Strip resistivity

University and INFN Padova

High strip resistivity and beam profile reconstruction a case study from CLEAR's TB 28-31/03/2023

- Typical strip resistance (*l*=20mm) for Tomsk sensors is measured to be 6.7kΩ for a strip, while 60Ω for the FBK sensors.
- Typical strip even-mode impedance, assuming a signal rise time of 100ps, is approx. 77Ω (93Ω) for the 110um-thick (150um) sensor.

Two key-points

- 1. high-strip resistivity implies signal attenuation (**loss**), whose intensity depends on the beam vertical position on the strip;
- 2. lossy-line $(6.7k\Omega \gg 77\Omega)$ means frequency-dependent termination: unproper matching and sig. **reflections.**
- Case study: signal from even/odd strips vs. beam pos. at CLEAR

🍘 TXLI	NE 2003 - Mici	rostrip Coupled Lir	ne			-	- 🗆	×
Microstri	p Stripline C	PW CPW Ground	l Round Coax	ial Slotline	Coupled MSLine Co	upled Stripline		
Materia	al Parameters		-					
Dielec	tric Alumina	_	 Conducto 	r Aluminum	_	- <u>←</u> \/	/→ ←\//-	
Dielec	tric Constant	9.8	Conductiviț	y 3.53E+07	S/m 💽	- <u> </u>	**	↑ T
Loss T	angent	0.0005			AWR		r ⁵ r	
Electric	al Characteristic	:5			Physical Characteris	tic		
	<u>Impedance</u>	77.322	Ohms 💌		Physical Length (L)	20	mm	•
F	Frequency	10	GHz 🔻		Width (W)	80	um	-
<u>El</u>	ectrical Length	632.007	deg 💌		Gap (S)	20	um	•
P	hase Constant	31600.4	deg/m 💌]	Height(H)	110	um	•
Effecti	ve Diel. Const.	6.92502			Thickness (T)	0.02	um	-
	Loss	0.966284	dB/mm ▼	1				
		Even Mode	C: Odd Mode					

Dielectric Alumina		 Conductor 	Aluminum	•] <u>←</u> ₩-	→ ←₩→
Dielectric Constant	9.8	Conductivity	1.86E+06	S/m 💌]]]	×s≮
Loss Tangent	0.0005			AWR]	^E r
lectrical Characteristi	cs		1	Physical Characterist	ic	
<u>Impedance</u>	77.322	Ohms 💌		Physical Length (L)	20	mm
Frequency	10	GHz 💌		Width (W)	80	um
Electrical Length	632.007	deg 💌		Gap (S)	20	um
Phase Constant	31600.4	deg/m 💌		Height(H)	110	um
Effective Diel. Const.	6.92502			Thickness (T)	0.02	um

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Conclusions and open points

Conclusions

- High strip resistance i.e., much bigger than strip impedance should be avoided.
- Quality check of strip metallization is important to ensure the layer thickness is uniform and resistivity within specifications.
- Thicker metal layers are less affected by this issue.
 - ► FBK sensors OK

Open points

- Early sapphire sensors (UniversityWafers-Inc. sapphire crystal + strip metallization by Tomsk-University) are affected by such issue.
- Is it expected to have such high-resistance?
- How well can the layer thickness be controlled in the manufacturing process?

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The **test** consists in moving the beam along the strip and measure the effect looking at the asymmetry between the beam charge from the reconstructed beam profile (gaus+const fit) using either the even or the odd strips $(4\sigma)_{mu} = (4\sigma)_{mu}$

$$asymA \equiv \frac{(A\sigma)_{even} - (A\sigma)_{odd}}{(A\sigma)_{even} + (A\sigma)_{odd}}$$

The signal attenuation depends on the path length $e^{-loss \Delta y}$. Readout of even strips signals is from the top, while odd from the bottom.

If
$$(A\sigma)_{odd} \propto e^{-\alpha \left(\frac{d}{2}+y\right)}$$
 and $(A\sigma)_{even} \propto e^{-\alpha \left(\frac{d}{2}-y\right)}$, we expect
 $asymA = \tanh(\alpha y) = \alpha y - \frac{(\alpha y)^3}{3} + O\left((\alpha y)^5\right)$
a line with positive slope, as observed!
(notice we have $(\alpha y) \sim 10^{-2}$)

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(vert.) movement
 Germa Bean Facility
 Germa Bean Facility</li

odd

even

