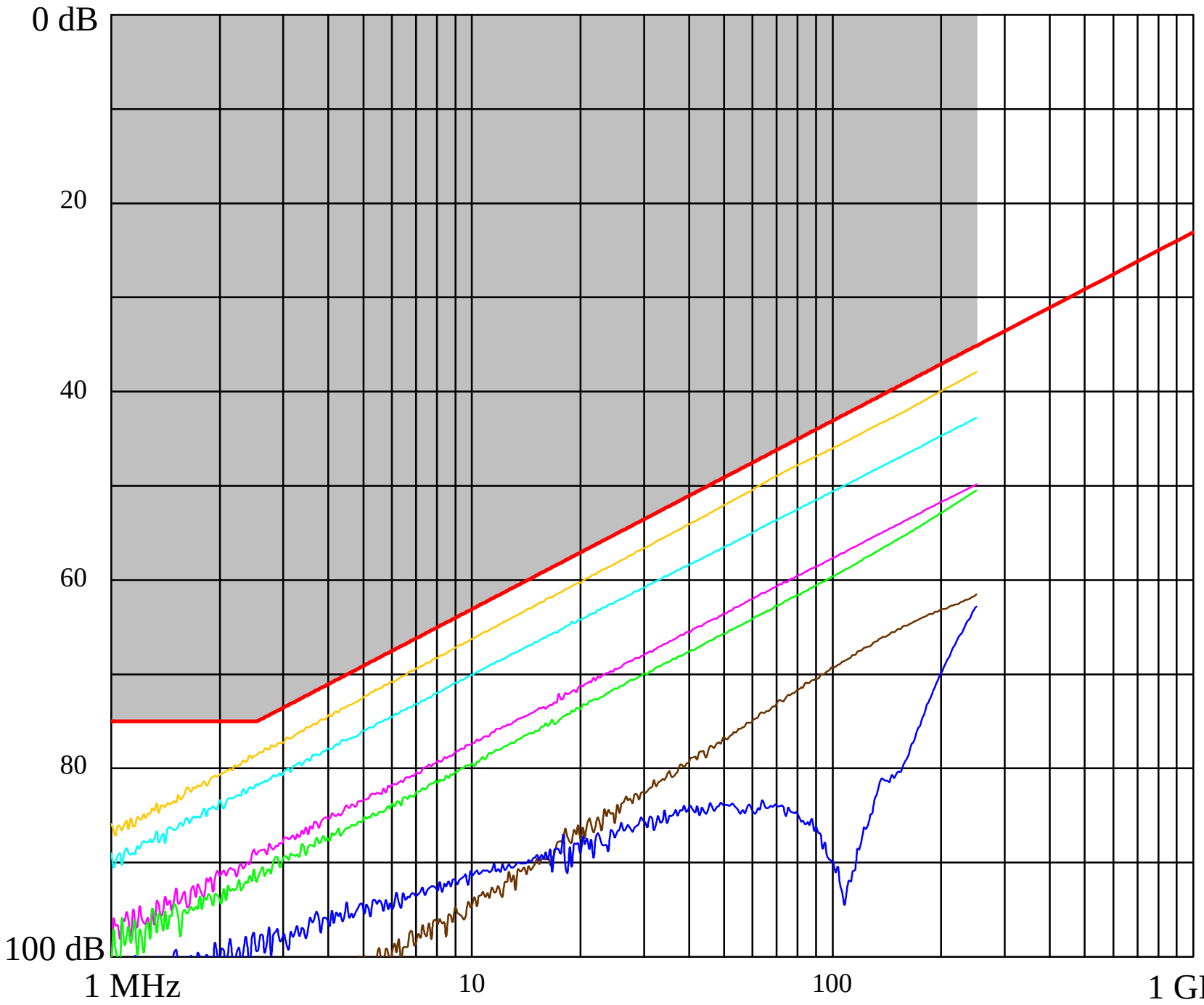
Low limit plug [57,0 dB]:
Worst case is measurement from plug side.

High limit plug [70,0 dB]:
Worst case is measurement from plug side.

Limiting function:
Category 6 limit:

The worst case of Near End Crosstalk for pair combination 4/5 – 7/8 measured with both low and high limit plugs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recordings of Far End Crosstalk for all six pair combinations from 1 MHz to 250 MHz.

Date: 2007.09.18

Pair combination 1/2 – 3/6:
Worst case is signal injection on pair 1/2.

Pair combination 1/2 – 4/5:
Worst case is signal injection on pair 1/2.

Pair combination 1/2 – 7/8:
Worst case is signal injection on pair 1/2.

Pair combination 3/6 – 4/5:
Worst case is signal injection on pair 3/6.

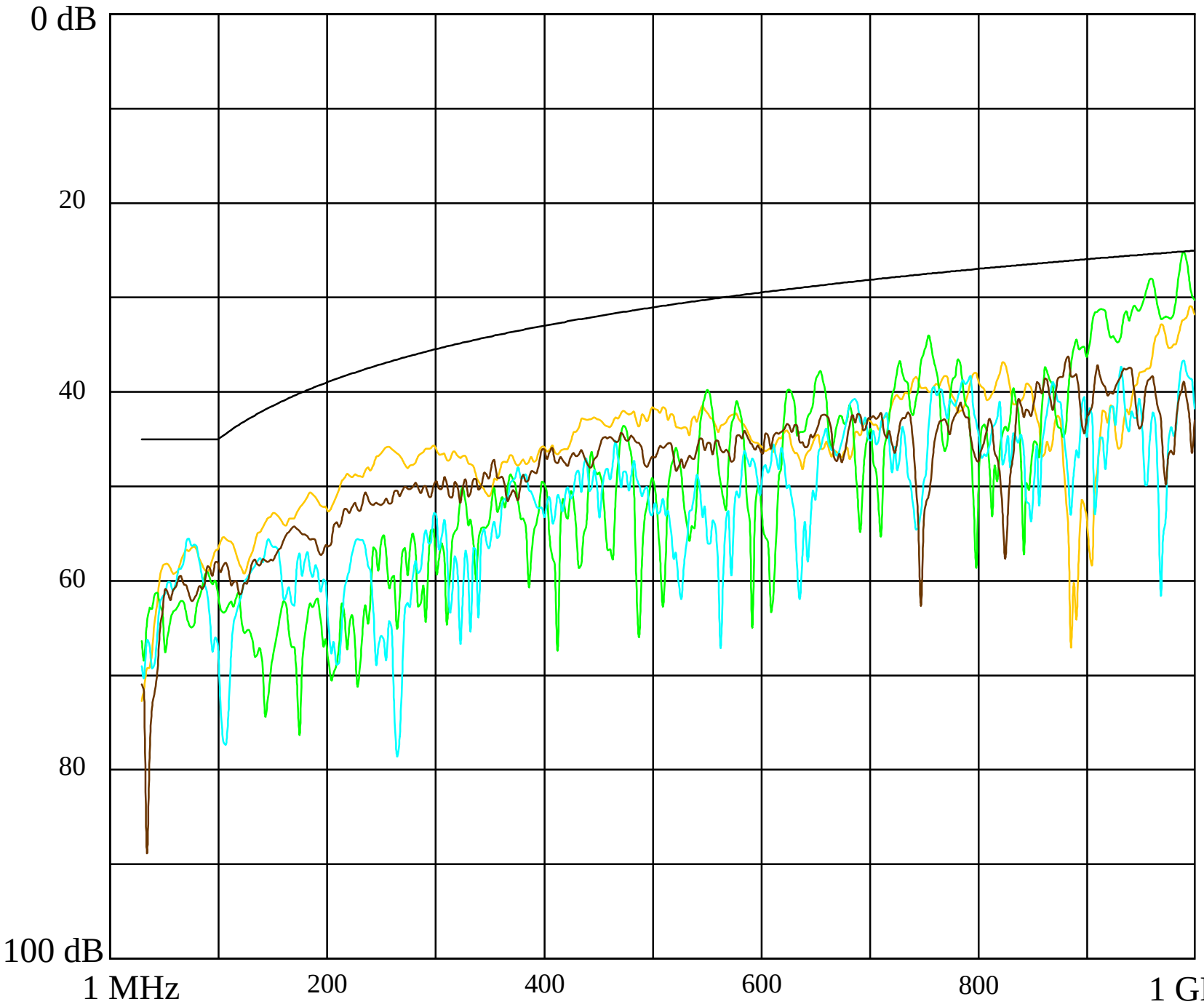
Pair combination 3/6 – 7/8:
Worst case is signal injection on pair 7/8.

Pair combination 4/5 – 7/8:
Worst case is signal injection on pair 4/5.

Limiting function:
Category 6 limit:

The worst case of Far End Crosstalk for all six pair combinations complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660



Worst case recording of EMC Performance from 30 MHz to 1 GHz. The measurement is based on recordings of Coupling Attenuation for all four pairs of the connecting hardware.

Measured on connecting hardware assembled unscreened cables and tested in aerial span. The cables alone were having EMC performance of 63 dB.

Date: 2007.10.08

EMC Performance: 45 dB

The EMC Performance is derived from the interception of a limiting function with the worst case Coupling Attenuation value at any frequency for any pair. The constant value from 30 MHz to 100 MHz is defined as the EMC performance.

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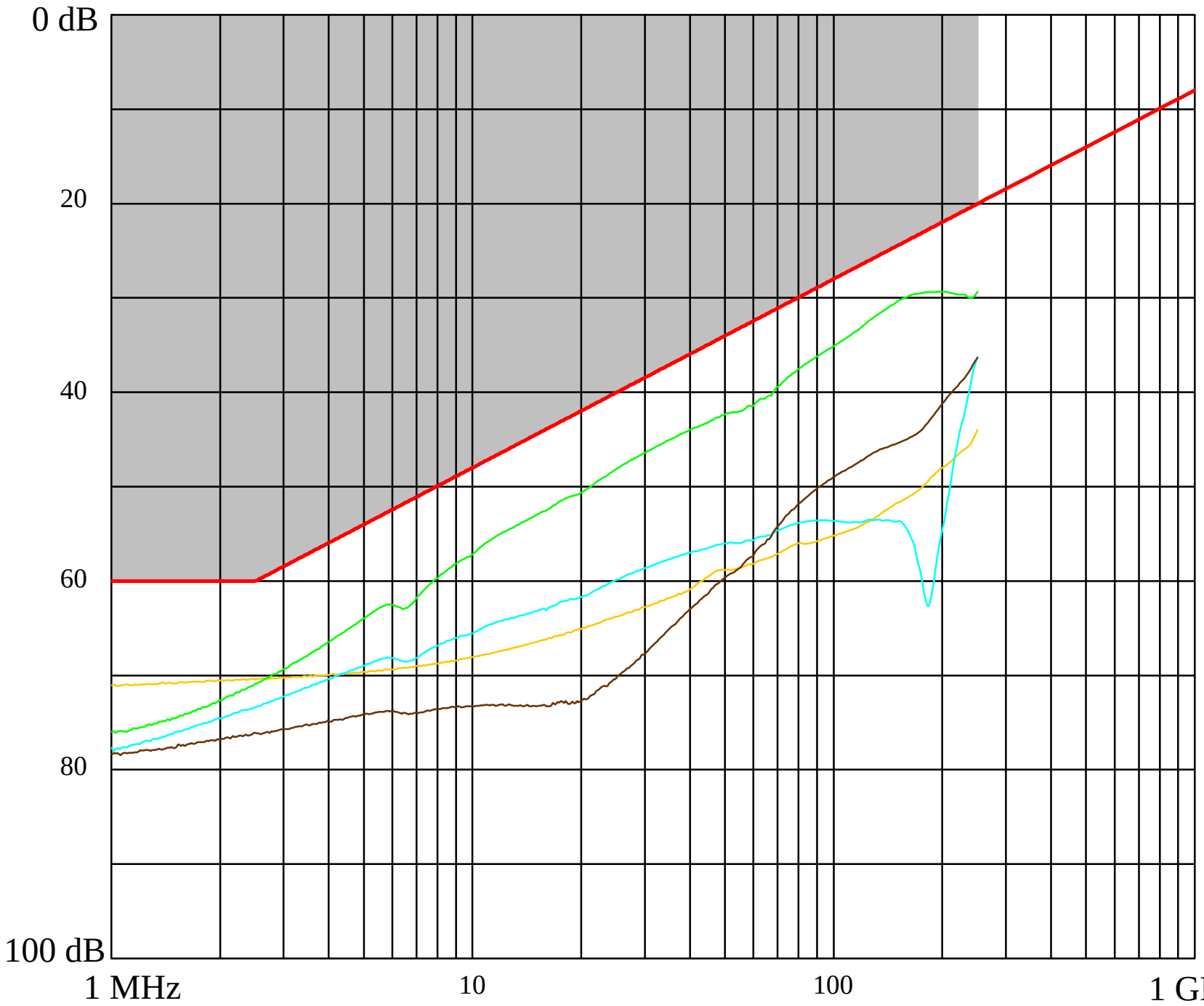

Worst case recordings of Transverse Conversion Loss (TCL) for all four pairs from 1 MHz to 250 MHz.

Date: 2007.10.09

Pair 1/2:
Worst case is measurement from plug side.

Pair 3/6:
Worst case is measurement from connecting block side.

Pair 4/5:
Worst case is measurement from connecting block side.

Pair 7/8:
Worst case is measurement from connecting block side.

Limiting function:
Category 6 limit:

The worst case of Transverse Conversion Loss for all four pairs complies with the specified Category 6 limit in the complete frequency range from 1 MHz to 250 MHz.

3P Project No. 1071660