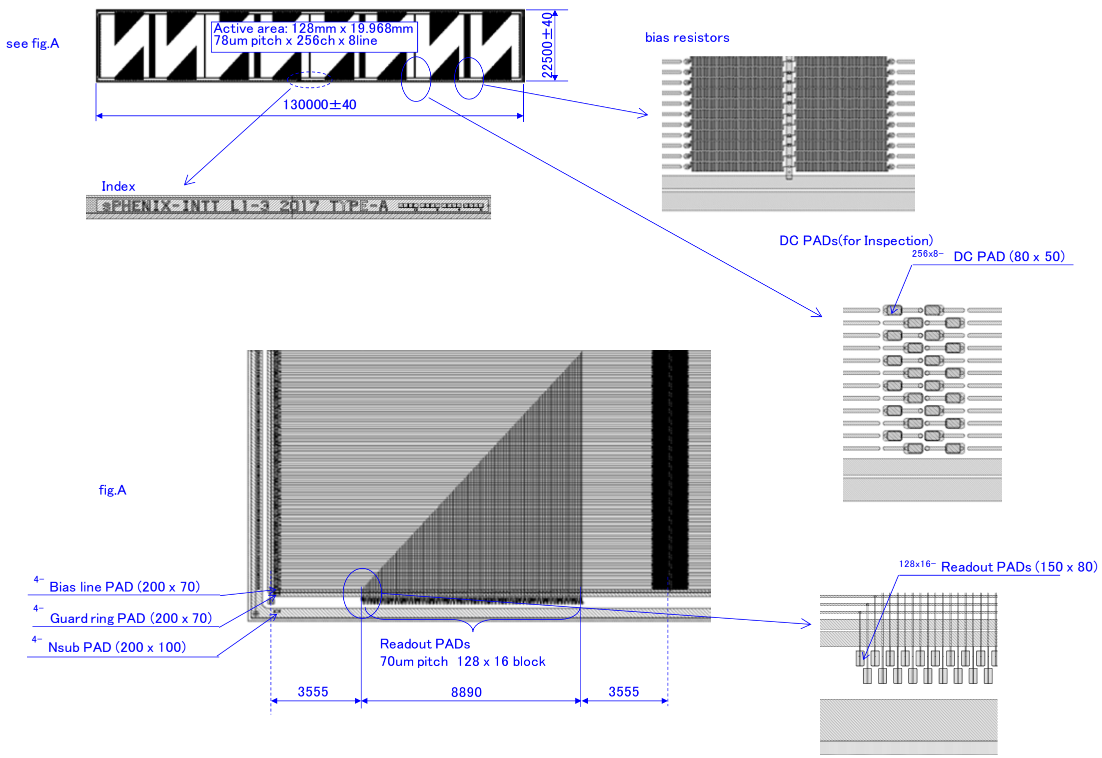
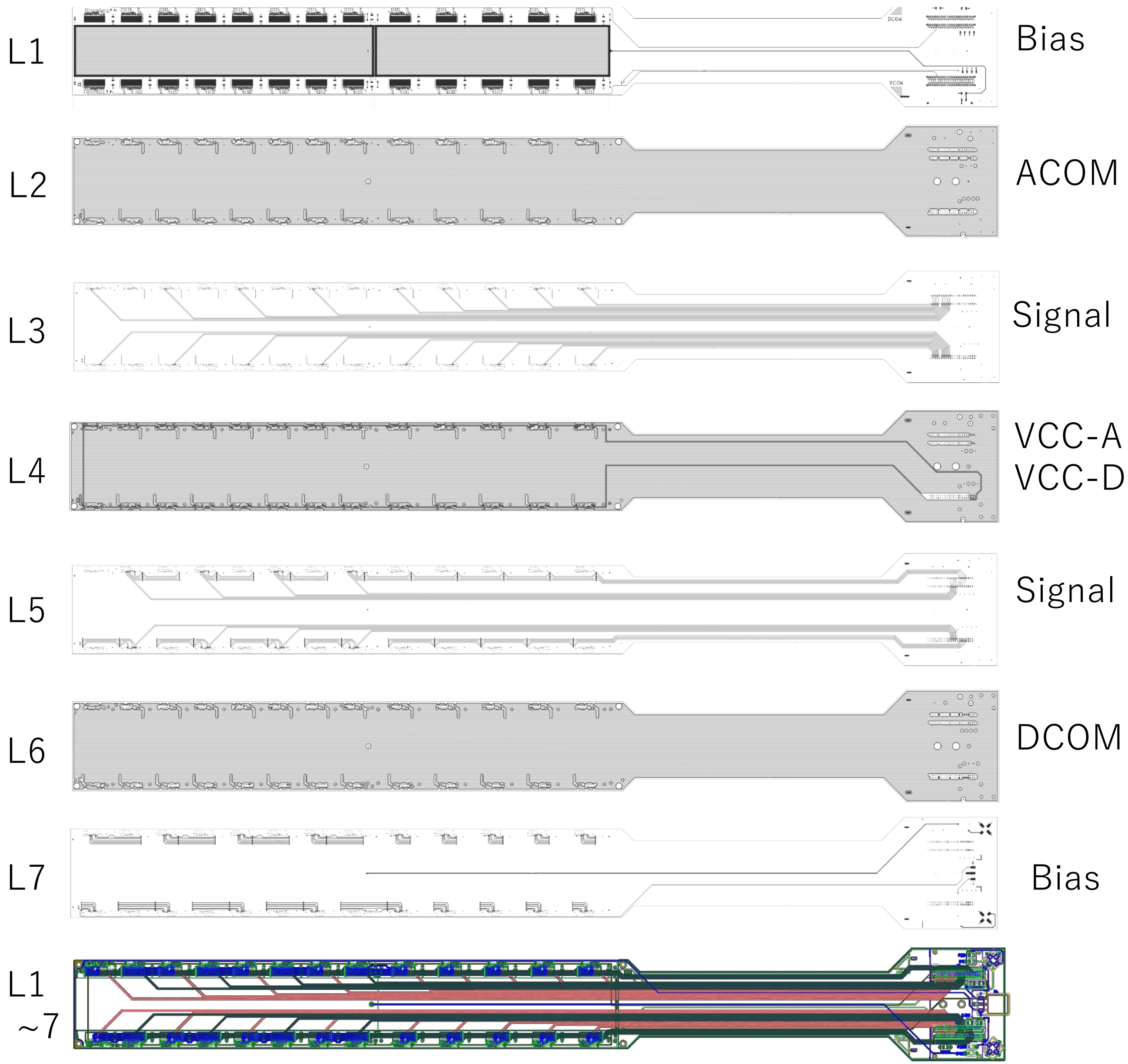
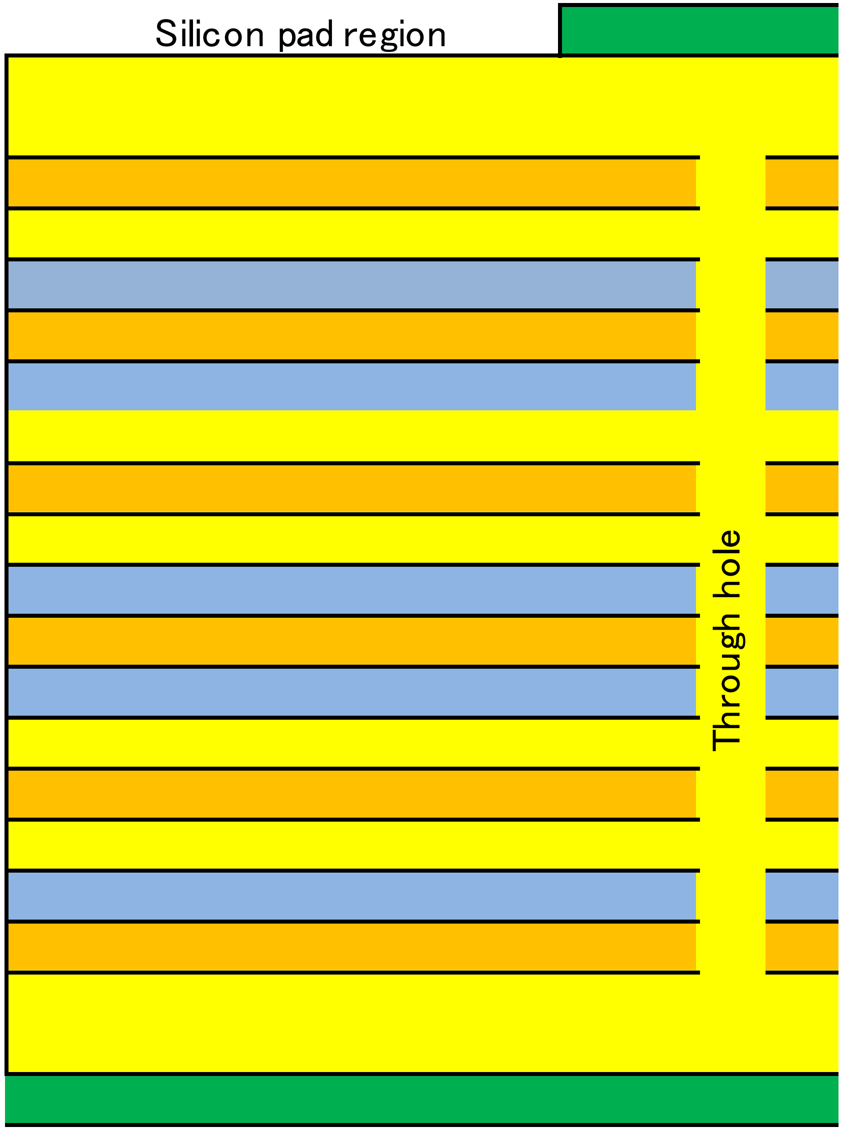
INTT Ladder NIM Figures

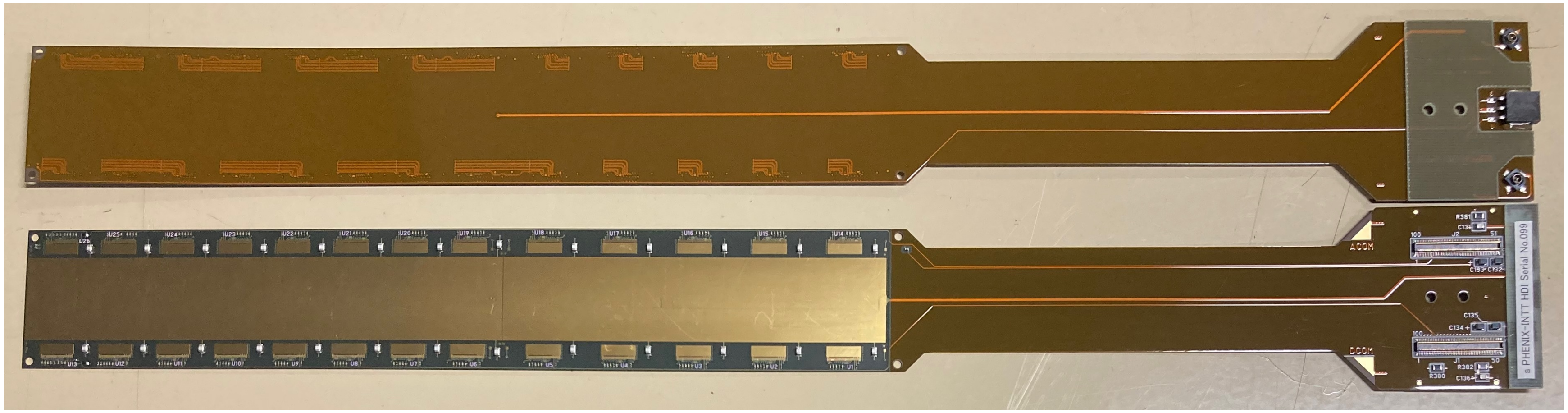

see fig.A
Active area: 128mm x 19.968mm
78um pitch x 256ch x 8line
22500±40
130000±40
bias resistors
Index
sPHENIX-INTT L1-3 2017 TYPE-A
DC PADs(for Inspection)
256x8- DC PAD (80 x 50)
fig.A
4- Bias line PAD (200 x 70)
4- Guard ring PAD (200 x 70)
4- Nsub PAD (200 x 100)
Readout PADs
70um pitch 128 x 16 block
3555
8890
3555
128x16- Readout PADs (150 x 80)

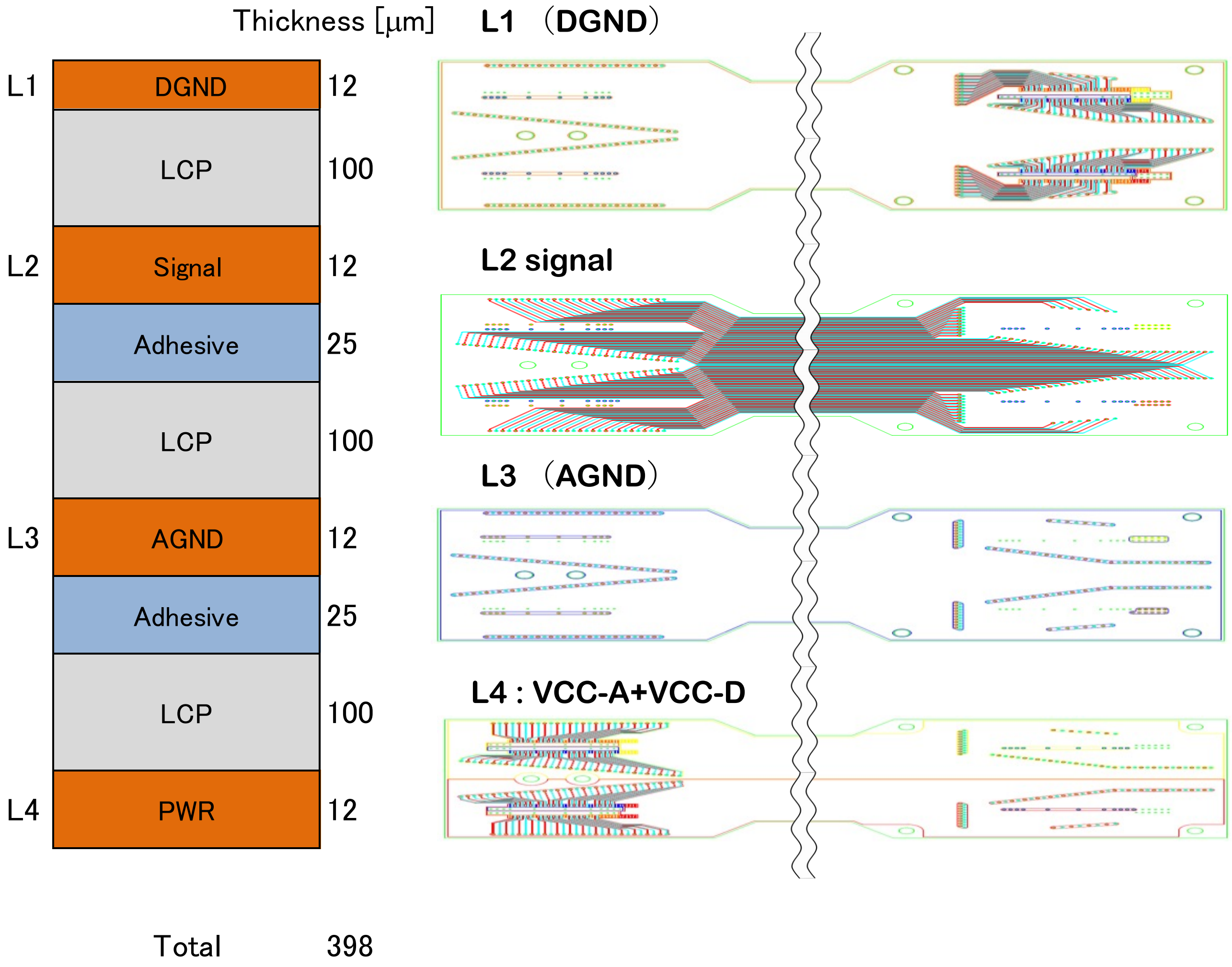

L1
Bias
L2
ACOM
L3
Signal
L4
VCC-A
VCC-D
L5
Signal
L6
DCOM
L7
Bias
L1
~7

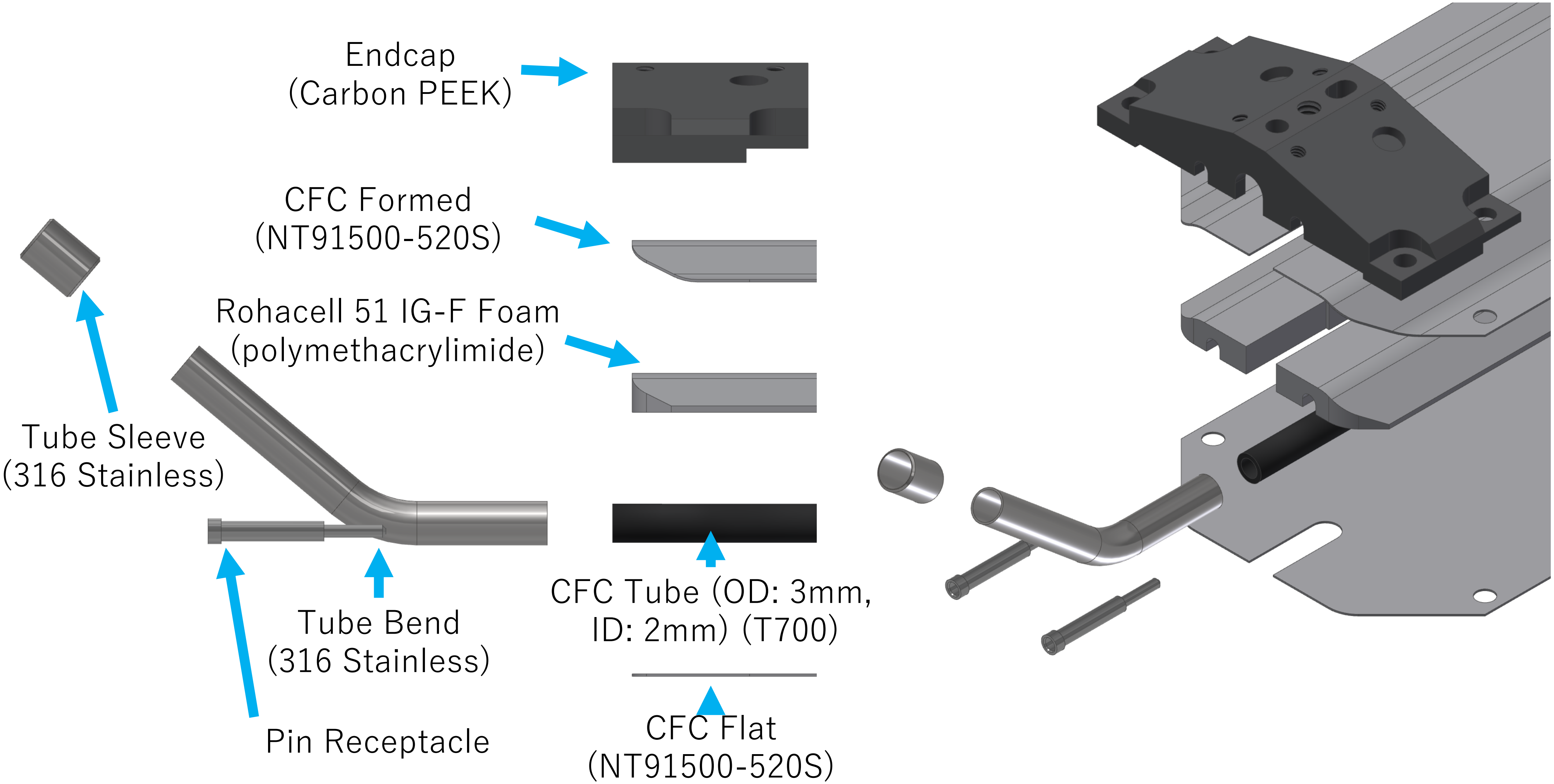


Total thickness 418 μm

	Regist	20 μm
	Copper plated	15 μm
L1	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L2	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	12.5 μm
	Glue	15 μm
L3	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L4	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	12.5 μm
	Glue	15 μm
L5	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L6	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	25 μm
L7	Electrolytic copper foil	9 μm
	Copper plated	15 μm
	Regist	20 μm
		438 μm


sPHENIX-INTT HDI Serial No.099
ACOM
DCOM
R381
J2
100
51
C193
C132
C135
C134
J1
1
50
R382
R380
C136


Thickness [μm]
L1
DGND
12
LCP
100
L2
Signal
12
Adhesive
25
LCP
100
L3
AGND
12
Adhesive
25
LCP
100
L4
PWR
12
Total
398
L1 （DGND）
L2 signal
L3 （AGND）
L4 : VCC-A+VCC-D

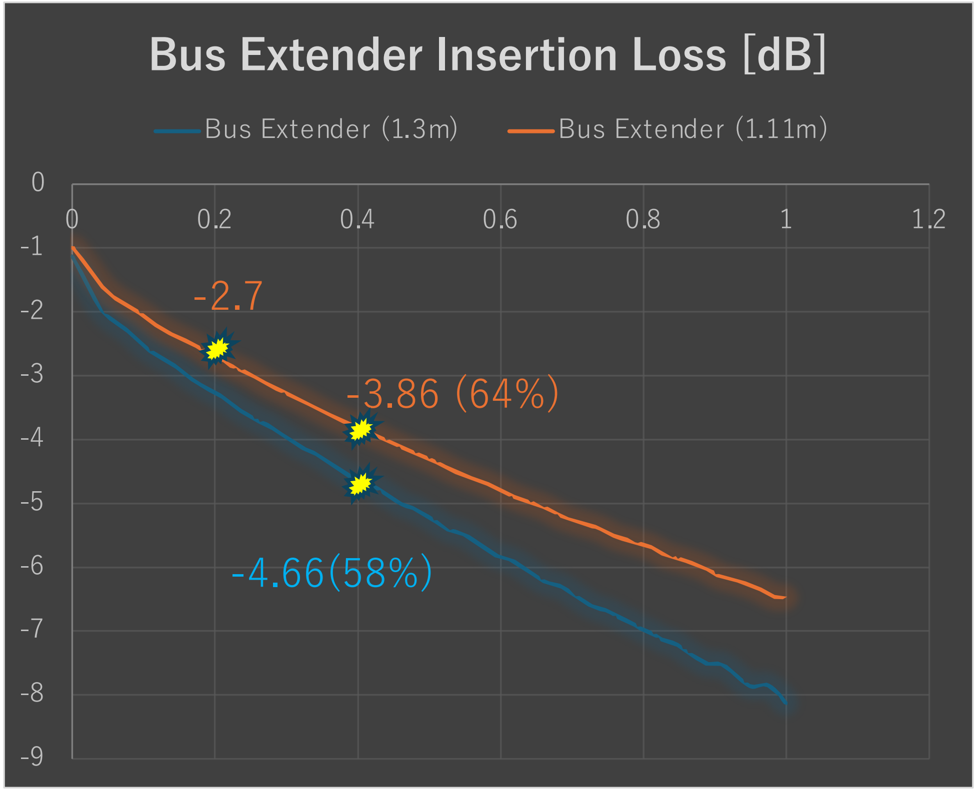

Endcap
(Carbon PEEK)
CFC Formed
(NT91500-520S)
Rohacell 51 IG-F Foam
(polymethacrylimide)
Tube Sleeve
(316 Stainless)
Tube Bend
(316 Stainless)
Pin Receptacle
CFC Tube (OD: 3mm,
ID: 2mm) (T700)
CFC Flat
(NT91500-520S)

INTT_Meeting_Minutes_200722.pdf

o Estimated effective thickness of the silver epoxy based on the volume of the glue mask provided from Rachid in the last meeting. The resulting effective thickness is 14um which is 28% of full thickness 50um. As a consequence, the contribution of the silver epoxy is now 0.04% instead of 0.14%. The total material budget was 1.12% before his update, and now 1.14%, very tiny increase. Although the carbon fiber stave thickness and silver epoxy glue are increased, these additional thickness were pretty much compensated by effective Cu thickness of HDI.

o **Although the effective thickness based on the BNL mask is implemented to GEANT INTT model, NCU crews should also measure the amount of glue actually used in Taiwan assembly.** The contribution of the silver epoxy in the material budget is not negligible if the effective thickness is near 50um, we should know realistic amount for the Taiwan ladders as well.

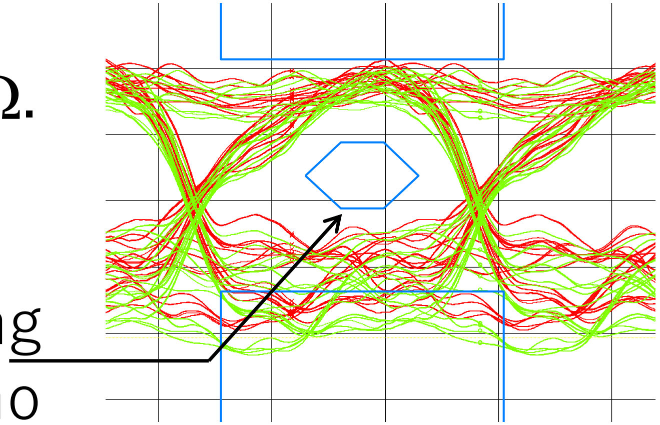
INTT_Cables_Performance.pptx



sPara_GrandSammry.xlsx

Eye Diagram Specifications

- The receiver is designed for regular LVDS f.i. 4mA@100Ω. This translates to be ΔV= 400mV.
- The receiver is not employing any commercial device, so no clear specification is defined.
- However Tom considers ΔV= 100mV should work, but ΔV= 50mV is a bit uncomfortable level.



This figure is presented by Doug in FVTX review. The center diamond is not provided by Tom.

FPHX_dicussion_190930.pptx

VoltageDrop.xlsx

HDI Resistance

Calculation from the cross section of the power layer

D14 =D13*26/1000

	A	B	C	D
1	HDI Power Layer Dimension			
2	Width [mm]	38	38	38
3	Thickness [um]	9	9	9
4	Length [m]	0.2	0.2	0.2
5	Area [m^2]	3.E-07	3.E-07	3.E-07
6	Mesh facto r[%]	100	90	10
7	Electric Resistivity (Cu) rho	1.68E-08	2.E-08	2.E-07
8	Resistance R=rho*L/A [ohm]	0.010	0.011	0.098
9				
10	FPHX Chip			
11	Power consumption/Chip [mW	65	65	65
12	Operation Voltage [V]	3	3	3
13	Current Draw/Chip [mA]	21.67	21.67	21.67
14	Current Draw for 26 chips [A]	0.56	0.56	0.56
15				
16	Voltage Drop in Length B4 [V]	0.006	0.006	0.055
17				
18	Voltage Drop in 40cm [V]	0.011	0.012	0.111
19				
20				
21				

電気抵抗率の比較（でんきていこうりつのひかく）では、電気抵抗率を比較できるよう、昇順に表にする。

長さL[m]、断面積A[m^2]の物体の電気抵抗R[Ω]は、次式で求めることができる。

$$R = \rho \cdot L/A$$

このρが電気抵抗率であり、単位はΩmである。

因数	単位	値 (Ωm)	物質	温度特性 (毎ケルビン)
$10^{-\infty}$		0	超伝導	
...				
10^{-8}	10 nΩm	1.59×10^{-8}	銀	.0061
		1.68×10^{-8}	銅	.0068
		2.21×10^{-8}	金	
		2.65×10^{-8}	アルミニウム	.00429
		4.42×10^{-8}	マグネシウム	
		5.29×10^{-8}	タングステン	.0045
		5.81×10^{-8}	コバルト	

Drawing Current for FPHX Chips

FPHX chip consumes about 1/3 power in analogue and 2/3 in digital sections, respectively.

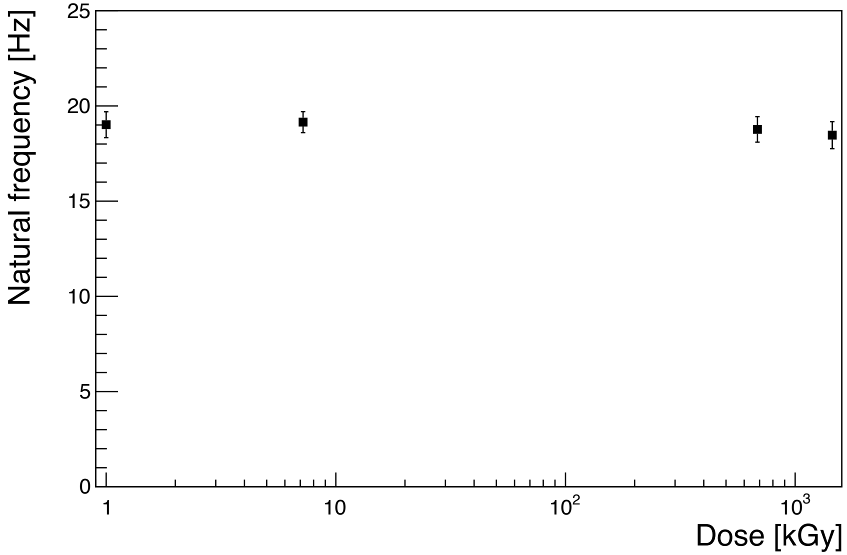
	Total	Digital	Analogue
LVDS min.	0.54 A	0.36 A	0.18 A
LVDS max.	0.64 A	0.42 A	0.21 A

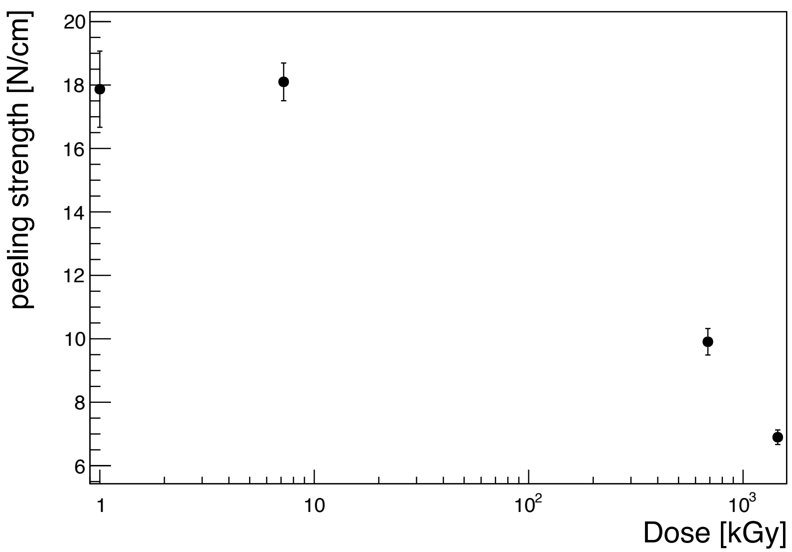
Typical currents after ‘INIT’

	Total	Partial	Conversion Cable		Bus Extender	HDI
	Current [A]	Current [A]	20cm [Ω]	40cm[Ω]	Resistance [Ω]	40cm[Ω]
LVDS min.	0.54		0.2	0.4	0.3	0.1
Digital		0.36	0.07	0.14	0.11	0.04
Analogue		0.18	0.04	0.07	0.05	0.02
LVDS max.	0.64					
Digital		0.42	0.08	0.17	0.13	0.04
Analogue		0.21	0.04	0.08	0.06	0.02

Anticipated Voltage Drop in each cables

Radiation Hardness of the BEX





H. Imai Diploma Thesis

Origin of 5 kGy in sPHENIX

[Technical Paper]

Development of Long and High-Density Flexible Printed Circuits

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Abstract

The super Pioneering High-Energy Nuclear Interaction eXperiment (sPHENIX), which aims to unravel the mysteries of the creation of the universe, is scheduled to be launched in 2023 at Brookhaven National Laboratory, U.S.A, using the relativistic heavy ion collider. As a typical high-energy particle accelerator-based experiment, the collision area of sPHENIX is to be tightly occupied with various radiation detectors, requiring a minimal special budget to run cables and transmit massive signals generated by these detectors to downstream electronics for data processing located in a remote distance. Accordingly, a long, high signal line-density cable has been developed based on the flexible printed circuit

more than the minimum required bit error rate of 50 ppm.

4.2 Mechanical characteristics

In sPHENIX, high reliability is required for the FPC because it is difficult to access the inside the radiation area during the experiment. This reliability was evaluated by the peeling and thermal-shock tests.

The objective of the peel test is to verify that the laminate substrate has sufficient peel strength between layers. We prepared a test sample of the same stackup as the prototype, but with no pattern in every layers, and then tested it by peeling it up and down at an angle of 180° in the second or third layer using a tensile tester. The test results are presented in Fig. 14. The peel strength is defined at the point of the observed tensile force where the stress samples demonstrated higher peel strength than the required 10 N/cm (a typical peel strength of conventional polyimide). This result is an improvement over the initial prototype test sample. This improvement was a biproduct of the new bonding sheet introduced in Section 3.3.

The observed peel strength can be degraded after daily use in the radiation environment. Therefore, the peel strength was measured for the samples under radiation exposure by 5 kGy. In addition, 5 kGy is the expected radiation dose for five years of operation in sPHENIX. We did not observe obvious degradation in the peel strength within the accuracy of the measurement.

Because the cable comprises 4 layers of 12-μm thick

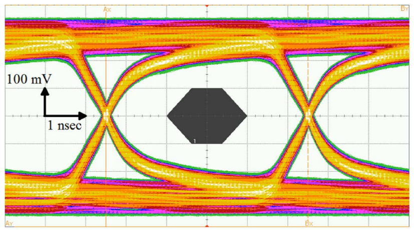


Fig. 13 Measurement result of eye-diagram

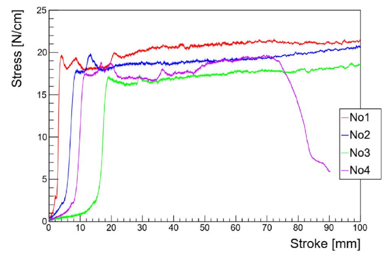
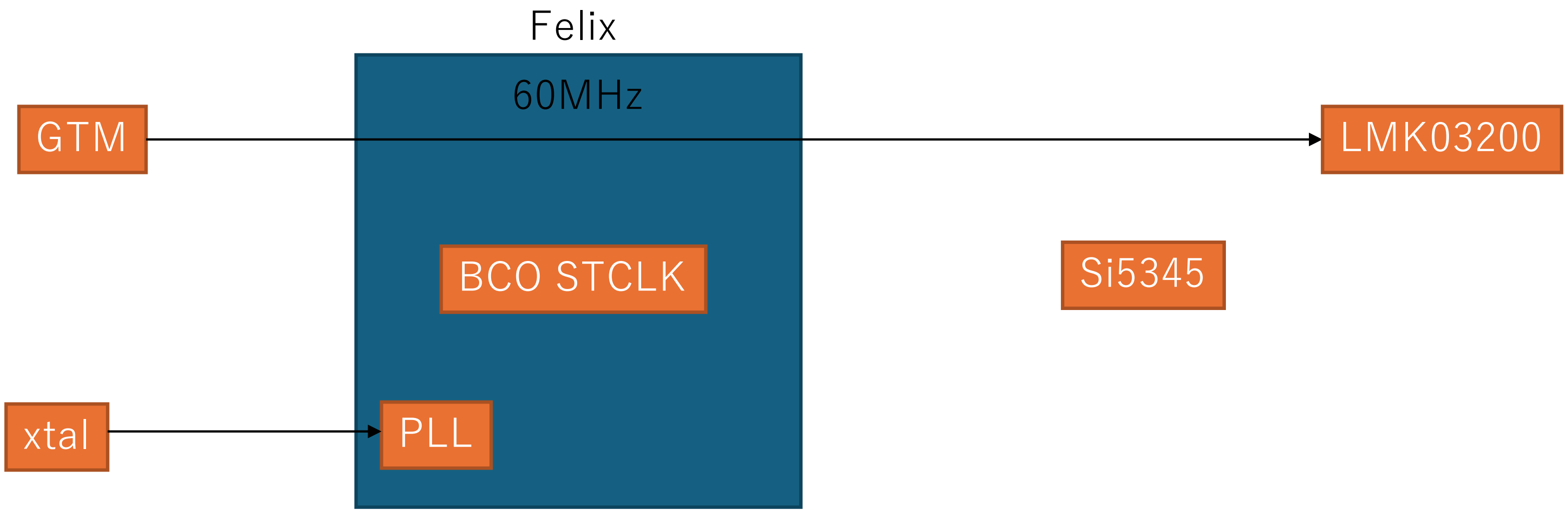


Fig. 14 Measurement result of peel strength

The origin of 5 kGy in sPHENIX needs to be double checked (Itaru)

230403_FelixPlan.pptx

Felix Clock Block Diagram



This is underdevelopment.