Survey: Automotive Cabling

Objective:

The survey is targeted at automotive OEMs and suppliers to be used to assist the IEEE 802.3 Reduced Twisted Pair Study Group (RTPSG) in developing link segment objectives and project criteria.

1 Purpose

The purpose of the survey is to characterize automotive cabling; e.g., cables, connectors, wire harnesses and assemblies *for current and future differential signaling over balanced twisted-pairs*.

The survey information will be used to assist the IEEE 802.3 Reduced Twisted Pair Study Group (RTPSG) in developing link segment objectives and project criteria.

Please take the time to fill in the following questionnaire. Your participation is appreciated.

Respondent Information – Automotive cabling survey

Company and Personal Profile - Please Print

Your Name: Stefan Schmerler   Helmut Leier

Your Company Name: Daimler AG   Daimler AG

City/State/Zip: 71034 Böblingen, Germany   89081 Ulm, Germany

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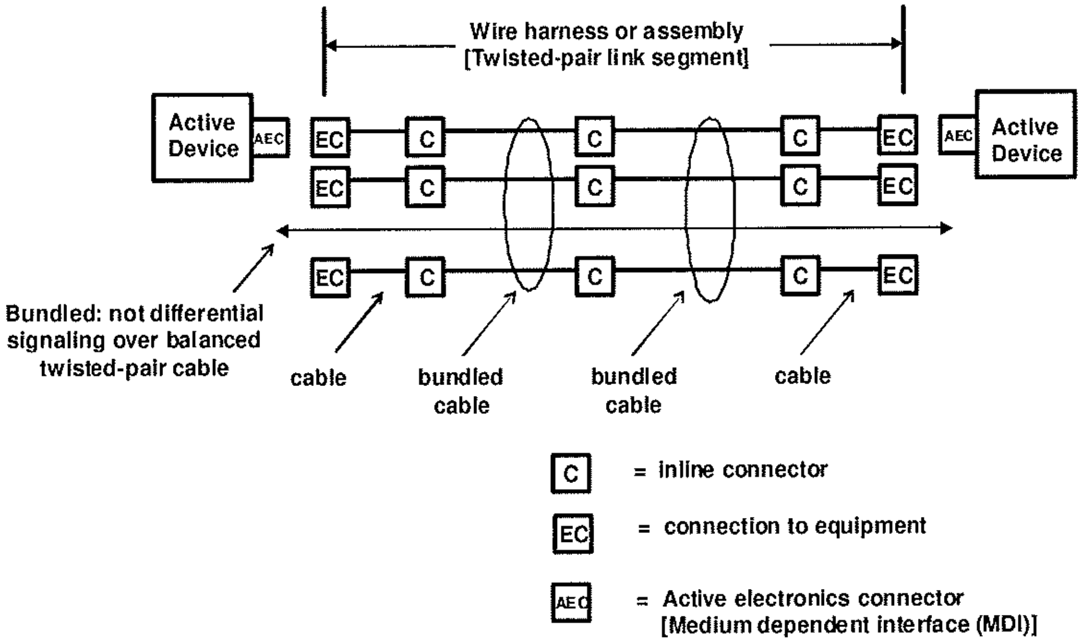
Your Job Function: Senior Manager   Manager

1. Survey Questionnaire –

1. Figures 1 is provided as a reference to assist in responding to survey questions. The IEEE 802.3 nomenclature is bracketed to identify relationship to the IEEE 802.3 definitions.

Figure 1 Automotive cabling Topology



2. Wire harness or assembly topology (see Figure 1).

2.1 Maximum length in meters of wire harness or assembly between active electronic devices – report current applications and lengths [EC] to [EC].
cars/vans: 12m, trucks/busses:32m

2.2 Maximum length in meters of wire harness or assembly between active electronic devices – report future applications and lengths [EC] to [EC].
cars/vans: 15m, trucks/busses:40m

2.3 Number and type of inline connectors [C] between active electronic devices – report current applications.
cars/vans/trucks/busses: max. 3 inline connectors different multi-pin connectors: e.g (as examples) from TE Connectivity (MQS, MLK,...), Rosenberger (HSD), Delphi, Hirschmann and others

2.4 Number and type of inline connectors [C] between active electronic devices– report future applications
cars/vans/trucks/busses: max. 3 inline connectors different multi-pin connectors (maybe new versions additional to those in 2.3)

2.5 Type of active electronic connectors [AEC] – report current applications.
see 2.3

2.6 Type of active electronic connectors [AEC] – report future applications.
see 2.4

2.7 Number and type of inline connectors [C] between active electronic devices– report future applications
see 2.3

2.8 Are there requirements for future applications to be mechanically compatible to existing connector systems?
Not necessarily

2.9 Are there requirements for mechanically compatible connector systems between automobile manufacturers?
Not necessarily, however due to same requirements and cost aspects same – or at least similar – connectors are possible

3. Balanced twisted-pair cable used in wire harness or assembly (see Figure 1 and Figure 2.) report parameters and values.

3.1 Current automotive applications

Gauge	[AWG] [or conductor in mm]
Impedance	[ohm +/-]
Shield	[Y/N] [shield type]
Copper conductors	[Y/N] solid [Y/N] stranded [#strands]
Direct current resistance	[milliohm/meter] → *see next page*

3.2 Future automotive applications

Gauge	[AWG] [or conductor in mm]
Impedance	[ohm +/-]
Shield	[Y/N] [shield type]
Copper conductors	[Y/N] solid [Y/N] stranded [#strands]
Direct current resistance	[milliohm/meter] → *see next page*

4. Bundled cable types in wire harness or assembly (Figure 1)

4.1 Report data rates of differential signaling applications in bundle
(20kBit/s ... ~ 3GBit/s) → see next page

4.2 Report other data rates not using differential signaling in bundle
(20kBit/s ... ~ 3GBit/s) → see next page

4.3 Report voltage/power in bundle
12V (cars) or 24V (trucks/busses) and 48V (future applications). Currents are up to 150A@12V (short time, e.g. el. Motors/el. steering/air condition compressor/...). Electric cars (BEV, Hybrid, FuelCell) have even higher voltages/currents for the electrical transmission system.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Data rate	20 kbit/s	500 kbit/s	10 Mbit/s	480 Mbit/s	200...3000 Mbit/s	Antenna signals (AM, FM, ISM, WLAN, Bluetooth, ...)
amplitude	12 V	2V	0,6V	0,4V	0,25...0,45V	different
differential?	single ended	differential	differential	differential	differential	single ended
typical cabling	Single wire, e.g. 0,35mm²	UTP 2x0,35mm² (Future: UTP 2x0,17mm²)	UTP 2x0,35mm² (e.g. FLRY 2x0,35 mm² - SB) (Future: UTP 2x0,17mm²)	STQ 4x0,5mm² (e.g. Leoni Dacar566)	STQ 4x0,14mm² (e.g. Leoni Dacar535-2)	Coax (e.g. Leoni Dacar302)
DC resistance max. values	125 mΩ/m	55 mΩ/m (for 0,35mm²)	55 mΩ/m (for 0,35mm²)	35 mΩ/m	125 mΩ/m	e.g. 50 mΩ/m (Leoni Dacar 302)
Differential Cable impedance (Z_{diff} Ω)	-	120 (±12)	100 (±10)	90 (±15)	100 (±15)	50 (±3)
Shield?	no	no	no	yes (braid + foil)	yes (braid + foil)	yes (braid + foil)
conductor	stranded (e.g. 7)	Stranded (e.g. 7)	stranded (e.g. 7x0,26)	stranded (e.g. 19x0,182)	stranded (e.g. 7x0,16)	stranded (e.g. 7x0,27)
Jacketed?	-	no	no	yes	yes	yes
typical connector	different multi pin connectors (e.g. Tyco MQS)	different multi pin connectors (e.g. Tyco MQS)	different multi pin connectors (e.g. Tyco MQS)	Rosenberger HSD	Rosenberger HSD	FAKRA

**) different data rates are possible for CAN, typically are 125kbit/s or 500kbit/s*

5. External noise sources

5.1 Report steady state noise (including frequency content)
5.2 Report time variable noise (things that come and go)
5.3 Report impulse noise
5.4 Report radio frequency interference - modulated signals (i.e., cell phone type signals)

Immunity to noise is ensured by EMC tests acc. to MBN10284-2 (e.g. by referring to measurements acc. to CISPR 16, CISPR 25, ISO 7637, ISO 10605, ISO 11452-1, ISO 11452-2, ISO/DIS 11452-4, ISO 11452-8) which is not public available but is available to suppliers via the Daimler Supplier Portal "Covisint": https://daimler.portal.covisint.com/web/portal/home

6. Automotive cabling system characteristics

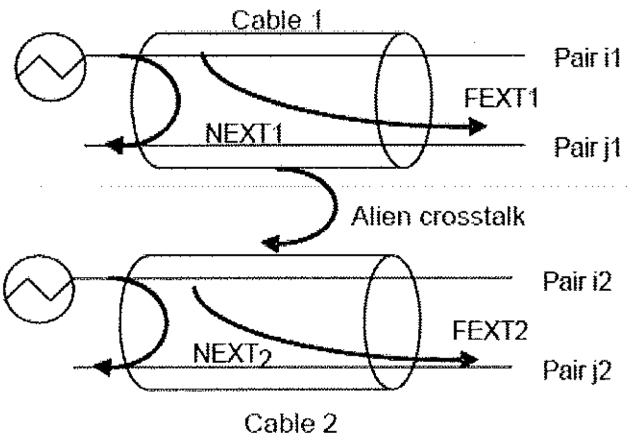
Table 1 is provided as a reference to assist in reporting automotive cabling parameters that are used by Ethernet PHY designers.

Table 1. Cabling parameters

Transmission parameters	Coupling parameters (within Link segments)	Coupling parameters (between Link segments)	Balance parameters
Insertion Loss	Near-End crosstalk (NEXT) loss	Alien Near-End crosstalk loss (ANEXT)	Transverse conversion loss (TCL) – SCD11
Differential characteristic impedance	Multiple disturber near-end crosstalk (MDNEXT) loss	Multiple Disturber Alien Far-End crosstalk loss (MDANEXT)	Longitudinal conversion loss (LCL) –SDC11
Return Loss	Far-End crosstalk (FEXT) loss Specified as equal level FEXT (ELFEXT)	Alien Near-End crosstalk loss (AFEXT)	Transverse conversion transmission loss (TCTL) – SCD12
Propagation Delay	Multiple disturber Far-end crosstalk (MDFEXT) loss Specified as MDELFEXT (ELFEXT)	Multiple Disturber Alien Far-End crosstalk loss (MDAFEXT) Specified as power sum (PSAELFEXT)	Longitudinal conversion transmission loss (LCTL) – SDC12
Delay Skew		Specified as power sum (PSAELFEXT)	

Figures 2 illustrates the coupling parameters NEXT, FEXT within a cable sheath and alien crosstalk between cable sheaths.

Figure 2 Crosstalk within and between cable sheath



Please check blank cell adjacent to cabling parameters in Table 2 that are used to specify balanced twisted-pair cables and/or connectors used with twisted-pair cables in automotive wire harnesses or assemblies.

Table 2 Cabling parameters

Check box	Transmission parameters	Check box	Coupling parameters (within Link segments)	Check box	Coupling parameters (between Link segments)	Check box	Balance parameters
✓	Insertion Loss	✓	Near-End crosstalk (NEXT) loss		Alien Near-End crosstalk loss (ANEXT)	(✓)	Transverse conversion loss (TCL) – SCD11
✓	Differential characteristic impedance	(✓)	Multiple disturber Near-End crosstalk (MDNEXT) loss		Multiple Disturber Alien Far-End crosstalk loss (MDANEXT)	(✓)	Longitudinal conversion loss (LCL) –SDC11
✓	Return Loss	✓	Far-End crosstalk (FEXT) loss		Alien Near-End crosstalk loss (AFEXT)	(✓)	Transverse conversion transmission loss (TCTL) – SCD12
✓	Propagation Delay	(✓)	Multiple disturber Far-end crosstalk (MDFEXT)		Multiple Disturber Alien Far-End crosstalk loss (MDAFEXT)	(✓)	Longitudinal conversion transmission loss (LCTL) –SDC12
✓	Delay Skew						

(✓) = *not always specified.*

Figure 3 and Table 3 provide references for signaling impairments naming and s-parameter designations derived from four port network.

Figure 3 Four port network

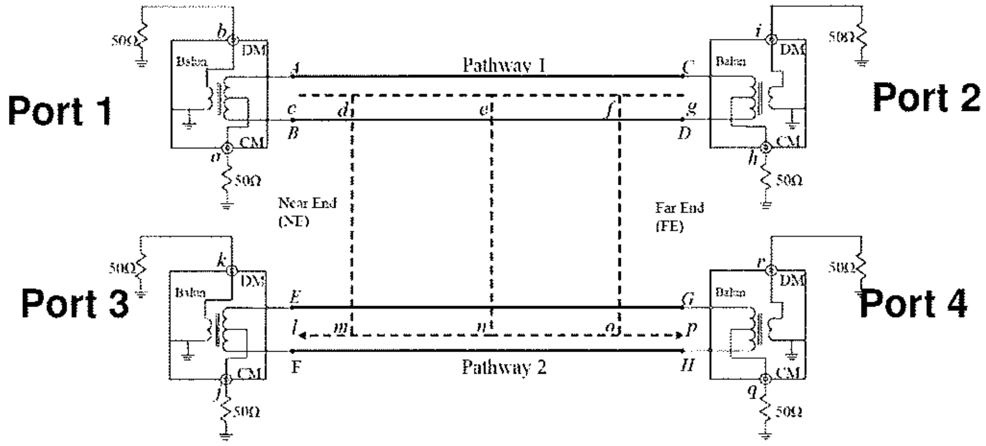


Table 3 Port mapping – signal impairment naming to s-parameters

		Port 1		Port 2		Port 3		Port 4	
Port 1	cc	Scc11	RLcc11	Scc12	ILcc12	Scc13	NEXTcc13	Scc14	FEXTcc14
	cd	Scd11	TCLcd11	Scd12	TCTLcd12	Scd13	NEXTcd13	Scd14	FEXTcd14
	dc	Sdc11	LCLdc11	Sdc12	LCTLdc12	Sdc13	NEXTdc13	Sdc14	FEXTdc14
	dd	Sdd11	RLdd11	Sdd12	ILdd12	Sdd13	NEXTdd13	Sdd14	FEXTdd14
Port 2	cc	Scc21	ILcc21	Scc22	RLcc22	Scc23	FEXTcc23	Scc24	NEXTcc24
	cd	Scd21	TCTLcd21	Scd22	TCLcd22	Scd23	FEXTcd23	Scd24	NEXTcd24
	dc	Sdc21	LCTLdc21	Sdc22	LCLdc22	Sdc23	FEXTdc23	Sdc24	NEXTdc24
	dd	Sdd21	ILdd21	Sdd22	RLdd22	Sdd23	FEXTdd23	Sdd24	NEXTdd24
Port 3	cc	Scc31	NEXTcc31	Scc32	NEXTcc32	Scc33	RLcc33	Scc34	ILcc34
	cd	Scd31	NEXTcd31	Scd32	NEXTcd32	Scd33	TCLcd33	Scd34	TCTLcd34
	dc	Sdc31	NEXTdc31	Sdc32	NEXTdc32	Sdc33	LCLdc33	Sdc34	LCTLdc34
	dd	Sdd31	NEXTdd31	Sdd32	NEXTdd32	Sdd33	RLdd33	Sdd34	ILdd34
Port 4	cc	Scc41	FEXTcc41	Scc42	FEXTcc42	Scc43	ILcc43	Scc44	RLcc44
	cd	Scd41	FEXTcd41	Scd42	FEXTcd42	Scd43	TCTLcd43	Scd44	TCLcd44
	dc	Sdc41	FEXTdc41	Sdc42	FEXTdc42	Sdc43	LCTLdc43	Sdc44	LCLdc44
	dd	Sdd41	FEXTdd41	Sdd42	FEXTdd42	Sdd43	ILdd43	Sdd44	RLdd44

Figure 4 Cable types