



Science and
Technology
Facilities Council

UK WP1 F2F meeting

FPC updates

(part of EPIC SVT WP3 Electrical interfaces)



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Outline

- Status of Low TRL OB prototypes
- Update on WP3 Electrical interfaces
- Update on the next iterations of FPCs
- Conclusion

Status of Low TRL OB prototypes

- Definition of design: ~mid Oct 2023 - ~mid Mar 2024;
- Desing with RPE LTU: ~mid Mar 2024 - ~early June 2024;
- Production by RPE LTU: ~mid Jun 2024 - ~mid Sept 2024;

Prototypes shipped from RPE LTU to DL on 27/09/2024:
Est. delivery 08/10/2024.

From now until the end of Mar 2025:

- Visual inspection;
- Distribution to sites;
- Assembly;
- Testing;

Extra text added to PO
due UKR export regs

REVISED PURCHASE ORDER

Supplier: LLC Research and Production Enterprise LTU (LLC RPE LTU) Novegorodska str. Bld 3 Kharkiv 61145 Ukraine +38 0993113751

Ship to: STFC - DL DL Daresbury Laboratory Warrington United Kingdom WA4 4AD

Invoice to: UKRI CIO UK Shared Business Services Ltd Polaris House North Star Avenue Swinson United Kingdom SN2 1UH

Order	4070385067
Order Date	26-JUL-2024
Revision	1
Revision Date	17-SEP-2024
Payment Terms	As per terms and conditions

For all purchase order queries, please contact P2PAdmin@stfc.ac.uk
For all invoicing queries, please contact finance@stfc.ac.uk

NOTES TO SUPPLIER:
Delivery break-down:
4 Prototype of assembled multilayered aluminium flexible printed circuit board ePIC SVT-L4 type (1400 EUR/ppc);
4 Set of aluminium flexible printed circuit boards for ePIC SVT-L4 type multilayered aluminium flexible printed circuit board (1700 EUR/ppc);
QUOTATION nr. ePIC SVT-1
vatcheslav.borishov@cern.ch

Line	Part Number/Description	Delivery Date	Quantity	UOM	Unit Price (EUR)	Tax	Net Amount (EUR)
1	Supplier Item: QUOTATION nr. ePIC SVT-1 according to quotation nr. ePIC SVT-1 Aluminum Flexible Printed Circuits	31-JUL-2024	1	Each	12,400.00	0%	12,400.00
Grand Total							12,400.00

VAT Registration Number GB 287 461 057
STFC - Science & Technology Facilities Council

STFC is part of UK Research and Innovation, a non-departmental public body funded by a grant-in aid from the UK Government. More information can be found at www.ukri.org

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Contract now signed by STFC

Issued on 17/05/2024

Contract text
edited by M.Borri

Contract nr 051724
dated May 17, 2024

"Manufacture and delivery of aluminium flexible printed circuit boards and demonstrators"

The Buyer
UK Research and Innovation (UKRI)
Rutherford Appleton Laboratory,
Harwell Campus, Didcot, OX11 0QX, the United Kingdom

Authorized person:
Commercial Business Partner
Declan Ward
Phone: + 44 07849307912
e-mail: Declan.ward@ukri.org

Technical Coordinator:
Marcello Borri
Phone: +44 01925 603 085
e-mail: marcello.borri@stfc.ac.uk

The Seller
Limited Liability Company "Research and production enterprise "LTU" (RPE LTU)
Novgorodska str., bld. 3, Kharkiv, 61145, Ukraine

Authorized person:
Prof. Dr. Vyacheslav Borshchov
First Deputy General Director - Chief Designer
of Limited Liability Company "Research and production enterprise "LTU", acting on a basis of the
Power of Attorney No.1/24 dated April 30, 2024.

Phone: +38 099 311 37 51
e-mail: vyacheslav.borshchov@cern.ch

Preamble
UK Research and Innovation (Buyer) and RPE LTU (Seller) are collaborating in R&D activities for the Electron Ion Collider project. Specifically, the Buyer needs to procure flexible printed circuit boards with aluminum conductors (called Al-FPCs). Al-FPCs are required to prototype and build modules and staves for the Silicon Vertex Tracker (SVT) of the ePIC experiment at the EIC in USA. RPE LTU has the Know How and infrastructure to produce Al-FPCs to satisfy the Buyer technical requirements. Therefore, the parties agree as follows:


1. Subject of the Contract
1.1. This contract describes the process by which goods can be ordered by the Buyer and then delivered by the Seller.
The Seller sells and the Buyer buys Al-FPCs.
The Buyer will become the owner of the Goods after completing the financial transaction as agreed by both parties outside of this contract in the purchase order.
1.2. This contract does not oblige the Buyer order any goods from RPE LTU. Terms and conditions for each order are agreed via separate a Purchase Order will be agreed and signed by both parties.
1.3. For each order of Goods within this contract a Quotation needs to be sent by the Seller to the Buyer, and then a Purchase Order needs to be sent by the Buyer to the Seller as a confirmation of quotation acceptance.

9.2. Any written correspondence concerning this contract, such as quotations, purchase orders or legal claims will be kept in English.

10. Annexes to the Contract
10.1. The Annexes 1 is integral part of this Contract.
10.2. The Quotations from the Seller and the Purchase orders from the Buyer, received while the Contract is valid, will follow the process described in this Contract.


11. Other conditions
11.1. Contract, annexes, amendments, quotations and purchase orders sent by fax or e-mail are of legal validity.
11.2. The validity of this Contract shall be subjected to provisions arising from foreign trade legislation.


12. Date of the Contract Validity
12.1. This contract will come to validity after signing both by the Seller and by the Buyer.
12.2. The present Contract is valid for three years.

The Buyer:
UK Research and Innovation
Commercial Business Partner
D. Ward
 D. Ward
23rd Sept 2024
stamp

Signed on 23/09/2024

The Seller:
Limited Liability Company "Research and production enterprise "LTU"
First Deputy Director - Chief Designer

 Prof. Dr. V. Borshchov
2024
stamp

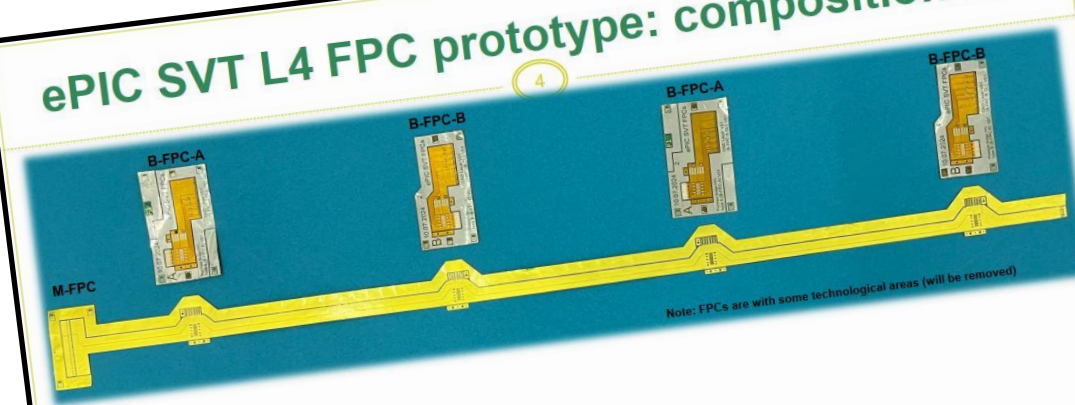




Prototypes ordered

ePIC SVT L4 FPC prototype: composition/set

4



M-FPC

B-FPC-A

B-FPC-B

B-FPC-A

B-FPC-B

Note: FPCs are with some technological areas (will be removed)

Planned delivery:

- 4 prototypes of assembled ePIC SVT-L4 FPC
- 4 sets of FPC prototypes for ePIC SVT-L4 FPCs (4 M-FPCs+ 16 B-FPCs)

Note: some test/technological M-FPCs and B-FPCs will be provided also for tuning-up assembly and test procedures


September 12, 2024

ePIC SVT WP3 Electrical Interfaces Meeting

viatcheslav.borshchov@cern.ch, ihor.tymchuk@cern.ch

ePIC SVT L4 FPC prototypes: M-FPCs

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Current status:

- 8 M-FPCs are assembled

Note: FPCs are with some technological areas (will be removed)

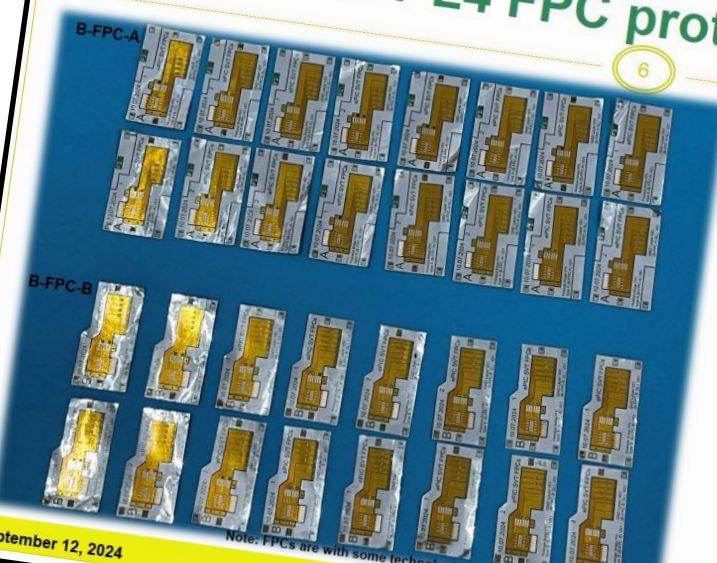
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ePIC SVT WP3 Electrical Interfaces Meeting

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ePIC SVT L4 FPC prototypes: B-FPCs

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Current status:

- 16 B-FPC-A are assembled
- 16 B-FPC-B are assembled

Note: FPCs are with some technological areas (will be removed)

September 12, 2024

ePIC SVT WP3 Electrical Interfaces Meeting

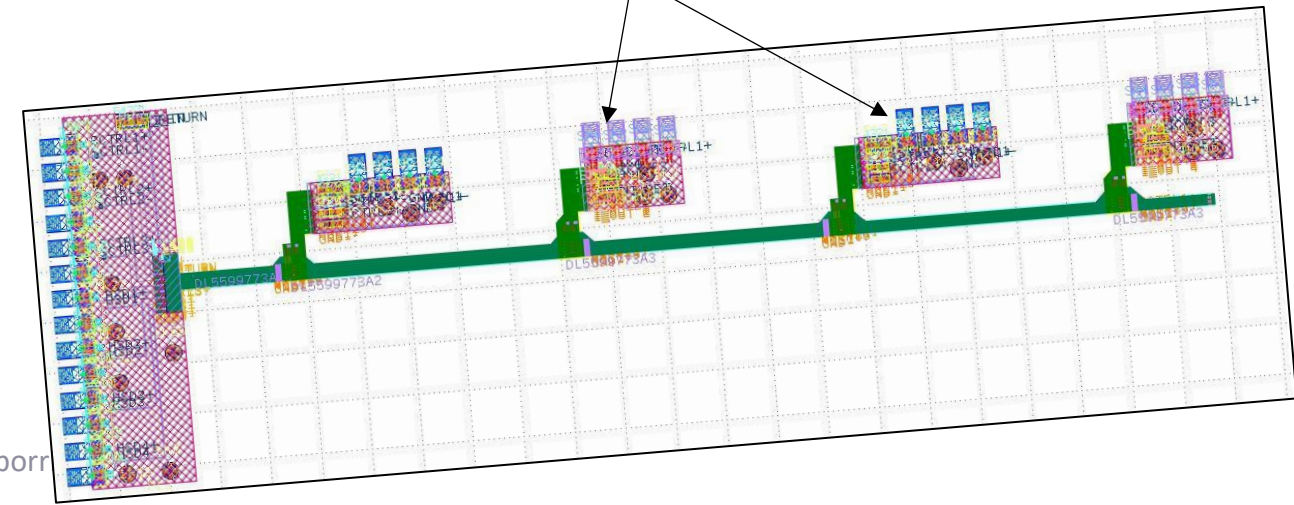
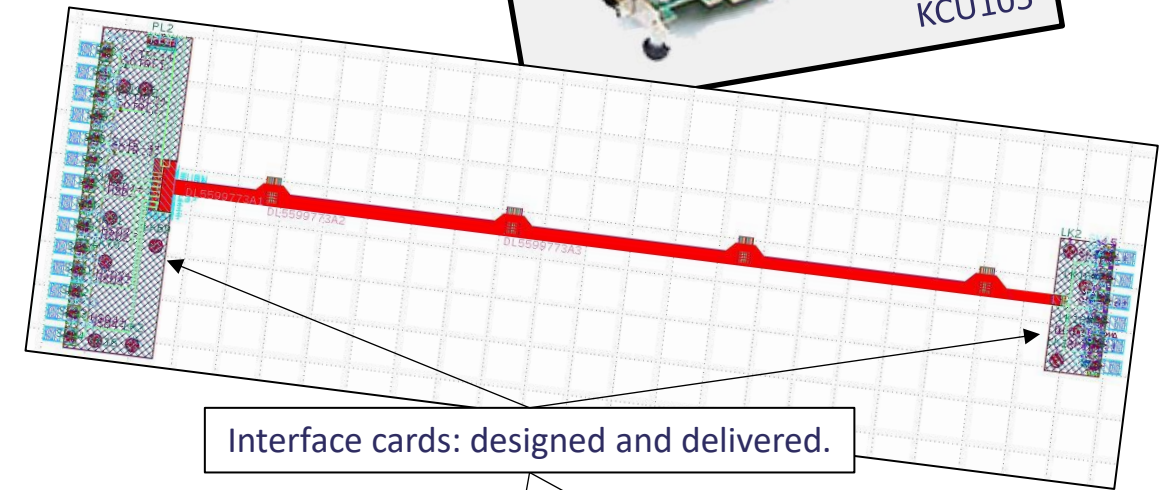
Test system preparation at DL

Hardware already available or booked for delivery.

Loaned equipment:

- Lecroy WaveMaster8330HD 33GHz scope (33 GHz, 12 bits, 160 GS/s, 200 Mpts)
- Lecroy WavePulser40iX 40GHz TDR instrument
- **Delivery date 22/10/2024**
 - 1st month free of charge.
 - Monthly rate to be clarified...

HELP NEEDED WITH INTERCONNECTION
(see next slides)



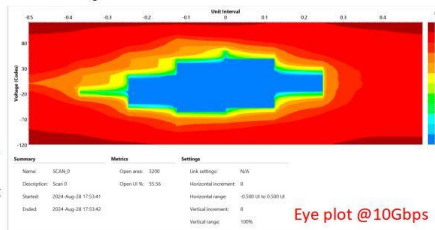
WP3 Electrical Interfaces

- Shared design of B-FPC Type2 with LANL to evaluate 2nd supplier: Q-Flex.
- LBNL presented further tests with Omni Circuits
 - LBNL discussing with RPE LTU new prototypes (using OB existing design as reference)

LBNL results w prototypes from Omni Circuits (dielectric is ArlonEmd)

Updates for Today

- Received a 2nd set of AI-based FPC prototypes from OMNI.
 - Double metal layer with **25 cm long** differential lines for high-speed data transmission
- Improvements compared to the previous set
 - Soldering and vias facilitated by selective Cu plating
 - Improved high frequency signal transmission property based on S21 measured up to 4 GHz
 - IBERT test done with FPGA suggests that these FPC support GTY communication @10Gbps
- Questions to follow up:
 - Check the mechanical properties of the FPC
 - 2 out of 36 connector pads detached from the FPC when disconnecting the cable
 - Total material budget of the FPC is **0.136% X₀ (TBC)**, with dominant contribution from dielectrics. Can this be reduced
- Plan:
 - Manufacture FPC based on LTU/STFC design but modified to be consistent with vendor's design rules if there is no objection.



Eye plot @10Gbps

Promising result

September 12, 2024 Zhengwei Xue



Q-flex proposed stack-up (w Polyimide)

	12um polyimide	Top Coverlay
	25um adhesive	
	L1 17um Aluminium	0.7mil Aluminium with Kapton
	12um adhesive	
	12um Polyimide	
	25um adhesive	Bondply
	25um polyimide	
	25um adhesive	
	12um Polyimide	0.7mil Aluminium with Kapton
	12um adhesive	
	L2 17um Aluminium	
	25um adhesive	Bottom Coverlay
	12um polyimide	
Flex Thickness	~233um +/-10%	

Q-flex proposed alternative dielectric

Flexible circuit board materials
LCP(Liquid Crystal Polymer)
フレキシブル基板材料 LCP(液晶ポリマー)

FELIOS LCP
Double-sided R-F7055

Applications: 用途
Smartphone/Antenna module, Laptop, Tablet PC, 4K/8K display/High-speed FPC cable, Automotive component, Etc.
スマートフォン/アンテナモジュール、ノートPC・タブレットPC・4K/8Kディスプレイ/高速FPCケーブル、自動車部品など

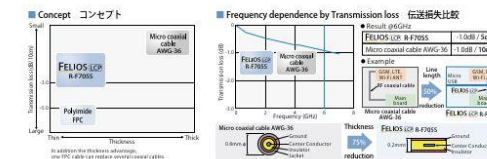
Properties: 特性
Suitable for high-speed large-volume data transmission of mobile devices with good high frequency property. It is suitable for replacement of micro coaxial cable and millimeter-wave radar antenna.
優れた高周波特性により、モバイル機器の大容量・高速伝送に貢献。同軸ケーブル置換え、ミリ波レーダー用アンテナ基板に対応

Dk 2.9 Df 0.002 @19GHz

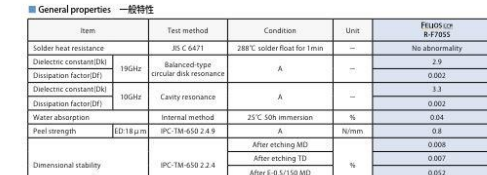
Water absorption 0.04%

Peel strength 0.8N/mm

Concept: コンセプト



Frequency dependence by Transmission loss: 伝送損失比較

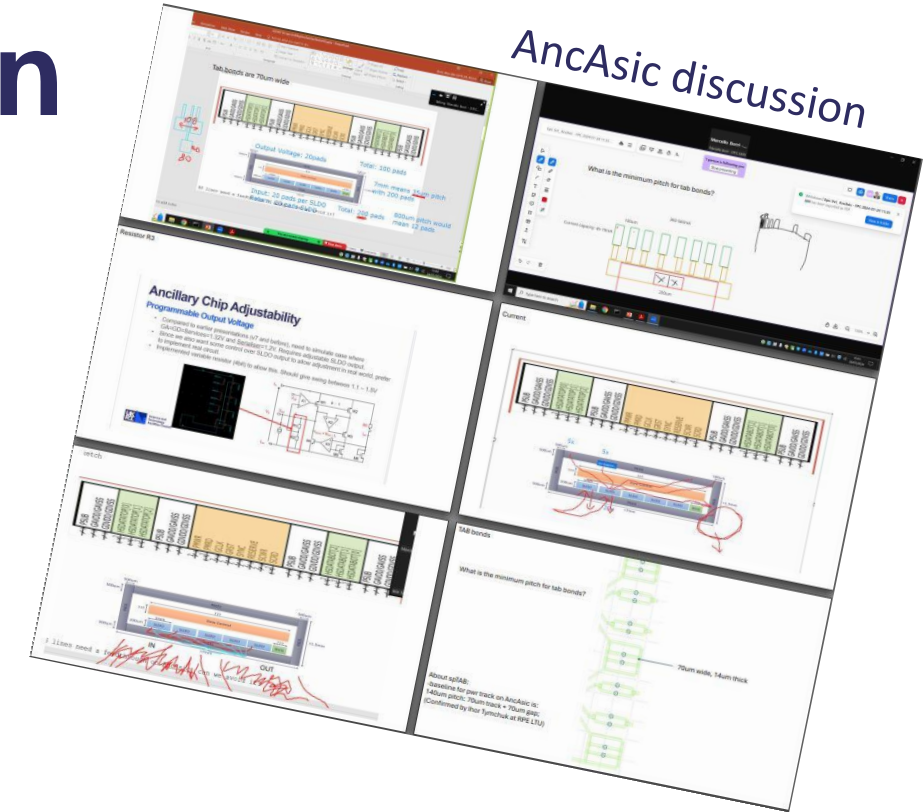


General properties: 一般特性				
Item	Test method	Condition	Unit	FELIOS LCP R-F7055
Solder heat resistance	JIS C 6471	288°C solder float for 1min	—	No abnormality
Dielectric constant(Dk)	19GHz	Balanced type	A	2.9
		Circular disk resonance	A	0.002
Dissipation factor(Df)	10GHz	Cavity resonance	A	0.002
		Internal method	25°C 50% immersion	%
Peel strength	ED18um	IPC-TM-650 2.4.9	A	N/mm
		After etching MD		0.008
Dimensional stability	IPC-TM-650 2.2.4	After etching TD	%	0.007
		After E-0.5/150 MD		0.052
		After E-0.5/150 TD		0.035
Flammability	UL	A + E 1687/0	—	94V-0
		UL 94V-0		16-100-14

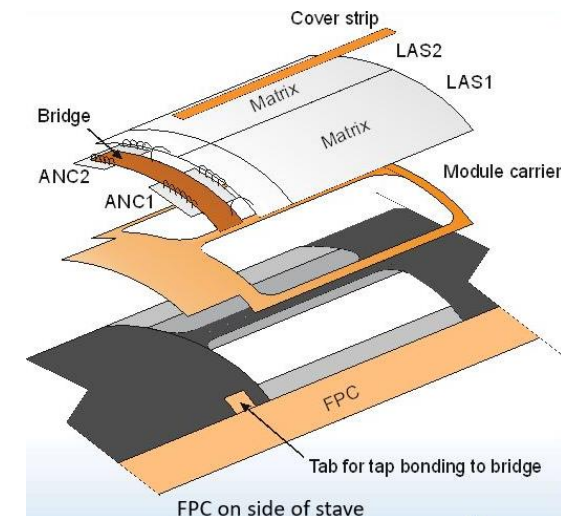
Future iteration of FPC design

- The next iteration of prototypes will be a higher maturity FPC.
- Brainstorming with I.Sedgwick on AncASIC.
- Brainstorming with G.Viehhauser on module & stave.

... pushing this back (gently) until some results from the existing low TRL OB FPC are available.



Module & stave discussion



Conclusion & discussion

- The delivery of prototypes is imminent.
- Need help with interconnection (spTAB).
 - Eve and James at UoB?
 - Or RAL? Or Oxford?
- ... We would like to get a few units interconnected by 22/10.

Wedge required to spTAB prototypes to interface PCBs

