

EMC ASIC-Board Design

**M. Kavatsyuk, E. Guliyev, P.J.J. Lemmens,
H. Löhner, T.P. Poelman, G. Tambave**

ASIC BOARD

decoupling capacitors

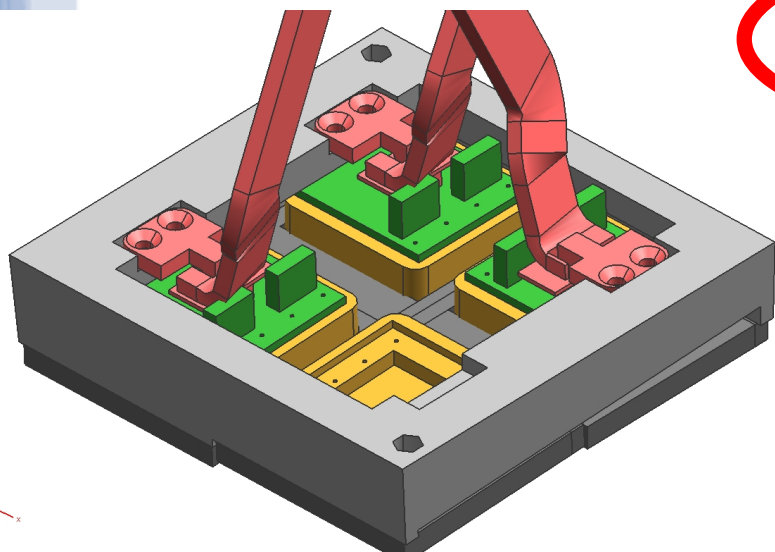
- measurements with $C = \{300\text{n}, 200\text{n}, 100\text{n}, 56\text{n}, 22\text{n}, 7\text{n}, 1.3\text{n}\}$
 - data taken with 100MHz 16bit SADC
 - traces analysed to deduce:
 - noise level
 - the peak integral
- constant for all values of C
- constant (deviation $< 0.5\%$) for $C \in \{300\text{n}, 200\text{n}, 100\text{n}, 56\text{n}, 22\text{n}\}$;
- for $C = 7\text{n}$ signal drop **2%**
- for $C = 1.3\text{n}$ signal drop **10%**

Conclusions: use $C = 56\text{n}$

- type: SMD, X7R dielectric, $V_{\text{max}} = \mathbf{630\text{V}}$
- dimensions: $4.5 \times 3.2 \text{ mm}^2$, height 2.54mm

This choice allows to:

- place capacitors on the same PCB side as ASIC (bottom side)
- rotate LAAPD capsule
- make output on the opposite side to the LAAPD pins



Dielectrics

(for ceramic capacitors)

- **COG** – large sizes; the material with the lowest:
 - capacitance/temperature dependence;
 - losses;
 - aging effects;
- **X7R** – smaller sizes; tend to have:
 - severe temperature drift ($\pm 15\%$);
 - high dependence of capacitance on applied voltage;
 - high voltage coefficient of dissipation factor;
 - high frequency coefficient of dissipation;
 - problems with aging due to gradual change of crystal structure;

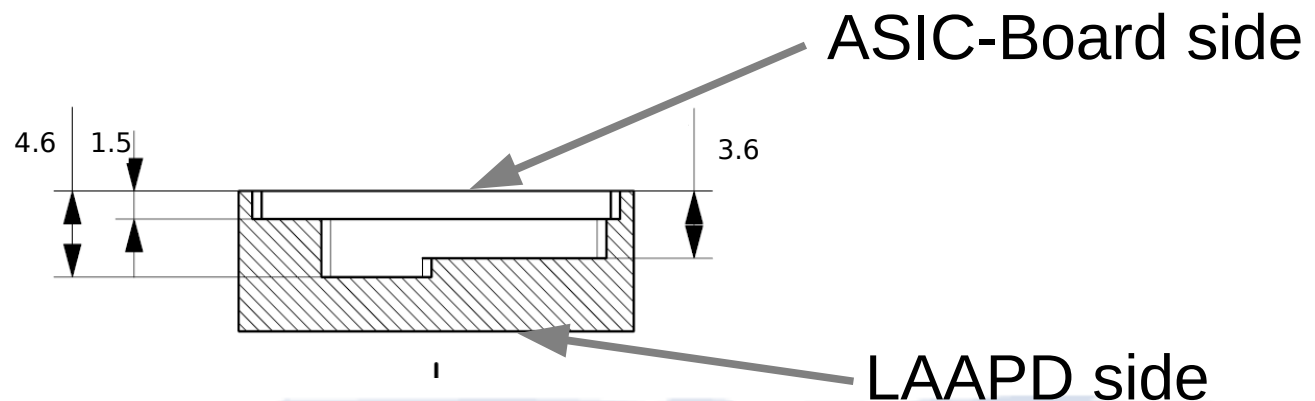
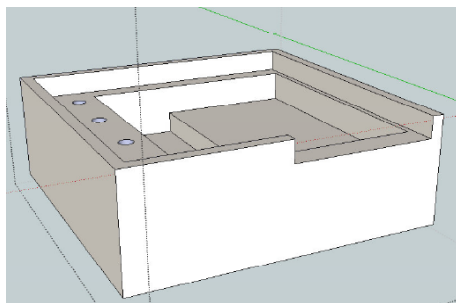
Capacitors for the ASIC Board

Check producers: AVX, Johanson,
TDK, Kemet, Murata, Epcos, Vishay

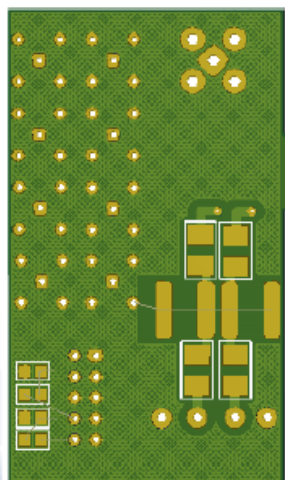
The best choice is AVX(2225CA183KAT2A):

- $V_{\max} = 600\text{V}$, $C = 18\text{nF}$,
- size: $5.72(25) \times 6.35(0.25) \text{ mm}^2$; max thickness 2.54 mm ;
- operating temperatures: -55°C to $+125^\circ\text{C}$
- maximal allowed temperature gradient: 4°C

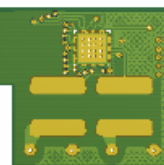
With this dimensions it is still possible to fit capacitors inside the LAAPD capsule!



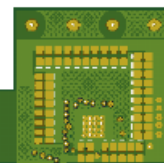
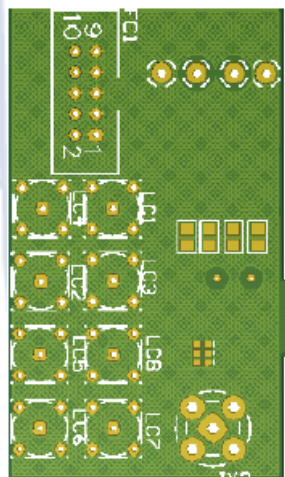
HV filter/Line driver
Board (debugging
version)



Flexible part



ASIC Board

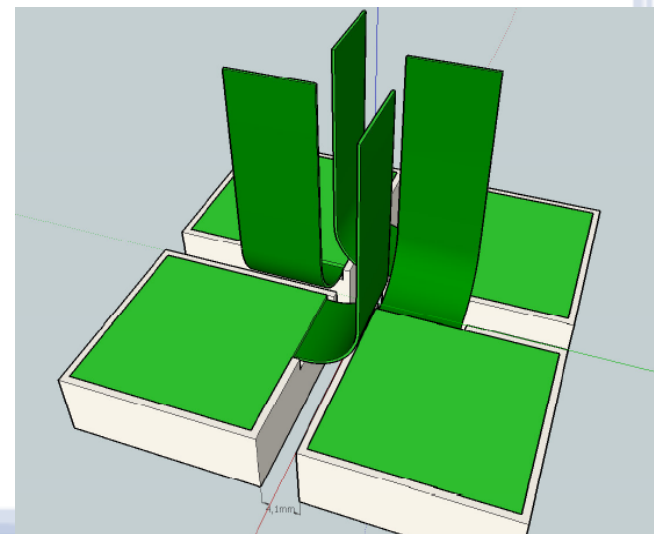


Advantages:

- Additional heat sources (HV filter, line driver are far from crystal)

Disadvantages:

- May be more sensitive for peak-up noise





Bandwidth Limitations

(due to the cable)

- ASIC does not have build-in line driver
 - flat cable has high capacity
- } Cable works like low-pass filter

ASIC-signal bandwidth < 10 MHz (~5 MHz)

Length (mm)	Thickness	Bandwidth (MHz)
100	3 mil	55
150	3 mil	38
200	3 mil	28
200	2 mil	26
200	4 mil	34

(simplified model of ASIC output stage and flat cable)







































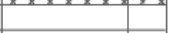
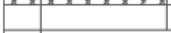


Cable should not affect ASIC performance!
(should be tested using prototype board)

Summary

(current status)

- The design of the capsule part and cable is ready
- The design of the Line-driver part is almost finished
- The design is being adapted for prototype production; we are in contact with two companies:
 - Thales Nedeland B.V. (www.thales-nederland.nl) – for prototype production only
 - GS-swiss PCB AG (www.swisspcb.ch) – for prototype and mass production
- The best placement/connection, length of the flexible part should be decided
- The prototype of 4×4 crystals with ASIC preamplifiers is being built at GSI (test with beam ~September)

Layers stack

PCB thickness ?? mm	Layer number	Copper thickness (um)	Insulation thickness (mil)	Material reference	Additional information	Layer stacking	Flex-PCB thickness, 0.64mm	Layer stacking	Additional information	Material reference	Insulation thickness (mil)	Copper thickness (um)	Layer number	Layer name in Altium
	63			Soldermask	Dry film				Dry film	Soldermask			63	
	2			Finish						Finish			2	
	01	25		Copper	Track				Track	Copper			25	01 Top Layer
		4		Rigid core FR4?	4000-6fc				4000-6fc	Rigid core FR4?			4	
		6.4		No flow prepreg Coverlayer (3mil)					No flow prepreg Coverlayer (3mil)				6.4	
		2		Glue						Glue			2	
	02	18		Copper	Ground plane				Ground Plane	Copper			18	02 MidLayer1
		3		Core AP8535						Core AP8535			3	
	03	18		Copper	High Voltage				High Voltage	Copper			18	03 MidLayer2
		3		Glue-kapton-glue						Glue-kapton-glue			3	
	04	18		Copper	Ground plane				Ground Plane	Copper			18	04 MidLayer3
		3		Core AP8535						Core AP8535			3	
	05	18		Copper	Diff. signals				Diff. signals	Copper			18	05 MidLayer4
		3		Glue-kapton-glue						Glue-kapton-glue			3	
	06	18		Copper	Ground plane				Ground Plane	Copper			18	06 MidLayer5
		3		Core AP8535						Core AP8535			3	
	07	18		Copper	Power 3U				Power 3U	Copper			18	07 MidLayer6
		2		Glue						Glue			2	
		6.4		Coverlayer (3mil) No flow prepreg						Coverlayer (3mil) No flow prepreg			6.4	
		4		Rigid core FR4?	4000-6fc				4000-6fc	Rigid core FR4?			4	
	08	25		Copper	Track				Track	Copper			25	08 BottomLayer
		2		Finish						Finish			2	
	63			Soldermask	Dry film				Dry film	Soldermask			63	

Totaal 288 39.8

Totale dikte is $288\mu\text{m} + 39.8 \times 0.0254 = 1.011\text{mm}$

Het soldeermasker mag ook vloeibaar soldeermasker zijn, dikte 28um.

Totale dikte is $218\mu\text{m} + 39.8 \times 0.0254 = 1.011\text{mm}$

2mm cutback coverlayer

2mm Cutback coverlayer