2014 CPMT Seminar

Latest Advances in Organic Interposers

APX (Advanced Package X) - Advanced Organic Technology for 2.5D Interposer

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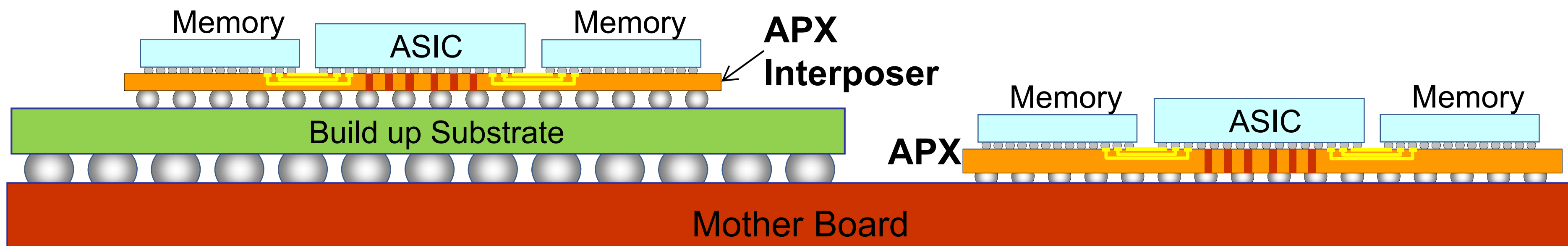
Agenda / Outline / Overview

- Benefits of 2.5D APX Interposer
- Technology Feature of APX
- Cross Section
- Design Rule Comparison
- Material Property
- Design Rule for Impedance Control
- Electrical Performance Study
- Routing Capability/Study
- Reliability Test Status
- Surface Finish Experience
- Technology Roadmap

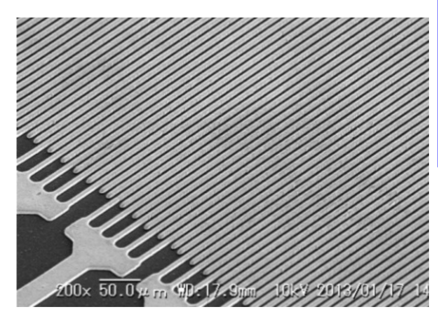
Benefits of 2.5D APX Interposer



《APX features and benefits》

- Fine pitch wiring and Small Size Via to support 2.5D interposer
- Plane pattern can be applied to POWER supply for lower IR Drop
- Z0 matching of Line, Via. and TH to 50**Ω**
- Smaller Signal transmission loss vs Silicon Interposer
- APX CTE is around 10ppm to strike a balance between 1st and 2nd assembly
- High stiffness by using high Young Modulus and Low CTE core for easy handling and assembly
- Open/short test can be done before APX is shipped
- Lower Cost potential vs Silicon Interposer or Glass interposer

Technology Feature of APX

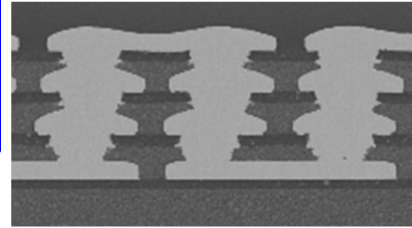


Fine Line/Space

Min. Line Width : 6um
Min. Space : 6um

Small Build Up VIA

Via Hole dia. : 20um
Via Land dia. : 32um
3 Stack

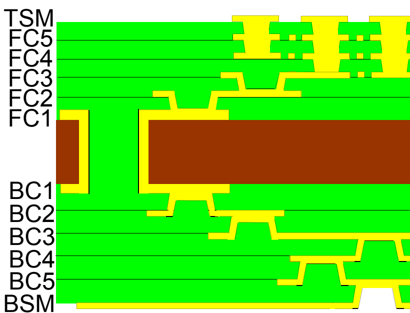


Micro bump pitch

Min. 40um (experienced)
Min. 50um (a line escape between vias)

32um 6um 6um

Max. Stack Up : 5-2-5



Fine Line/Space on Core (FC1/BC1)

Min. Line Width : 20um
Min. Space : 20um

Fine Pitch PTH

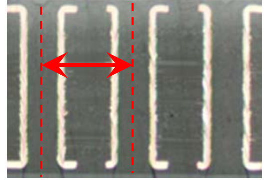
Pitch : 110um
Hole dia. : 60um
Land dia. : 80um

Advanced Build-up Material

Ultra-Thin : 8um
Low Loss Tangent : 0.0066

Low CTE Organic Interposer

10~11 ppm (total)



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Cross Section of APX 5-2-5 Structure

(UNIT : mm)

TSM
TSV
FC5
FV4
FC4
FV3
FC3
FV2
FC2
FV1
FC1

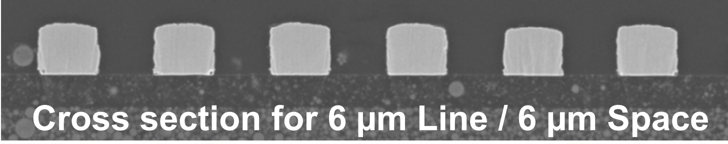
BC1
BV1
BC2
BV2
BC3
BV3
BC4
BV4
BC5
BSV
BSM

(3)(2x)0.0095±0.002
(4)(2x)0.014±0.0028
(5)(2x)0.006±0.0012
(6)(2x)0.008±0.0016
(5)(2x)0.006±0.0012
(6)(2x)0.008±0.0016
(5)(2x)0.006±0.0012
(6)(2x)0.008±0.0016
(5)(2x)0.006±0.0012
(6)(2x)0.008±0.0016
(5)(2x)0.006±0.0012
0.371±0.038

FINISHED CARRIER CROSS SECTION

Design rule Comparison

	ABF Build Up (most advanced)	APX
Min. Line Width (um)	9	6
Min. Space (um)	12	6
Via Hole Diameter (um)	65	20
Via Land Diameter (um)	85	32
Max. number of Via Stack	5	3
Build up Layer Thickness (um) (2nd or above B/U Layer)	30	8
Max. build up layer	11	5
Max. Layer Count	24 (11-2-11)	12 (5-2-5)
PTH Pitch (um)	150	110



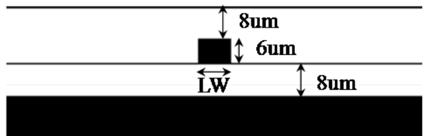
Material property

Item		ABF		APX	
		GX-13	GZ-41	Build Up (ZS-100) (Measured by KST with 10umt film)	CORE (Supplier's Catalogue Value)
Loss tangent		0.016/0.012 (1MHZ/1GHz)	0.0057/0.0058 (1MHZ/1GHz)	0.0063/0.0066 (2.8GHz/10GHz)	0.005 (1GHz)
Dielectric constant		3.6/3.35 (1MHZ/1GHz)	3.4/3.3 (1MHZ/1GHz)	3.1 / 3.1 (2.8GHz/10GHz)	4.0 (1GHz)
CTE x-y	TMA (ppm/degC)	46 (25-150degC)	20 (25-150degC)	28 (30-100degC)	4 (α1)
CTE z	TMA (ppm/degC)	47 (25-150degC)	20 (25-150degC)	28 (30-100degC)	12 (α1)
Tg	TMA (degC)	156	171	150	255 (by DMA)
Young's Modulus	Gpa	4.0	9.0	6.4-7.3	32 (@30degC)

Design Rule for Impedance Control by APX

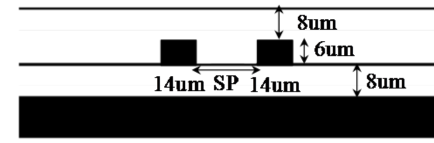
Micro strip line

Single end



LW =16.5um Z0 =50 ohm

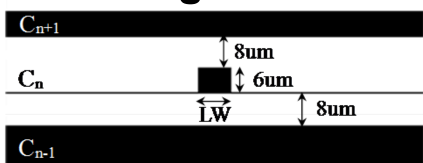
Differential pair



SP =30.5um Zdiff =100 ohm

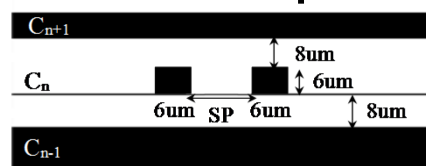
Strip line

Single end



LW =7.5um Z0 =50 ohm

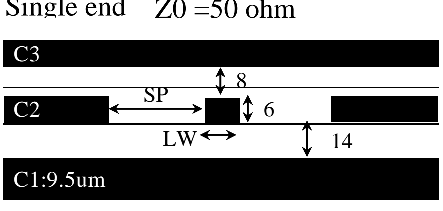
Differential pair



SP =14.5um Zdiff =100 ohm

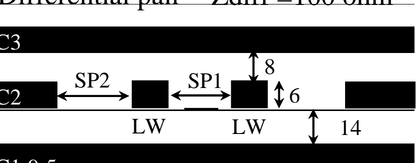
Strip line

Single end



LW =10um SP=19.5um
Z0 =50 ohm

Differential pair



LW=9um SP1 =21um SP2=16um
Zdiff =100 ohm

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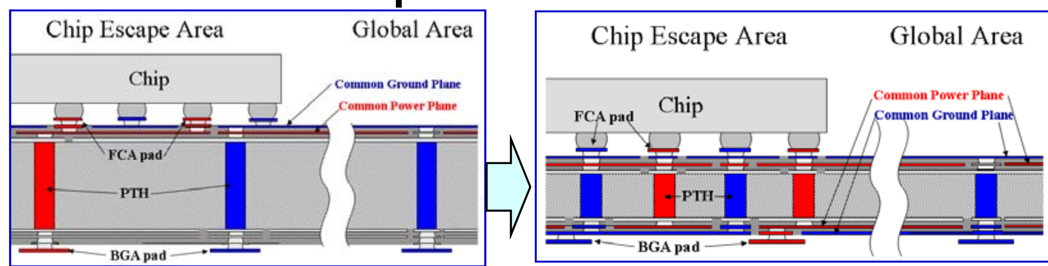
Electrical Performance Study

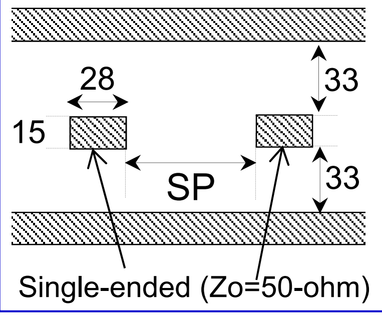
Loop Inductance Comparison

Current Build Up **APX**

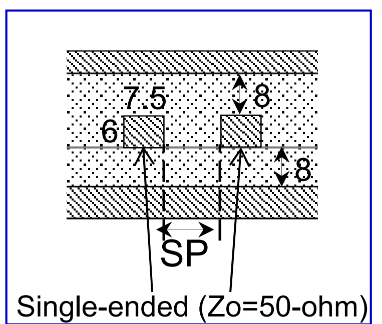


Cross Talk Noise Comparison

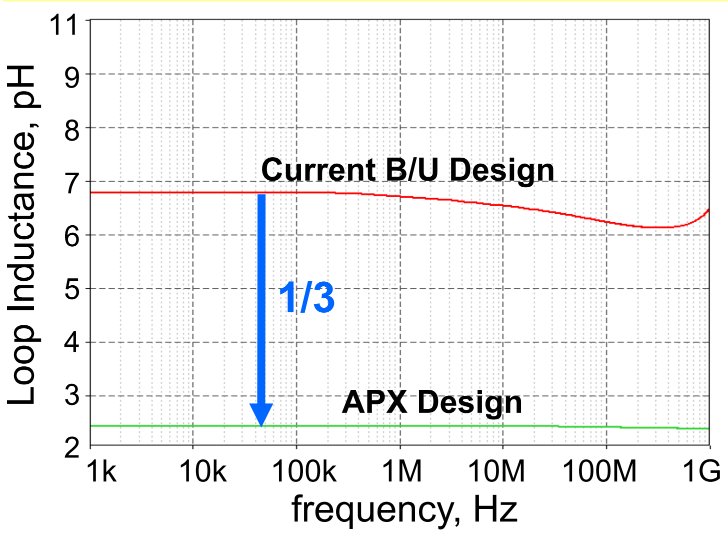
Current Build Up



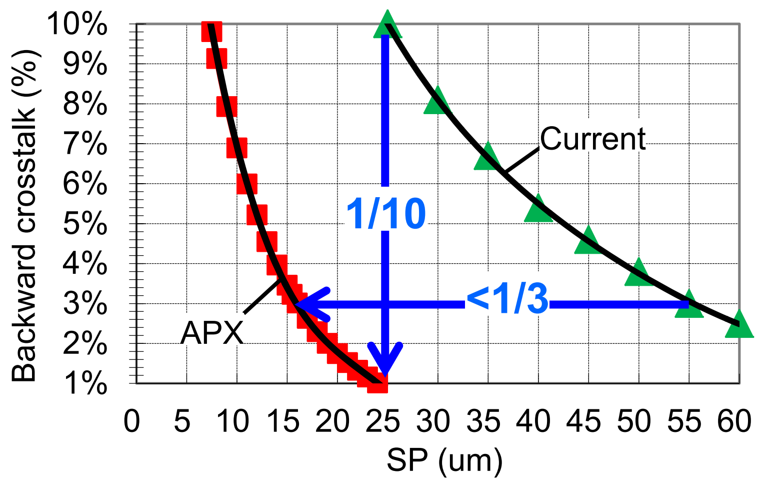
APX



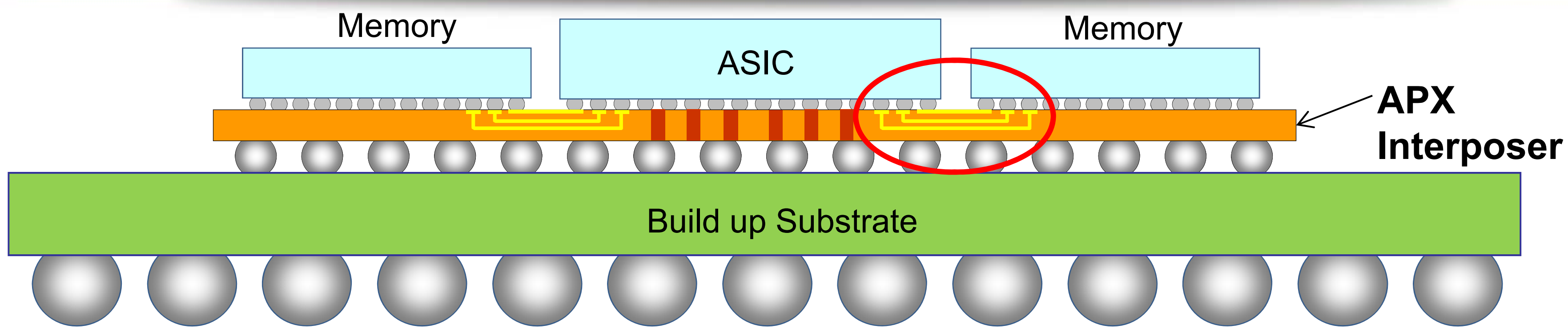
Loop Inductance Simulation Result

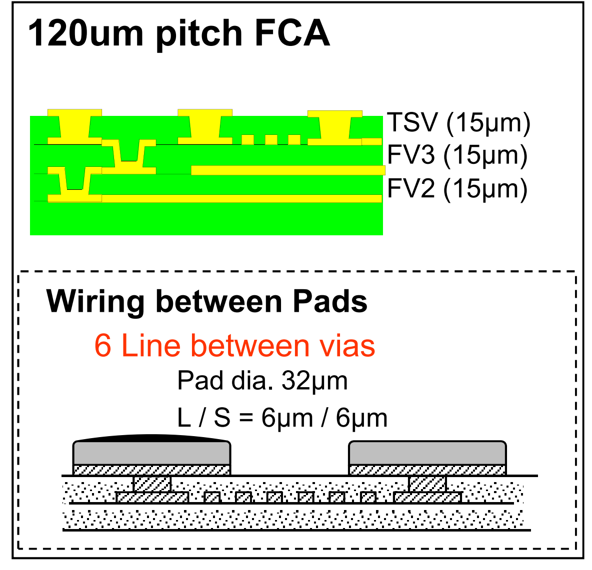


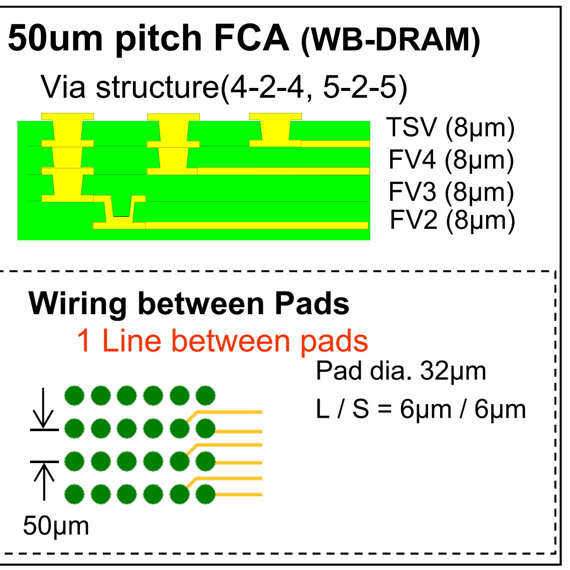
Cross talk noise Simulation Result

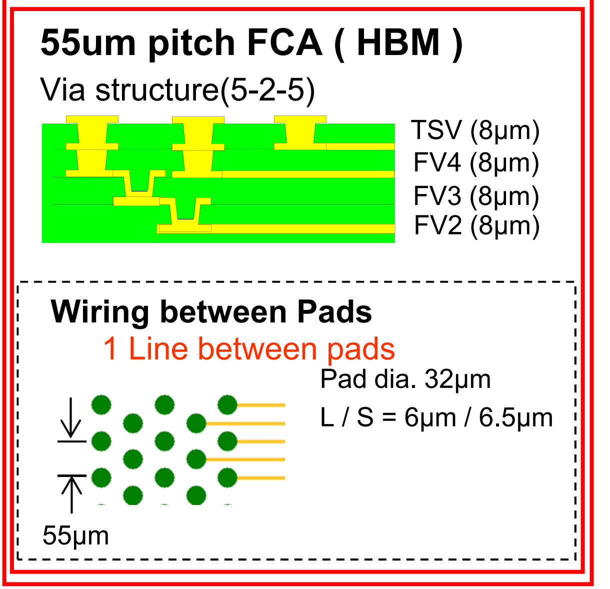


APX Routing Capability Study for 2.5D Package

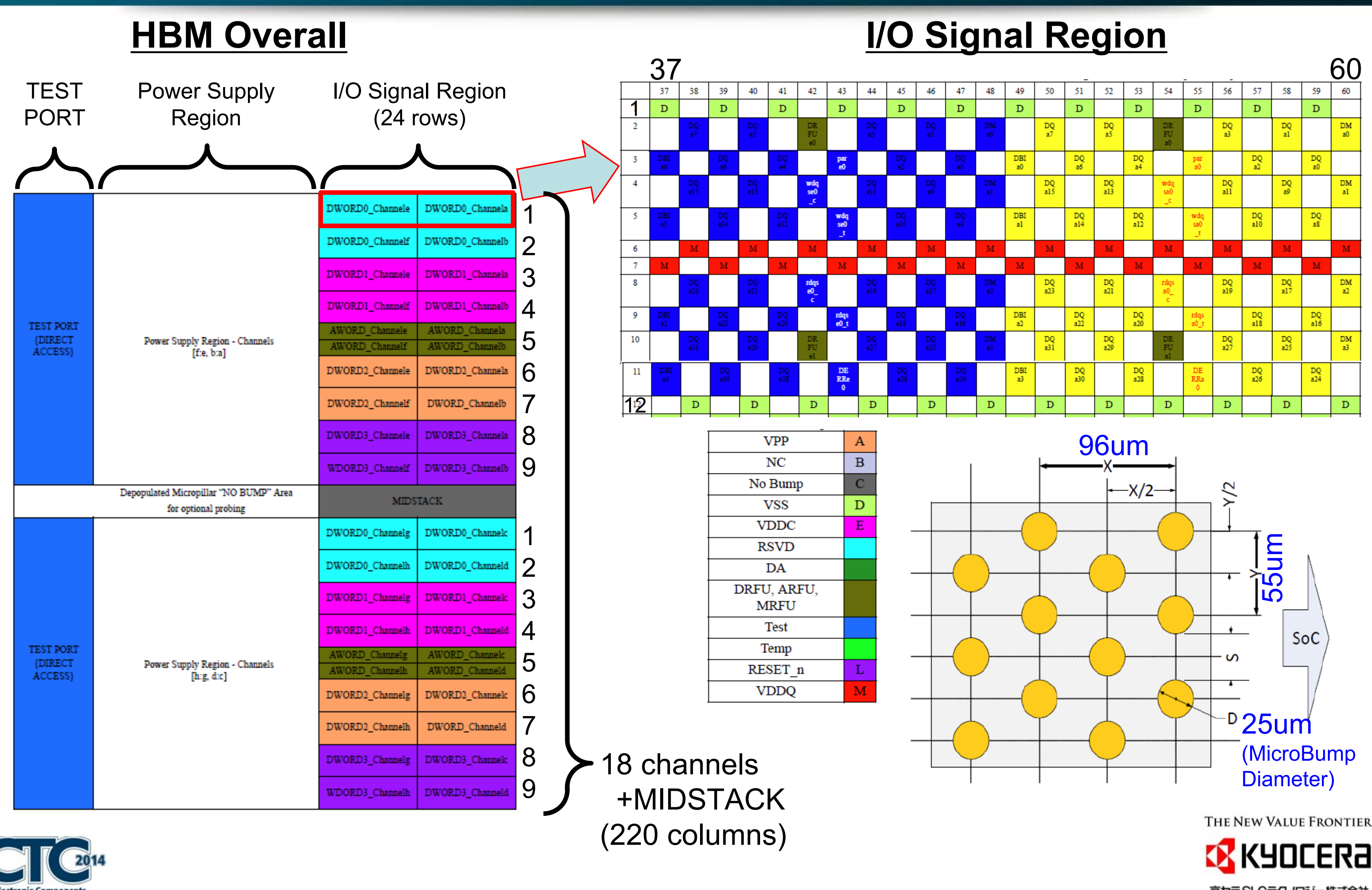








HBM Ballout Map



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Signal Fan-out Design Study from HBM

37
60
1
13
330um

Signals (24)

Signals (24)

Signals (24)

Signals (24)

PTH

Top （FCA PAD）
FC5 (Power)
FC4 (Signal)
FC3 (GND)
FC2 (Signal)
FC1 (Power)
CORE
BC1 (Power)
BC2 (Signal)
BC3 （GND）
BC4 (Signal)
BC5 (Power)
BOTTOM （BGA PAD）

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Signal Fan-out Design Study Result

VPP | VDD | VDDQ | VSS | SIGNAL

I/O Signal Region

TSM

FC5

FC4

FC3

FC2

FC1

All Signals can be fan-out !

Reliability Test Status

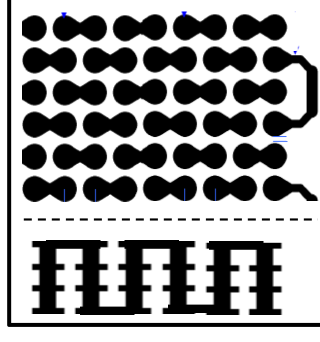
Substrate Level Reliability Test Status

Test Vehicle

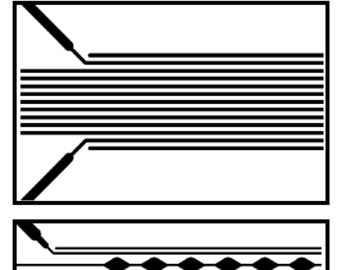
1. 3 Stacked VIA Chain
2. 6umLine width / 6um Line-to-Line -Space
3. 6um Line-to VIA_Land Space

Qualification Test Status

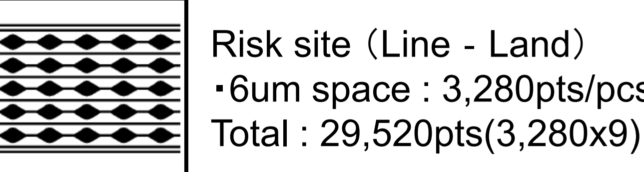
WTC (-65/150degC; 400cycles)	Passed
DTC (-55/125degC; 1000cycles)	Passed
HAST(130degC,85%,3.7V; 288hrs)	Passed
THB (85degC,85%,5V; 1000hrs)	under Testing



Risk site （3stacked via)
・40um pitch : 1,044vias/pcs
・50um pitch : 1,044vias/pcs
Total : 10,440vias(1,044x10)



Risk site （Line-Line)
・6um space :198mm/pcs
Total : 1,782mm(198x9)



Risk site（Line - Land）
・6um space : 3,280pts/pcs
Total : 29,520pts(3,280x9)

Module Level Reliability Test Status

Test Vehicle

1. Dummy Chip Attached / No FCA Joint on 3 Stacked VIA Chain

Qualification Test Status

WTC (-65/150degC ; 400cycles)	Passed
DTC (-55/125degC ; 1000cycles)	Passed

Surface Finish Experience

	OSP	NiAu , NiPdAu	SAC (Solder)
Pad Pitch	> 40um	> 50um	> 150um
Pad-Pad Space	> 8um	> 18um	
	Glicoat-SMD F2(PK) Entek Cu56	* Reference picture	* Reference picture

APX Technology Roadmap

			CY 2013		CY 2014	CY 2015	CY2016	CY2017
			~3Q	4Q~				
Substrate	CTE (ppm)		10-11	10-11	10-11	10-11	10-11	10-11
						7 (target)	7 (target)	7 (target)
	Size (mm) Depend on Build up L/S Depend on Equipment		≤93(12/12) ≤70(10/10)	≤93(12/12) ≤70(10/10) ≤30(6 / 6)	≤93(12/12) ≤70(10/10) ≤30(5 / 5)	≤77(5 / 5)	≤77	≤77
Core	Core Layer		2	2	2	2	2	2
	Min Line/ Space (um)		20/20	20/20	20/20	20/20	15/15	15/15
	Core Thickness (um)		200	200	200	200	150 or 200	150 or 200
	PTH Hole (um)		>50	>50	>50	T.B.D.	T.B.D.	T.B.D.
	PTH Pitch (um)		≥150	≥110	≥100	≥100	≥80	≥80
	PTH Land (um)		80	80	80	80	65	65
Build Up	Build up Material		Polyimide	Epoxy	Epoxy	T.B.D.	T.B.D.	T.B.D.
	Number of Build up Layer		4	5	5	3	3	3
	Min. Line/ Space (um)		10/ 10	6/ 6	5/ 5	3/ 3	3/ 3	2/ 2
	Conformal V1 via	Hole (um)	40/38	40/38	33	20	20	15
		Land (um)	50	50	50	32	32	25
	Filled Vn via	Hole (um)		20	20	15	15	13
		Land (um)		32	32	25	25	22
	Number of Via stack		0	3	3	2	2	2

Update: May.2014

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