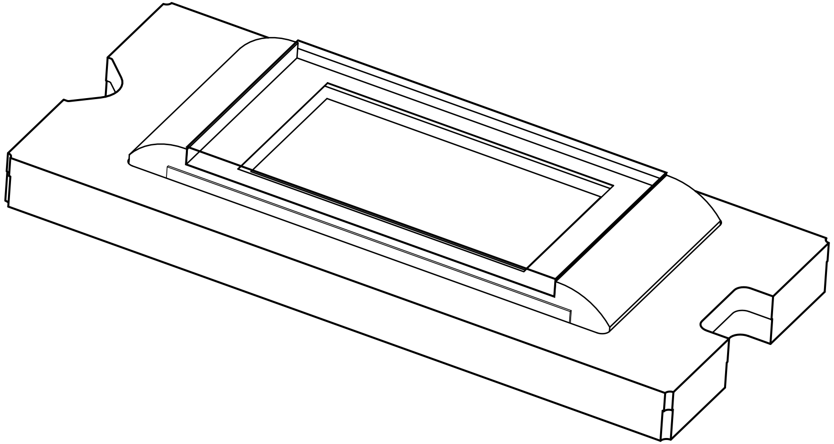
.46 Series 320 DMD Overview

Design Considerations and System Mounting

DLP4620S-Q1 and DLP4621-Q1

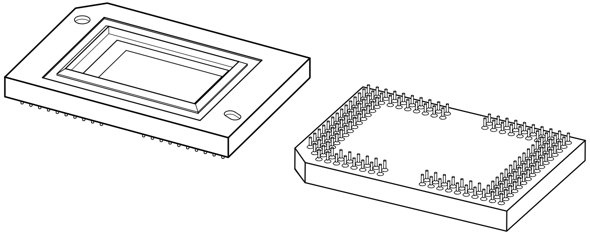


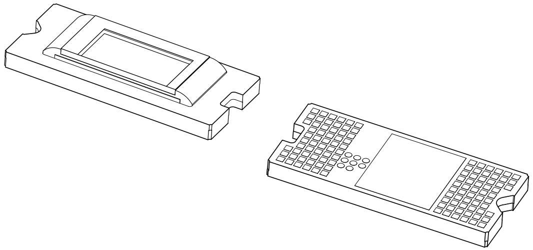
28 June 2022

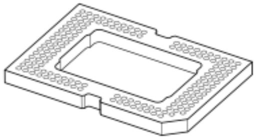
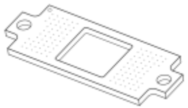
Updated 19 June 2024

John McKinley

.55 Series 450A Comparison to .46 Series 320 :: High Level Summary

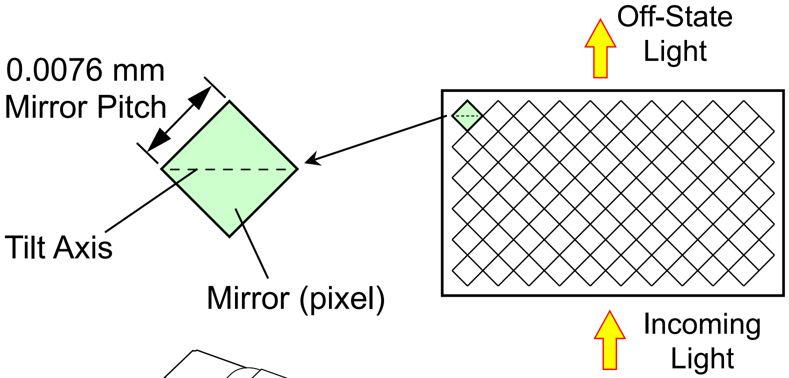


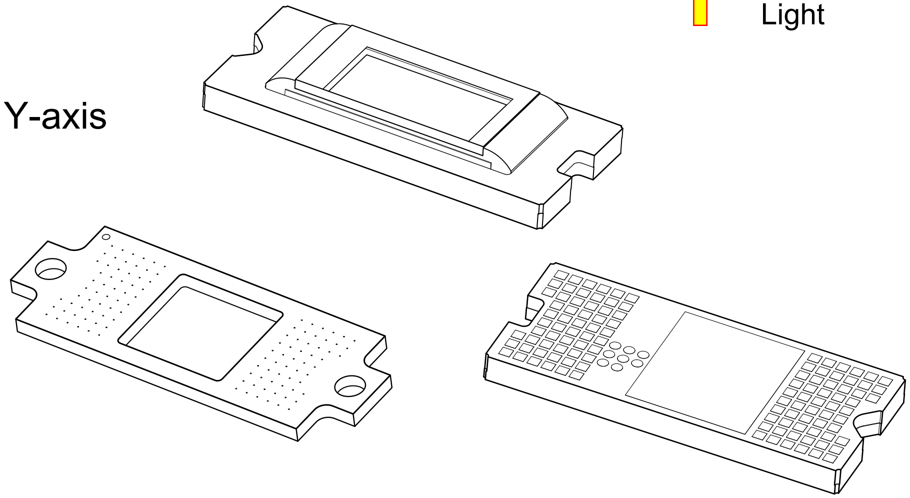


	.55 Series 450A (DLP5530S-Q1)	.46 Series 320 (DLP4620S-Q1)
Ceramic Size (mm)	22.30 x 32.20 x 2.95	11.00 x 25.304 x 1.925
Array size (mm)	12.447 x 6.2262	10.373 x 5.189
Glass thickness (mm)	1.10	0.70
Electrical Connection	149 pins	112 pads
pressure for connection	None 	Constant load 
Datums 'B' and 'C'	Hole and Slot	'V' Notch and Edge of 'C' Slot
Interface Loads		
Thermal area (N)	110.8	90
Electrical area (N)	111.3	135

.46 Series 320 DMD :: Highlights

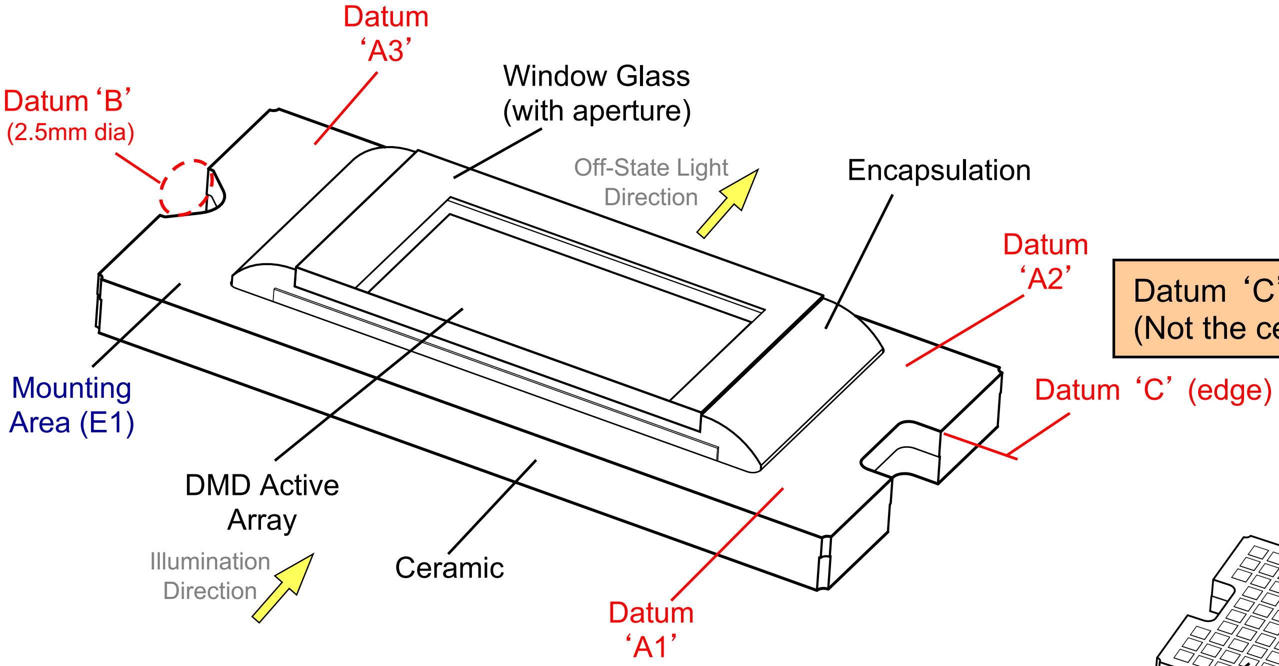
- Array resolution – 1920 x 960 (960 x 960 native)
- Pixel pitch – 7.6 um (0.0076 mm)
- Pixel configuration – Bottom Diamond
- Illumination direction – from long side
- Array size – 10.373 x 5.189 mm
- Series 320 style package
- Outside dimensions – 25.20 x 11.00
- Datums ‘A’, ‘B’, and ‘C’ *(like Pico DMDs v-notch, c-notch)*
- Array center from Datum ‘B’ – 12.538 X-axis, 1.082 Y-axis
- Ceramic Thickness – 1.925 mm
- Glass thickness – 0.70 mm
- Glass material – Corning Eagle XG
- Distance from Datum ‘A’ to array – 0.28 mm
- Distance from array to window – 0.307 mm
- Electrical interface – 112 LGA pads
  - 0.75 x 0.75 pads on 1.000 mm pitch



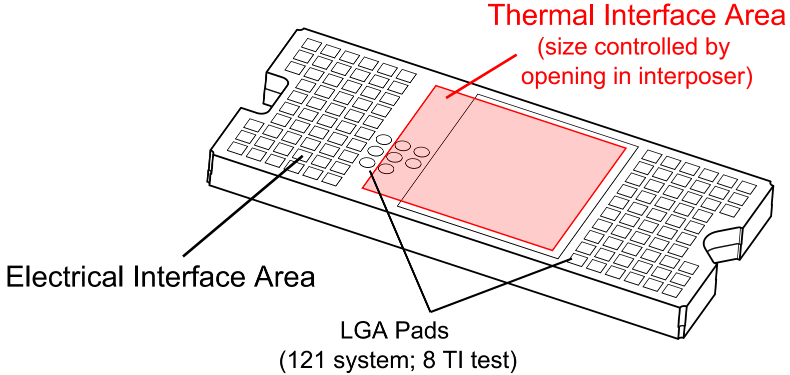


FOR REFERENCE ONLY – use Data Sheet and Mech ICD drawings for final design

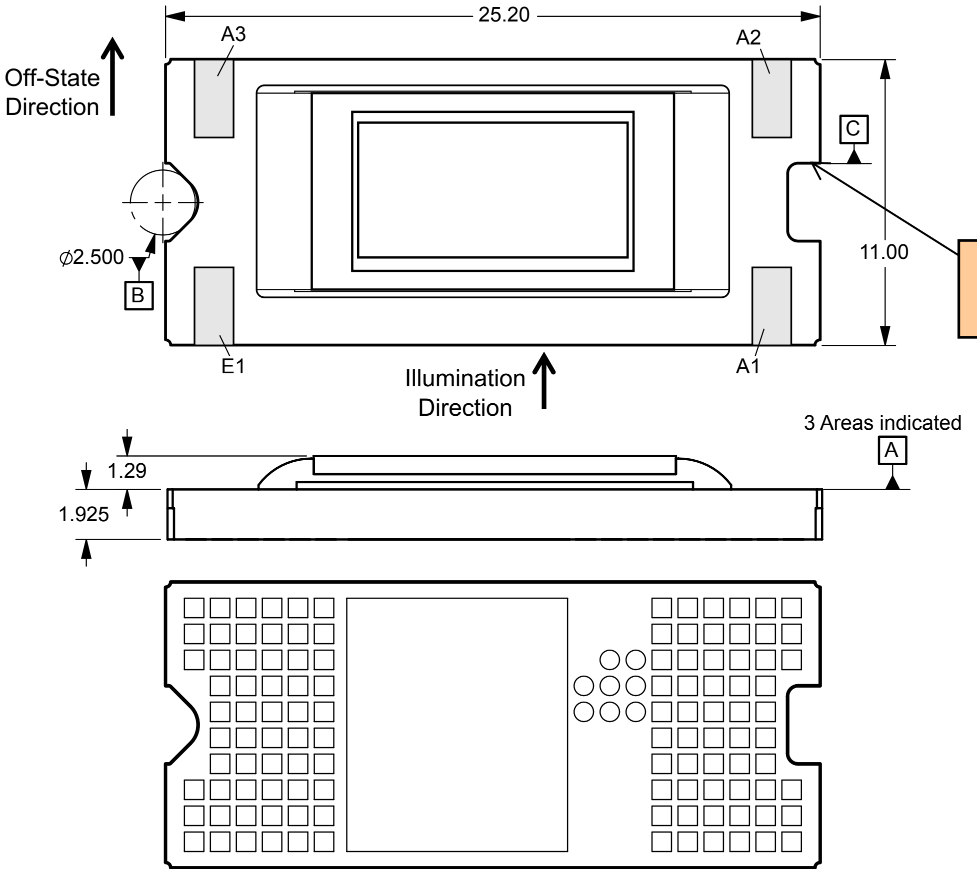
.46 Series 320 DMD :: Features



Datum 'C' is edge of notch
(Not the center of the notch)



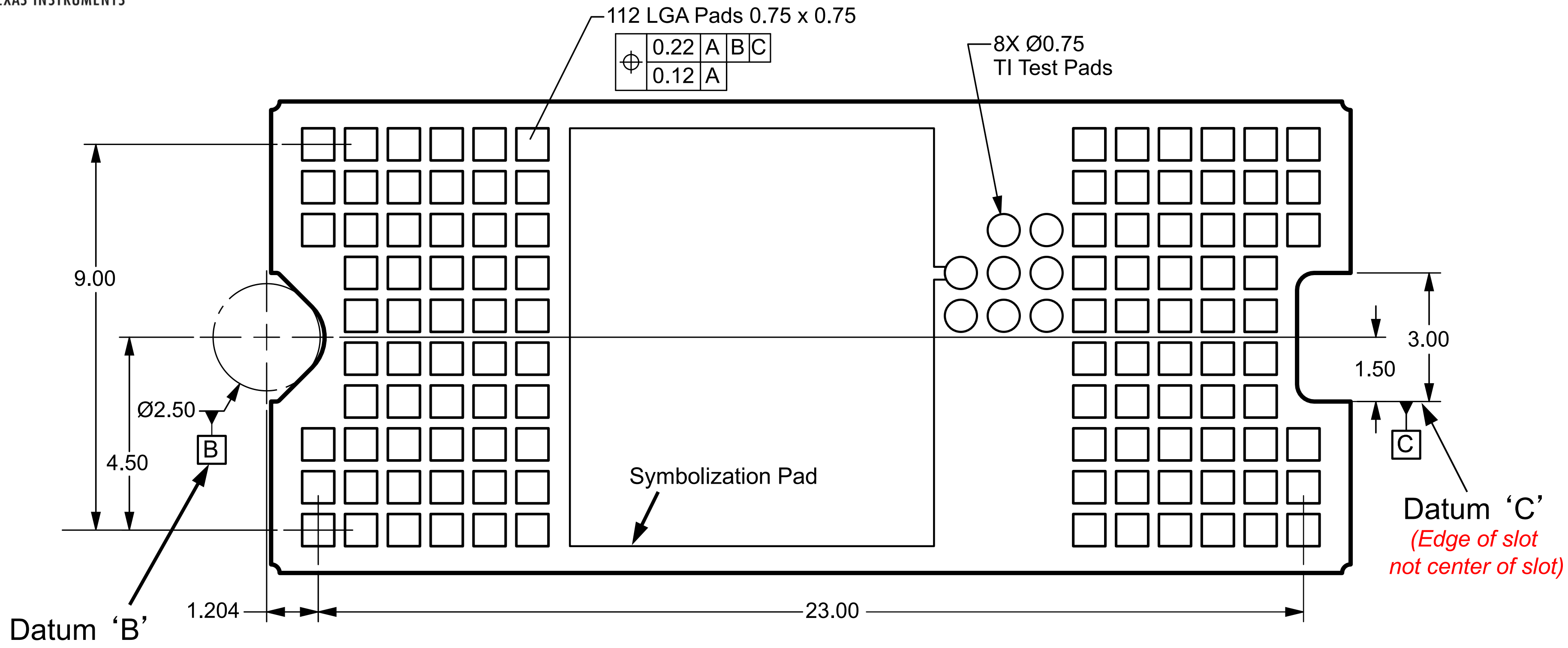
.46 Series 320 DMD :: Datums & Size



Datum ‘C’ is edge of notch
(Not the center of the notch)

The array parallelism is controlled to the Datum ‘A’ areas. Contacting areas other than just Datum ‘A’ (‘E’) increases the variation

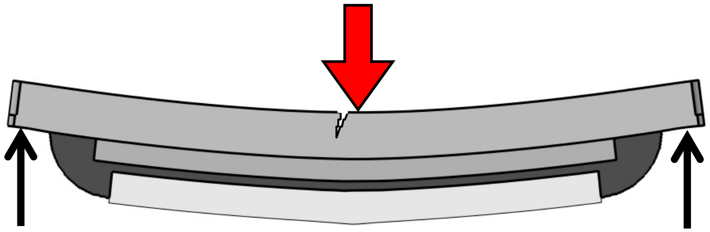
.46 Series 320 DMD :: Electrical Connection

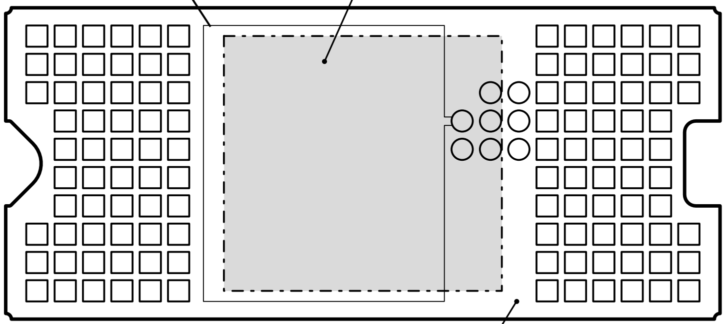


- Use of defined Datum's 'B' and 'C' critical for good electrical connection
  - Location of electrical pads controlled relative to Datum's 'B' and 'C'
- Round test pads and symbolization pad can be contacted with heat sink

.46 Series 320 DMD :: Mechanical Loads

Damage to the DMD can be avoided by not exceeding the DMD mechanical and thermal interface load specifications





Mechanical Loads

- Distribute loads Uniformly over specified areas
- Thermal Interface – 90 N maximum
- Clamping & Electrical interface – 135 N maximum

Note: Symbolization pad and round pads can be contacted by heat sink

System Mounting Interface Loads

PARAMETER	Condition	MIN	NOM	MAX	UNIT
Thermal interface area	Maximum load uniformly distributed within each area (1)			90	N
Electrical interface area	Maximum load uniformly distributed within each area (1)			135	

- Loads must be uniformly distributed within the areas

DMD Data sheet DLP4620-Q1

Absolute Maximum Ratings

		MIN	MAX	UNIT
ENVIRONMENTAL				
T_{ARRAY}	Operating DMD array temperature	–40	105	°C

- Stress Ratings only - for accelerated test considerations
- Not for long term operation

Storage Conditions

		MIN	MAX	UNIT
T_{stg}	DMD storage temperature	–40	125	°C

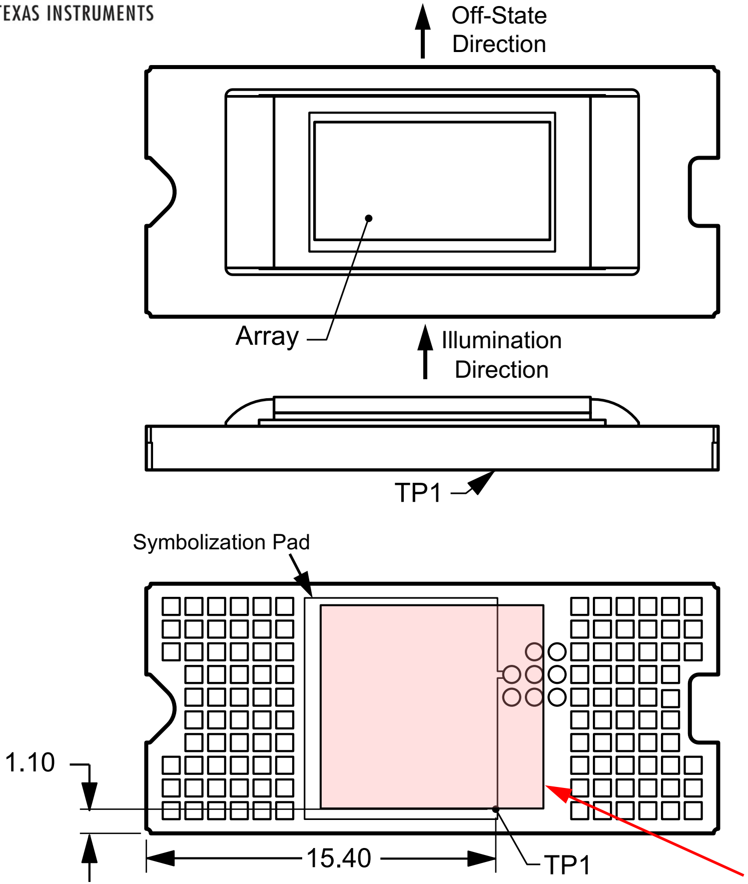
- Anytime DMD is NOT operating

Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
ENVIRONMENTAL					
T_{ARRAY}	Array Temperature(9) (11)	–40		105	°C

- Anytime DMD is operating

.46 Series 320 DMD :: Thermal Test Points



Nominal electrical power dissipation = 0.40 W
$R_{ARRAY\text{-}TO\text{-}CERAMIC}$ = 1.3ºC/W for DLP4620S-Q1

<u>Sample calculation</u> :

AOI OF 34º and f/1.7
Incident light on array and POM = 90%
DMD Absorption = 0.895 - 0.004783 x (incident light on array and POM) = 0.46
$Q_{INCIDENT}$ = 10W *(measured)*
$T_{CERAMIC}$ = 50ºC *(measured)*

Q_{ARRAY} = <u>0.40</u> + <u>(0.46 x 10W)</u> = 5W

Thermal load from Optical

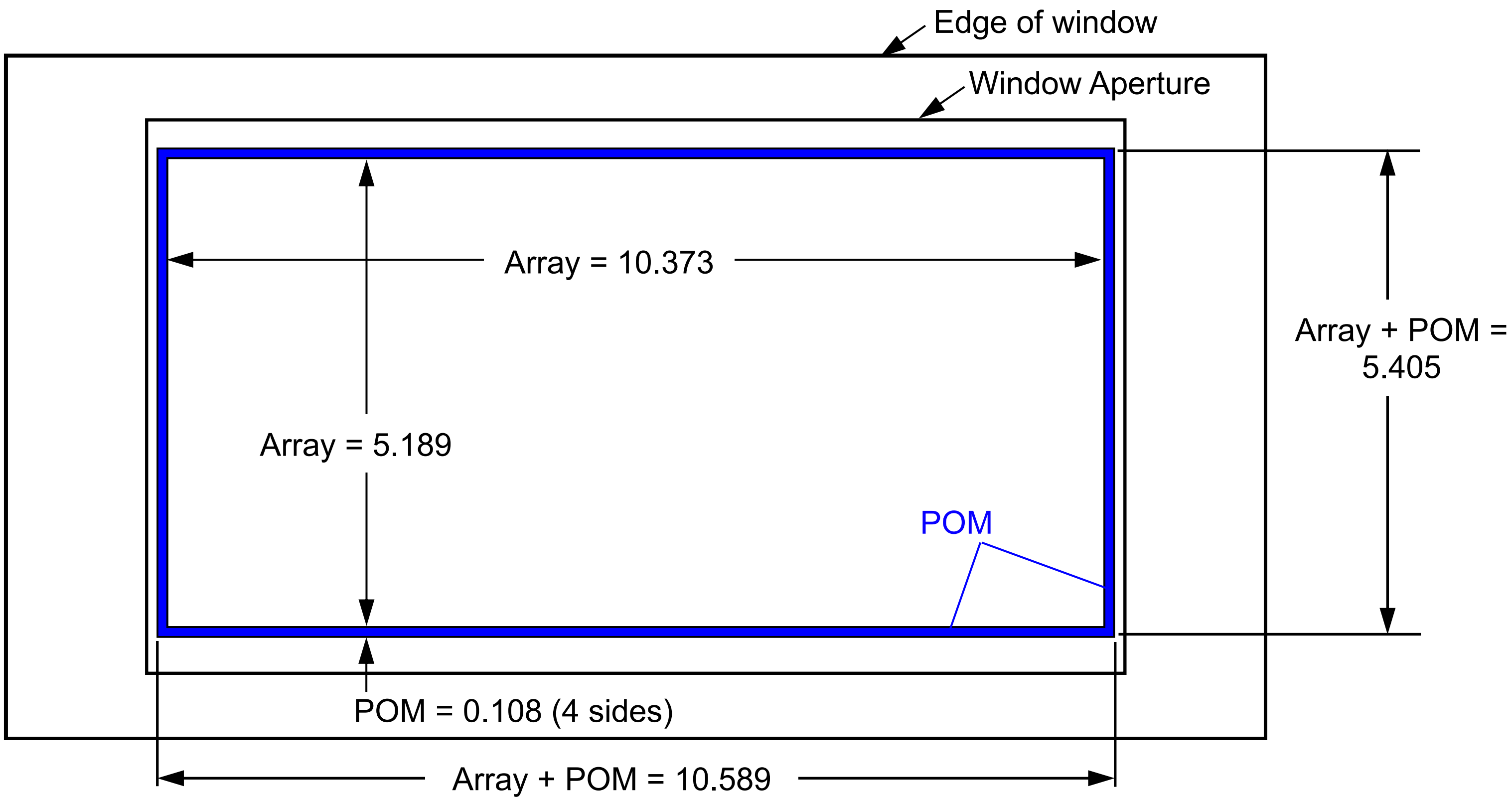
Thermal load from Electrical

T_{ARRAY} = 50ºC + (5W x 1.3ºC/W) = 56.5ºC

Resistance from TP1 to Array
1.3ºC/W for DLP4620S-Q1
1.5ºC/W for DLP4621-Q1

Size of thermal interface area determined by opening in Interposer

.46 Series 320 DMD :: POM Size



Pond Of Mirrors (POM) is a band of mirrors around the active array that are always in the Off-state. The size of POM is defined in the DMD data sheet (physical characteristics section).

% of light on ActiveArray + POM

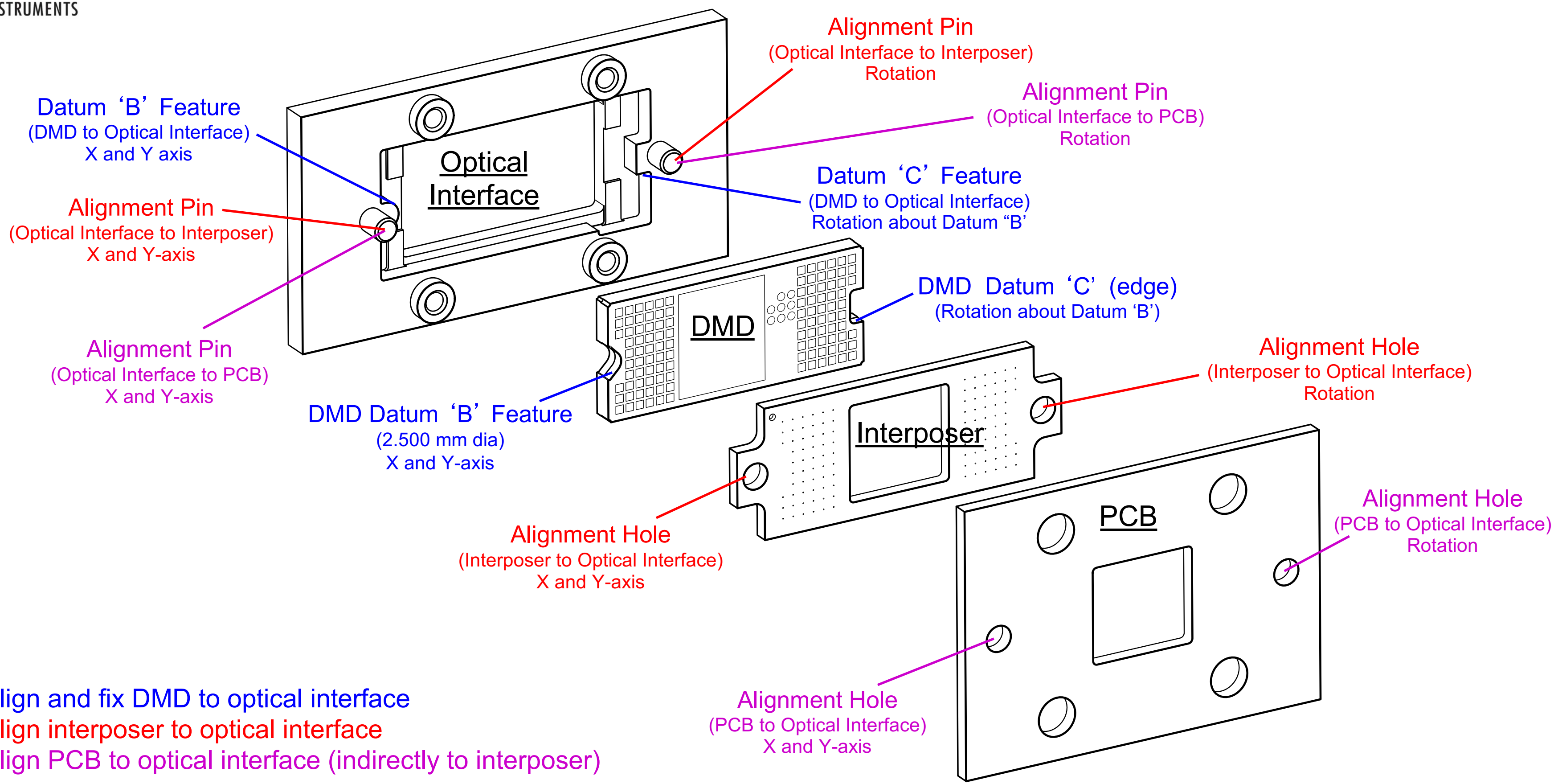
Example:
(% of light on ActiveArray + POM) = [Array area + POM area) ÷ (Array Area)] × (1- OV_{ILL})

OV_{ILL} = 15.4%   (percent overfill from optical model)
Array + POM area = (5.405mm * 10.589mm)
Array area = (5.189mm * 10.373mm)

(% of light on ActiveArray + POM) = ((5.405 × 10.589) ÷ (5.189 × 10.373)) × (1-.154) = 90%

Series 320 System Mounting Concepts

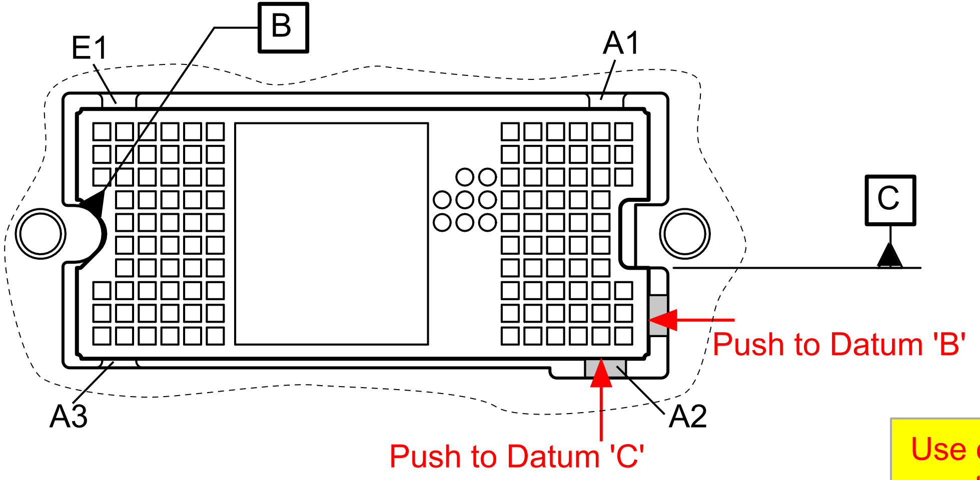
Series 320 System Mounting :: Alignment



1. Align and fix DMD to optical interface
2. Align interposer to optical interface
3. Align PCB to optical interface (indirectly to interposer)

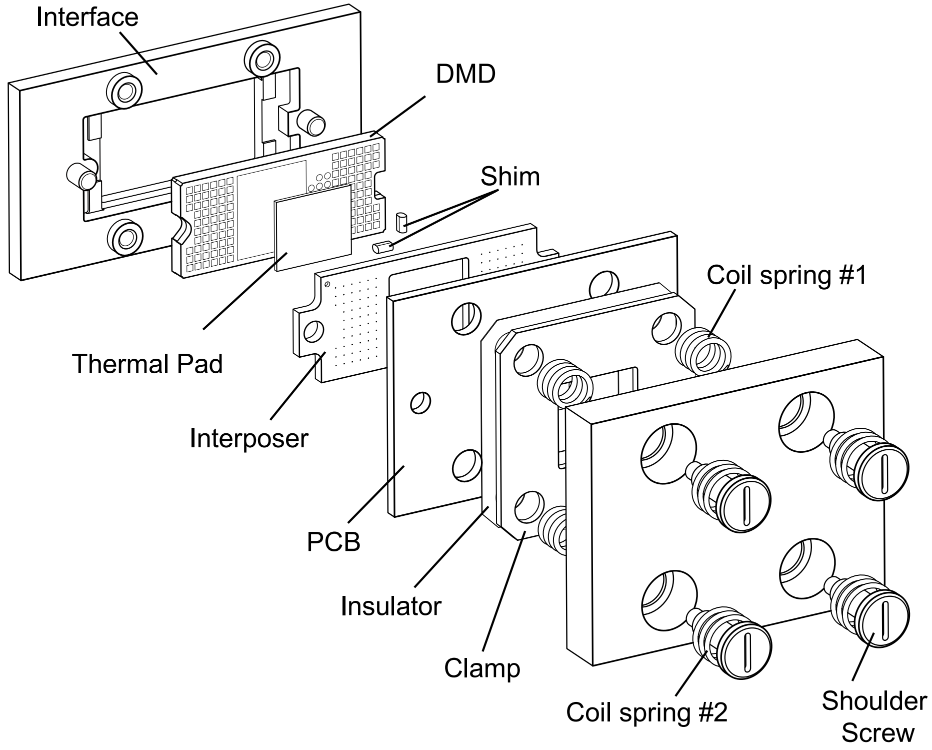
Series 320 System Mounting :: Alignment

- System interface should contact 4 areas (for distribution of mechanical loads)
  - Datum ‘A’ – 3 areas (A1, A2, A3)
  - Datum ‘E’ – 1 areas (E1)
- Push DMD against Datums ‘B’ and ‘C’ when mounting and fix in place
  - Datum ‘B’ is 2.500 mm diameter
  - Datum ‘C’ is edge of c-shaped slot *(not the center of the slot)*

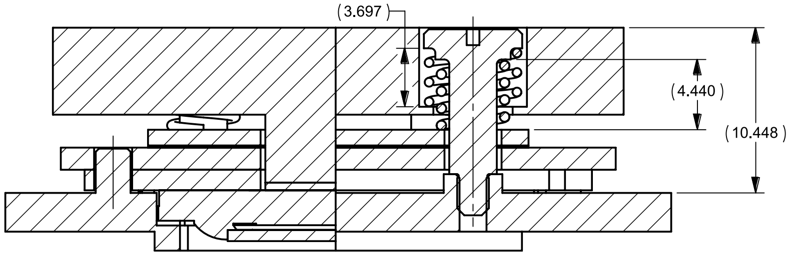


Use of DMD Datums are important for:
- optical alignment
- good electrical connection

Series 320 DMD Mounting Concept 8399 :: Preferred



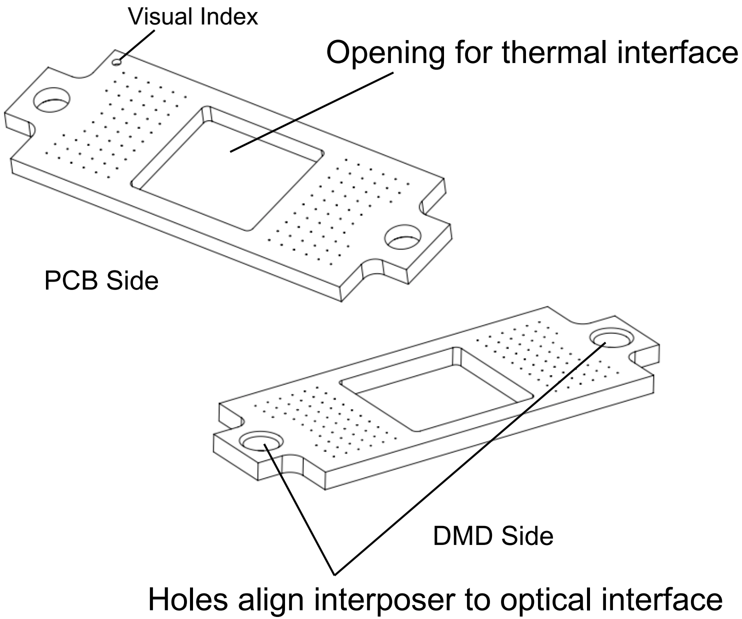
- Shims keep the DMD and optics chassis Datums aligned during the assembly
  - Critical for electrical and optical alignment
- Clamp prevents PCB from bowing
  - Stiffness of material and thickness important
- Insulator prevents coupling of PCB signals through clamp
- Torque on shoulder screws not critical to control loads
- Coil spring #1 controls load on the electrical interface area
  - Spring-rate of spring & size of gap in which it fits are important
- Coil spring #2 controls load on the thermal interface area
  - Spring-rate of spring & size of gap in which it fits are important

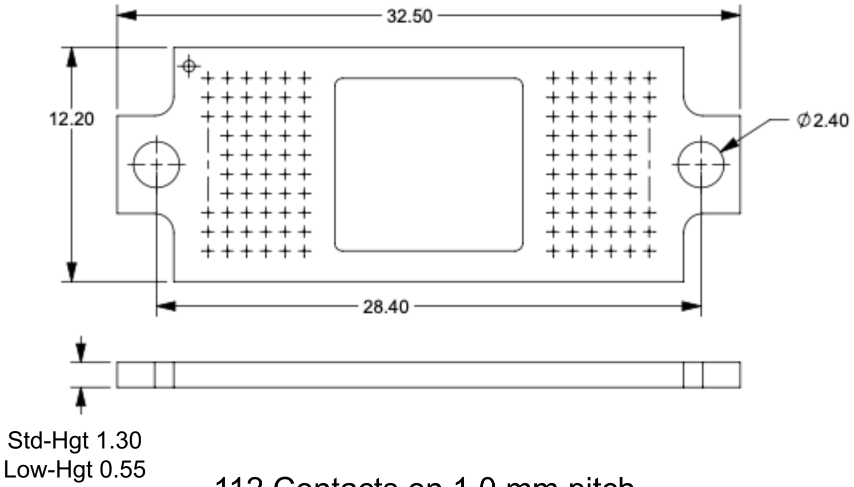


Series 320 System Mounting :: Alignment & Clamping

- Critical considerations
  - Tolerances of all part features associated with electrical alignment
    - Alignment of DMD to optical interface (X-axis, Y-axis, and rotation)
      - Size and location of Datums ‘B’ and ‘C’ on optical interface that contact corresponding features on DMD
      - Fix DMD in position during assembly
    - Alignment of interposer to optical interface (X-axis, Y-axis, and rotation)
      - Optical interface pin diameters and location
    - Alignment of PCB to interposer (X-axis, Y-axis, and rotation)
      - PCB hole diameter and location on PCB
  - Prevent PCB from bending
    - Stiffness of clamp (distance between fasteners and material important)
    - Minimize space between fasteners that clamp assembly
  - Control force on DMD Thermal and Electrical interface areas
    - Uniform applied mechanical loads (clamping)
    - Assembly process (partial tightening, fixture, order of screw tightening)
    - Use of components to absorb tolerance variation of parts (coil spring, compressive washer)
    - If components to absorb tolerances are not used torque on fasteners are critical to control loads on electrical and thermal interfaces

Series 320 Interposer





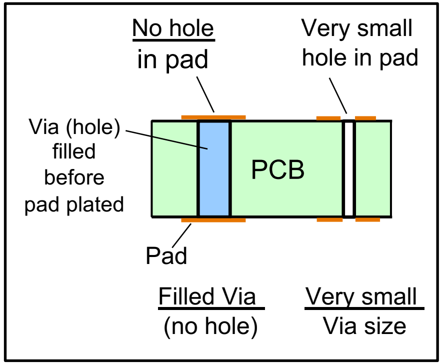
112 Contacts on 1.0 mm pitch

Suppliers:

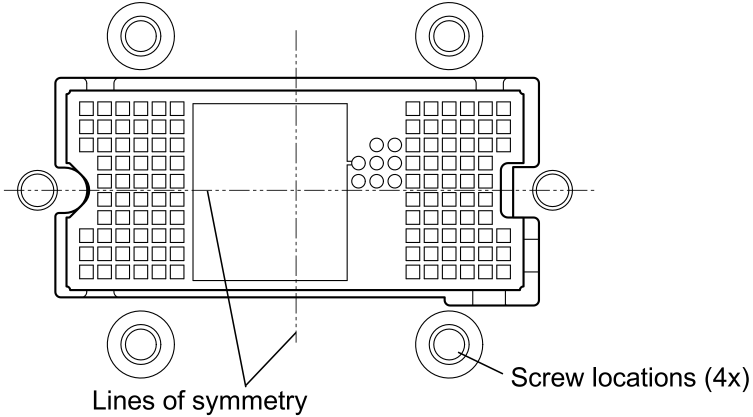
- Foxconn Interconnect Technology (FIT)
  https://www.fit-foxconn.com/
  Standard-Height Part Number: PL01121-11ZZ0-4H
- Neoconix (NCX)
  https://neoconix.com
  Standard-Height Part number: BDX0112DMMSXAU00
  Low-Height Part number: BDX0112DMMSXAU01

Series 320 System Mounting :: Electrical Connection

- Electrical connection requires
  - Continuous uniformly applied compression of contacts on both DMD and PCB sides
    - Minimum gap between PCB and optical chassis
    - Preventing the PCB from bending
    - Symmetrical location of mounting screws helps provide uniformly applied loads
  - Vias in PCB pads should be filled (if using FPC the size of vias should be very minimum)

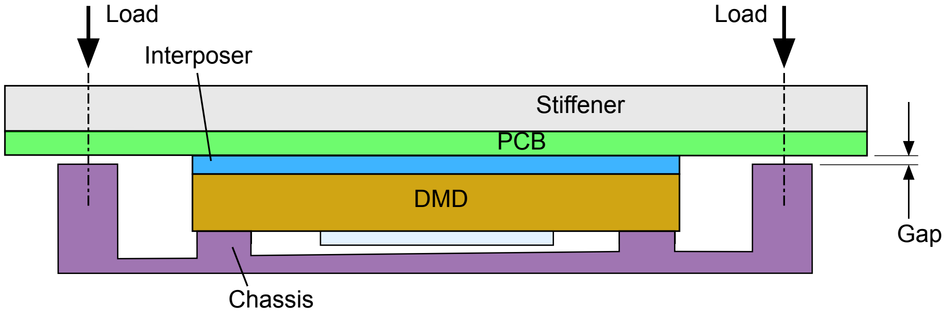


PCB Vias



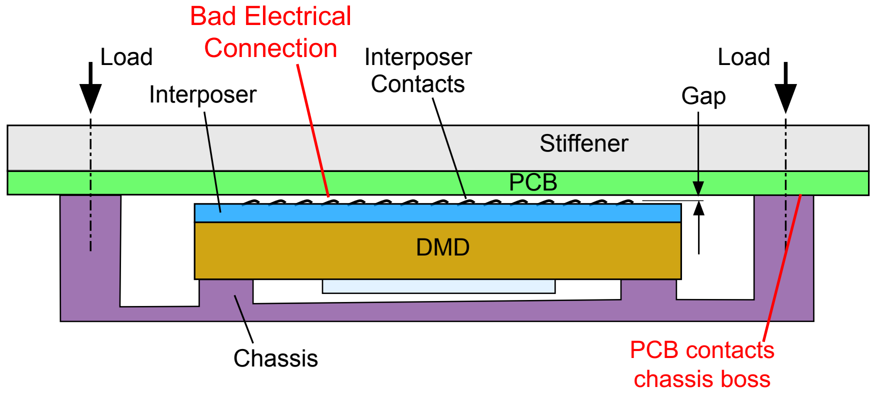
Screw location symmetry

Series 320 System Mounting :: Electrical Connection

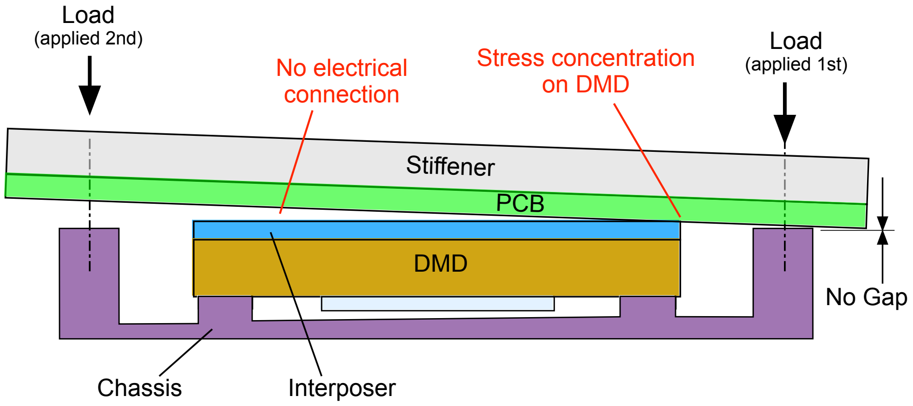


Good electrical connection requires a minimum gap required to ensure electrical connection

- Size of gap is determined by part tolerances
  - Interposer thickness
  - DMD thickness
  - Optical chassis

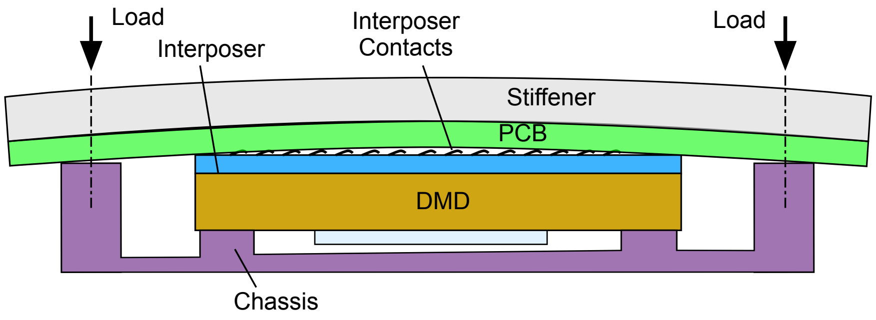


No electrical connection results when chassis boss contacts PCB before interposer (gap between PCB and Interposer)

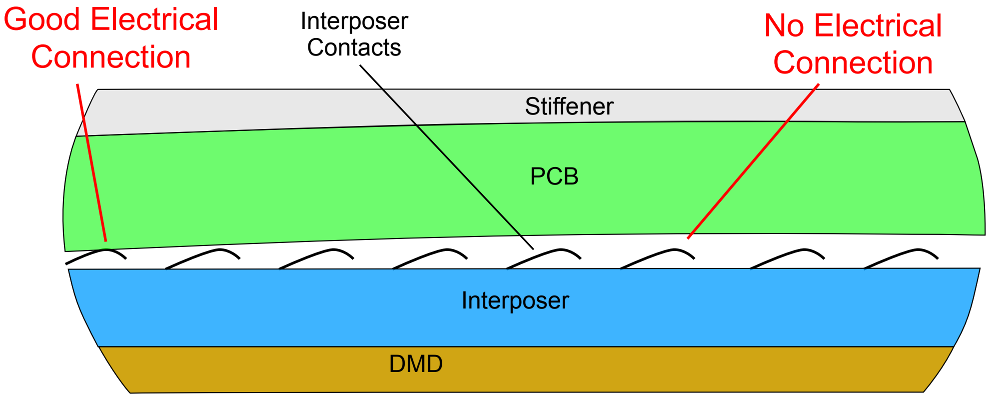


No electrical connection results from non-uniform load (like tightening one fastener before the other fasteners. This can also result in damage to DMD caused by stress concentration

Series 320 System Mounting :: Electrical Connection



- Good electrical connection requires *preventing the PCB from bending*. Bending of PCB prevents all the interposer contacts from making contact with the PCB
- Stiffener must prevent PCB from bending
  - Stiffener material critical
  - Stiffener thickness critical



Caution: Power applied to DMD when certain contacts are not making connection could result in permanent damage to the DMD called Block Boundary Failure.

Frequently Ask Questions (FAQ)

1. Can the full ceramic area be contacted rather than just the Datum ‘A’ areas ?
   a) Yes, but be aware:
      - Of the areas define on the ICD where encapsulation is permitted
      - The parallelism of the array is specified relative to the Datum ‘A’ areas. Contacting areas other than just Datum ‘A’ will increase the variation of the parallelism
2. Does the DMD need to be held against Datums ‘B’ and ‘C’ ?
   a) Contacting the DMD Datums ‘B’ and ‘C’ with corresponding features in the system optical chassis provides mechanical alignment of both the electrical and optical interfaces. Not using the DMD Datums ‘B’ and ‘C’ can result in none or non-consistent electrical connection. Powering up the DMD when misaligned can result in damage to the DMD.
3. What do the shims do ?
   a) The shims push and hold the DMD Datums ‘B’ and ‘C’ against the corresponding features in the system optical chassis while the remaining assembly is completed.
4. What material should be used for the shims ?
   a) The shims shown in the mounting concept are frequently made of closed cell foam materials that meet the system temperature requirements. Other methods to ensure the DMD and system optical chassis Datum ‘B’ and ‘C’ features are in contact can be used.

Frequently Ask Questions (FAQ)

5. Can the DMD be glued to the optical chassis to hold it in place ?
   a) To avoid damage to the DMD it should not be glued to the optical interface. The wide temperature range of the products operating and manufacturing needs to be considered. The differences in the coefficient of thermal expansion (CTE) between the DMD (~8ppm/K) and the chassis material will result in high stress levels in the DMD. The high stress levels will damage the DMD. The damage to the DMD is not visible or apparent at the time the damage occurs but results in significantly reduced lifetime.
6. What are the best locations for the mounting screws ?
   a) The best location for the screws that clamp the clamp/insulator/PCB/interposer/DMD to the optical chassis are locations which reduce bending. This will typically be on the long sides of the DMD.
7. What is the purpose of the clamp ?
   a) The clamp prevents bowing (bending) of the PCB that can result from the clamping force of the mounting screws. The clamp needs to be of sufficient thickness and stiffness to prevent the PCB from bowing. Bowing of the PCB can result in none or intermittent electrical connection to the DMD.
8. What is the purpose of the insulator ?
   a) The insulator prevents shorting and capacitively coupling between PCB vias or traces. The material needs to be of sufficient thickness to provide the needed isolation. The mounting concept utilizes 0.13 mm thick polyimide film. Conformal coating on PCBs does not provide sufficient isolation.

Frequently Ask Questions (FAQ)

9. Do coil springs have to be used when mounting the DMD?
   i) Coils spring are not required but provides a simple way to calculate the minimum and maximum forces that would be applied to the DMD for the given part tolerances.