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# AMS-02 SPD <> S-Crate Cabling

## Assembly Procedure

Revision 4 (2<sup>nd</sup> Oct. 2007)

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**TSPD <> S-Crate Cabling**  
Assembly Procedure

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<b>Reviewed by</b>	<b>Alessandro Basili</b>
<b>Approved by</b>	



## Scope of the document

This document has been written to support the assembly of the ToF Electronics Cabling between ToF Power Distribution Box (SPD), ToF-Electronics-Crate (S-Crate) and ToF HV Brick (SHV). The entire procedure should be read before starting assembly.

**This document is used as attachment to the T cable assembly document and gives specific datasheets for S-Cables. Detailed procedure is given in U or T Cable assembly document.**



## 1. Assembly Information

### 1.1 Cleaning of materials

Area for the UPD assembly must be maintained in a clean and orderly condition. The surface of working table must be cleaned by IPA (Isopropyl Alcohol).

The subsequent objects need to be cleaned by IPA before assembly:

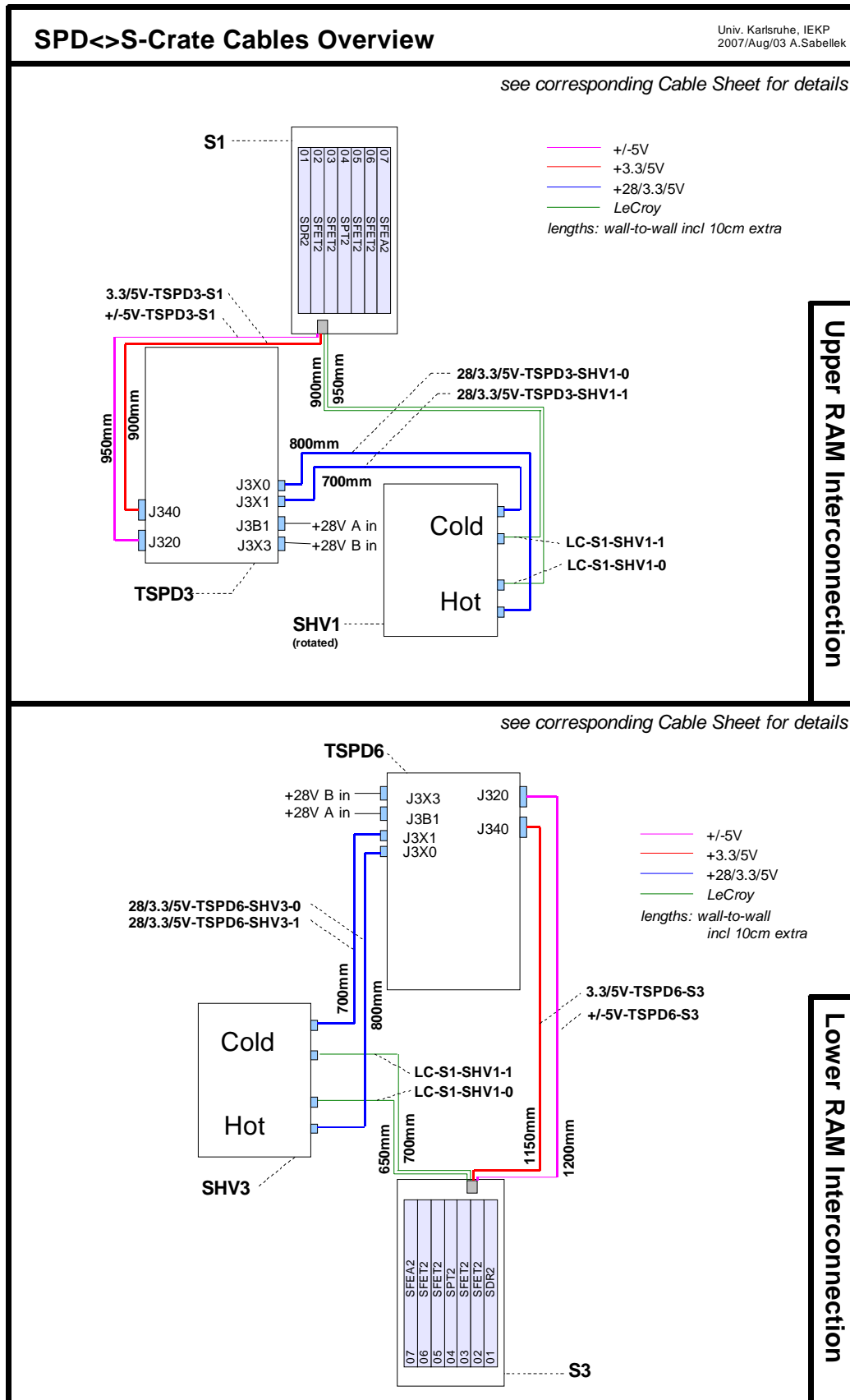
- all mechanical parts and cables
- all assembly tools

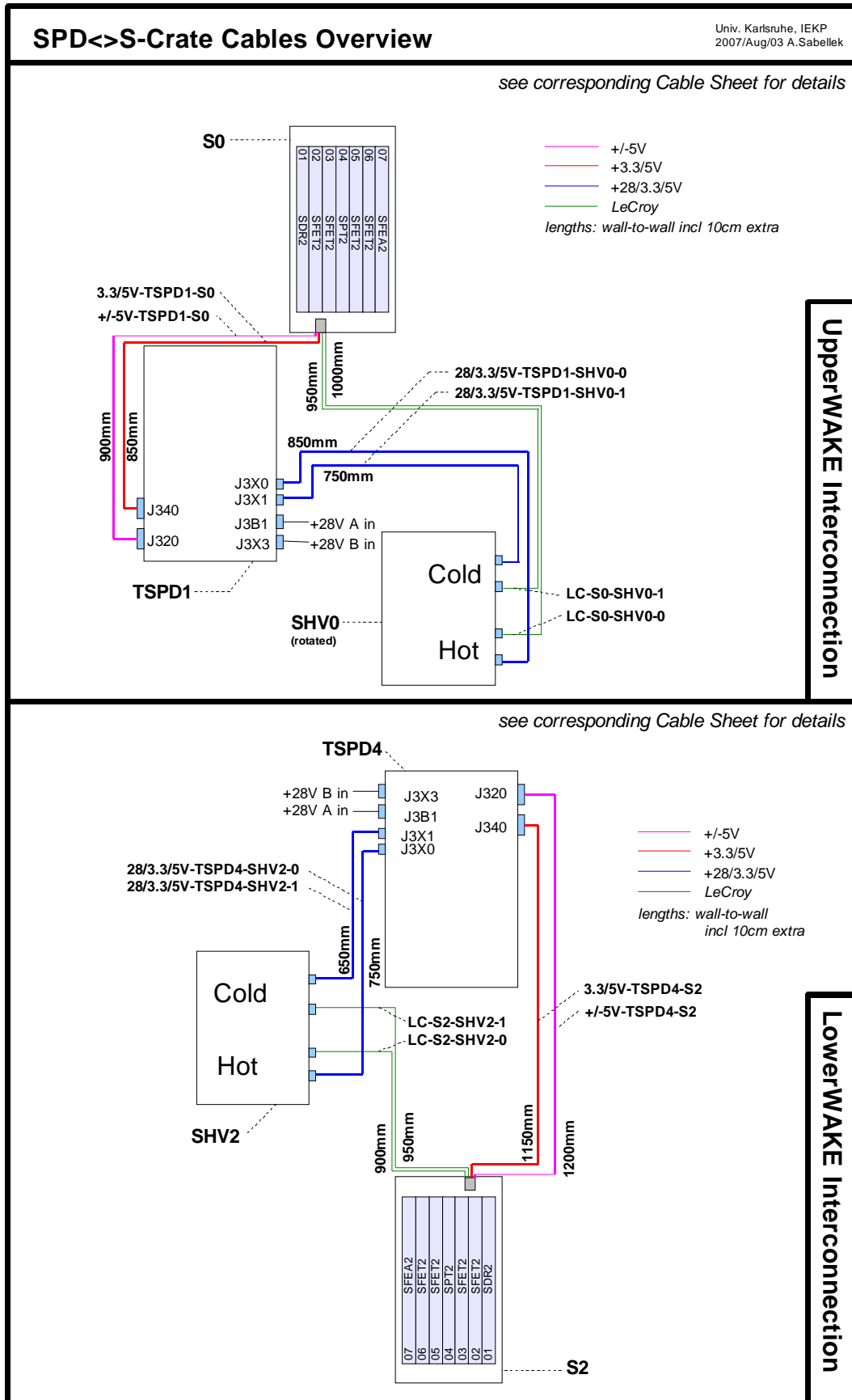
During the assembly you must wear 100% natural rubber gloves.

For a complete procedure the NASA technical standards for flight hardware workmanship should be followed.



## 1.2 SPD <> S-Crate Cable Assignment and Labeling







Cable	TSPD		conn to	S-Crate	SHV	Wall<>Wall	SBP Path (max)	total Cable
ID	Box No.	Conn.ID	(boards)	No.	No.	Length (mm)	Length (mm)	Length (mm)
<b>RAM</b>								
+/-5V-TSPD3-S1	TSPD3	J320	S9052	S1	-	950	300	1250
3.3/5V-TSPD3-S1	TSPD3	J340	S9074	S1	-	900	300	1200
28/3.3/5V-TSPD3-SHV1-0	TSPD3	J3X0	S9074(A)	-	SHV1	800	-	800
28/3.3/5V-TSPD3-SHV1-1	TSPD3	J3X1	S9074(B)	-	SHV1	700	-	700
LC-S1-SHV1-0			-	S1	SHV1	950	250	1200
LC-S1-SHV1-1			-	S1	SHV1	900	100	1000
+/-5V-TSPD6-S3	TSPD6	J320	S9052	S3	-	1200	300	1500
3.3/5V-TSPD6-S3	TSPD6	J340	S9074	S3	-	1150	300	1450
28/3.3/5V-TSPD6-SHV3-0	TSPD6	J3X0	S9074(A)	-	SHV3	800	-	800
28/3.3/5V-TSPD6-SHV3-1	TSPD6	J3X1	S9074(B)	-	SHV3	700	-	700
LC-S3-SHV1-0			-	S3	SHV3	650	250	900
LC-S3-SHV1-1			-	S3	SHV3	700	100	800
<b>WAKE</b>								
+/-5V-TSPD1-S0	TSPD1	J320	S9052	S0	-	900	300	1200
3.3/5V-TSPD1-S0	TSPD1	J340	S9074	S0	-	850	300	1150
28/3.3/5V-TSPD1-SHV0-0	TSPD1	J3X0	S9074(A)	-	SHV0	850	-	850
28/3.3/5V-TSPD1-SHV0-1	TSPD1	J3X1	S9074(B)	-	SHV0	750	-	750
LC-S0-SHV0-0			-	S0	SHV0	1000	250	1250
LC-S0-SHV0-1			-	S0	SHV0	950	100	1050
+/-5V-TSPD4-S2	TSPD4	J320	S9052	S2	-	1200	300	1500
3.3/5V-TSPD4-S2	TSPD4	J340	S9074	S2	-	1150	300	1450
28/3.3/5V-TSPD4-SHV2-0	TSPD4	J3X0	S9074(A)	-	SHV2	750	-	750
28/3.3/5V-TSPD4-SHV2-1	TSPD4	J3X1	S9074(B)	-	SHV2	650	-	650
LC-S2-SHV2-0			-	S2	SHV2	900	250	1150
LC-S2-SHV2-1			-	S2	SHV2	950	100	1050

Uni Karlsruhe, IEKP, 2007/Aug/10 A.Sabellek

Tab.1 List of Cables



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In the following, unique label assignment for cables between SPD and S-Crate given in Fig.1 is used. Four set of Cables are needed. Each cable set consists of:

- 1 x +/-5V Cable to connect LV output of S9052 DCDC Converter with SBP
- 1 x +3.3/5V Cable to connect LV output of S9074 DCDC Converter to SBP
- 2 x 28/3.3/5V Cable to connect LV output of S9074(A/B) DCDC Converter to SHV Brick

Position for Cable set x-S1-x (connecting TSPD3 and S1) and set x-S1-x (connecting TSPD6 and S3) is the RAM-Radiator and position for Cable set x-S0-x (connecting TSPD1 and S0) and set x-S2-x (connecting TSPD4 and S2) is the WAKE- Radiator. Lecroy cables (LC-Sx-x) connecting SBP to Controller inside SHV Brick are part of SBP (S-Backplane) and its BOM and excluded in this document.



1.4 Cable Assembly Sheets

### (1) Cable Assembly +/-5V-TSPD1-S0

100mm

L

L1

J1

1,2    9,11    3,4,5,6,7,8,10    9,11    12

J2/J5  
J3/J6  
J4/J7  
J8/J11  
J9/J12  
J10/J13

		Qty	
1	connector	MS27484E20F16P	pc
2	shell	MS27506F20-2	pc
3	wire	M22759/44-16-0	mm L 2
4	wire	M22759/44-16-1	mm L 2
5	wire	M22759/44-16-2	mm L 2
6	wire	M22759/44-16-6	mm L 2
7	wire	M22759/44-16-7	mm L 2
8	wire	M22759/44-16-9	mm L 2
9	heat shrink	RW-175	mm 50 3
10	sleeve	DM686 1/4"	mm L1 1
11	lacing tape	A-A-52081-PTH-5	pc 2
12	ring lug	AMP 332453	pc 12

Cable ID	L1 (mm)	L(mm)
+/-5V-TSPD1-S0	950	1200

Wires Twisting

TSPD1    Cable +/-5V-TSPD1-S0    S0

*t.b.d*

Assembly Drawing and BOM

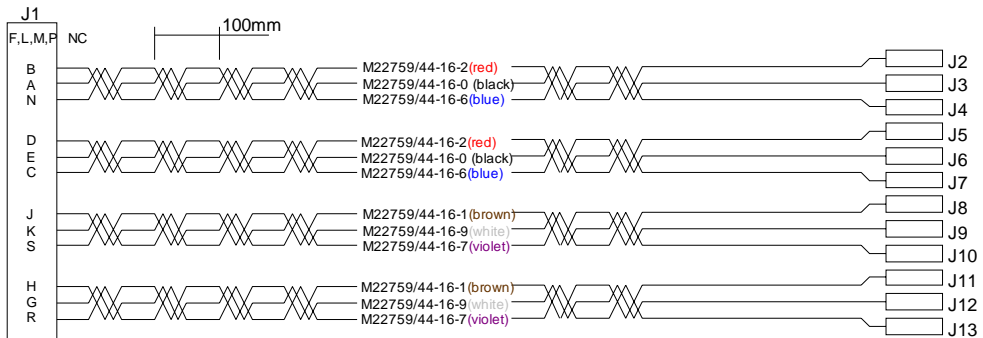
TSPD1    Cable +/-5V-TSPD1-S0    S0

*t.b.d*

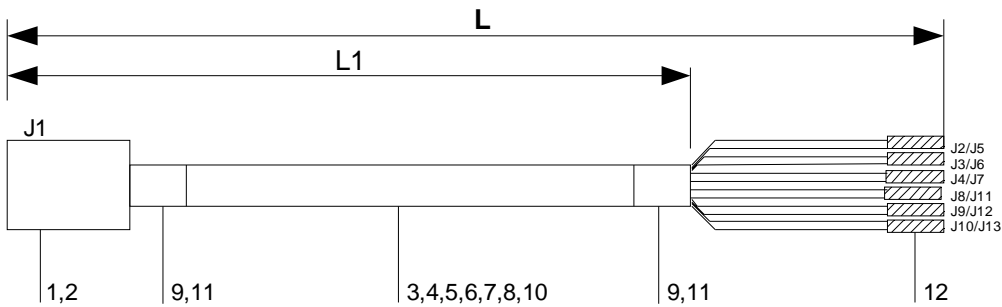
Interconnection Scheme



**(2) Cable Assembly +/-5V-TSPD3-S1**



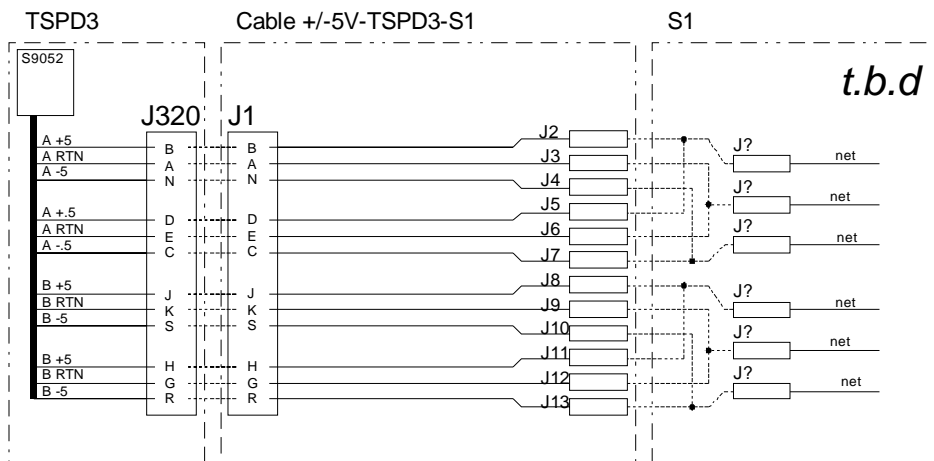
Wires Twisting



		Qty	
1	connector MS27484E20F16P	pc	1
2	shell MS27506F20-2	pc	1
3	wire M22759/44-16-0	mm	L 2
4	wire M22759/44-16-1	mm	L 2
5	wire M22759/44-16-2	mm	L 2
6	wire M22759/44-16-6	mm	L 2
7	wire M22759/44-16-7	mm	L 2
8	wire M22759/44-16-9	mm	L 2
9	heat shrink RW-175	mm	50 3
10	sleeve DM686 1/4"	mm	L1 1
11	lacing tape A-A-52081-PTH-5	pc	2
12	ring lug AMP 332453	pc	12

Cable ID	L1 (mm)	L(mm)
+/-5V-TSPD3-S1	1000	1250

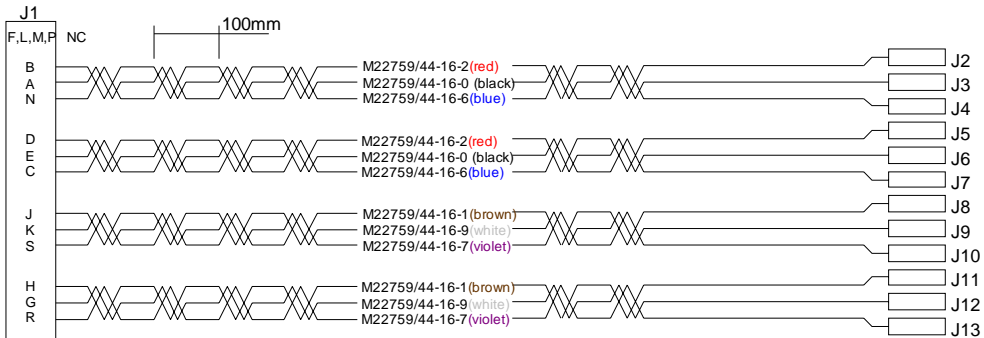
Assembly Drawing and BOM



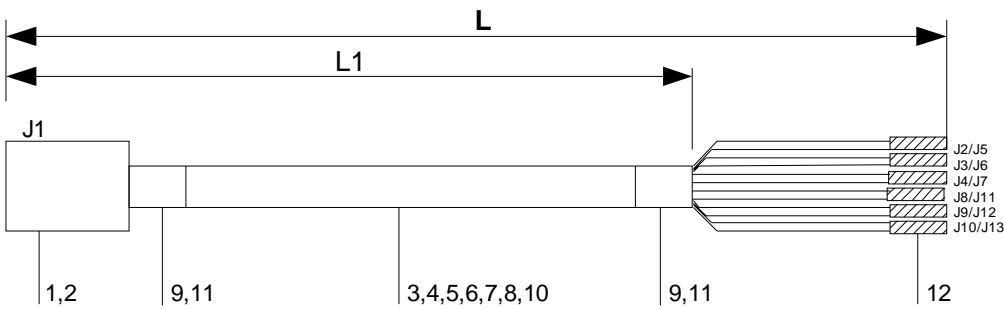
Interconnection Scheme



**(3) Cable Assembly +/-5V-TSPD4-S2**



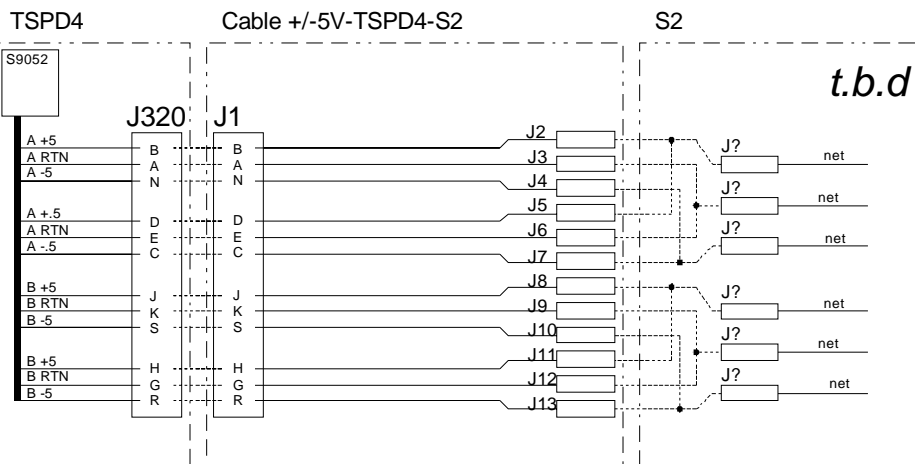
Wires Twisting



Assembly Drawing and BOM

		Qty	
1	connector MS27484E20F16P	pc	1
2	shell MS27506F20-2	pc	1
3	wire M22759/44-16-0	mm	L 2
4	wire M22759/44-16-1	mm	L 2
5	wire M22759/44-16-2	mm	L 2
6	wire M22759/44-16-6	mm	L 2
7	wire M22759/44-16-7	mm	L 2
8	wire M22759/44-16-9	mm	L 2
9	heat shrink RW-175	mm	50 3
10	sleeve DM686 1/4"	mm	L1 1
11	lacing tape A-A-52081-PTH-5	pc	2
12	ring lug AMP 332453	pc	12

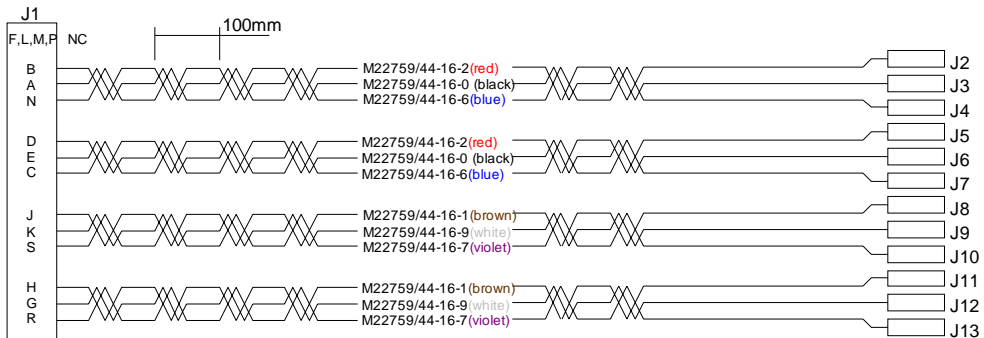
Cable ID	L1 (mm)	L(mm)
+/-5V-TSPD4-S2	1250	1500



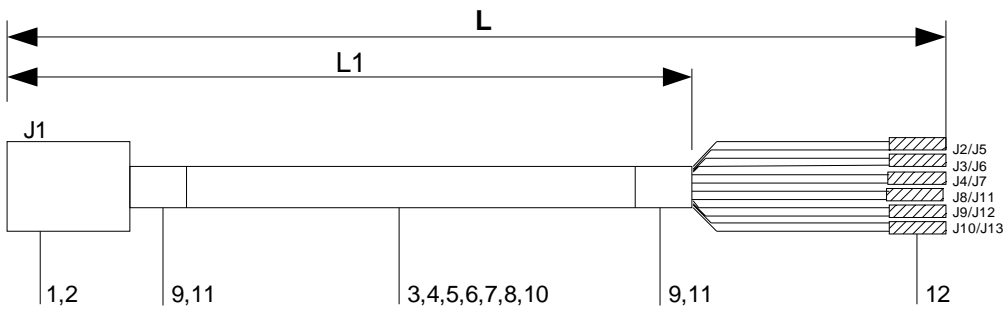
Interconnection Scheme



**(4) Cable Assembly +/-5V-TSPD6-S3**



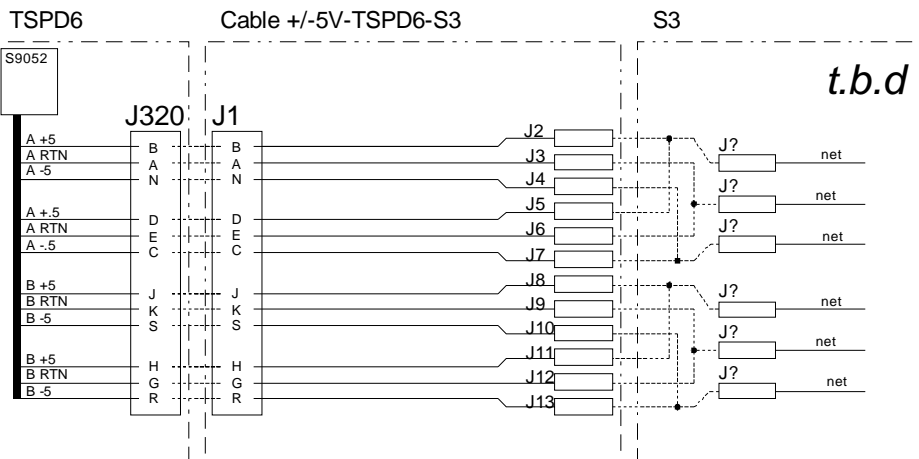
Wires Twisting



Assembly Drawing and BOM

		Qty	
1	connector MS27484E20F16P	pc	1
2	shell MS27506F20-2	pc	1
3	wire M22759/44-16-0	mm	L 2
4	wire M22759/44-16-1	mm	L 2
5	wire M22759/44-16-2	mm	L 2
6	wire M22759/44-16-6	mm	L 2
7	wire M22759/44-16-7	mm	L 2
8	wire M22759/44-16-9	mm	L 2
9	heat shrink RW-175	mm	50 3
10	sleeve DM686 1/4"	mm	L1 1
11	lacing tape A-A-52081-PTH-5	pc	2
12	ring lug AMP 332453	pc	12

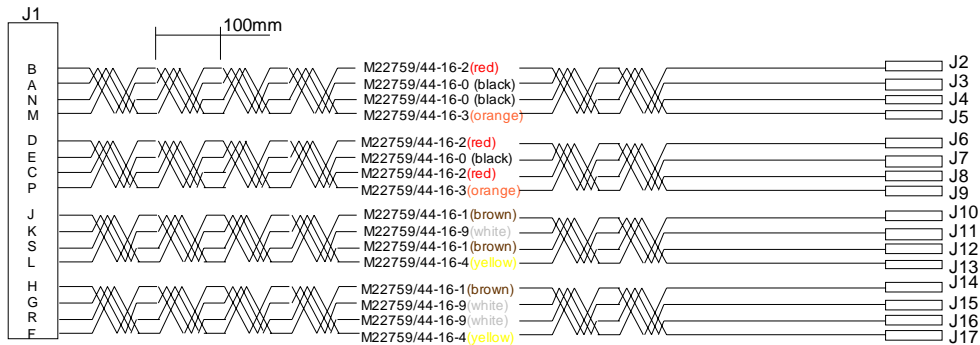
Cable ID	L1 (mm)	L(mm)
+/-5V-TSPD6-S3	1250	1500



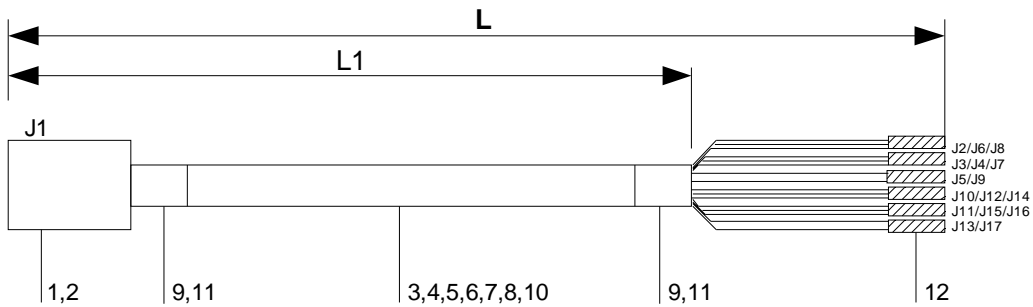
Interconnection Scheme



**(5) Cable Assembly 3.3/5V-TSPD1-S0**



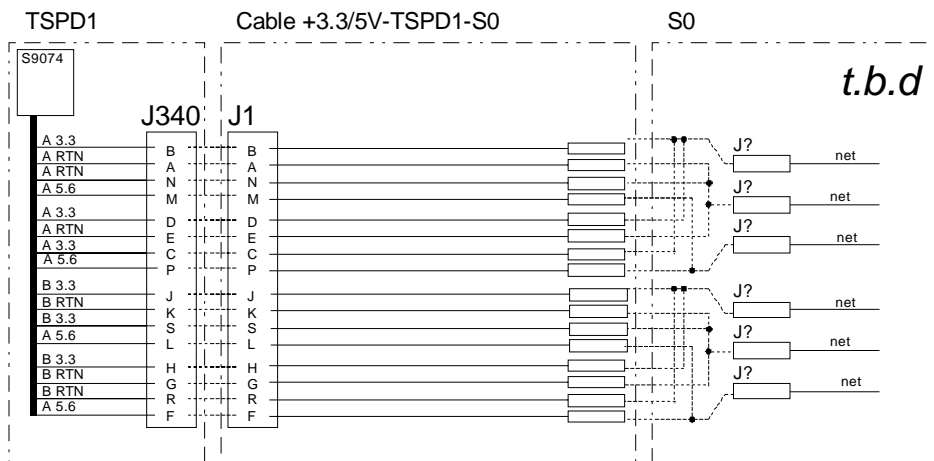
**Wires Twisting**



**Assembly Drawing and BOM**

		Qty		
1	connector	MS27484E20F16P	pc	1
2	shell	MS27506F20-2	pc	1
3	wire	M22759/44-16-0	mm	L 3
4	wire	M22759/44-16-1	mm	L 3
5	wire	M22759/44-16-2	mm	L 3
6	wire	M22759/44-16-3	mm	L 2
7	wire	M22759/44-16-4	mm	L 2
8	wire	M22759/44-16-9	mm	L 3
9	heat shrink	RW-175	mm	50 3
10	sleeve	DM686 1/4"	mm	L1 1
11	lacing tape	A-A-52081-PTH-5	pc	2
12	ring lug	AMP 332453	pc	16

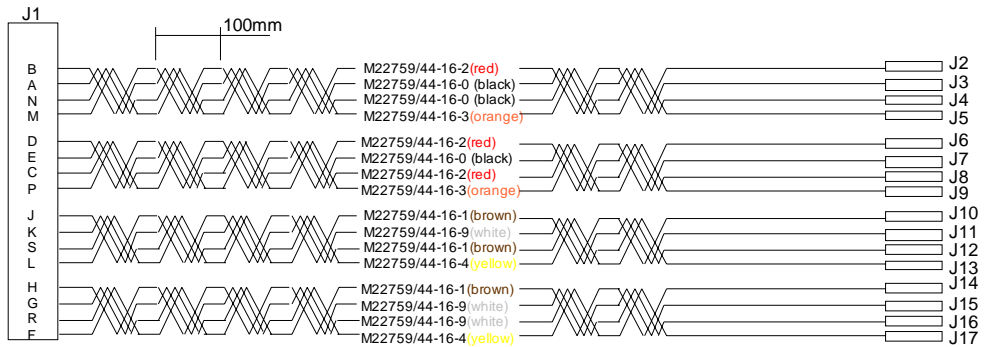
Cable ID	L1 (mm)	L(mm)
3.3/5V-TSPD1-S0	900	1150



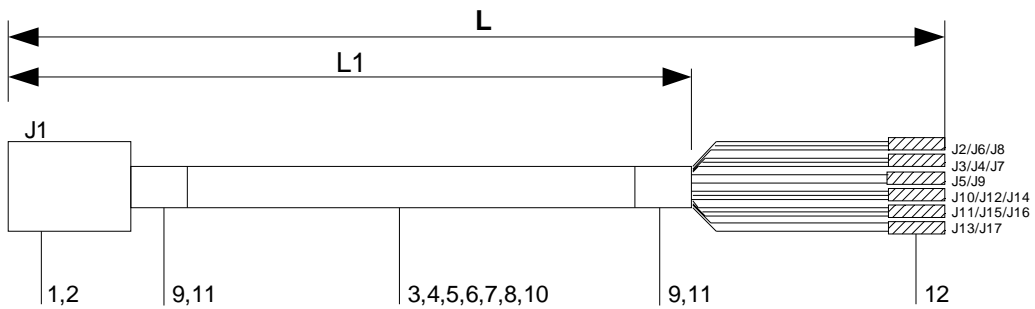
**Interconnection Scheme**



**(6) Cable Assembly 3.3/5V-TSPD3-S1**



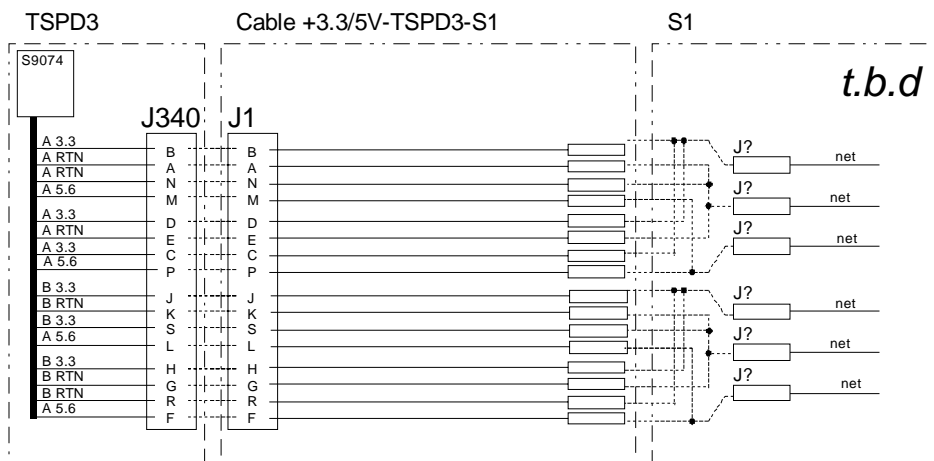
**Wires Twisting**



**Assembly Drawing and BOM**

		Qty		
1	connector	MS27484E20F16P	pc	1
2	shell	MS27506F20-2	pc	1
3	wire	M22759/44-16-0	mm	L 3
4	wire	M22759/44-16-1	mm	L 3
5	wire	M22759/44-16-2	mm	L 3
6	wire	M22759/44-16-3	mm	L 2
7	wire	M22759/44-16-4	mm	L 2
8	wire	M22759/44-16-9	mm	L 3
9	heat shrink	RW-175	mm	50 3
10	sleeve	DM686 ¼"	mm	L1 1
11	lacing tape	A-A-52081-PTH-5	pc	2
12	ring lug	AMP 332453	pc	16

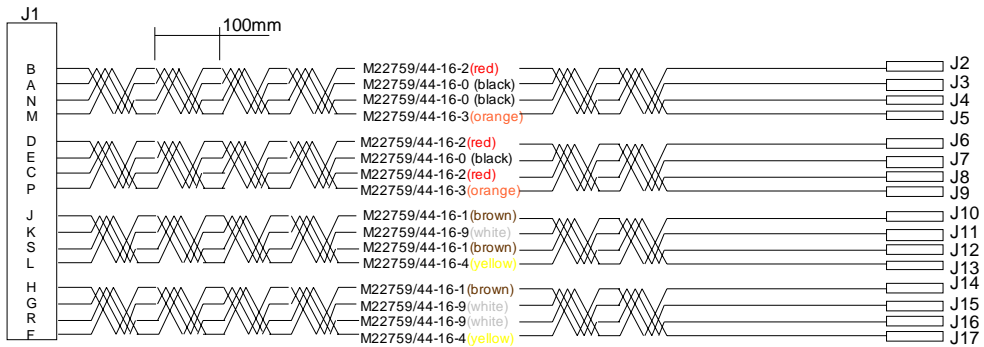
Cable ID	L1 (mm)	L(mm)
3.3/5V-TSPD3-S1	950	1200



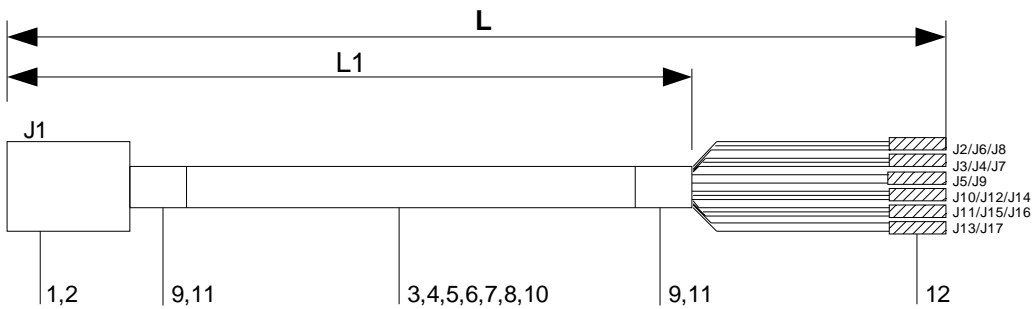
**Interconnection Scheme**



(7) Cable Assembly 3.3/5V-TSPD4-S2



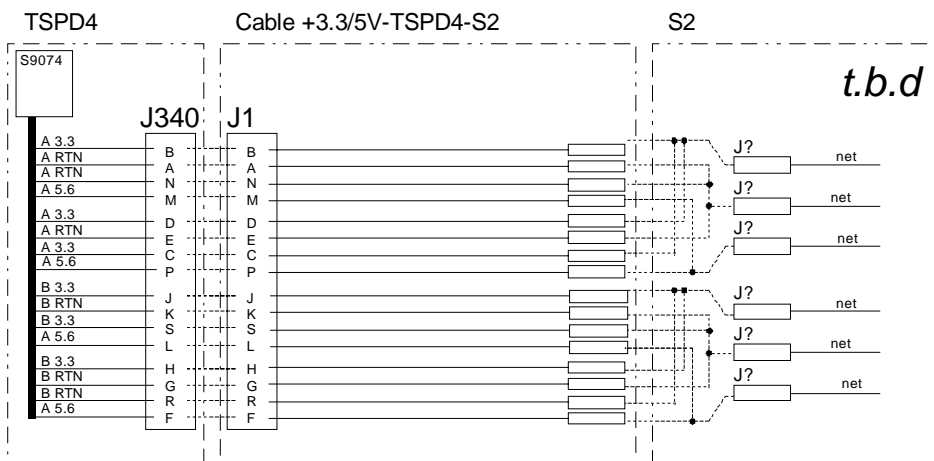
Wires Twisting



Assembly Drawing and BOM

		Qty		
1	connector	MS27484E20F16P	pc	1
2	shell	MS27506F20-2	pc	1
3	wire	M22759/44-16-0	mm	L 3
4	wire	M22759/44-16-1	mm	L 3
5	wire	M22759/44-16-2	mm	L 3
6	wire	M22759/44-16-3	mm	L 2
7	wire	M22759/44-16-4	mm	L 2
8	wire	M22759/44-16-9	mm	L 3
9	heat shrink	RW-175	mm	50 3
10	sleeve	DM686 ¼"	mm	L1 1
11	lacing tape	A-A-52081-PTH-5	pc	2
12	ring lug	AMP 332453	pc	16

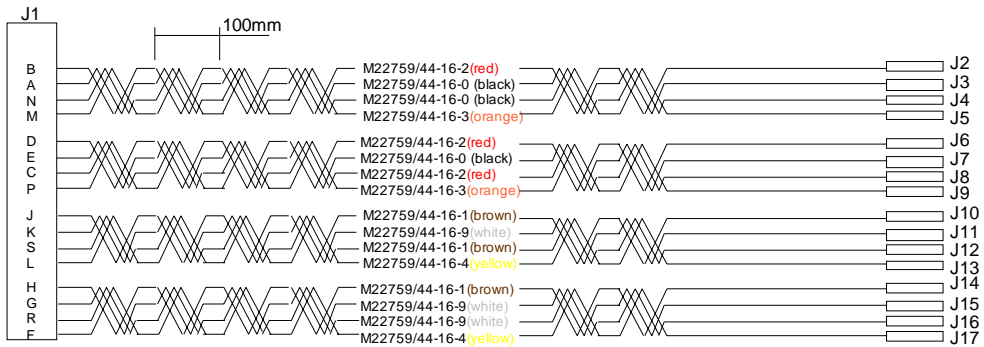
Cable ID	L1 (mm)	L(mm)
3.3/5V-TSPD4-S2	1200	1450



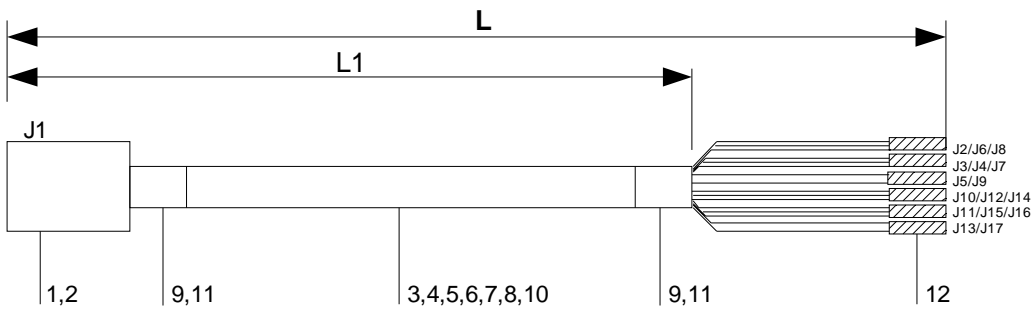
Interconnection Scheme



**(8) Cable Assembly 3.3/5V-TSPD6-S3**



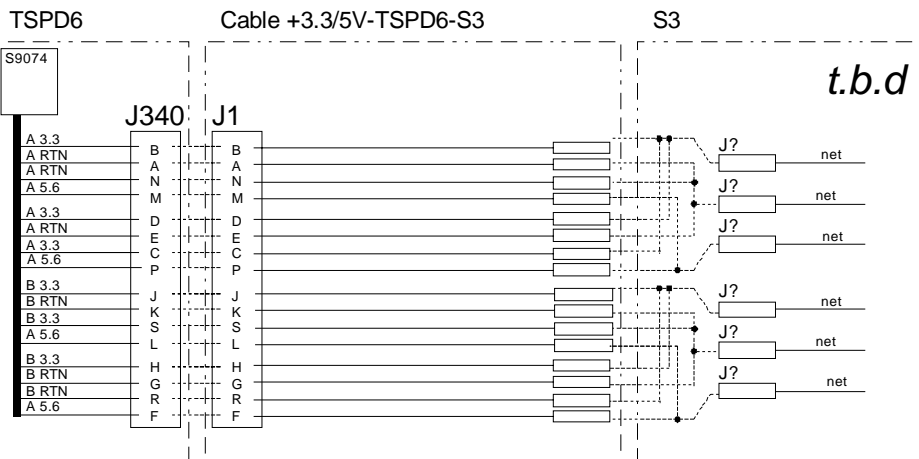
Wires Twisting



Assembly Drawing and BOM

		Qty		
1	connector	MS27484E20F16P	pc	1
2	shell	MS27506F20-2	pc	1
3	wire	M22759/44-16-0	mm	L 3
4	wire	M22759/44-16-1	mm	L 3
5	wire	M22759/44-16-2	mm	L 3
6	wire	M22759/44-16-3	mm	L 2
7	wire	M22759/44-16-4	mm	L 2
8	wire	M22759/44-16-9	mm	L 3
9	heat shrink	RW-175	mm	50 3
10	sleeve	DM686 ¼"	mm	L1 1
11	lacing tape	A-A-52081-PTH-5	pc	2
12	ring lug	AMP 332453	pc	16

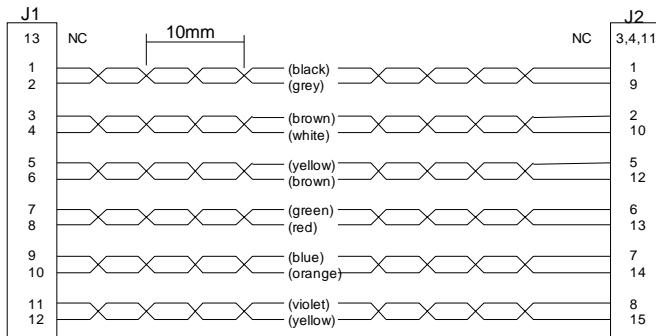
Cable ID	L1 (mm)	L(mm)
3.3/5V-TSPD6-S3	1200	1450



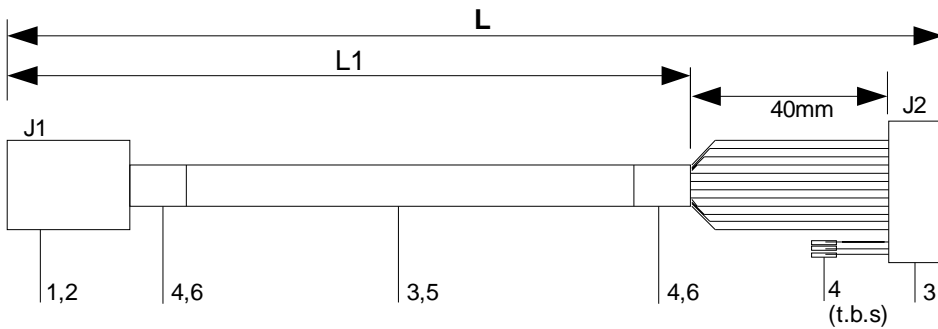
Interconnection Scheme



**(9-16) Cable Assembly 28/3.3/5V-TSPDx-SHVx**



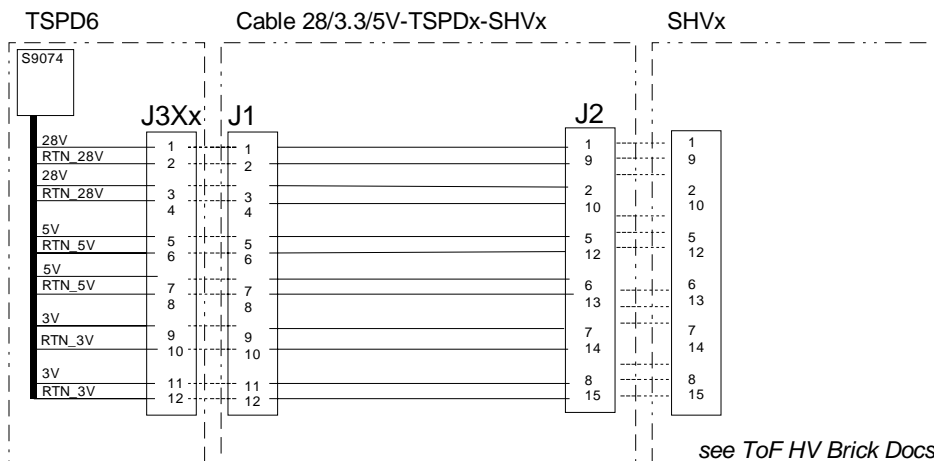
Wires Twisting



Assembly Drawing and BOM

		Qty		
1	connector	MS27508E10F35P	pc	1
2	shell	MS27506F10-2	pc	1
3	connector	M83513/03-B12N	pc	1
4	heat shrink	RW-175	mm	50
5	sleeve	DM686 1/4"	mm	L1
6	lacing tape	A-A-52081-PTH-5	pc	2

No.	Cable ID	L1 (mm)	L(mm)
9	28/3.3/5V-TSPD1-SHV0-0	800	850
10	28/3.3/5V-TSPD1-SHV0-1	700	750
11	28/3.3/5V-TSPD3-SHV1-0	750	800
12	28/3.3/5V-TSPD3-SHV1-1	650	700
13	28/3.3/5V-TSPD4-SHV2-0	700	750
14	28/3.3/5V-TSPD4-SHV2-1	600	650
15	28/3.3/5V-TSPD6-SHV3-0	750	800
16	28/3.3/5V-TSPD6-SHV3-1	650	700



Interconnection Scheme

see ToF HV Brick Docs



## 2 List of Tools

### 2.1 Wire Cutters

Wire cutting tools that shear the conductor shall be selected in preference to diagonal cutters that cut the conductor by bringing two blade edges together. The cutting edges of wire trimming tools shall be maintained sharp and free from nicks and indentations.

Recommended Wire Cutter 512N by EREM or similar.



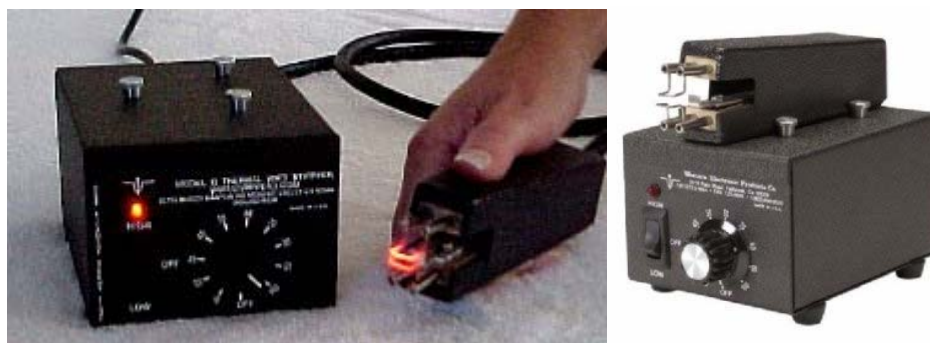
### 2.2 Wire Stripper

Either precision mechanical tools or thermal strippers shall be selected for insulation stripping. Thermal strippers shall have variable temperature control. The tools shall not nick, ring, gouge, or stretch conductors or remove plating so that the base metal shows.

Superficial scraping of conductors is acceptable providing conductor base material is not exposed.

The conductor shall be clean and free from damage. Strands shall be twisted together in the original lay, or as nearly as possible to the original lay.

Use of a Thermal Wire Stripper is recommended.



**Fig.5 Thermal Wire Stripper, Model G**



<p align="center"><b>ACCEPTABLE RETWISTED LAY</b></p> <p>If the twist pattern (lay) of wire strands is disturbed, it shall be restored as nearly as possible to the original pattern. Retwisted lay is acceptable, provided no other damage is evident.</p> <p><a href="#">NASA-STD-8739.3 [7.2.4]</a>  <a href="#">NASA-STD-8739.4 [10.1.4], [19.6.1.a.2]</a></p>	<p align="center"><b>UNACCEPTABLE OVERTWISTED STRANDS</b></p> <p>Strands twisted in excess of the normal twist pattern (lay) exert increased stress on individual strands, and may result in conductor breakage.</p> <p><a href="#">NASA-STD-8739.3 [7.2.4]</a>  <a href="#">NASA-STD-8739.4 [10.1.4]</a></p>
<p align="center"><b>ACCEPTABLE SCUFFED INSULATION/JACKET</b></p> <p>Slight scuffing (a dull or rubbed appearance) of the insulation surface finish is acceptable, provided no other damage is evident.</p> <p><a href="#">NASA-STD-8739.3 [7.2.2]</a>  <a href="#">NASA-STD-8739.4 [10.1.2]</a></p>	<p align="center"><b>UNACCEPTABLE DAMAGED INSULATION/JACKET</b></p> <p>The conductor insulation and /or cable jacket shall not exhibit any damage, such as nicks, cuts, or charring. Conductors/Jackets exhibiting damage (other than minor scuffing) shall not be used.</p> <p><a href="#">NASA-STD-8739.3 [13.6.2.a.1]</a>  <a href="#">NASA-STD-8739.4 [19.6.2.a.2]</a></p>

**Fig.6: General wire stripping criteria**

### 2.3 Crimper (Connector Pins)

**List of mandatory crimping tools:**

Hand Tool (crimper itself)	p/n: M22520/2-01
Hand Tool (crimper itself)	p/n: M22520/1-01
AWG 22 turret for M22520/2-01 tool	p/n: M22520/2-09
AWG 12-20 turret for M22520/1-01 tool	p/n: M22520/1-04



**Crimping Instruction:**

1. Insert stripped wire into contact crimp pot. The stripping length of the wires is given in Fig 11. Wire must be visible thru inspection hole.
2. Using correct crimp tool and locator, cycle the tool once to be sure the indentors are open. Insert contact and wire into locator. Fig. 10 shows the socket in the correct position. Squeeze tool handles firmly and completely to insure a proper crimp. The tool will not release unless the crimp indentors in the tool head have been fully actuated.
3. Release crimped contact and wire from tool. Be certain the wire is visible thru inspection hole in contact.

Connector	Contact	Comment	Tool	Comment	Turret	Comment	AWG	Pin Size
<b>Cable Side Connectors (MS27484)</b>								
MS27474E10F35P	22D-P	S9056	M22520/2-01	Crimp Tool 22D	M22520/2-09	Turret P 22D	22	22
MS27474E16F6P	12-P	S9053U	M22520/1-01	Crimp Tool 12-20	M22520/1-04	Turret P/S 12-20	12	12
MS27474E20F16P	16-P	S9048	M22520/1-01	Crimp Tool 12-20	M22520/1-04	Turret P/S 12-20	16	16

Fig.7 Table of mandatory Tools and Turret for Connectors



Fig.8 crimping tool M22520/1-01 and turret M22520/1-04

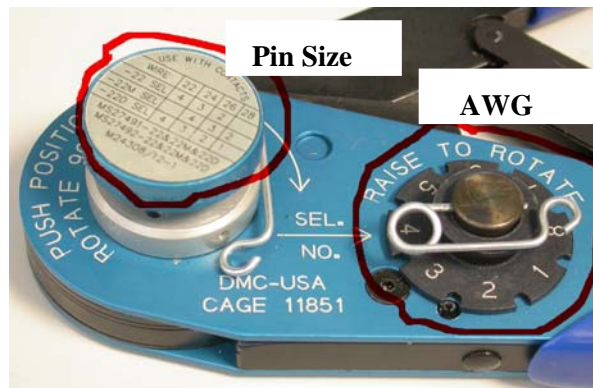


fig. 9 crimping tool M22520/2-01 and turret M22520/2-09



Fig. 10 crimping tool backside with socket



Wire Size	A
22D or 22M*	.125 (3.18)
20	.188 (4.77)
16	.188 (4.77)
12	.188 (4.77)

Fig.11: Wire Stripping length; Dimensions are shown in inches (millimetres)

<p><b>CRIMP LOCATIONS (ALL CRIMP TYPES)</b></p> <p>Crimp indents should be centered between the wire entry shoulder of the crimp barrel and the inspection hole/wire exit shoulder. Crimp indents shall not encroach on the wire entry shoulder or the inspection hole/wire exit shoulder.</p>	<p><b>MAXIMUM INSULATION CLEARANCE (ALL CRIMP TYPES)</b></p> <p>1. For conductors 20 AWG and smaller, the maximum clearance is 0.75 mm (0.030 in.). 2. For 18 AWG and larger conductors, the maximum clearance is 1.25 mm (0.05 in.). <a href="#">NASA-STD-8739.4 [10.1.7.b.2], [19.6.2.c.9]</a></p>
<p><b>MINIMUM INSULATION CLEARANCE (ALL CRIMP TYPES)</b></p> <p>The minimum insulation clearance for all crimped connections is 0.25 mm (0.010 in.). <a href="#">NASA-STD-8739.4 [10.1.7.b.1], [19.6.2.c.9]</a></p>	<p><b>SOLDER-TINNED STRANDED WIRE SOLID WIRE</b></p> <p>Crimping of solid wire, component leads, or stranded wire that has been solder-tinned, is prohibited. <a href="#">NASA-STD-8739.4 [4.3.4]</a></p>

Fig.12: General crimping criteria



## 2.4 Connector Wire Insertion tools

### List of mandatory metal insertion/extraction tools:

Insert Tool 22D	p/n: MS27495 A22M
Extract Tool 22D	p/n: MS27495 R22M
Insert Tool 16	p/n: MS27495 A16
Extract Tool 16	p/n: MS27495 R16
Insert Tool 12	p/n: MS27495 A12
Extract Tool 12	p/n: MS27495 R12



Insertion



Extraction



2. Using proper plastic or metal insertion tool for corresponding contact, position wire in tip of the tool so that the tool tip butts up against the contact shoulder.



3. Press tool against contact shoulder and, with firm and even pressure, insert wired contact and tool tip into center contact cavity. A slight click may be heard as metal retaining tines snap into place behind contact shoulder.



4. Remove tool and pull back lightly on wire to make sure contact is properly seated. Repeat operation with remainder of contacts to be inserted, beginning with the center cavity and working outward in alternating rows.



5. After all contacts are inserted, fill any empty cavities with wire sealing plugs, Ressemble plug or receptacle hardware.

**Fig.13: Insertion tool Instruction**



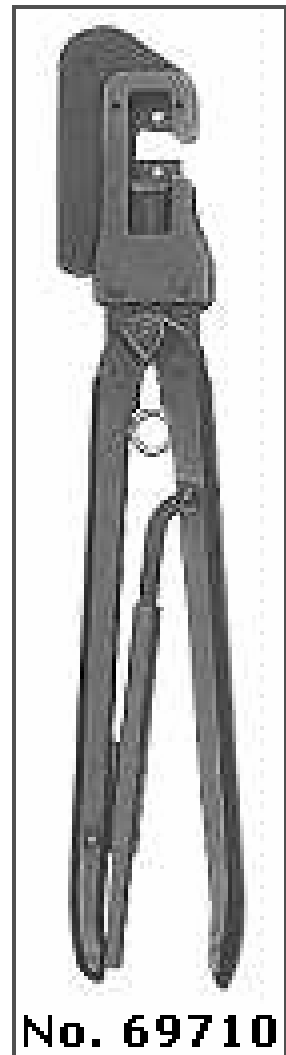
## 2.5 Crimper Tool for Terminal Ring Lugs

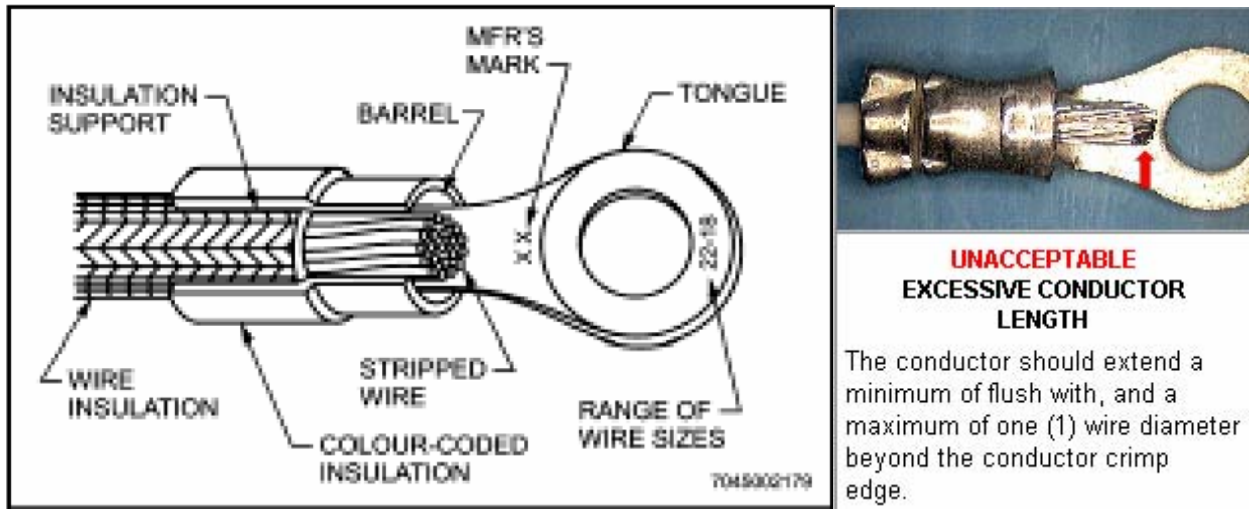
### List of mandatory crimping tools:

Hand Tool	p/n: 69710-1
AWG 22 die for 69710-1 tool	p/n: 69732
AWG 16 die for 69710-1 tool	p/n: 69733
AWG 12 die for 69710-1 tool	p/n: 69735

Manufacturer Crimping Instructions have to be followed:

- Strip wire insulation using one of the recommended stripping procedures.
- Check tool for correct die for wire thickness.
- Insert terminal lug, tongue first, into wire side of hand tool barrel crimping jaws, until terminal lug barrel butts flush against tool stop on the locator.
- Squeeze tool handles slowly until tool jaws hold terminal lug barrel firmly in place, but without denting it.
- Insert stripped wire into terminal lug barrel until wire insulation butts flush against near end of wire barrel.
- Squeeze tool handles until ratchet releases.
- Remove completed assembly and examine it for proper crimp.





**Fig.14: General crimping criteria for terminal ring lugs**



### 3. Assembly Steps Instruction

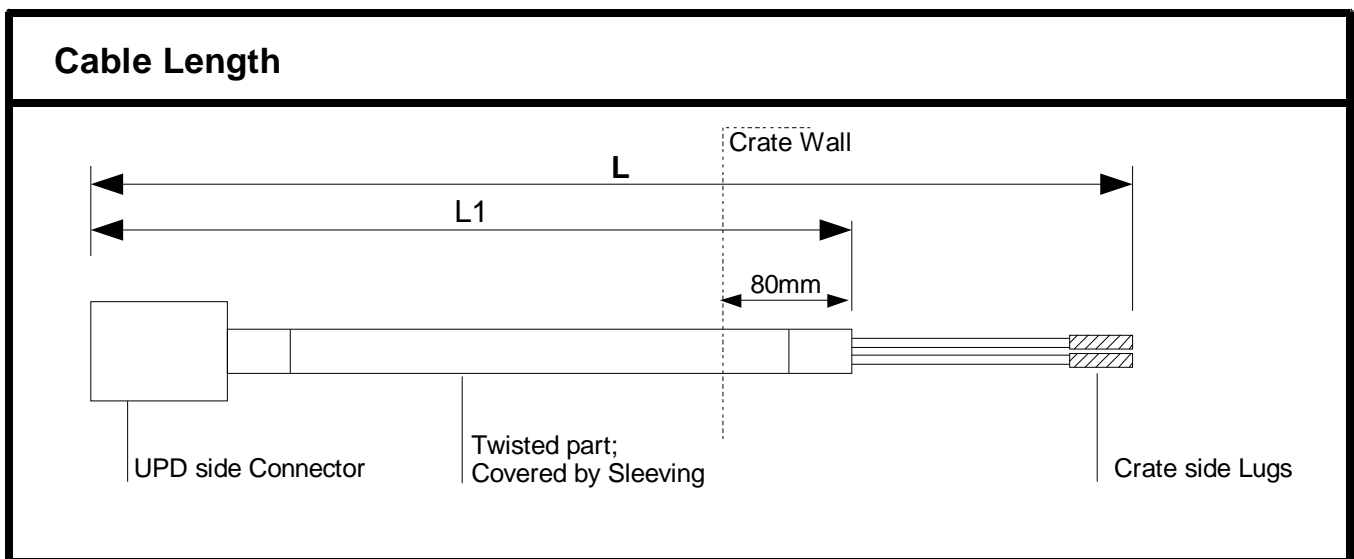
#### Assembly sequence overview

- 1) Cut needed wires with total length given in cable sheet +100mm.
- 2) Crimp one end of wire and insert it into the connector.
- 3) Do the manual twisting of wires to required length.
- 4) Apply expando sleeving and heat shrink tube to the cable.
- 5) Cut Crate-side wires to required length and crimp terminal ring lugs.

Each step of cable assembly is specified in detail in following step-by-step instruction. Last step (5) should be processed during assembly of U-Crates.

Assembly work should be based on cable assembly sheets given in chapter 1.4, these instructions gives additional working considerations.

#### 3.1 Preparation of Wires



**Fig.15 Cables are divided into twisted part covered by expando sleeving and a not twisted ends of wires on crate side**

Cable length is specified in two parts. First one is a twisted part, where two or three wires merge into a bundle of twisted wires. All bundles of twisted wires form the cable, which is covered by an expandable sleeving. **Lengths (L1) in this part are given after twisting.**

Each single wire of a cable may be of individual additional length in the second part on crate side of the cable. This is because wires will be attached to different pads on the backplane of the crate. In cable



sheets the given length (L) corresponds to the length of longest wire. In case of shorter wires on crate-side, the difference in length (L2) is given in the assembly drawings.

On UPD-side wires are crimped and inserted into connector pins. On Crate-side single wire ends are crimped with gold plated terminal ring lugs.

Two set of FM cables are needed to connect two set of UPD Boxes and U-Crates. Each Cable has to be assembled according to its cable assembly sheet from chapter 1.

During assembly cut wires with the total wire length (L) given in the corresponding cable sheet +100mm extra length added. This is because cables will shrink a bit when twisted. Prepare one end of each wire for the crimping of connector pins. Remove insulation by wire stripper from one side for all wires in one cable and crimp this side like shown in next paragraph.

Note: Units in cable sheets are given in Millimeters.

## 3.2 Connector mounting

### 3.2.1 Connector pins

A visual inspection of stripped wire end should be done before pin crimping. The original lay of wire strands must be maintained. Do the crimping on one end of each wire one by one.

Before the crimping of pins the correct crimping tool and turret, the AWG adjustment of the tool and the turret pin size need to be chosen according to tools instruction in chapter 2.3.

For manual crimping operations prior to wire insertion, the assembler shall examine the crimp contacts. Make sure that wire strands are visible in the inspection hole of the pin to be crimped.



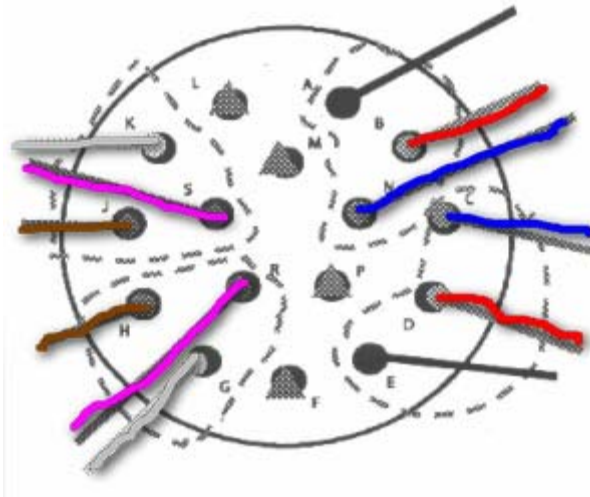


### 3.2.2 Connector wiring

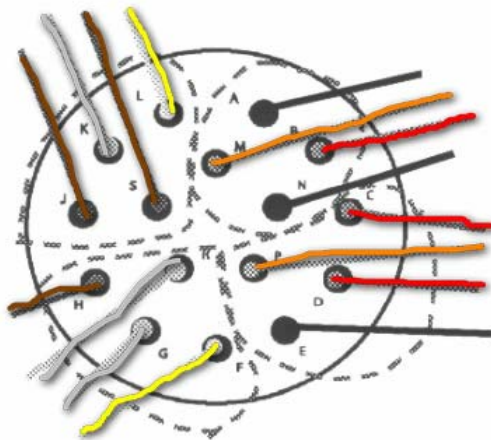
First step is to assemble the connector and connector backshell. Before the wire insertion the connector should be inspected for damage, scratch, or discoloration. In case of any failure the connector must not be used.

Wires with crimped pins are inserted into connectors housing with proper insertion tool. Detailed instructions of tool application are given in chapter 2.4. Wires assignment is given in corresponding cable assembly sheet.

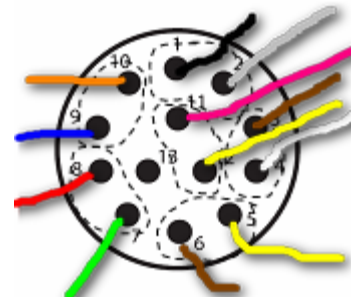
Mappings of the equipped connectors are shown in Fig.16 for general overview and should be checked again when the complete connector is assembled. Wires twist assignment is marked.



Cable +/-5.6V-TSPDx-Sx



Cable 3.3/5V-TSPDx-Sx



Cable 28/3.3/5V-TSPDx-SHVx

Fig.16 Twisted Wires Bundles Overview (connectors in upright position)



### 3.3 Twisting of wires

The wire twisting should be done by hand only. **Do not use a drilling machine**, since twisting quality is hard to control. Twisting of three wires should be done with braid technique shown in Fig.17. An example for two wires is shown in fig. 18. Take care of uniformity. Final twisting step should be

3 twists per foot for AWG16/12 wires (1 twist per 10cm) and  
6 twists per foot for AWG22 wires (1 twist per 5cm).  
12 twists per foot for AWG26 wires (1 twist per 2cm)

After twisting one pair, fix it on the end with 3M Capton Tape. Then twist all other pairs one-by-one. A careful visual inspection of wire insulation should be done after twisting. For temporary fixation of twisted wires use 3M capton tape.

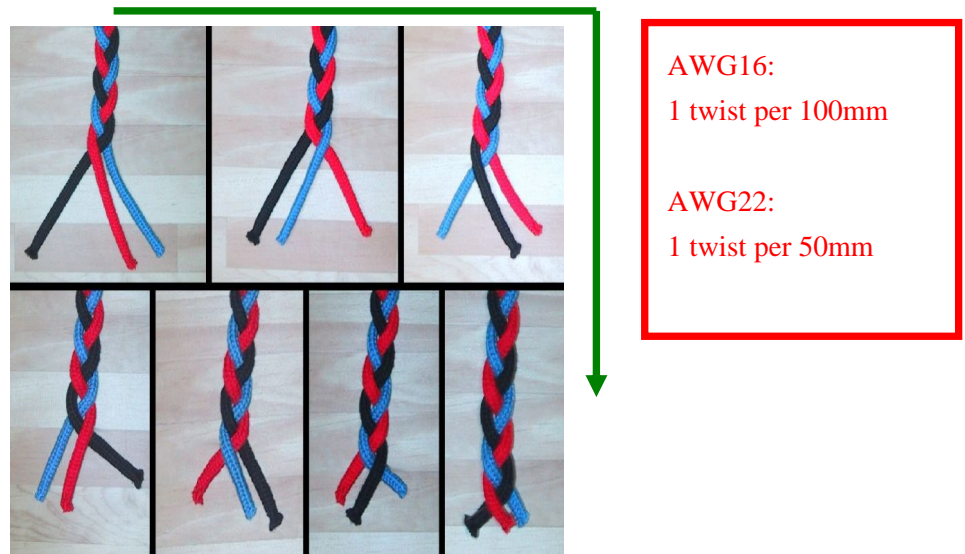


Fig.17 Braid twisting instruction 3-wire

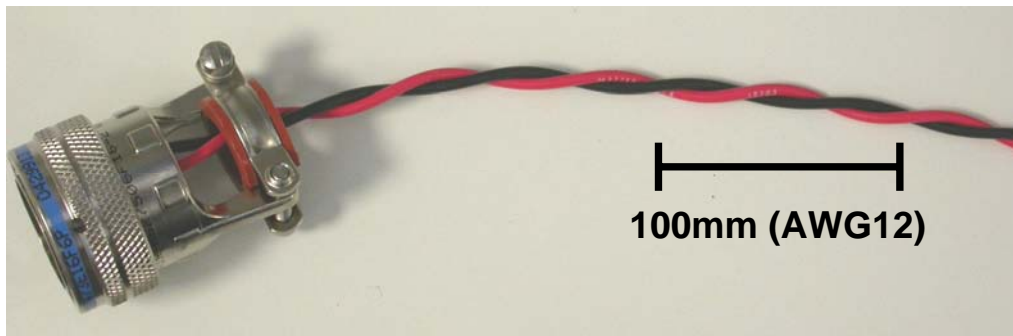


fig.18 Twisting Example 2-wire

Do wire twisting until twisted length complies with twisted part (L1) length from corresponding cable sheet. Check wires twist assignment on Fig.16.



### 3.4 Expandable Sleeving

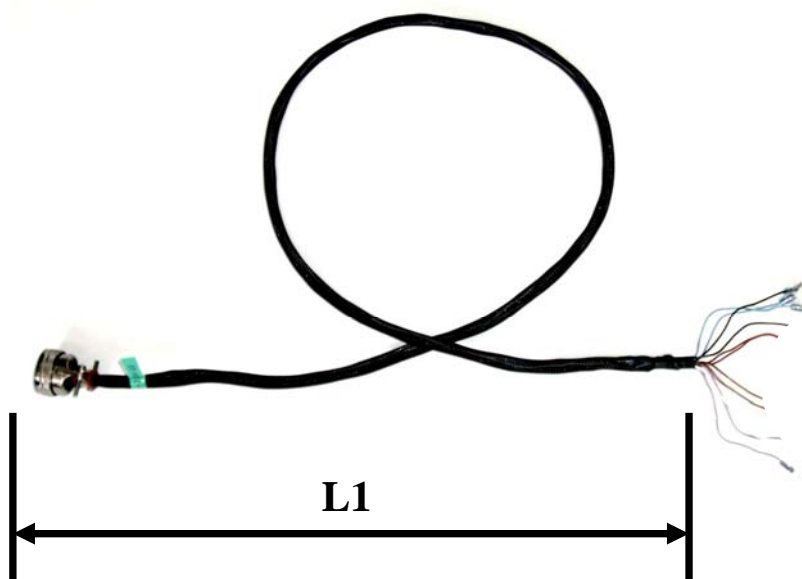
**Materials to prepare (see assembly drawings for quantity):**

Expando sleeve DM686 ¼"	5211000603S
Kynar heat shrink tube	RW-175
Lacing tape	A-A-52084-PTH-5
3M Kapton Polyimide Tape	3M 5413 or 3M 5563 if avail.

After wire twisting cables ties must not be used. Fix the whole bundle of twisted wires inserted to the same connector with 3M Kapton tape each 20-30cm of length.

An expandable sleeving is applied according to a common procedure for all xPD<>Crate Cabling. The bundle of all twisted wires is covered by an expandable sleeving with the length of the twisted part (L1). When the length of the expandable sleeving is fitted, take care that the ends of the sleeve is not frayed. In order to fix the ends lacing tape is wrapped around the wire like show in Fig.19 for xPD and Crate ends. Shrink tube (Kynar RW-175) is applied to cover both ends. The minimum shrink temperature is 155°C (311°F).

Make sure that the part of the cable that is covered by expandable sleeving (including connector) and heat shrink tube is of the length (L1) like shown below. "Connector wrench tool" may be the corresponding counterpart connector fixed on metal plate and should be self-assembled.





STEP	Protecting Procedure U<>UPD Cables	WORKING STEP COMMENTS
1		<p>1) clean cables and check twisting 2) check wirelength: L+10cm (see cablesheet) 3) use amount of M3 capton tape as needed to keep wirebundles together</p> <p>NOTES:</p>
2		<p>1) preferred shrink tube length: 5cm (max. length: 8cm) 2) Kynar heat shrink tube p/n RW-175</p> <p>NOTES:</p>
3		<p>1) see cable sheet for length L1 2) Expando sleeve DM686 1/4" p/n 5211000603S</p> <p>NOTES:</p>
4		<p>1) use amount of lacing tape to increase thickness of cable to fit shell-rubber 2) make a knot on beginning and end of wrapping 3) use appropriate force to hold sleeve in place 4) Lacing tape p/n A-A-52084-PTH-5</p> <p>NOTES:</p>
5		<p>1) preferred shrink tube length: 5cm 2) Attention: Do not overheat expando sleeve! needed temperatur for heat shrink tube: 155°C</p> <p>NOTES:</p>
6		<p>1) use „connector wrench“ to tighten connector shell 2) insert rubber and fix shell screws</p> <p>NOTES:</p>
7		<p>1) squeeze expando sleeve by pulling away from connector 2) check length L1 from connector front to end of sleeve (see cable sheet)</p> <p>NOTES:</p>
8		<p>1) see work step 4 comments 1) preferred shrink tube length: 5cm 2) Attention: Do not overheat expando sleeve! needed temperatur for heat shrink tube: 155°C 2) store cable in plastic bag until final installation</p> <p>NOTES:</p>

Fig.19 Expando Sleeve Fixation



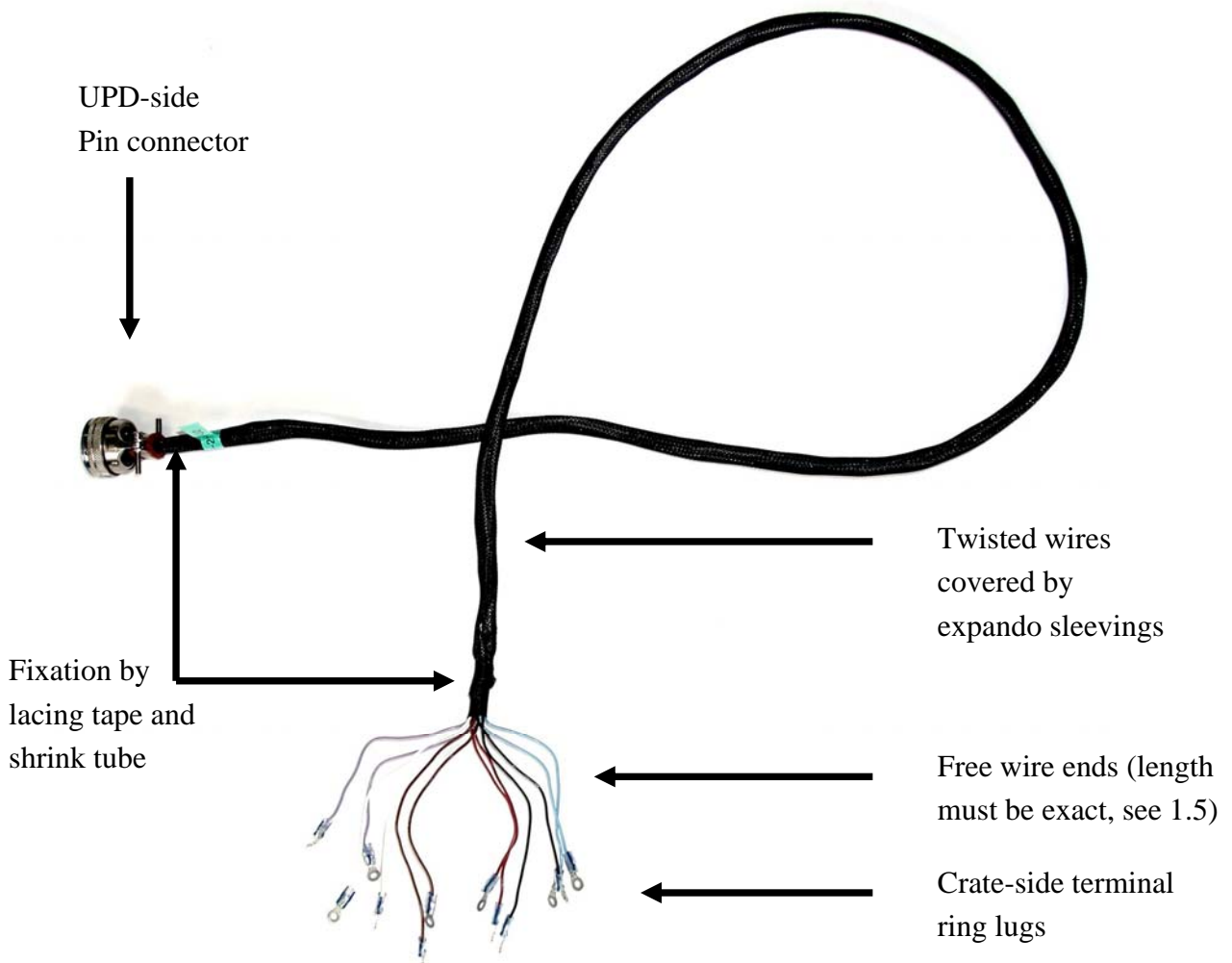
### 3.5 Final Cut and Crimping

This step should be done with the U-Backplane on side during U-Crate assembly.

Ends of free wires on crate-side of the cable are cut to length given in tables 1.5.x or corresponding cable sheet. Free cable length must be measured from the end of shrink-tube on crate side of the cable. Note that each single wire of a cable in this part may be of individual additional length. In cable sheets the given length (L) corresponds to the length of longest wire. In case of shorter wires on crate-side, the difference in length (L2) is given in the assembly drawings.

Length of the resulting trimmed wire should be checked on U-Crate Backplane immediately. Wires will be attached to different pads on the backplane of the crate. (This step should be done with assistance from TRD group; see Fig.21)

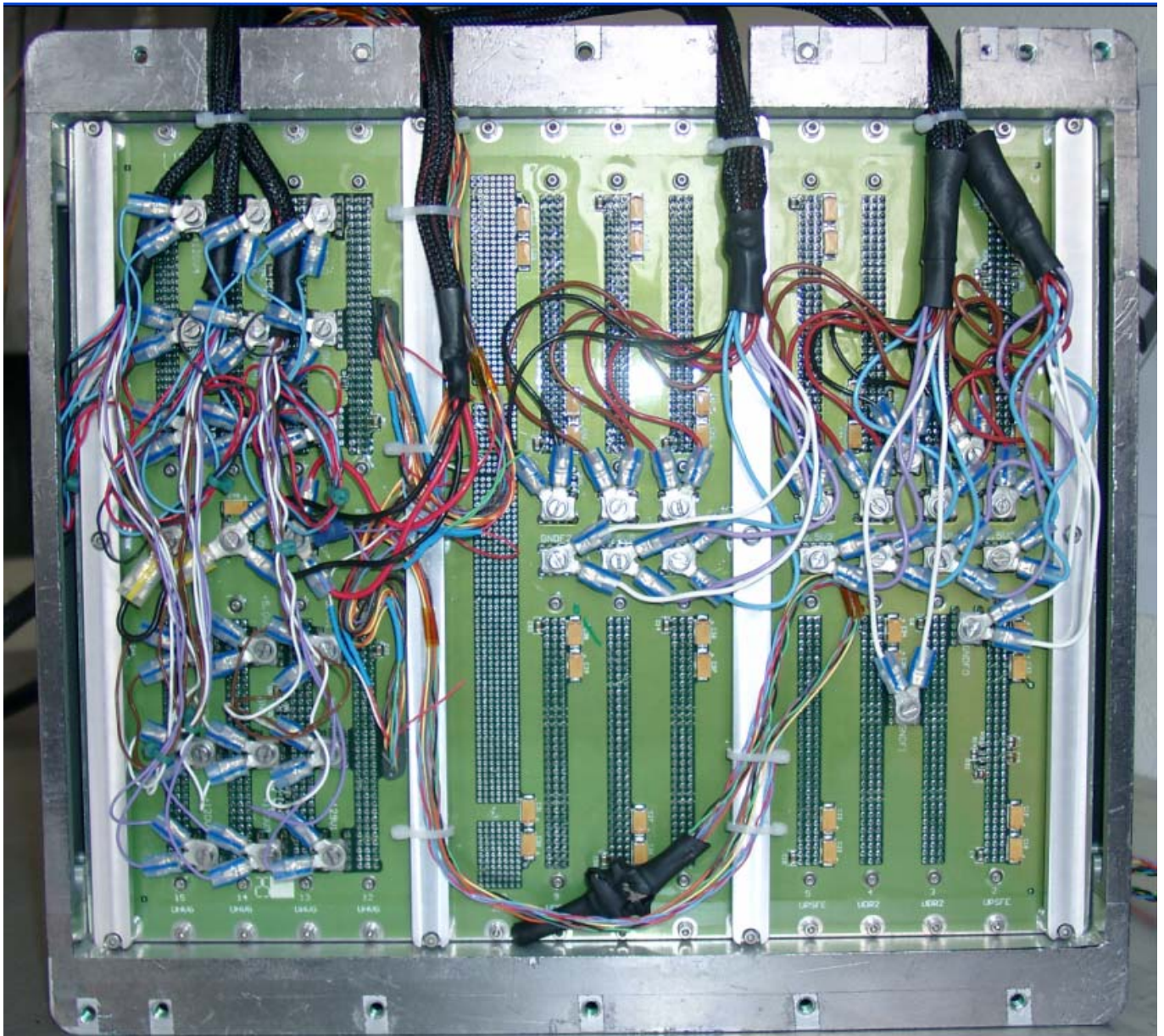
After length of cut wires is checked, remove insulation by electrical wire stripper. Gold plated ring lugs are crimped to the ends of wires according to terminal ring lug mounting instruction in chapter 2.5. Note the different types of ring lugs and tools for AWG12, AWG16 and AWG22 wires.



**Fig.20: Sample Cable with applied sleeving**



### 3.6 Cable Installation



**Fig.21: U-Crate Backplane (UBP) with installed cables (prelim.)**

For power taps with 2 lugs use screw and washer M3x6, for 3 lugs M3x8 for temporary fixation.

Cables running through the same crate-slot are fixed together by cable tie. Length of protected cable should be of 80mm measured from crate wall.



#### 4. Recommended Torque Values

##### 5.1 INSTALLATION TORQUE VALUES FOR CIRCULAR ELECTRICAL CONNECTOR ACCESSORIES

Backshell size	Torque ( $\pm 5$ lb.in)
Shell 10	35 lb.in (4 Nm)
Shell 16	40 lb.in (4.5 Nm)
Shell 20	80 lb.in (9 Nm)

MIL-DTL-38999, Series II

##### 5.2 TORQUE VALUES FOR CABLE CLAMP SCREWS

Screw size	Recommended Max Torque
4-40	4 lb.in (45 Ncm)
6-32	6 lb.in (68 Ncm)
8-32	8 lb.in (90 Ncm)



AMS-02 ToF  
TSPD <> S-Crate Cabling

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Assembly Procedure

Date

2/Oct/2007

5. BOM

No	Part Number	Description	Type	Unit	Qty
1	M22759/44-16-0	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Black	wire	m	30
2	M22759/44-16-1	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Brown	wire	m	30
3	M22759/44-16-2	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Red	wire	m	30
4	M22759/44-16-3	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Orange	wire	m	12
5	M22759/44-16-4	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Yellow	wire	m	12
6	M22759/44-16-6	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Blue	wire	m	12
7	M22759/44-16-7	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, Violet	wire	m	12
8	M22759/44-16-9	M22759 Wire, Silver plated, XL-ETFE light weight insulation, AWG 16, White	wire	m	30
9	M83513/03-B12N	MIL PRF 83513 Connector, Plug, 15-pin, len=36"	connector	pc	8
10	MS27484E10F35P	MIL-DTL-38999, Series II, Connector, Straight Grounded Plug, shell 10, 13 pins	connector	pc	8
11	MS27484E20F16P	MIL-DTL-38999, Series II, Connector, Straight Grounded Plug, shell 20, 16 pins	connector	pc	8
12	MS27506F10-2	MIL-DTL-38999, Series II, Backshell, Straight Clamping, Shell 10	backshell	pc	8
13	MS27506F20-2	MIL-DTL-38999, Series II, Backshell, Straight Clamping, Shell 20	backshell	pc	8
14	5211000603S	Expando sleeve DM686 ¼"	sleeving	m	26
15	RW-175	Kynar heat shrink tube	shrink tube	m	2
16	A-A-52081-PTH-5	Lacing tape	tape	m	5
17	AMP 332453	Ring Lugs for AWG16 (insul.)	ring lug	pc	112
18	3M 5563/5413	3M Kapton Polyimide Film Tape (acrylic/silicone)	tape	m	3

Separate BOM for each cable is given in its cable assembly sheet.