Conceptual Design of HGTD Modules

João Guimarães da Costa

August 26, 2019

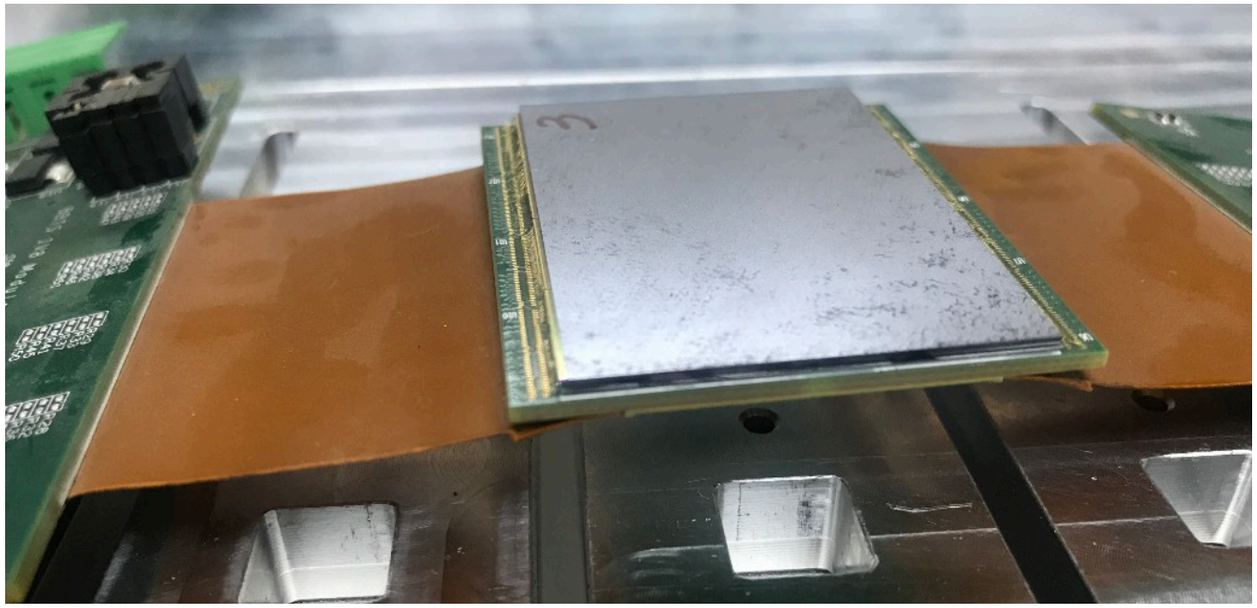
中國科學院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

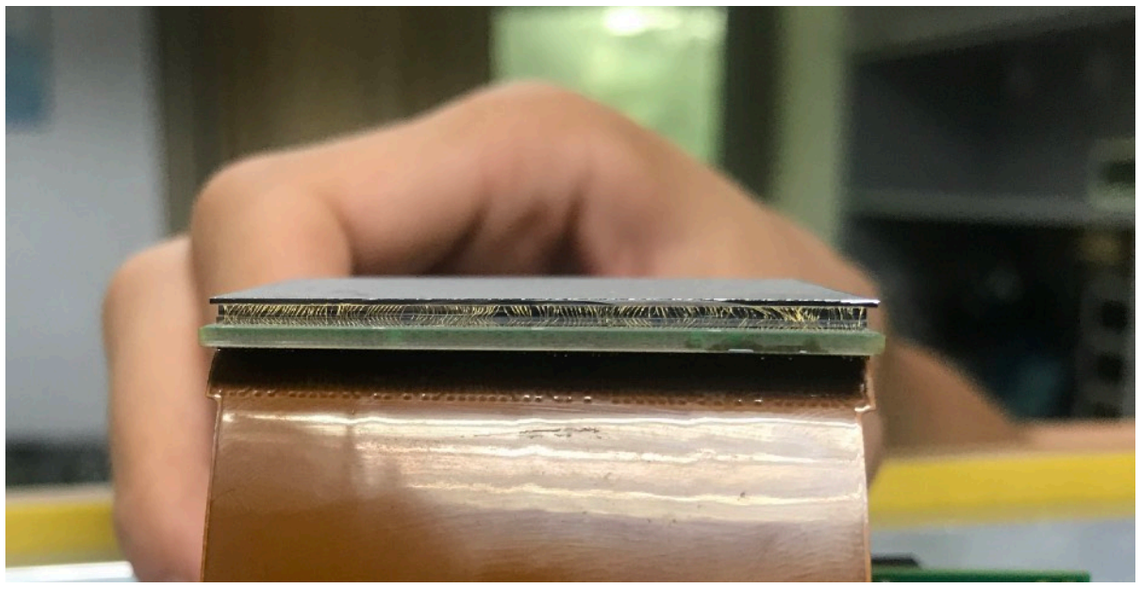
Similar projects at IHEP

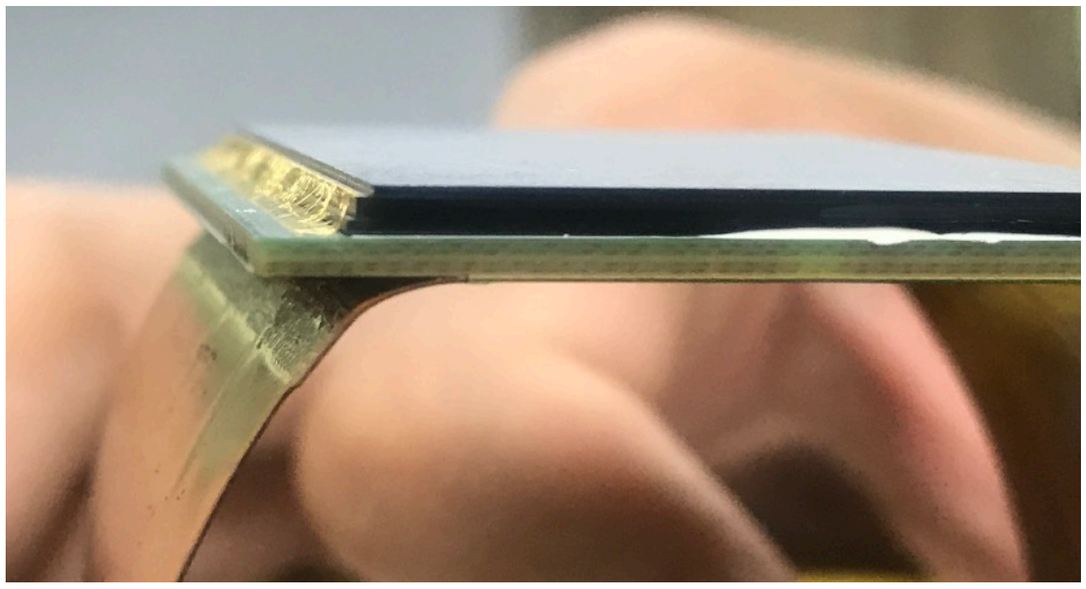
- X-ray camera uses a similar module concept

First Option

3-layer bump bonded sensor+ASIC
ASIC glued to PCB
Cable integrated into PCB

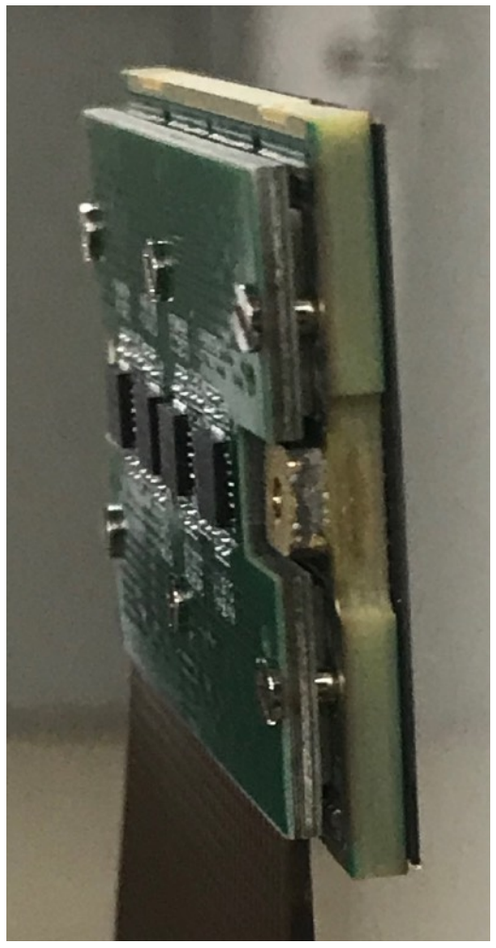






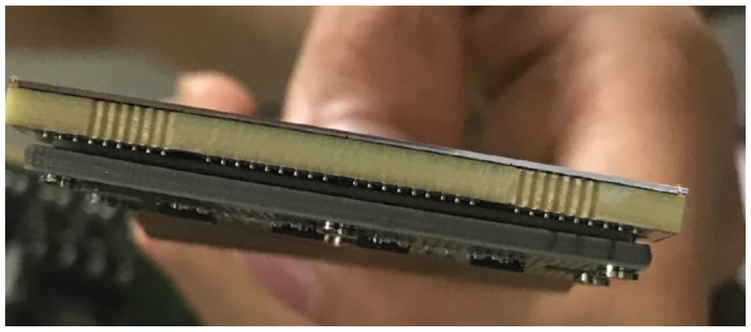
Similar projects at IHEP

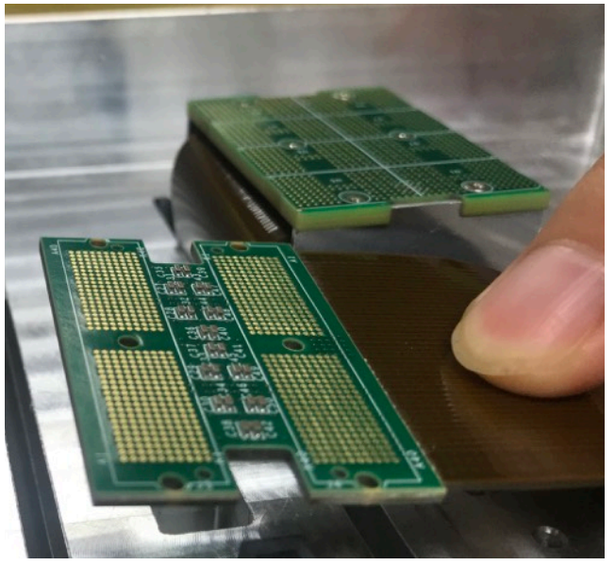
- X-ray camera uses a similar module concept

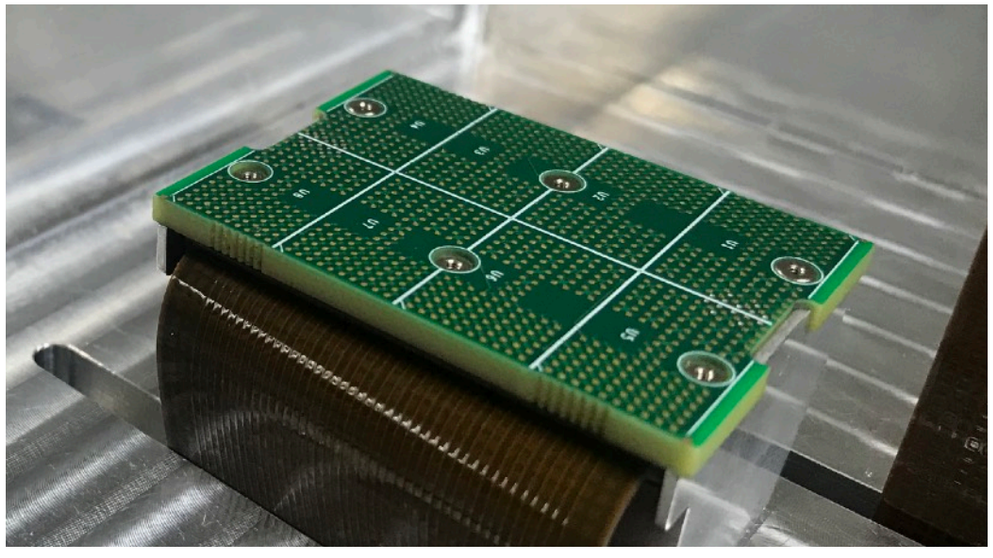


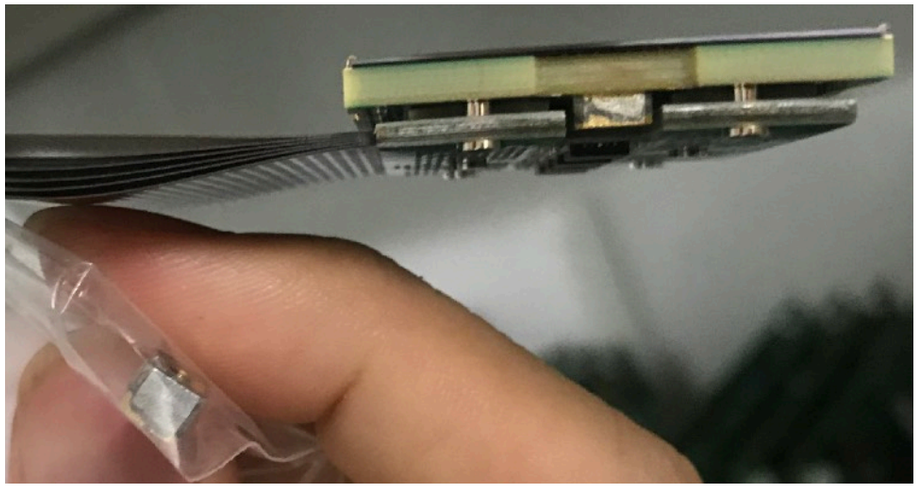
Second Option

3-layer bump bonded sensor+ASIC
ASIC glued to PCB
Cable integrated into PCB









Connectors

- Unimicron
  - http://www.unimicron.com/product.php?lang=en&tb=1&cid=25
  - Fabrication in Taiwan, China, Germany and Japan
  - Connectors done in partnership with Neoconix, a company located in California
    - https://neoconix.com/pcb-board-to-board-connectors-interposers/
- Company seems to have main fabrication facilities in China
  - Not clear where the connectors are being made

Unimicron facilities in China

Unimicron (Suzhou)：

Main Product(CARRIER)

CarrierSALES@unimicron

+86-512-62996168

No. 160, Fengli Street, Suzhou Ind. Park 215123, Jiangsu, China

Unimicron-FPC (Kunshan)：

Main Product(FPC/FPCA)

JackChen@fpc.unimicron.com

+86-512-57750888

No. 999, Hanpu Road, Kunshan 215316, Jiangsu, China

Unimicron (Kunshan)：

Main Product(PCB/HDI)

PCBSALES_CN@unimicron.com

+86-512-57799168

No. 168, Xiaolin Road, Kunshan 215316, Jiangsu, China

Unimicron (Shenzhen)：

Main Product(PCB/HDI)

PCBSALES_CN@unimicron.com

+86-755-27245188

Building A-D, Environment Protection Ind. Zone, Shayi Village, Shajing Town, Baoan District, Shenzhen 518104, Guangdong, China

Unimicron (Huangshi)：

Main Product(PCB/HDI)

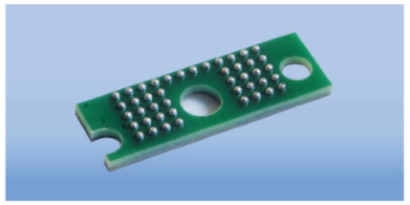
PCBSALES_CN@unimicron.com

+86-714-3268168

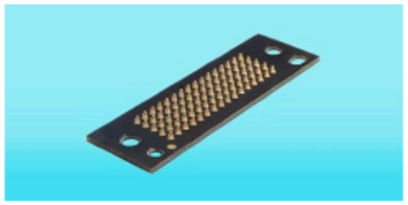
No.168, East of Daqi Avenue,Huangshi Economic and Technological Development Zone 435000, Hubei,China

Neoconix connectors

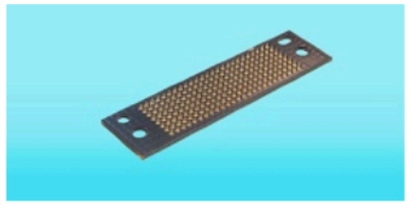
PCBeam™ LPM Connectors
Standard designs
Pitch(mm): 0.74
Contacts: 16–80+
High speed: 10Gbps–28Gbps
Height(mm): 0.43
LGA/LGA
Hardware available



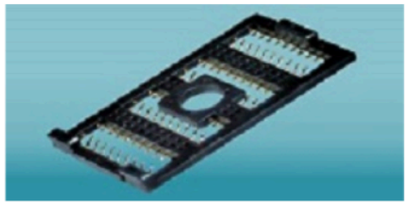
PCBeam™ LPS Connectors
Standard designs
Pitch(mm): 0.74
Contacts: 16–80+
High speed: 10Gbps–28Gbps
Height(mm): 0.96
LGA/BGA
Hardware available



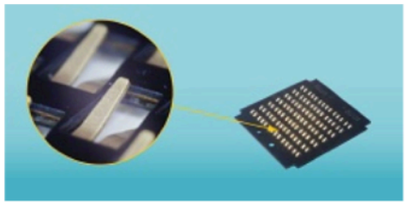
PCBeam™ SPH1 Connectors
Standard designs
Pitch(mm): 0.80, 1.00, 1.27
Contacts: 80–120
High speed: 10Gbps–28Gbps
Height(mm): 0.80–3.0
LGA/LGA
Hardware available



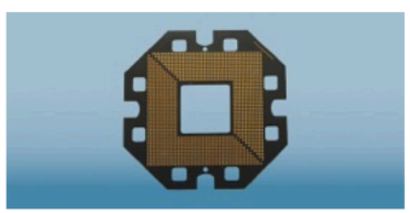
PCBeam™ SPH2 Connectors
Standard designs
Pitch(mm): 0.65, 0.80, 1.00, 1.27
Contacts: 102–250
High speed: 10Gbps–28Gbps
Height(mm): 0.80
LGA/LGA
Hardware available



X-Beam™ Connectors
Standard & custom designs
Contacts: 12–68, custom
Height(mm): 0.35–0.46
Power & return: 5A–14A
LGA/SMT
SMT processing
1-step reliable screw assembly
Hardware available



High Speed Connectors
Custom designs
Pitch(mm): 1.00, 1.27
High speed: 10Gbps–56+Gbps
Height: 0.28mm–3.5mm
LGA/LGA or LGA/BGA
Hardware available
Design services available

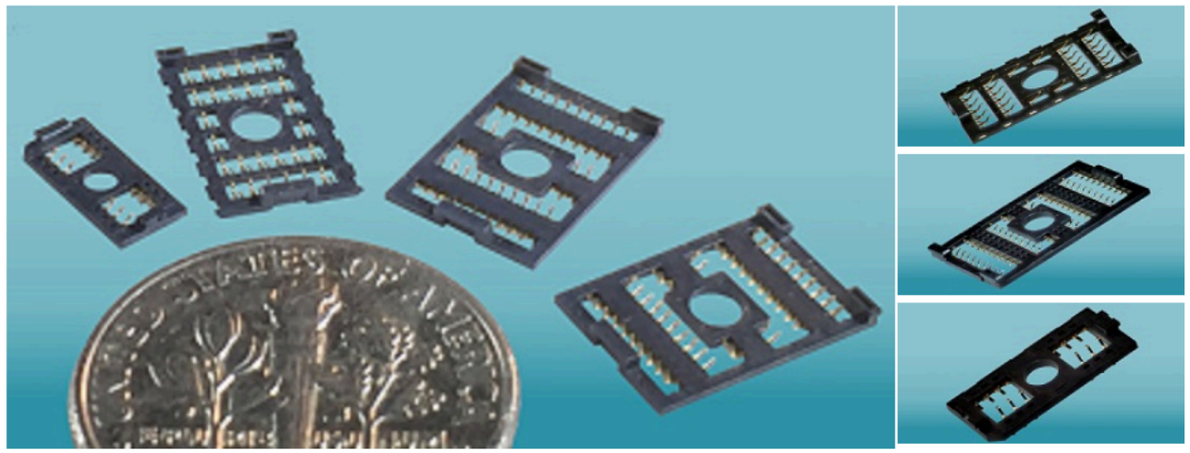


Custom Connectors & Interposers
Variable shape, size, pitch, height
Pitch(mm): 0.65, 0.74, 0.80, 1.00, 1.27
Board-to-Board, FPC-to-Board, Device-to-Board
Height(mm): 0.28–3.50
LGA/LGA, LGA/BGA, LGA/Pad
Design services available

https://neoconix.com/pcb-board-to-board-connectors-interposers/

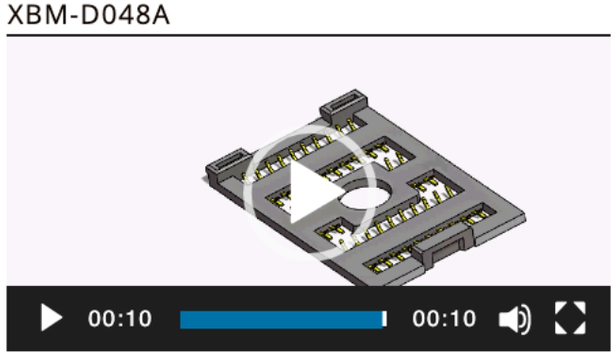
Neoconix: X-Beam™ FPC Connectors

https://neoconix.com/x-beam-fpc-connectors/

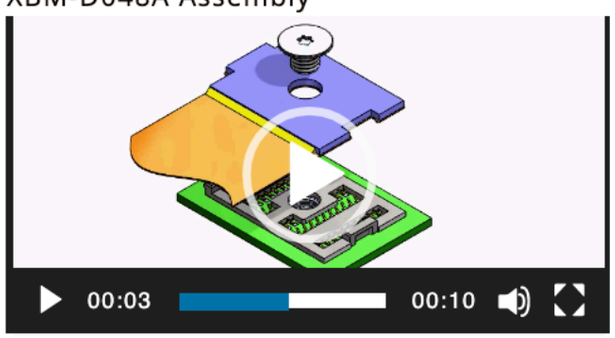


Mobile devices get increasingly thinner, yet demands are continually increasing for more power and higher signal performance. As a result, smaller, lower profile and higher efficiency connectors are needed to optimize designs and maximize performance. The X-Beam™ connector provides a unique solution in the ability to support both high current and high signal speed in one design. By integrating the historically proven Neoconix micro-spring design into an overmolded thermoplastic carrier, the X-Beam™ connector provides superior electrical performance coupled with ease of assembly in a ~1mm total mated height solution.

XBM-D048A



XBM-D048A Assembly



Product Features

- Ultra-low profile 0.35-0.46mm connector height
- High speed 10Gbps
  - Road map 28Gbps
- Current capacity 1.5A/pos
- One-step reliable screw assembly
- SMT Processing
- Standard hardware
- Tape & reel packaging
- RoHS 2011/65/EU
- Halogen-free

Documents

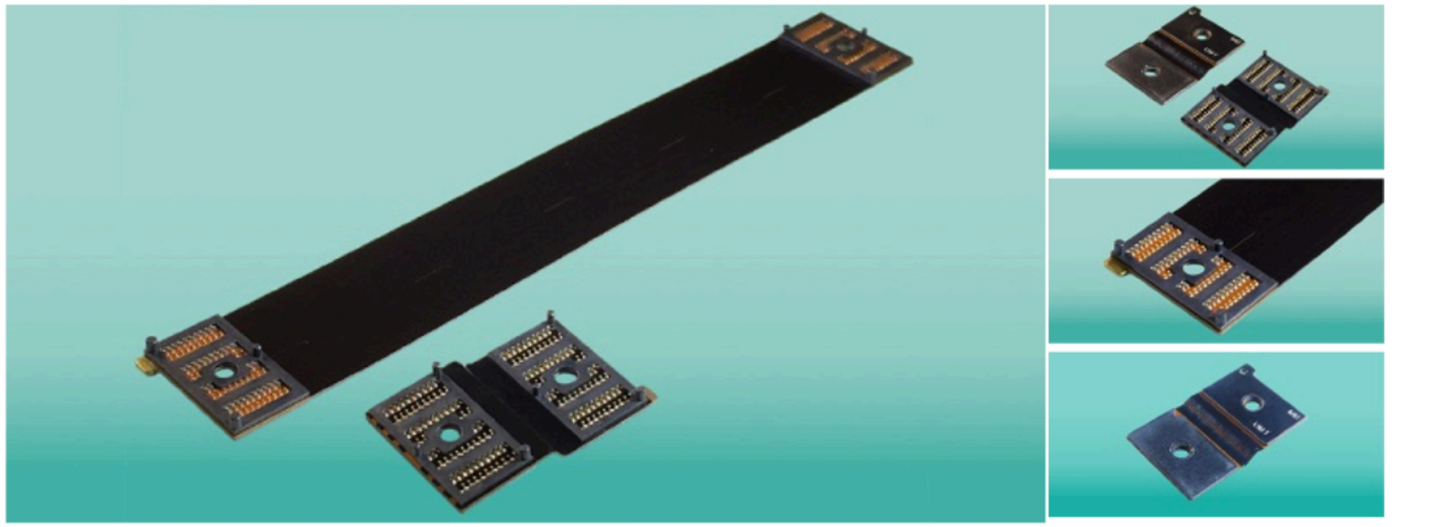
- Application Spec
- Overview

Related

- FPConnected™ XFPC
- FPConnected™ PFPC
- PCBeam™ LPM Connectors
- PCBeam™ LPS Connectors
- Quote Request Form
- Request Information

Neoconix integrated connector

https://neoconix.com/fpconnected-fx-beam-integrated-fpc-jumper/



The Neoconix FX-Beam™ products are semi-custom FPCs that provide a flexible, separable, electro-mechanical link between two printed circuit boards (PCBs). The product consists of an advanced flexible printed circuit (FPC) including an ultra-low profile 68-position X-Beam™ connector and stiffener integrated on each end and is secured to the PC with a simple, highly reliable screw-down fastening system.

The X-Beam™ is a compressive interconnect, eliminating the need for any mating SMT connectors on the PC Board. X-Beam™ connectors occupy minimal board space and offer a rare combination of outstanding reliability, signal integrity, and power delivery. While the connectors and FPC pad patterns are standardized, the FPC layout is designed for each application, based on the particular signal, power, and length requirements of each application.

By combining the advanced FPC design with an extremely short electrical termination path, the FX-Beam FPC jumper uniquely combines high speed signaling (>10Gbps) with significant power delivery (>10A). The FX-Beam jumpers can be designed for signal, power or signal+power applications.

Product Features

- Single piece Board-to-Board jumper
- No SMT parts on PCB
- Integrated pins
- Assured z-axis assembly via 3rd pin
- X-Beam™ high reliability contacts
- Low profile 1.18mm mated
- Hard gold plated interface
- Fully integrated
- High speed to -0.7dB IL @5GHz
- Simple screw-down assembly
- Quick assembly
- Tight true position (pin/flange)

Documents

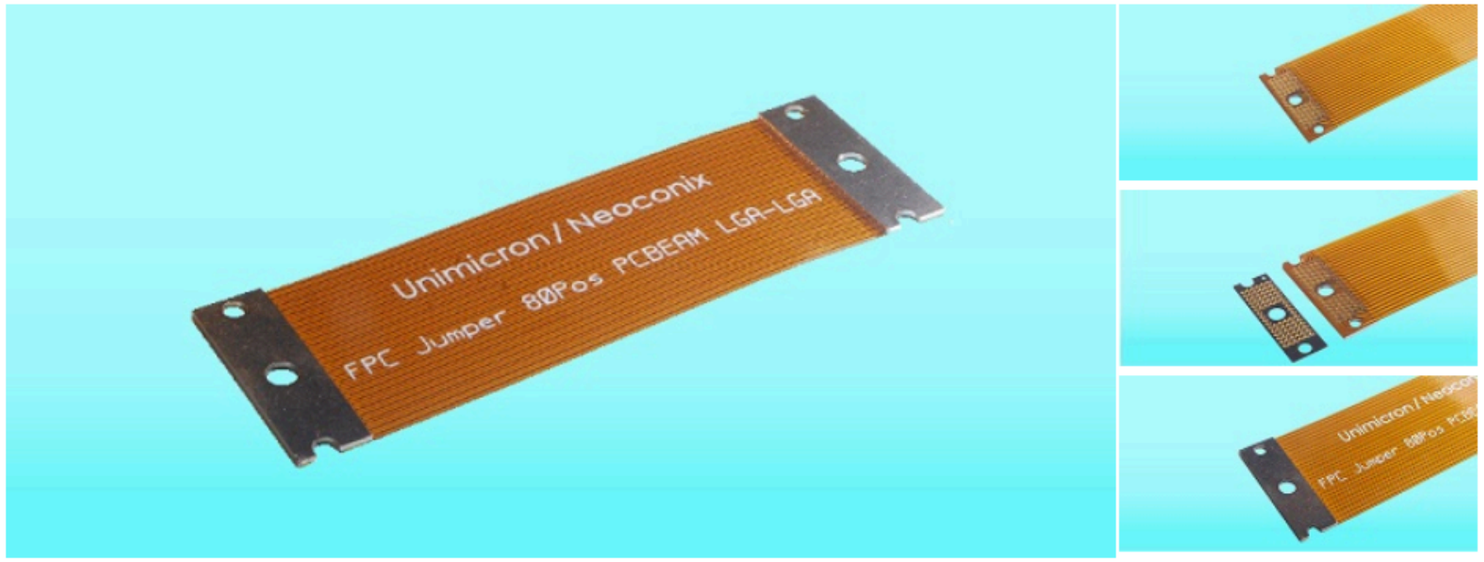
Overview

Related

- FPConnected XFPC
- FPConnected X-Beam™
- FPConnected USB3.1

Neoconix: FPConnected™ PFPC (LPM FPC Jumper)

https://neoconix.com/fpconnected-pfpc-lpm-fpc-jumper/



Developed for mobile devices and other space constrained applications, the Neoconix semi-custom PFPC LPM Jumper product series provides a flexible electro-mechanical link between two circuit boards, utilizing an advanced flexible printed circuit (FPC) design mated to ultra-low profile LPM PCBeam™ connectors on both ends. The PFPC Jumper features gold plated pads as well as integrated stiffeners on both ends and is secured to the LPM PCBeam™ connector with a simple, highly reliable screw-down fastening system. By combining the advanced FPC design with an extremely short electrical termination path, these assemblies can uniquely combine high speed signaling (>10Gbps) and significant power delivery (>10A). The PFPC Jumpers can be designed for Signal, Power or both Signal and Power applications.

Product Features

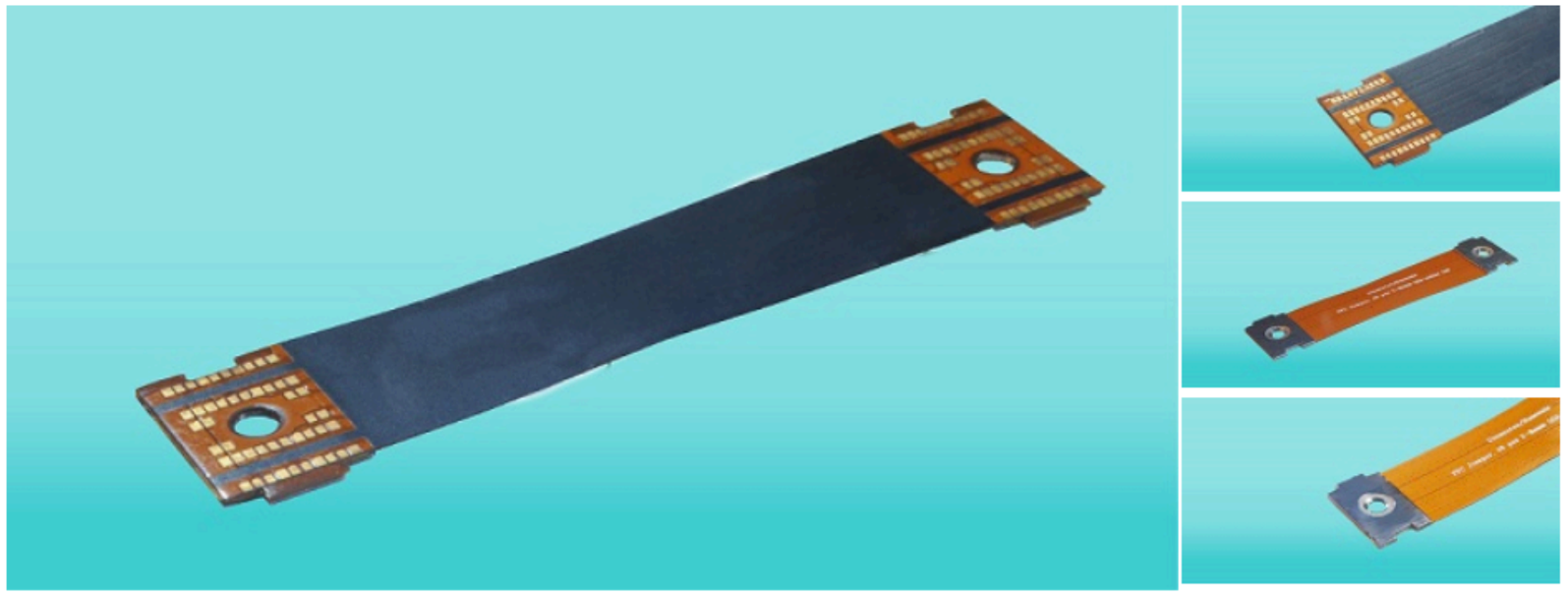
- High performance FPC mates with ultra-low profile (0.28mm) PCBeam™ LPM connector
- Pin count 24,56,80 & custom
- High speed, 10Gbps
  - Road map 28Gbps
- High density 0.74mm
- Custom FPC length
- Current capacity >10A on some configurations
- Pick & place hardware (pins & nut)
- PCIe 3.0 & USB3.1
- RoHS 2011/65/EU
- Halogen-free

Documents

Application Spec
Overview

Neoconix: FPConnected™ XFPC (X-Beam FPC Jumper)

https://neoconix.com/fpconnected-xfpc-x-beam-fpc-jumper/



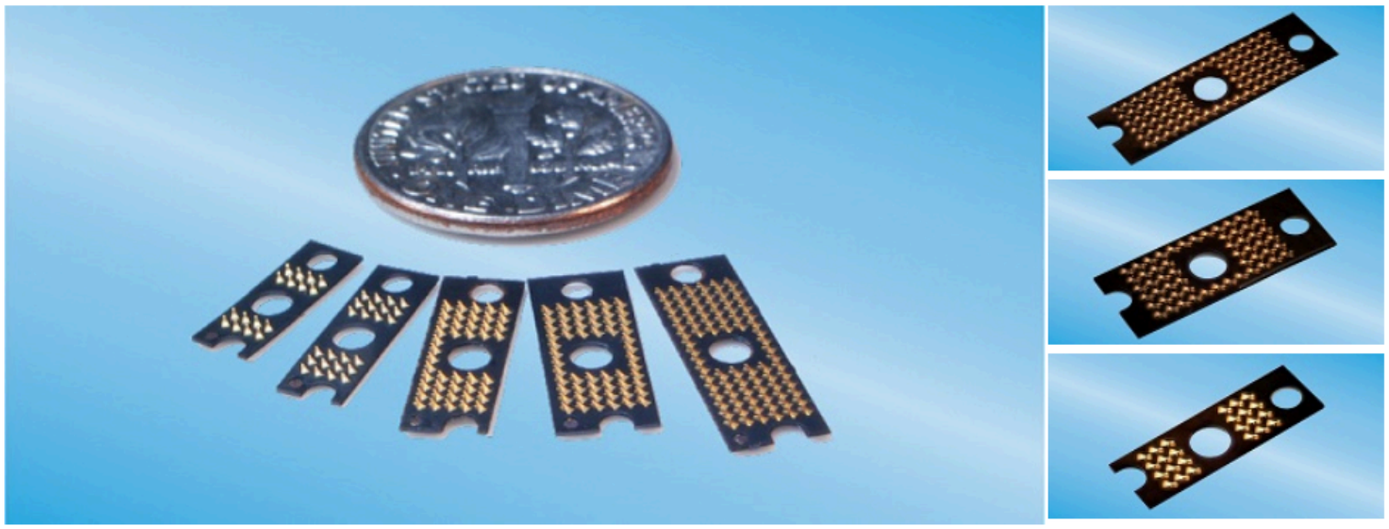
The X-Beam™ semi-custom FPC jumper solution provides a flexible electro-mechanical link between two circuit boards, utilizing an advanced flexible printed circuit (FPC) with an ultra-low profile 48 position connector on each end. The board connections are made with a surface mounted, ultra-low profile X-Beam™ connector, which occupies minimal board space and offers outstanding reliability. The high performance FPC maintains excellent signal integrity with the capability to carry more than 5A of current.

Product Features

- High power FPC
- Mates with low profile X-Beam™ connector
- High speed 10Gbps
  - Road map 28Gbps
- Pin count 28,48,68 & custom
- Custom FPC length
- Low profile 1.17mm or less mainboard Connection
- Current capacity up to 5A in some configurations
- Standard hardware
- High reliability screw-down connection
- Small footprint to mainboard 11.25 x 7.48mm
- RoHS 2011/65/EU
- Halogen-free

Neoconix: PCBeam™ LPM Connectors (Signal + Power)

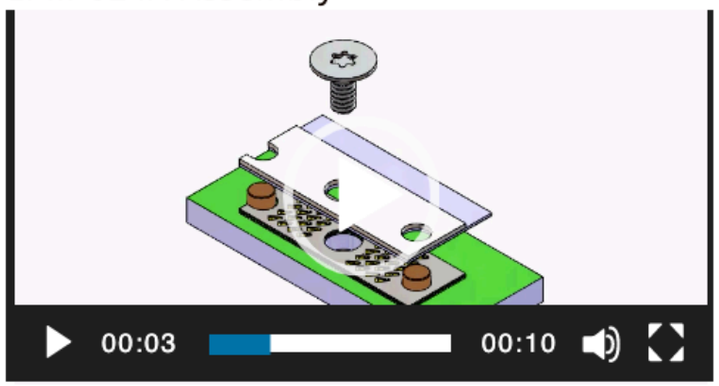
https://neoconix.com/pcbeam-lpm-connectors-signal-power/



Developed for mobile devices and other space constrained applications, the Neoconix LPM line of connectors feature exceptional X-Y-Z density with a simple, highly reliable screw-down fastening system. With an extremely short electrical path, these products uniquely combine high speed signaling (10Gbps) and significant power delivery (>10A) within one connector.

LPM-024A

LPM-024A Assembly



Product Features

- High performance PCBeam™ technology
- High speed 10Gbps
  - Road map 28Gbps
- High density 0.74mm pitch
- Low insertion loss
- Low profile 0.43mm
- Current capacity >10A on some configurations
- Pick & place hardware (pins & nut)
- LGA/LGA
- PCIe 3.0 & USB3.1
- RoHS 2011/65/EU
- Halogen-free

Documents

- Application Spec
- Overview

Related

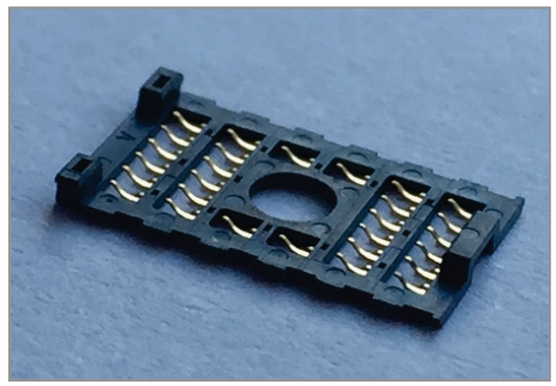
- PCBeam™ Technology
- FPConnected™ PFPC
- PCBeam™ LPS Connectors

A preferred solution?

X-Beam™ Product Series (XBM)

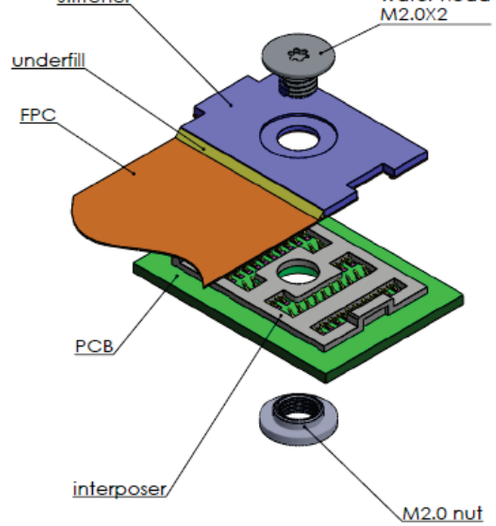
OVERVIEW

The **X-Beam™ Connector** provides a unique solution in its ability to support both high current and high signal speed in one design. By integrating the historically proven Neoconix micro-spring design into an over-molded thermoplastic carrier, the X-Beam connector enables superior electrical performance coupled with ease of assembly in a ~ 1mm total mated height solution. The ultra low profile design provides excellent signal integrity at data rates of up to 25Gbps. The current capacity is scalable, with flexibility to allocate as many positions to power and ground as desired in the 12 position, 48 position and 68 position configurations.



FEATURES

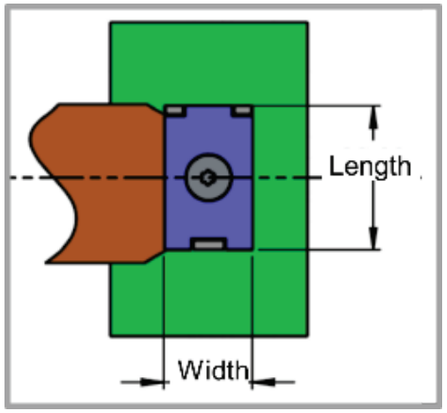
- Ultra-low profile, 0.42 – 0.46mm interposer base height
- One-step high reliability screw assembly
- High speed signal contacts to >25Gbps
- SMT Processing
- Current capacity up to 1.5A per position
- Offered with pick & place cap and tape & reel packaging
- Pick & place compatible standard hardware
- Additional customization options offered
- Compliant with ROHS 2011/65/EU and IPC-4101B (halogen-free)

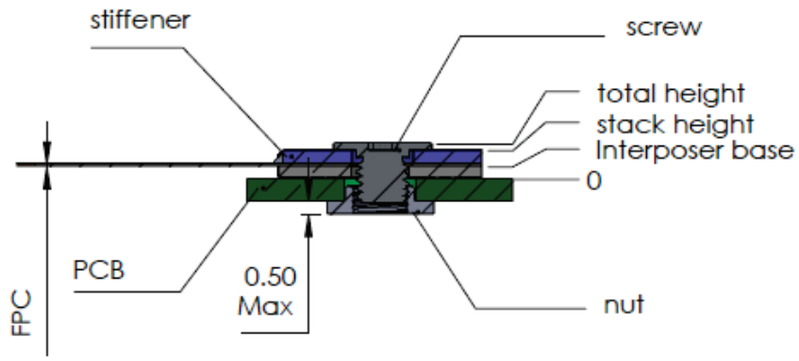


XBM STANDARD PRODUCT SERIES

Minimum “maximum real height”: 2 mm (limited by screw height)

Connection dimensions



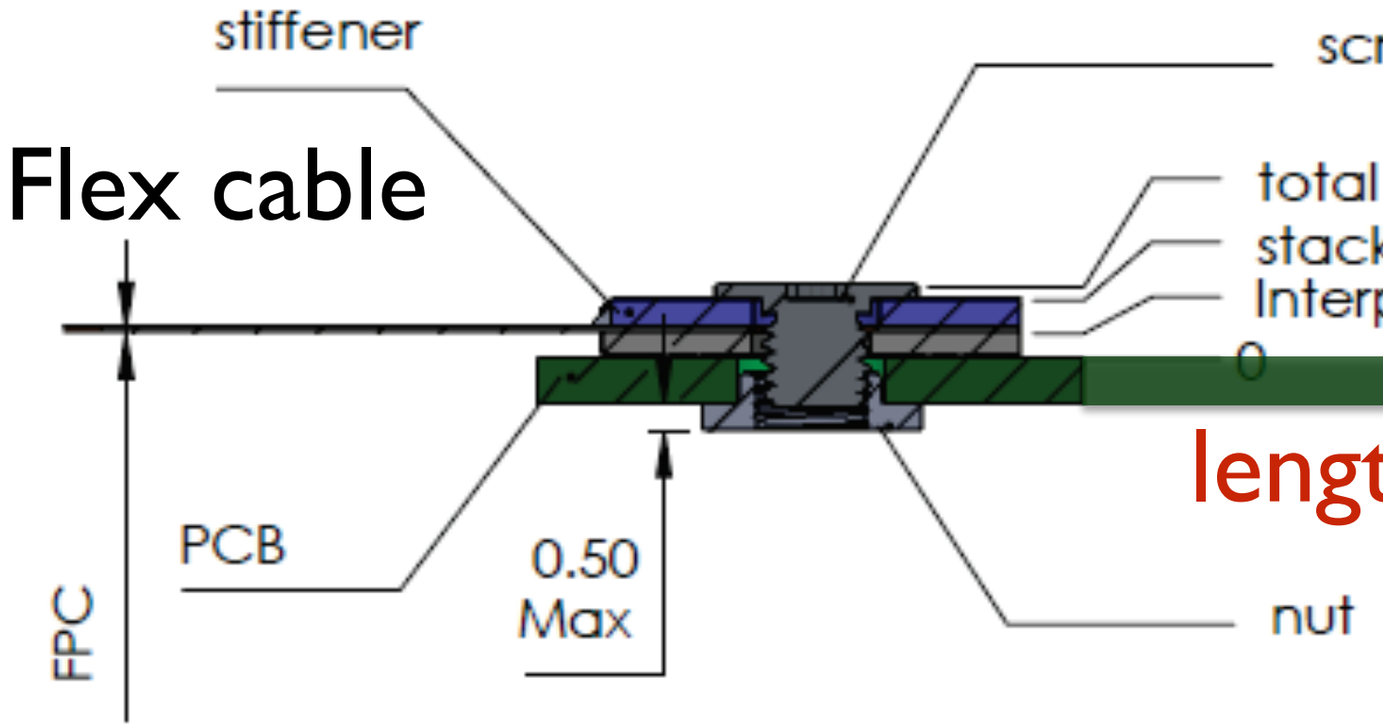


Part Number	Application	Contacts	Current Max (A)	Length (mm)	Width (mm)	Base Height (mm)	FPC Thickness (mm)	Stiffener Thickness (mm)	Hardware (Nut and Screw)	Total Height (mm)
XBM-D012A	Power or Signal	12	5.5	7.96	3.60	0.48	0.10	0.20	M1.2	1.03
XBM-G028A	Power	28	8.5	10.80	6.65	0.42	0.15	0.40	M2.0	1.22
XBM-D048A	Signal	48	11	11.35	7.68	0.48	0.10	0.50	M2.0	1.33
XBM-D048C	Signal	48	11	11.35	7.68	0.48	0.10	0.50	M2.0	1.68
XBM-D068A	Signal	68	14	13.60	7.68	0.48	0.10	0.50	M2.0	1.68
XBM-D068C	Signal	68	14	13.60	7.68	0.48	0.10	0.50	M2.0	1.33

Table 2 Recommended screw/nut configuration vs PCB thickness

Product	PCB Thickness (mm)	Description	SMT Nut Part Number	Screw Part Number
XBM-G028A XBM-D048X XBM-D068X	2.6-4.0	M2x0.40mm pitch, 5mm Screw Length	B01-000654	B01-000659
	1.6-2.6	M2x0.40mm pitch, 4mm Screw Length		B01-000660
	1.0-1.6	M2x0.40mm pitch, 3mm Screw Length		B01-000661
	0.6-1.0	M2x0.25mm pitch, 2mm Screw Length	B01-000633	B01-000662
XBM-D012A	2.6-4.0	M1.2x0.25mm pitch, 5mm Screw Length	B01-000588	B01-000668
	1.6-2.6	M1.2x0.25mm pitch, 4mm Screw Length		B01-000667
	1.0-1.6	M1.2x0.25mm pitch, 3mm Screw Length		B01-000666
	0.6-1.0	M1.2x0.25mm pitch, 2mm Screw Length		B01-000665

A possible design?



PCB: 0.6 mm thick
can it be thinner?

length?

Sensor with
wire bound for power

ASIC mounted to cooling plate

Several problems with this design:

- Total height acceptable?
- Interference with adjacent modules

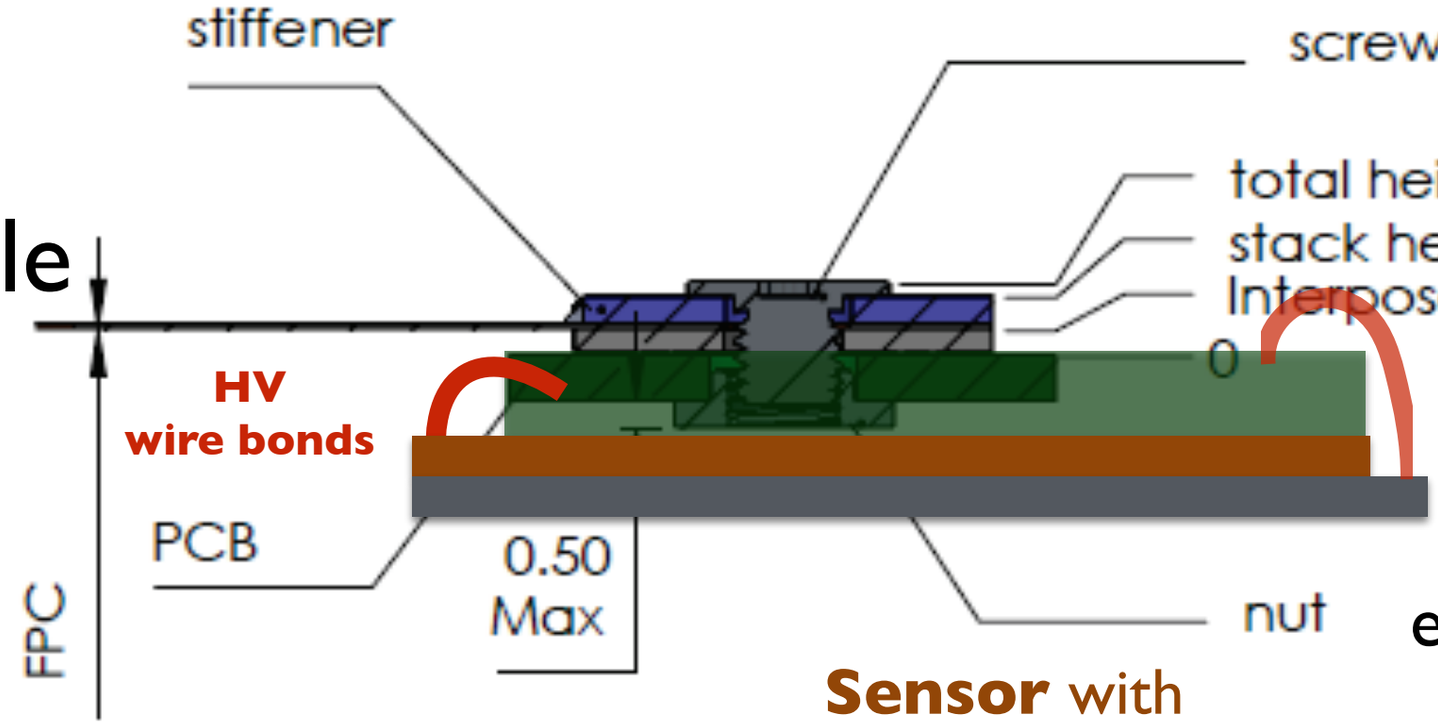
Total extra height:
1-1.3 mm

Could we use a thinner flexible PCB?

Embed nut into PCB make module thicker?

Second possible design?

Flex cable



PCB: ~ 1 mm thick
can it be thinner?

embedded screw nut into PCB

Sensor with
wire bound for power

ASIC mounted to cooling plate

Several problems with this design:

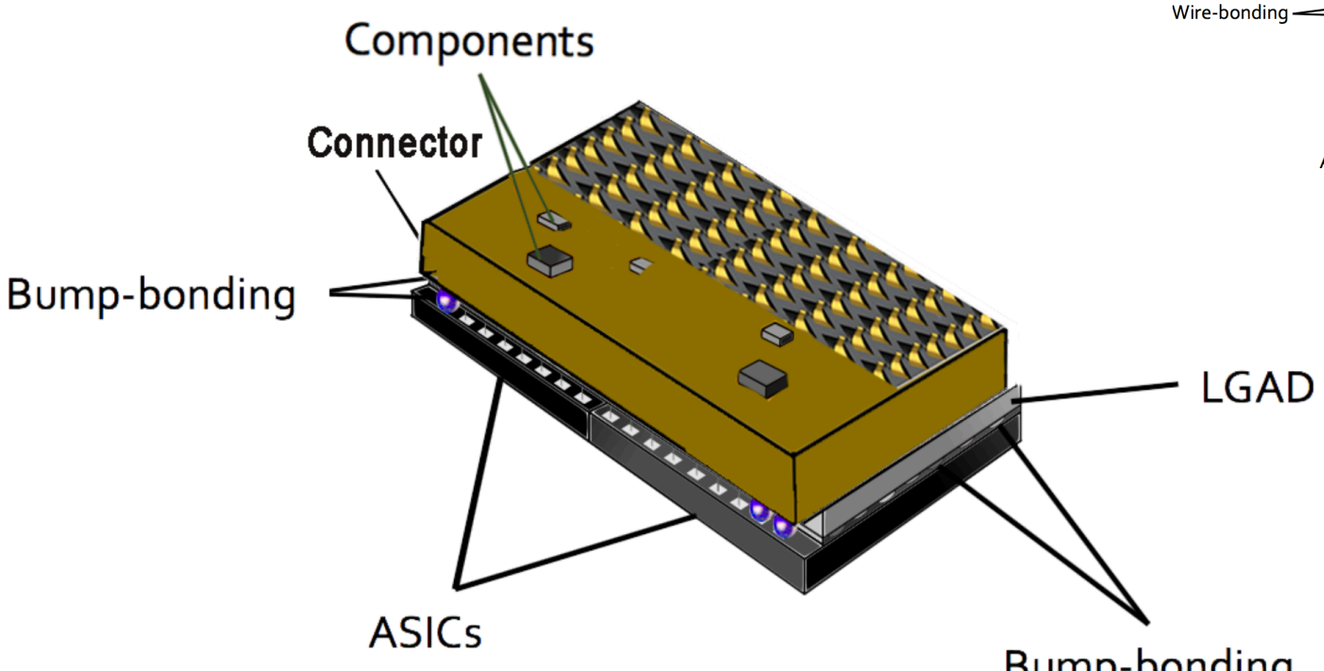
- Total height acceptable?

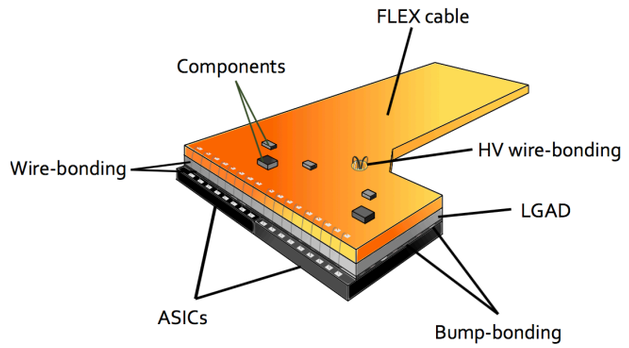
Total extra height:
2 mm

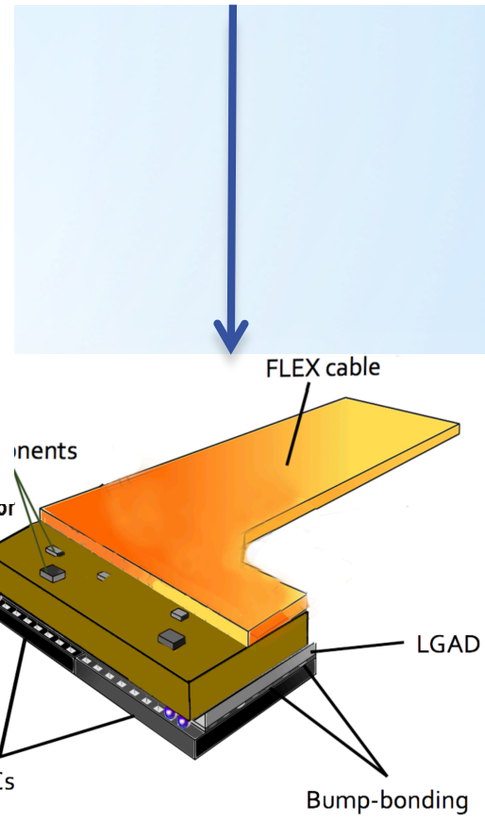
Can we get an extra millimeter somewhere else?
(the total increase inside closure would be 4 mm)

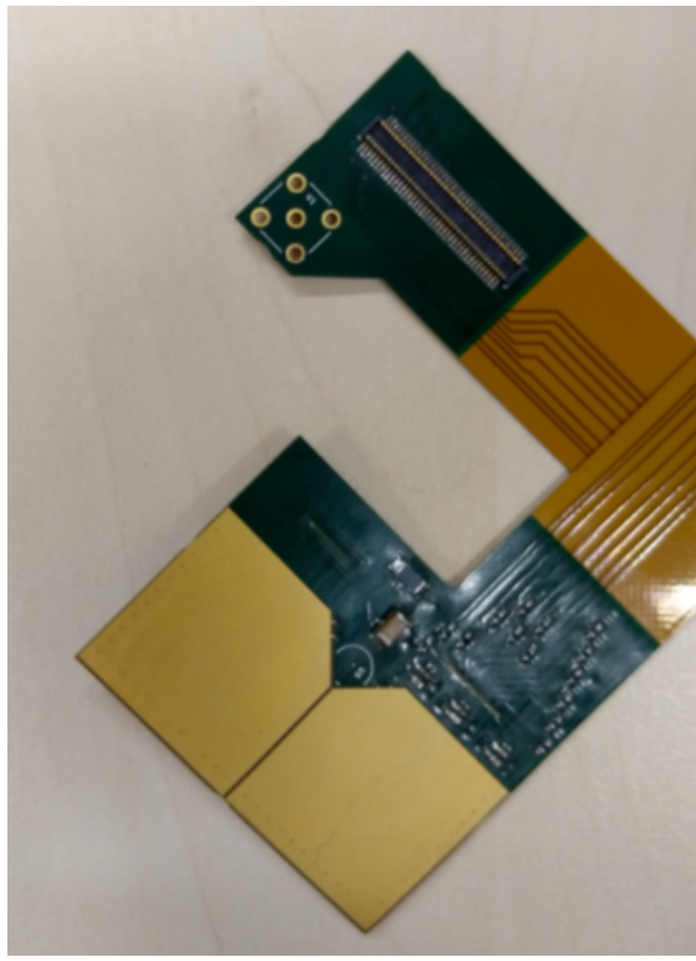
Previous designs from ATLAS

Connectors candidates for connecting flex cables to PEB









Price, space, feasibility to make bump bonding = ?

Wire bonding ➔ bump bonding = more robust
Flexes without connectors on both sides
Flexes can be reused
Possibility to adjust to flexes length difference
…

Connectors

Connectors candidates for connecting flex cables to PEB

To be checked if can be used in HGTD environment samtec https://www.samtec.com/

Z-RAY® ULTRA-LOW PROFILE ARRAYS

Z-RAY® ULTRA-LOW PROFILE ARRAYS

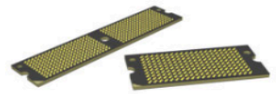
Z-Ray® High-Density, Ultra-Low Profile, Highly Customizable Arrays

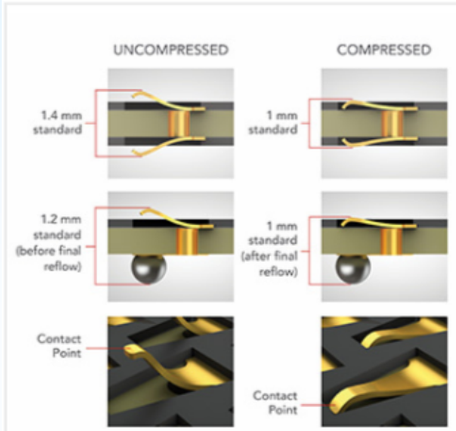
Features

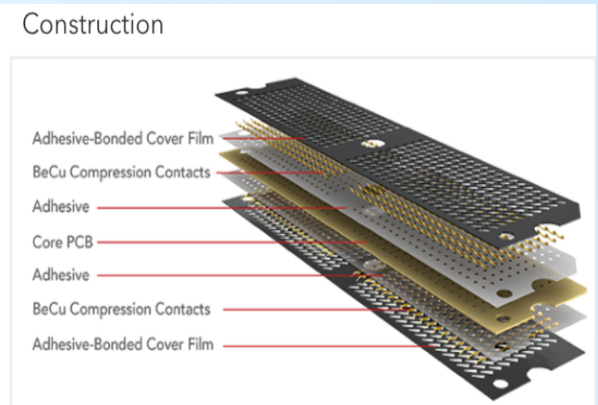
- 1 mm standard body height
- Dual compression contacts
- Single compression with solder ball
- Performance up to 20 GHz / 40 Gbps
- 0.80 mm or 1.00 mm pitch standard
- Highly customizable system

Series

Select

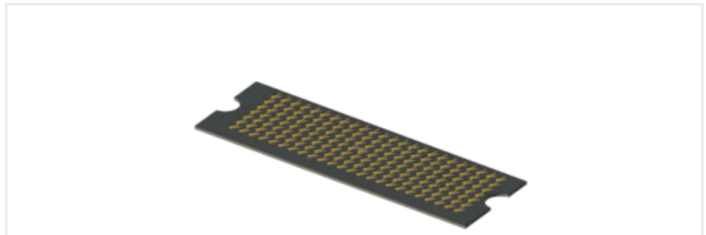






ZA8H Back To Top ↑

0.80 mm High-Speed Dual Compression Array

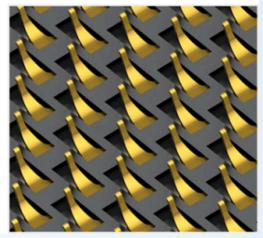


Features

- Performance up to 56 Gbps NRZ
- 0.33 mm height provides shortest signal path
- Dual compression BeCu contacts
- Up to 168 contacts: 4 or 7 rows with 3, 12 or 24 pairs per row
- 30 g normal force with .008" (0.20 mm) contact deflection

High Density

- Customer-specific pin counts for ultimate high density and speed flexibility
- Choice of 0.80 mm or 1.00 mm pitch grid
- Up to 400 I/Os standard with custom capabilities to 3,000+ I/Os
- Also Available: 1.00 mm pitch system with up to 400 I/Os,1.27 mm and 2 mm standard heights, and up to 56 Gbps performance (GMI Series)



Specifications

- Performance up to 14 Gbps (ZA8, ZA1 Series) and 56 Gbps NRZ (ZA8H Series) with a migration path to 100 Gbps
- Up to 1,000 cycles, with alternate contact design for up to 3,000 cycles also available (tested to 85˚C)
- Low 30 g normal force with .008" contact deflection
- 500 mA per line
- Differential Vias™ PCB routing available
- Also Available: 1.00 mm pitch system with up to 400 I/Os, 1.27 mm and 2 mm standard heights, and up to 56 Gbps performance (GMI Series)
- Also Available: Ultra-low profile Z-Ray® Cable Assembly designed for high-speed, micro pitch applications (ZRDP Series)

		Single Compression w/ Solder Balls		Dual Compression			
Series		ZA8	ZA1	ZA8	ZA1	Custom	ZA8H
Pitch		0.80 mm	1.00 mm	0.80 mm	1.00 mm	1.27 mm	0.80 mm
Max Row		25	20	50	58	58	14
Max Column		25	20	50	58	37	50
Thickness	Kapton Core	N/A	N/A	0.33 to 0.5 mm	0.33 to 0.5 mm	0.33 to 0.5 mm	0.33 mm
	FR4 Core	1.00 to 4 mm	1.00 to 4 mm	0.5 to 4 mm	0.5 to 4 mm	0.5 to 4 mm	N/A
Thickness Tolerance	Kapton Core	N/A	N/A	±5%	±5%	±5%	±5%
	FR4 Core	±10%	±10%	±10%	±10%	±10%	N/A
Deflection / Normal Force per Pin		0.20 mm / 30g				0.20 mm / 25-50g	0.20 mm / 30g
Operating Temperature		-55˚C to +105˚C (85˚C Single Cycle)					

ompression Hardware Systems

Engineered to provide precise alignment, compression and retention of dual compression (LGA) or single compression with solder balls (BGA) Z-Ray® Interposers

Z-Ray® hardware systems are ultra-low profile and designed to reduce risk of damage to the interposer

ZSO Series provides alignment for single compression solder ball interposers

ZHSI Series provides alignment and ensures proper contact retention for dual compression interposers

ZD Series press-in hardware provides proper PCB to interposer alignment for dual compression interposers