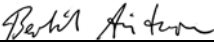


Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.		
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Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev	File
		2005-03-22	A	

## DELIVERY PROTOCOL #6 AND CONFORMANCE CERTIFICATE

### SCOPE

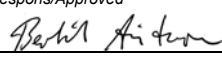
Contract No. F416/EP/CMS: Dense multi-ribbon cable (8x12 fibres).

Each delivery of the 96-fibre cable will have a protocol and certificate attached or mailed at the time of shipping, starting with

- delivery #3 (June, 2004) Tracker: HL/ECA/T/TX-04:115
- delivery #4 (November, 2004) Tracker: HL/ECA/T/TX-04:145
- delivery #5 (February, 2005) Tracker: HL/ECA/T/TX-05:071

### CONTENTS

1. Special delivery note
  - 1.1 Cable
  - 1.2 Delivery
  - 1.3 Compliance with comments
2. Fibre specification
3. Ribbon specification
4. Cable specification

Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.	
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Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev
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			File

1 SPECIAL DELIVERY NOTE

1.1 CABLE E-CAL

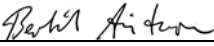
Batch: z000265549; Cable id.: P035P, see sheath-marking.

Cable length: 1,1 km, the length can be part of several deliveries.

Date March 2, 2005

OTDR length 1105 m

Ribbon	Fiber	1310nm	1550nm	Ribbon	Fiber	1310nm	1550nm
	1 Blu01	0,33	0,19		2 Blu01	0,33	0,19
	1 Or02	0,33	0,19		2 Or02	0,32	0,19
	1 Gr03	0,33	0,19		2 Gr03	0,33	0,19
	1 Br04	0,33	0,19		2 Br04	0,33	0,19
	1 SI05	0,33	0,19		2 SI05	0,33	0,19
	1 Wh06	0,33	0,19		2 Wh06	0,33	0,19
	1 Re07	0,33	0,19		2 Re07	0,33	0,19
	1 Bla08	0,33	0,19		2 Bla08	0,33	0,2
	1 Ye09	0,32	0,19		2 Ye09	0,33	0,19
	1 Vi10	0,33	0,19		2 Vi10	0,33	0,19
	1 Ro11	0,32	0,19		2 Ro11	0,32	0,19
	1 Aq12	0,33	0,19		2 Aq12	0,32	0,19
	3 Blu01	0,32	0,2		4 Blu01	0,33	0,2
	3 Or02	0,32	0,2		4 Or02	0,32	0,21
	3 Gr03	0,32	0,2		4 Gr03	0,33	0,22
	3 Br04	0,32	0,19		4 Br04	0,32	0,2
	3 SI05	0,32	0,2		4 SI05	0,32	0,19
	3 Wh06	0,32	0,2		4 Wh06	0,33	0,19
	3 Re07	0,33	0,2		4 Re07	0,33	0,21
	3 Bla08	0,32	0,21		4 Bla08	0,32	0,21
	3 Ye09	0,32	0,2		4 Ye09	0,32	0,21
	3 Vi10	0,33	0,2		4 Vi10	0,33	0,21
	3 Ro11	0,33	0,21		4 Ro11	0,35	0,23
	3 Aq12	0,32	0,2		4 Aq12	0,35	0,23
	5 Blu01	0,33	0,2		6 Blu01	0,33	0,19
	5 Or02	0,32	0,19		6 Or02	0,33	0,19
	5 Gr03	0,33	0,19		6 Gr03	0,33	0,19
	5 Br04	0,33	0,21		6 Br04	0,32	0,19
	5 SI05	0,33	0,2		6 SI05	0,32	0,19
	5 Wh06	0,33	0,21		6 Wh06	0,34	0,2
	5 Re07	0,33	0,19		6 Re07	0,33	0,19
	5 Bla08	0,33	0,19		6 Bla08	0,33	0,19
	5 Ye09	0,33	0,2		6 Ye09	0,33	0,19
	5 Vi10	0,33	0,21		6 Vi10	0,33	0,19
	5 Ro11	0,33	0,2		6 Ro11	0,32	0,19
	5 Aq12	0,33	0,21		6 Aq12	0,33	0,18
	7 Blu01	0,33	0,19		8 Blu01	0,33	0,19
	7 Or02	0,32	0,19		8 Or02	0,33	0,19

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			File

7 Gr03	0,33	0,19	8 Gr03	0,33	0,19
7 Br04	0,32	0,19	8 Br04	0,32	0,19
7 SI05	0,33	0,19	8 SI05	0,33	0,19
7 Wh06	0,32	0,19	8 Wh06	0,32	0,19
7 Re07	0,33	0,18	8 Re07	0,33	0,19
7 Bla08	0,33	0,19	8 Bla08	0,33	0,19
7 Ye09	0,32	0,19	8 Ye09	0,33	0,19
7 Vi10	0,33	0,18	8 Vi10	0,33	0,19
7 Ro11	0,33	0,19	8 Ro11	0,33	0,19
7 Aq12	0,33	0,19	8 Aq12	0,33	0,19

1.2 DELIVERY #6

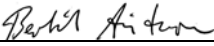
March, 2005: One box with two lengths of 62 m, E-Cal. Attenuation is measured on a longer cable, see above. Specification fulfilled.

**ONE BOX**

BATCH: Z000265549
ORDER NR: 100147856
MATERIALNR: TOL4051017/96C
L 1: 03 M - 65 M
L 2: 66 M - 128 M

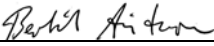
1.3 COMPLIANCE

Fully complied to CERN Optical Readout Link Specification part 4.1: Dense Multi-Ribbon Cable, V3.7.

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Dokansv/Godk - Doc respons/Approved		Kontr - Checked		Datum - Date	Rev
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Special comments

Cern 4.1 c3.7		
4.1.1	Fibre Type	Guaranteed from handling
4.1.2	Material	From delivery data
4.1.3	Geometry	"
4.1.4	Cladding	"
4.1.5	Primary	"
4.1.6	Conc. Error	"
4.1.7	Wavelength	Given by type
4.1.8	Attenuation	Delivery data for each fibre. 100% in each ribbon length of typically 8-10 km and in each cable of 1-2 km length at 1310nm, and 1550nm just before cutting. Short delivery length not measured .
4.1.21	Ribbon channels	12 visual 100%
4.1.22	Dimensions	100% on each run
4.1.23	Pitch	100% on each run
4.1.30	Colour-code	Visual
4.1.31	Colour	Uncoloured visual
4.1.32	Marking	Visual
4.1.41	Cable Number of channels	96 visual
4.1.42	Cable diameter	100% on each run
4.1.49	Sheath colour	Visual
4.1.50	Sheath marking	Visual
4.1.51	Cable cut-off	No, guaranteed by type test

Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.		File	
HL/ECA/T/TF Bertil Arvidsson		HL/ECA/T/TX-05:075 Uen			
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		2005-03-22	A		

2 **FIBRE SPECIFICATION**

The used fibre complies with G652B, IEC B1.1 and is specially radiation selected (Cern) Corning-fibre.

2.1 **TRANSMISSION**

Attenuation at 1310nm (dB/km)	0.35 max
Attenuation at 1550nm “	0.21 max
Attenuation at 1625nm “	0.22 typical
Maximum chromatic dispersion (ps/nm.km)	18 max
at 1550 and 1570 respectively	19 max
Zero dispersion wavelength range (nm)	1302-1322
Zero dispersion slope (ps/nm <sup>2</sup> .km)	0.092 max
Polarization mode dispersion, PMD (ps/√km)	0.2 max
PMD link-value (ps/√km)	0.1 max
Typical fibre cut-off wavelength range (nm)	1190 – 1360
Cable cut-off wavelength (nm)	1260 max
Mode field diameter range (µm)	8.8 - 9.6
at 1310 nm.	

2.2 **GEOMETRY & COATING**

2.2.1 **COATING NON-CIRCULARITY**

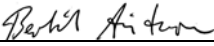
90<sup>th</sup> % < 2%  
 (max diameter - min diameter) / max diameter.  
 Maximum < 5%.  
 This is a non-routine measurement.

2.2.2 **COATING CONCENTRICITY ERROR**

This is a non-routine measurement. ≤ 10 µm

2.2.3 **MODE FIELD NON-CIRCULARITY**

≤ 6%  
 (max diameter - min diameter) / max diameter. This is a non-routine measurement.

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Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev		
		2005-03-22	A		

#### 2.2.4 GEOMETRY

Cladding diameter ( $\mu\text{m}$ )	125.0 $\pm$ 0.7
Cladding non-circularity (%)	0.7 max
Coating diameter ( $\mu\text{m}$ )	245 $\pm$ 5
Core concentricity error ( $\mu\text{m}$ )	0.5 max
Curl (bow) radius of curvature(m)	>4

#### 2.2.5 COATING

UV-curable acrylate compatible with inks used by ECA

#### 2.2.6 MECHANICAL PERFORMANCE

Proof test (%)	$\geq 1$
Macrobend test (dB)	$\leq 0.05$
60 mm diameter mandrel, 100 turns, loss at 1550 nm.	
Bend radius 10 mm or larger no mechanical degradation.	

#### 2.2.7 ENVIRONMENTAL PERFORMANCE

#### 2.2.8 TEMPERATURE

The quality of the fibres shall be repeatedly tested by the manufacturer in temperature cycling, constant heat and water immersion:  
 Temperature cycling for 30 days -60°C to + 85°C.  
 Heat (+85 °C dry air for 30 days).  
 Water (+20 °C in tap water for 30 days).  
 Details of measurements to be presented by the supplier.

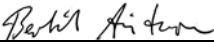
*The attenuation change during tests shall be smaller than 0.05dB/km at 1550 nm.*

#### 2.2.9 FIBRE LIFETIME

The supplier shall present a technique for estimating the lifetime. Failure probability 1.6-E-7 after 40 years.

#### 2.2.10 DYNAMIC TENSILE PERFORMANCE

The tensile test shall be performed on a coated fibre with a gauge length of 500 mm in the air at +23°C and 50%RH. The test shall be performed on at least 25 samples at each one of the pulling speeds 1, 5, 50 and 500 mm/min. The stress corrosion factor n shall be > 19 calculated for the coated fibre. The variation of fibre strength shall be sufficiently small, corresponding to a Weibull slope of minimum 40, calculated from 60% of the fractures. The medium tensile strength at the speed of 50 mm/min shall be larger than 4.5 GPa.

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Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev	File
		2005-03-22	A	

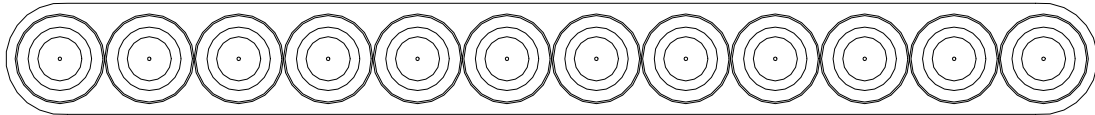
### 2.2.11 STRIPPABILITY

The coating shall be mechanically removable: At +23°C and 50% RH the mean stripping force for every fibre sample shall be within 1.0 and 3.5 N. The same apply when the force is measured within 5 minutes after an environmental test (as described in 4.7) and the standard deviation among fibres around a nominal mean strip force shall be  $\pm 0.5$  N or smaller. The strip force shall be measured with the IEC standard method with a 25 or 50 mm strip length and a 500 mm/min stripping speed. This is a non-routine test.

### 2.2.12 GENERAL

The fibre shall be protected against dirt, dust and mechanical influence by the UV-cured acrylate. The coating shall be mechanically strippable.

## 3 RIBBON SPECIFICATION



**Figure 1** 12-fibre ribbon

### 3.1 RIBBON

Fibres in standard ribbons are encapsulated in one UV-curable acrylate coating layer (ribbon matrix).

### 3.2 FIBRE AND RIBBON IDENTIFICATION

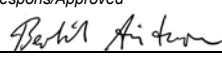
#### 3.2.1 Fibre identification

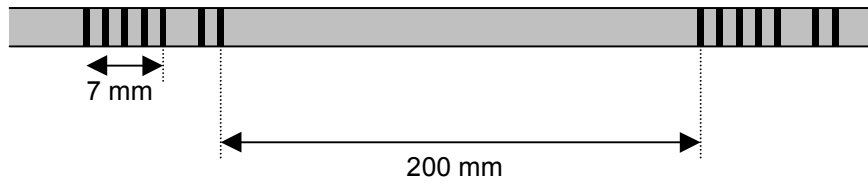
The fibres are coloured with UV-curable acrylate inks. See last page.

#### 3.2.2 Ribbon identification

Individual ribbons are identified by bar symbols printed on the matrix surface, see Figure 2.

Printed symbols are spaced approximately 200mm. Each symbol is a number of bars spaced approximately 1.7mm. Bar symbols are divided into groups of 5 bars (subgroups separated by approximately 3.4mm) for readability reasons. On 12-fibre ribbon text printing is as follows.

Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.		File	
HL/ECA/T/TF Bertil Arvidsson		HL/ECA/T/TX-05:075 Uen			
Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev		
		2005-03-22	A		

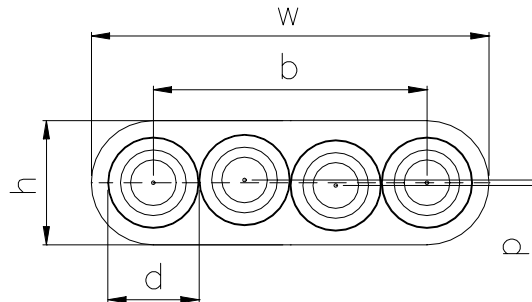


**Figure 2** Example of ribbon bar symbols. The symbol in the example shall be interpreted as “7”.

3.3 RIBBON GEOMETRY

All ribbons fulfil the geometry requirements of IEC 60794-3.

In Figure 3 the ribbon geometry measures are defined and in Table 1 the specification values are given.



**Figure 3** Ribbon geometry measures.

**Table 1** Ribbon geometry

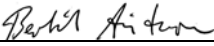
Ribbon type	w [ $\mu\text{m}$ ]	h [ $\mu\text{m}$ ]	b [ $\mu\text{m}$ ]	p [ $\mu\text{m}$ ]	d [ $\mu\text{m}$ ]
12F	3100±30	320±20	2790±20	≤60	255±5

3.4 TRANSMISSION

The transmission requirements of the fibres used in all ribbons specified here are given in the fibre section. The same specification applies to fibres encapsulated in ribbons.

*Note:* some transmission parameters can be temporarily affected when the ribbon is wound on production or shipping reels.



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### 3.5 MECHANICAL PERFORMANCE

#### 3.5.1 Strippability

##### 3.5.1.1 Test requirements

The test is performed in accordance with EN 60794.

Test conditions:	Strip length:	25mm
	Stripping speed:	100mm/min
	Pre-heating temperature:	(100±5)°C
	Time of pre-heating:	10 seconds
	Sample size:	10
	Preconditioning:	24 hours (23±2°C, 50±10 %RH)

##### 3.5.1.2 Acceptance criteria

There shall be no fibre break during the test. There shall be no significant coating debris left on the fibres.

#### 3.5.2 Breakout

##### 3.5.2.1 Fibre breakout from ribbon

It shall be possible to separate individual fibres from the ribbon without damaging the fibre colour layer.

#### 3.5.3 Macrobend

##### 3.5.3.1 Test requirements

The test is performed in accordance with EN 60794-1-2, method G1.

One hundred turns of ribbon is wound with a low tension on a 60mm diameter mandrel.

##### 3.5.3.2 Acceptance criteria

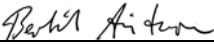
The attenuation change shall be  $\leq 0.20$ dB at 1550nm.

#### 3.5.4 Torsion

##### 3.5.4.1 Test requirements

The test is performed in accordance with EN 60794-1-2, method G6.

Measurement cycle: 5 ±720°, 1 ±2160°. Power loss is recorded for both 1310 and 1550nm for all extreme positions of the ribbon.

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Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev
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			File

3.5.4.2 Acceptance criteria

No change in attenuation.

3.5.5 Crush

3.5.5.1 Test requirements

The test is performed in accordance with EN 60794-1-2, method E3.

Plate-plate test, 500N load during 5 minutes.

3.5.5.2 Acceptance criteria

No change in attenuation after test.

3.6 ENVIRONMENTAL PERFORMANCE

3.6.1 Temperature cycling

3.6.1.1 Test requirements

The test is performed in accordance with EN 60793-1-52.

A ribbon with a length of 1250m is wound with low tension on a collapsible reel and put inside a climate chamber. Attenuation is measured at T<sub>A</sub> and T<sub>B</sub> according to the test conditions below.

Test conditions:	Sample length:	1250m
	T <sub>A</sub> :	-40°C
	T <sub>B</sub> :	+70°C
	Dwell time:	4 hours
	Rate of heating and cooling:	5°C/min
	Number of cycles:	10

3.6.1.2 Acceptance criteria

No change in attenuation.

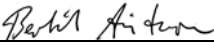
The strip force shall not change more than ± 30% compared to a non-aged ribbon.

3.6.2 Dry heat

3.6.2.1 Test requirements

The test is performed according to IEC 60068-2-2, test Bb.

Test conditions:	Sample length:	1250m
	Dwell time:	21 days
	Temperature:	+70°C

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### 3.6.2.2 Acceptance criteria

No change in attenuation.

The strip force shall not change more than  $\pm 30\%$  compared to a non-aged ribbon.

### 3.6.3 Damp heat

#### 3.6.3.1 Test requirements

The test is performed in accordance with IEC 60068-2-3, test Ca.

Test conditions:	Sample length:	1250m
	Dwell time:	72 days
	Test environment:	+40°C, 90-95% RH

#### 3.6.3.2 Acceptance criteria

No change in attenuation. The strip force shall not change more than  $\pm 30\%$  compared to a non-aged ribbon.

### 3.6.4 Water soak

#### 3.6.4.1 Test requirements

The test is performed in accordance with EN 60794-3.

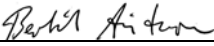
Test conditions:	Sample length:	1250m
	Temperature:	+23 $\pm$ 2°C
	Dwell time:	30 days
	Water:	tap water

#### 3.6.4.2 Acceptance criteria

No change in attenuation. The strip force shall not change more than  $\pm 30\%$  compared to a non-aged ribbon.

### 3.7 MATERIALS

Ribbon matrix materials and colouring inks are carefully selected and approved to meet the requirements listed above. Full compatibility in terms of life time functionality is guaranteed.

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		File	

4 CABLE SPECIFICATION

**OPTICAL CABLE, INDOOR, HALOGEN FREE, FLAME RETARDANT  
GAYGLBD 12-96 fibres**

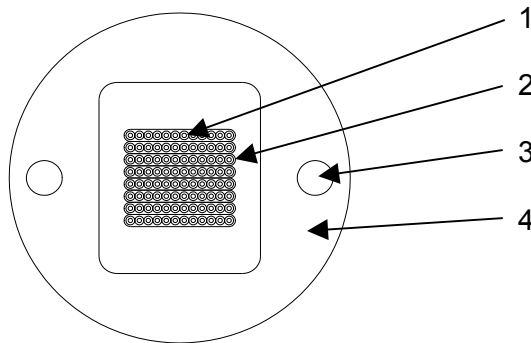
CABLE PROPERTIES

Temperature range	operation	-20 to +70°C
Temperature range	storage	-40 to +70°C
Temperature range	handling	-10 to +40°C
Bending radius, permanently and during installation	minimum	80 mm
Tensile force permanent	maximum	80 N
Pulling force during installation	maximum	800 N
Crush resistance	maximum	500 N
Cable net weight		75 kg/km
Factory length	Customer requirement	

Mechanical tests in accordance with IEC 60794 specifications

<b>CONSTRUCTION</b>	Diameter
1. Acrylate coated fibres	0.25 mm
2. 12-fibre ribbon	3.1x0.32 mm
3. FRP-rod (fibre glass (E-glass), vinylesther resin)	1.0 mm
3. Sheath: Polyethylene, flame retardant	9.2 mm

Cross section



**COLOUR SCHEME**

Colour of fibres in ribbon (Bellcore) :

- 1-BLUE, 2-ORANGE, 3-GREEN, 4-BROWN, 5-SLATE, 6-WHITE, 7-RED,
- 8-BLACK, 9-YELLOW, 10-VIOLET, 11-ROSE, 12-AQUA

Line prints on ribbon matrix.

Sheath marking repeated each meter:

"ERICSSON NETWORK TECHNOLOGIES year-week GAYGQBD 96x10/125 OPTICAL  
FIBRE SYSTEM HAZARD LEVEL 1 PxxxPyyyyyM -----  
-----" Total text with dashes shall be 1 m.

x = cable id. and y = meter-marking.