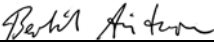


Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.		
HL/ECA/T/TF Bertil Arvidsson		HL/ECA/T/TX-05:075 Uen		
Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev	File
		2005-03-22	A	

## DELIVERY PROTOCOL #6 AND CONFORMANCE CERTIFICATE

### SCOPE

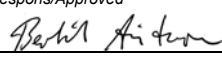
Contract No. F416/EP/CMS: Dense multi-ribbon cable (8x12 fibres).

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.	
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
			File

1 SPECIAL DELIVERY NOTE

1.1 CABLE E-CAL

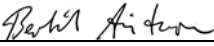
Batch: z000265549; Cable id.: P035P, see sheath-marking.

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

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

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

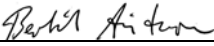
March, 2005: One box with two lengths of 62 m, E-Cal. Attenuation is measured on a longer cable, see above. Specification fulfilled.

**ONE BOX**

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

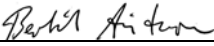
1.3 COMPLIANCE

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

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

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.			
HL/ECA/T/TF Bertil Arvidsson		HL/ECA/T/TX-05:075 Uen			
Dokansv/Godk - Doc respons/Approved	Kontr - Checked	Datum - Date	Rev	File	
		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**

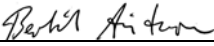
90<sup>th</sup> % < 2%  
 (max diameter - min diameter) / max diameter.  
 Maximum < 5%.  
 This is a non-routine measurement.

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.

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		

#### 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.

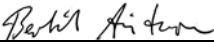
*The attenuation change during tests shall be smaller than 0.05dB/km at 1550 nm.*

#### 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.

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

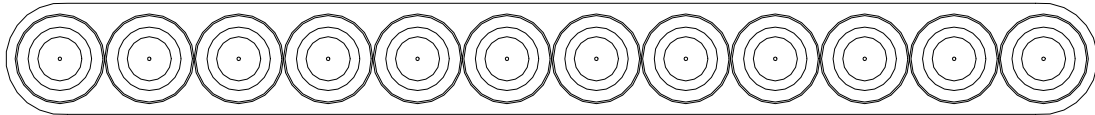
### 2.2.11 STRIPPABILITY

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

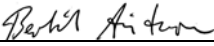
#### 3.2.1 Fibre identification

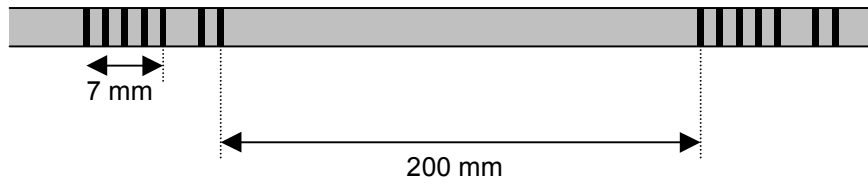
The fibres are coloured with UV-curable acrylate inks. See last page.

#### 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		

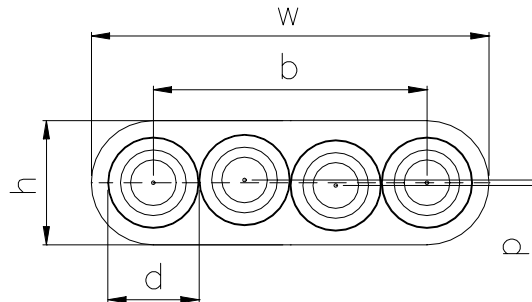


**Figure 2** Example of ribbon bar symbols. The symbol in the example shall be interpreted as “7”.

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

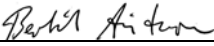
Ribbon type	w [ $\mu\text{m}$ ]	h [ $\mu\text{m}$ ]	b [ $\mu\text{m}$ ]	$\rho$ [ $\mu\text{m}$ ]	d [ $\mu\text{m}$ ]
12F	3100±30	320±20	2790±20	≤60	255±5

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.



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

### 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

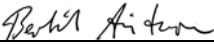
The attenuation change shall be  $\leq 0.20$ dB at 1550nm.

#### 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.

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		

### 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  $T_A$  and  $T_B$  according to the test conditions below.

Test conditions:	Sample length:	1250m
	$T_A$ :	-40°C
	$T_B$ :	+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.

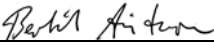
The strip force shall not change more than  $\pm 30\%$  compared to a non-aged ribbon.

### 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

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		

### 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.

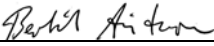
Test conditions:	Sample length:	1250m
	Temperature:	+23 $\pm$ 2°C
	Dwell time:	30 days
	Water:	tap water

#### 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.

Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other)		Nr - No.	
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
		File	

4 CABLE SPECIFICATION

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

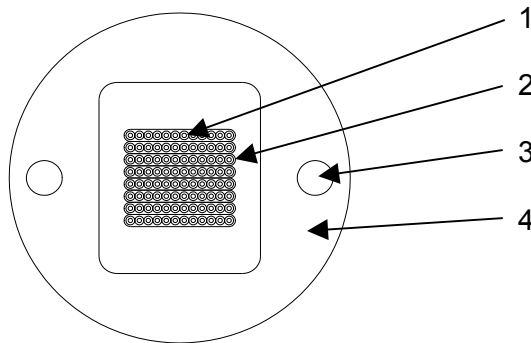
CABLE PROPERTIES

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.