

TEST REPORT No. 2001-166-271-TSE

August 6, 2001

Transmission Performance Testing

according to: ISO/IEC JTC 1/SC 25 N 696 (2001)
Limits relating to Channel Performance Class E

Prepared for: Telegärtner Karl Gärtner GmbH LEONI Kabel GmbH & Co.KG
Lerchenstrasse 35 Stieberstr. 5
D-71144 Steinenbronn D-91154 Roth

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to
J00020B0361
Type 1: Bodentank-Dose Class E VAD/B 8/8 UP/50 EK RAL 9010
Bodentank-Dose Class E VAD/B 8/8 UP/50 EK RAL 1013

Part number 2: J02023A0019(1x) electrically identical to
J02023B0019, J02023C0019, J02023D0019, J02023E0019,
J02022A0028, J02021A0015, J02021A0017, J02022A0019.
Type 2: Mod. Patch Panel Cat.6 MPP24-HS screened RAL 7035
Mini Verteiler Cat.6 MPD12-HS screened
Mini Verteiler Cat.6 Typ II MPD6-HS screened
Mini Verteiler Cat.6 3HE / 8TE MPD6-HS screened
Mini Verteiler Cat.6 3HE / 10TE MPD12-HS screened

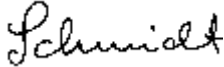
Part number 3: M06019A0105
Type 3: Microtest OmniScanner Cable Kit

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H
Individual Foil and Braid Screened Category 6 EN & ISO/IEC
Communication Cable in LSFROH Version. Fire Retardancy
according to IEC 60332-3, Cat. C.

Date tested: 2001-08-06

Test passed: YES

Testing Location: ELMAC GmbH, Boschstrasse 2
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Tested by: 
U. Schmidt 2001-08-06
Date

Engineer in charge: 
J. Böhne 2001-08-06
Date

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Notes:

ELMAC GmbH represents to the client that testing is done in accordance with the standard procedures stated under 2.1. All deviations will be listed separately.

The test results of this report are exclusively referring to the specific sample tested under stated test conditions. ELMAC GmbH shall have no liability for any deductions, inferences or generalizations drawn from the test results.

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2. Test Specifications and Equipment under Test

2.1. Test Specifications:

ISO/IEC JTC 1/SC 25 N 696 (2001)

IT-Cabling for Customer Premises
Channel Performance Class E

Following tests had to be performed:

- Maximum Attenuation
- Minimum Next Loss
- Minimum Attenuation to Crosstalk Ratio (ACR)
- Minimum ELFEXT Loss
- Minimum PowerSum NEXT Loss
- Minimum PowerSum ELFEXT Loss
- Minimum PowerSum ACR
- Return Loss
- Propagation Delay
- Delay Skew
- Resistance

2.2. Specification of the Equipment under Test (EUT)

- Part number 1: J00020B0360(1x) electrically identical to J00020B0361
- Type 1: Bodentank-Dose Class E VAD/B 8/8 UP/50 EK RAL 9010
Bodentank-Dose Class E VAD/B 8/8 UP/50 EK RAL 1013
- Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.
- Type 2: Mod. Patch Panel Cat.6 MPP24-HS screened RAL 7035
Mini Verteiler Cat.6 MPD12-HS screened
Mini Verteiler Cat.6 Typ II MPD6-HS screened
Mini Verteiler Cat.6 3HE / 8TE MPD6-HS screened
Mini Verteiler Cat.6 3HE / 10TE MPD12-HS screened
- Part number 3: M06019A0105
- Type 3: Microtest OmniScanner Cable Kit
- Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H
Individual Foil and Braid Screened Category 6 EN & ISO/IEC
Communication Cable in LSFROH Version. Fire Retardancy
according to IEC 60332-3, Cat. C.

3. Summary of the Test Results

3.1. Overview

Test	Test report See Paragraph	Test passed	Remarks
Maximum Attenuation	4.1.	^YES	
Minimum Next Loss	4.2.	YES	
Minimum ACR	4.3.	YES	
Minimum ELFEXT Loss	4.4.	YES	
Minimum PowerSum NEXT Loss	4.5.	YES	
Minimum PowerSum ELFEXT Loss	4.6.	YES	
Minimum PowerSum ACR	4.7.	YES	
Minimum Return Loss	4.8.	YES	
^Propagation Delay	4.9.	YES	
Delay Skew	4.10	YES	
Maximum Resistance	4.11	YES	

3.2. Verification and Certification Status

The EUT - specified in paragraph 2.2. - has been verified as being compliant with the standard ISO/IEC JTC 1/SC 25 N 696 (2001) relating to Channel Performance Class E.

4. Test Results

4.1. Attenuation

The attenuation was measured as the signal power loss due to the connecting hardware and was derived from swept frequency voltage measured on short lengths of twisted-pair test leads before and after splicing in the connector.

The summarized test results see table 1.

The required limits were met: **YES**

4.2. Next Loss

The Next loss was measured as the signal coupling from one cable pair to another. A balanced input signal was applied to a disturbing pair of the connector while the induced signal on the disturbed pair was measured. Each pair was terminated by a 100 Ohm one percent resistor on both sides.

The summarized test results see table 1.

The required limits were met: **YES**

4.3. Attenuation to Crosstalk Ratio (ACR)

The Attenuation to Crosstalk Ratio (ACR) was calculated from the results of attenuation and next loss measurements.

$$\text{ACR [dB]} = \text{Next loss [dB]} - \text{Attenuation [dB]}$$

The summarized test results see table 2.

The required limits were met: **YES**

4.4. ELFEXT Loss

Fext loss is a measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end. ELFEXT Loss is expressed in dB as the difference between the measured FEXT loss and the attenuation of the disturbed pair.

$$\text{ELFEXT Loss [dB]} = \text{FEXT Loss [dB]} - \text{Attenuation [dB]}$$

The summarized test results see table 2.

The required limits were met: **YES**

4.5. Power Sum Next Loss

Power Sum Near End Crosstalk takes into account the combined crosstalk on a receive pair from all near end disturbers operating simultaneously. The power sum crosstalk (Psum NEXT) is calculated in accordance to ASTM D4566 as a power sum on a selected pair from all other pairs as shown in equation for the case of 4-pair connecting hardware.

The summarized test results see table 3.

The required limits were met: **YES**

4.6. Power Sum ELFEXT Loss

The power sum ELFEXT Loss (Psum ELFEXT)is calculated in accordance to ASTM D4566 as a power sum on a selected pair from all other pairs as shown in equation for the case of 4-pair connecting hardware.

The summarized test results see table 3.

The required limits were met: **YES**

4.7. Power Sum ACR

The PowerSum ACR is computed from PowerSum NEXT and attenuation as follow:

$$\text{PowerSum ACR} = \text{PowerSum NEXT} - \text{Attenuation}$$

The summarized test results see table 4.

The required limits were met: **YES**

4.8. Return Loss

The return loss was measured from both sides of the link.

The summarized test results see table 4.

The required limits were met: **YES**

^

4.9. Propagation Delay

The Propagation Delay was measured according to IEC 61935-1.

The summarized test results see table 5.

The required limits were met: **YES**

4.10. Delay Skew

The difference in propagation delay between any two pairs in a channel measured according to IEC 61935-1.

The summarized test results see table 5.

The required limits were met: **YES**

4.11. Resistance

The loop resistance was measured by using a precision LCR meter.

The summarized test results see table 5.

The required limits were met: **YES**

4.12. Remarks about Presentation of Test Results

The detailed test results (parameters vs. frequency) automatically collected by the Microtest OmniScanner were stored as ASCII text files on a personal computer and then imported into an Excel spread sheet file. These data were taken and saved with the continuous limits. For a simple presentation of test results in tables the frequency range 1 MHz to 500 MHz was splitted into some frequency bands. In the tables the worst case limit of each band and the worst case reading of each band is given.

Normally the margin between the readings and the continuous limits is at least equal but normally better than resulting from the tables.

The detailed test results (ASCII text files) are saved by the testing laboratory for later retrieval if necessary.

5. List of Test Equipment

Name	Model	Manufacturer	Serial Number	Inventory No.	Last calibration
Link test set	OMNIScanner2	Microtest	2950-4010-02	INV292	06.2000
	OMNIRemote2	Microtest	2950-4011-01	INV293	06.2000
Channel adapter	CHAN 5/5E/6	Microtest	2950-4012-01	INV313	06.2000
Channel adapter	CHAN 5/5E/6	Microtest	2950-4012-01	INV314	06.2000
^Link adapter	TG-Class E Adapter	Telegärtner	01	-	-
Link adapter	TG-Class E Adapter	Telegärtner	25	-	-

Appendices

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to J00020B0361

Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.

Part number 3: M06019A0105

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H Individual Foil and Braid Screened Category 6 EN & ISO/IEC Communication Cable in LSFROH Version. Fire Retardancy according to IEC 60332-3, Cat. C.

Table 1: Summarized Test Results – Max. Attenuation, Next Loss

Max. Attenuation [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency [MHz]	Class E Limit	EUT Results			
		1-2	3-6	4-5	7-8
1.0	-4.0	-2.0	-2.1	-2.0	-2.0
4.0	-4.2	-3.8	-3.8	-3.9	-3.7
10.0	-6.5	-5.4	-5.8	-5.7	-5.4
16.0	-8.3	-6.8	-7.1	-7.2	-7.0
20.0	-9.3	-7.6	-7.9	-7.9	-7.7
25.0	-10.4	-8.6	-8.8	-8.9	-8.6
31.3	-11.7	-9.7	-9.9	-10.0	-9.6
62.5	-16.8	-13.9	-14.3	-14.3	-13.9
100.0	-21.6	-18.0	-18.2	-18.5	-18.0
125.0	-24.4	-20.3	-20.6	-20.7	-20.3
155.5	-27.4	-22.5	-23.2	-23.0	-22.5
175.0	-29.3	-23.9	-24.7	-24.3	-24.0
200.0	-31.6	-25.7	-26.3	-26.3	-25.8
250.0	-35.7	-29.0	-29.8	-29.4	-28.9
300.0	n.a.	-31.5	-34.2	-33.0	-31.7

Min. NEXT [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)					
Frequency [MHz]	Class E Limit	EUT Results					
		1-2/7-8	1-2/3-6	1-2/4-5	4-5/3-6	4-5/7-8	3-6/7-8
1.0	-65.0	-88.4	-81.6	-86.7	-89.0	-92.3	-93.5
4.0	-63.0	-80.6	-78.5	-78.3	-77.7	-79.9	-85.9
10.0	-56.6	-71.8	-74.5	-74.4	-67.8	-69.5	-77.4
16.0	-53.2	-68.3	-67.6	-67.5	-64.4	-67.5	-75.4
20.0	-51.6	-66.5	-66.3	-65.9	-62.5	-66.1	-73.6
25.0	-50.0	-64.5	-65.6	-64.9	-60.6	-62.7	-69.7
31.3	-48.4	-63.1	-63.6	-63.4	-59.7	-60.9	-67.7
62.5	-43.4	-57.3	-58.3	-58.4	-54.5	-55.4	-60.6
100.0	-39.9	-54.4	-54.6	-54.4	-52.3	-52.5	-55.1
125.0	-38.3	-52.1	-53.2	-52.5	-51.9	-51.7	-52.9
155.5	-36.7	-50.2	-51.5	-51.4	-51.5	-49.2	-48.9
175.0	-35.8	-49.4	-50.4	-51.0	-49.1	-47.5	-47.4
200.0	-34.8	-48.5	-48.8	-50.2	-46.6	-45.4	-46.0
250.0	-33.1	-47.0	-46.8	-48.8	-42.4	-42.2	-43.3
300.0	n.a.	-46.0	-44.5	-47.4	-38.1	-39.7	-40.1

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to J00020B0361

Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.

Part number 3: M06019A0105

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H
Individual Foil and Braid Screened Category 6 EN & ISO/IEC
Communication Cable in LSFROH Version. Fire Retardancy according to IEC 60332-3, Cat. C.

Table 2: Summarized Test Results – ACR, ELFEXT Loss

Min. ACR [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)					
Frequency [MHz]	Class E Limit	EUT Results					
		1-2/7-8	1-2/3-6	1-2/4-5	4-5/3-6	4-5/7-8	3-6/7-8
1.0	-70.4	-86.5	-79.6	-84.7	-87.0	-90.4	-91.5
4.0	-58.9	-76.8	-74.7	-74.5	-73.8	-76.0	-82.1
10.0	-50.0	-66.4	-68.8	-68.7	-62.1	-63.8	-71.7
16.0	-44.9	-61.3	-60.5	-60.4	-57.3	-60.4	-68.3
20.0	-42.3	-58.8	-58.4	-58.0	-54.6	-58.2	-65.7
25.0	-39.6	-55.9	-56.8	-56.1	-51.7	-53.8	-60.9
31.3	-36.7	-53.4	-53.8	-53.5	-49.7	-50.9	-57.9
62.5	-26.5	-43.4	-44.1	-44.1	-40.2	-41.1	-46.4
100.0	-18.3	-36.3	-36.2	-36.1	-33.9	-34.2	-36.7
125.0	-13.9	-31.9	-32.6	-31.9	-31.2	-31.1	-32.3
155.5	-9.2	-27.7	-28.5	-28.6	-28.5	-26.3	-25.9
175.0	-6.5	-25.3	-25.8	-26.7	-24.5	-23.2	-22.8
200.0	-3.2	-22.8	-22.4	-23.7	-20.1	-18.9	-19.6
250.0	2.6	-17.8	-16.8	-19.3	-12.4	-12.7	-13.3
300.0	n.a.	-14.3	-10.3	-14.4	-4.0	-6.6	-6.0

Min. ELFEXT [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)					
Frequency [MHz]	Class E Limit	EUT Results					
		1-2/7-8	1-2/3-6	1-2/4-5	4-5/3-6	4-5/7-8	3-6/7-8
1.0	-63.3	-88.3	-82.7	-89.6	-89.6	-83.8	-94.5
4.0	-51.2	-91.6	-83.7	-79.8	-66.6	-73.1	-81.8
10.0	-43.3	-79.1	-77.5	-72.0	-58.8	-64.7	-75.3
16.0	-39.2	-74.9	-73.9	-68.1	-55.2	-60.3	-70.7
20.0	-37.2	-74.4	-71.0	-67.4	-53.6	-58.3	-68.6
25.0	-35.3	-71.4	-69.1	-64.3	-51.3	-56.8	-66.7
31.3	-33.4	-67.9	-67.8	-60.8	-49.1	-55.3	-65.8
62.5	-27.3	-62.4	-59.7	-54.3	-43.5	-49.0	-56.2
100.0	-23.3	-56.6	-60.2	-48.2	-37.7	-46.2	-50.7
125.0	-21.3	-55.1	-54.9	-48.1	-35.7	-44.1	-47.3
155.5	-19.5	-54.3	-48.2	-49.9	-33.9	-43.2	-45.7
175.0	-18.4	-53.5	-49.9	-49.8	-32.2	-43.4	-48.3
200.0	-17.2	-53.9	-46.1	-53.0	-31.1	-42.3	-50.2
250.0	-15.3	-46.6	-45.4	-50.4	-27.7	-37.8	-44.3
300.0	n.a.	-44.2	-45.4	-50.6	-27.9	-38.2	-44.0

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to J00020B0361

Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.

Part number 3: M06019A0105

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H Individual Foil and Braid Screened Category 6 EN & ISO/IEC Communication Cable in LSFROH Version. Fire Retardancy according to IEC 60332-3, Cat. C.

Table 3: Summarized Test Results - PsumNEXT Loss, PsumELFEXT Loss

Min. PsumNEXT [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency [MHz]	Class E Limit	EUT Results			
		1-2	3-6	4-5	7-8
1.0	-62.0	-79.8	-80.6	-84.2	-86.2
4.0	-60.5	-74.7	-75.4	-73.8	-77.1
10.0	-54.0	-69.6	-67.6	-65.1	-67.4
16.0	-50.6	-63.7	-63.4	-61.5	-64.9
20.0	-49.0	-62.1	-61.5	-59.8	-63.3
25.0	-47.3	-60.9	-60.0	-57.7	-60.5
31.3	-45.7	-59.5	-58.9	-56.3	-58.8
62.5	-40.6	-53.9	-53.4	-51.1	-53.0
100.0	-37.1	-50.1	-50.4	-48.3	-50.1
125.0	-35.4	-48.2	-49.2	-47.3	-48.2
155.5	-33.8	-46.4	-45.7	-46.6	-46.1
175.0	-32.9	-45.5	-44.2	-45.0	-44.5
200.0	-31.9	-44.6	-42.3	-42.7	-42.7
250.0	-30.2	-42.9	-39.1	-39.2	-39.7
300.0	n.a.	-42.0	-35.5	-35.8	-36.9

Min. PsumELFEXT [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency [MHz]	Class E Limit	EUT Results			
		1-2	3-6	4-5	7-8
1.0	-60.3	-81.8	-75.9	-75.7	-82.9
4.0	-48.2	-78.3	-66.5	-65.6	-72.6
10.0	-40.3	-70.7	-58.8	-57.8	-64.7
16.0	-36.2	-67.1	-55.1	-53.9	-60.1
20.0	-34.2	-65.6	-53.4	-52.3	-58.2
25.0	-32.3	-62.9	-51.2	-50.1	-56.8
31.3	-30.4	-59.9	-49.1	-48.0	-55.2
62.5	-24.3	-53.3	-43.3	-42.3	-48.7
100.0	-20.3	-47.9	-37.5	-36.9	-45.1
125.0	-18.3	-47.1	-35.4	-35.0	-43.5
155.5	-16.5	-46.1	-33.6	-33.4	-41.6
175.0	-15.4	-46.4	-32.1	-32.1	-42.5
200.0	-14.2	-45.9	-31.1	-30.9	-42.4
250.0	-12.3	-42.9	-27.6	-28.2	-37.2
300.0	n.a.	-38.6	-23.8	-25.4	-33.1

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to J00020B0361

Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.

Part number 3: M06019A0105

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H Individual Foil and Braid Screened Category 6 EN & ISO/IEC Communication Cable in LSFROH Version. Fire Retardancy according to IEC 60332-3, Cat. C.

Table 4: Summarized Test Results – PsumACR, Return Loss

Min. PsumACR [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency [MHz]	Class E Limit	EUT Results			
		1-2	3-6	4-5	7-8
1.0	-68.1	-77.9	-86.3	-82.3	-84.3
4.0	-56.4	-71.0	-73.8	-70.0	-73.4
10.0	-47.5	-64.2	-64.6	-59.4	-62.0
16.0	-42.3	-56.9	-59.8	-54.4	-58.0
20.0	-39.7	-54.5	-57.6	-51.8	-55.6
25.0	-36.9	-52.4	-54.8	-48.8	-51.9
31.3	-34.0	-49.8	-52.1	-46.4	-49.1
62.5	-23.8	-40.1	-41.2	-36.8	-39.1
100.0	-15.4	-32.2	-32.8	-29.9	-32.1
125.0	-11.0	-28.0	-28.7	-26.7	-28.0
155.5	-6.3	-23.8	-22.7	-23.7	-23.6
175.0	-3.5	-21.4	-19.6	-20.7	-20.5
200.0	-0.3	-18.9	-15.9	-16.2	-17.2
250.0	5.6	-13.9	-9.1	-9.7	-10.5
300.0	n.a.	-10.5	-1.4	0.0	0.0

Min. Return Loss [dB]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency [MHz]	Class E Limit	EUT Results			
		1-2	3-6	4-5	7-8
1.0	-19.0	-26.7	-37.9	-31.6	-28.0
4.0	-19.0	-23.8	-26.4	-25.8	-25.4
10.0	-19.0	-27.6	-33.8	-29.7	-29.3
16.0	-18.0	-30.7	-32.9	-31.6	-33.2
20.0	-17.5	-31.1	-36.5	-35.2	-34.5
25.0	-17.0	-33.2	-38.8	-48.4	-34.5
31.3	-16.5	-25.0	-37.9	-26.8	-27.8
62.5	-14.0	-26.2	-35.0	-31.8	-36.1
100.0	-12.0	-26.0	-26.4	-29.5	-28.5
125.0	-11.0	-23.7	-22.8	-29.9	-24.6
155.5	-10.1	-21.6	-25.5	-32.3	-23.6
175.0	-9.6	-19.1	-24.1	-22.4	-25.1
200.0	-9.0	-19.5	-22.2	-26.3	-19.4
250.0	-8.0	-20.4	-17.7	-27.4	-19.3
300.0	n.a.	-20.5	-15.0	-18.5	-22.3

Equipment under Test:

Part number 1: J00020B0360(1x) electrically identical to J00020B0361

Part number 2: J02023A0019(1x) electrically identical to J02023B0019, J02023C0019, J02023D0019, J02023E0019, J02022A0028, J02021A0015, J02021A0017, J02022A0019.

Part number 3: M06019A0105

Installation cable: 90m Leoni Q-Line 4P23 SC300 FRNC, Order No.87501342H Individual Foil and Braid Screened Category 6 EN & ISO/IEC Communication Cable in LSFROH Version. Fire Retardancy according to IEC 60332-3, Cat. C.

Table 5: Summarized Test Results – Delay, Skew, DC Resistance

Propagation Delay [ns]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency	Class E	EUT Results			
[MHz]	Limit	1 - 2	3 - 6	4 - 5	7 - 8
10.0	555	420.0	420.0	420.0	418.0

Delay Skew [ns]		ISO/IEC JTC 1/SC 25 N 696 (2001)
Frequency	Class E	EUT Results
[MHz]	Limit	
10.0	50	2.0

Max. DC Resistance [Ohm]		ISO/IEC JTC 1/SC 25 N 696 (2001)			
Frequency	Class E	EUT Results			
[MHz]	Limit	1 - 2	3 - 6	4 - 5	7 - 8
DC/1 kHz	40	17.0	16.3	17.1	16.8