High Density and Low Cost Approach for the PCB of semiconductor tester

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Technical trend for testing

- **High Speed ;**

Speed of electric device is getting higher

- **High Density ;**

More signal is required
- increasing in Pin count
- Pair drive for High speed signal

- **Fine Pattern ;**

Testing system becomes complicated and various components to be required
- pin count of comps. increased and pin pitch become narrow due to comps. downsizing

Conflicting PCB Requirements

Suitable for standard P/E

High Speed

Lower Cost

High Density

Fine pattern

Material

Trace width

Layer Count
PCB Thickness

Trace width

Yield

Routing density / Pin

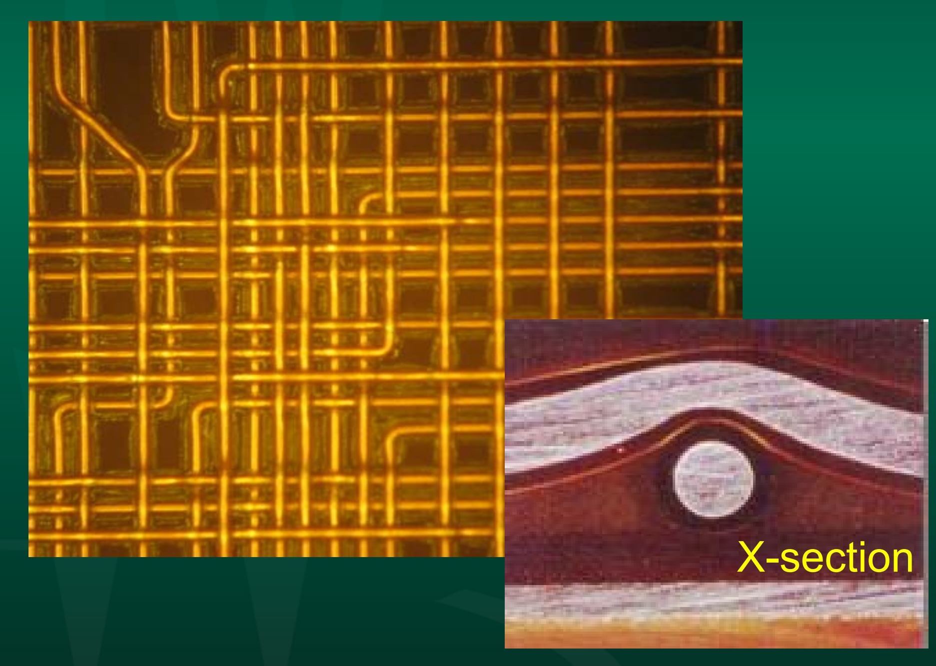
Suitable for MWB

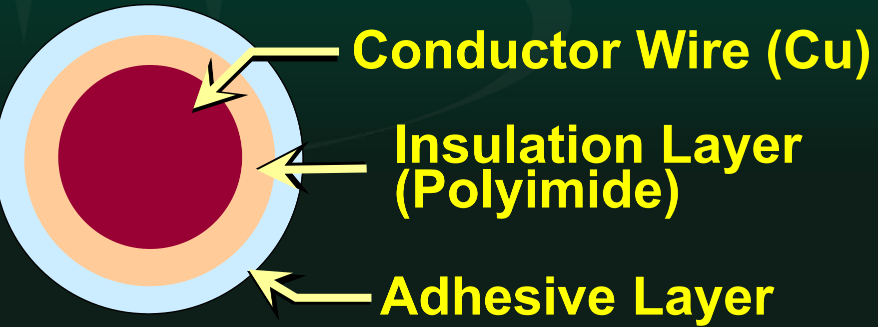
Suitable for HDI P/E

MWB technology

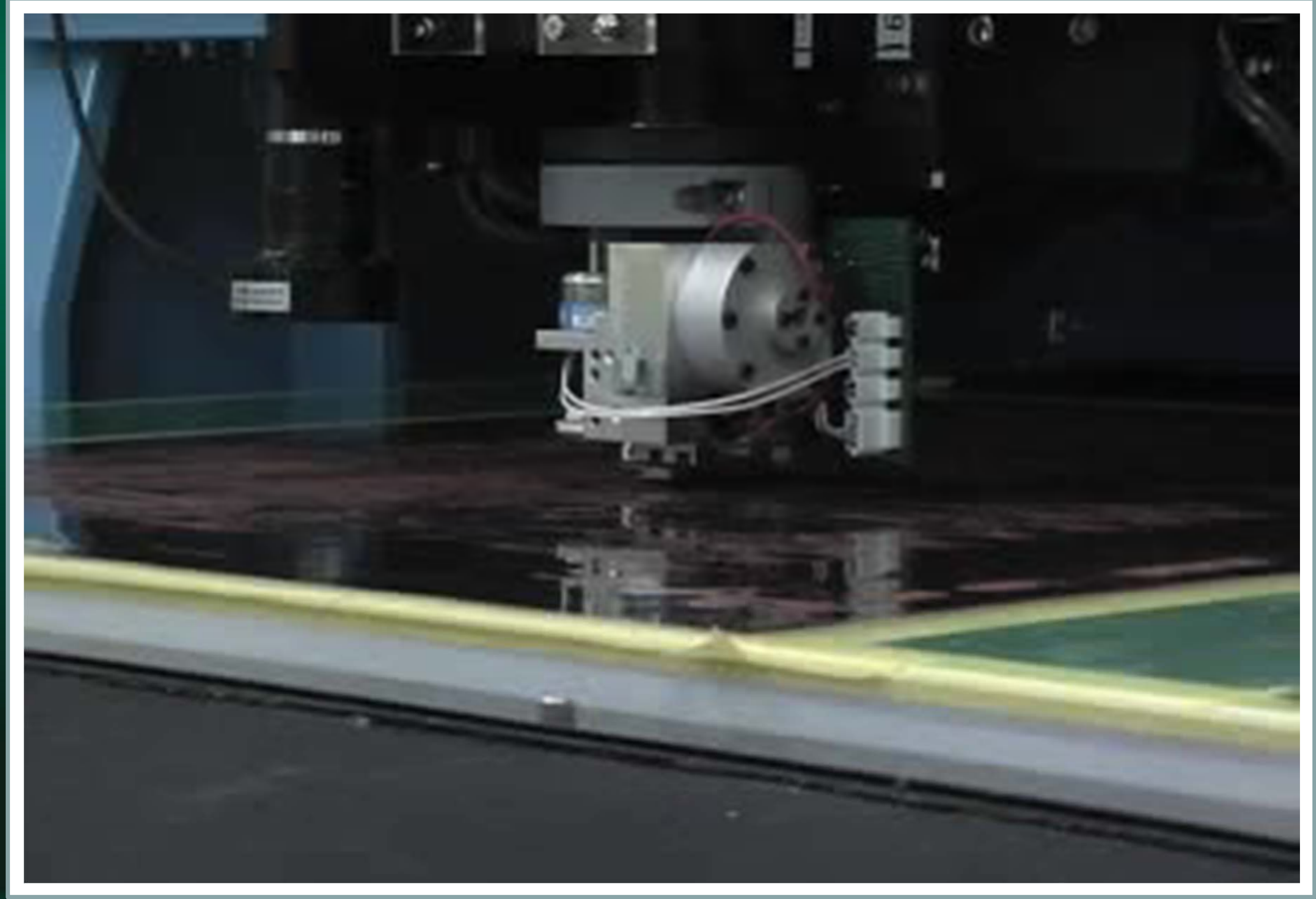
*MWB is a PCB which replaces etched signal traces with copper wires

*Signal lines are able to cross over each other because copper wire is insulated with resin coating.

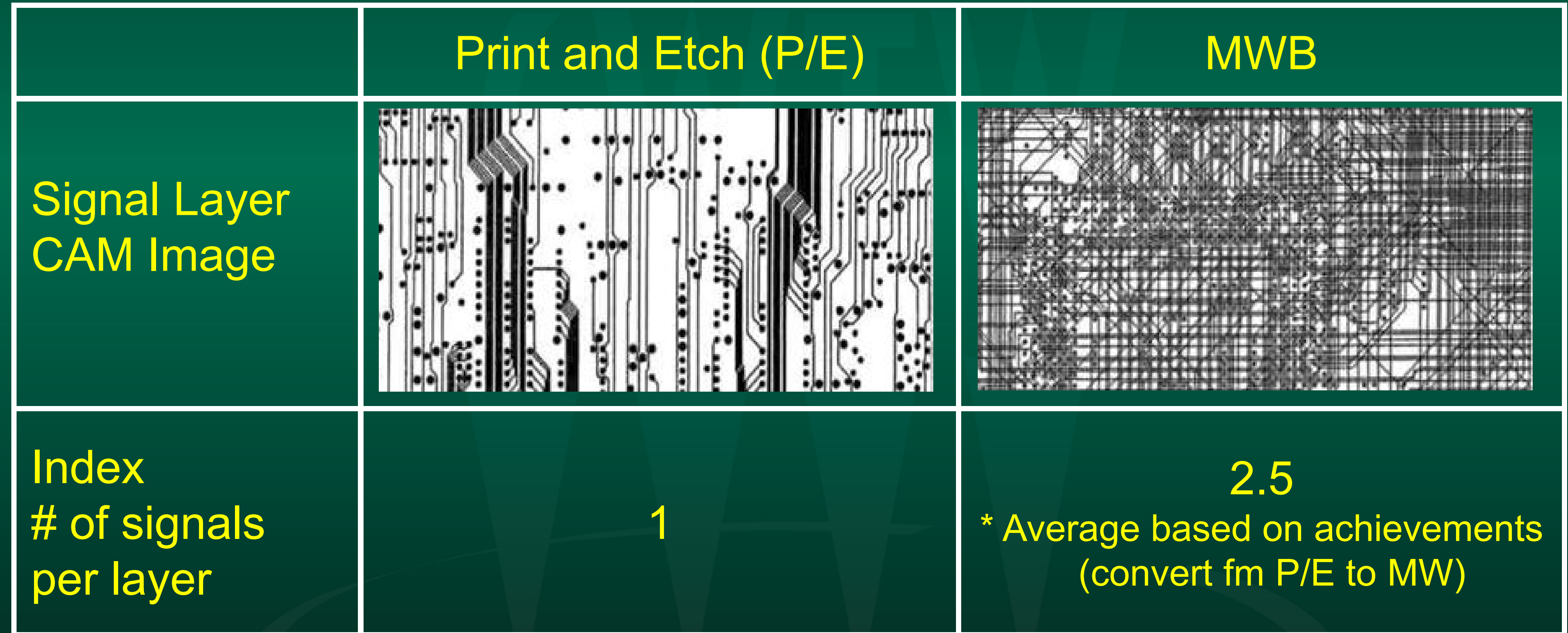




Actual wiring operation



High Density Wiring



	Print and Etch (P/E)	MWB
Signal Layer CAM Image		
Index # of signals per layer	1	2.5 * Average based on achievements (convert fm P/E to MW)

Multi-Wire has abilities to,

- Route 2.5 times of signals than P/E PCB into one layer.

- Increase total # of routed signals in PCB.

Based on Achievements for Probe Card PCB

MWB (P/E)

Layer Count

60 (100)
54 (89)
48 (78)
42 (67)
36 (56)
30 (45)
24 (34)

P/E

0.080 wire

0.065 wire

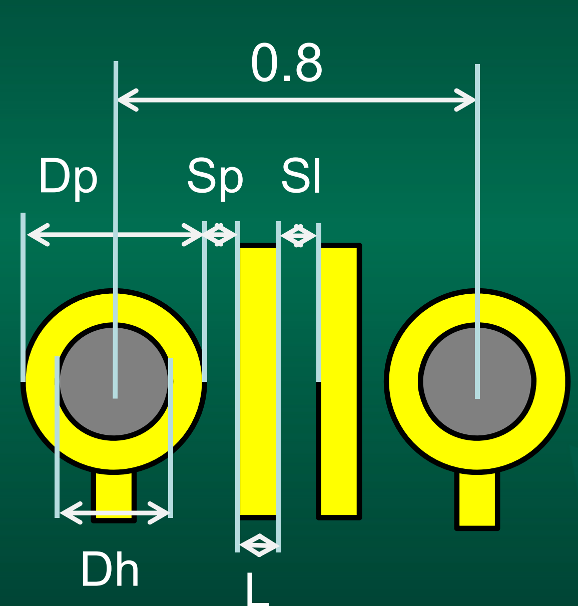
1.0mm
1.0mm
1.25mm
1.25mm

~ 500 DUT
~750 DUT
~ 1000 DUT
~ 1500 DUT

3k 6k 9k 12k 15k 18k 21k 24k

# of Signal Nets

Design study for pair drive (1)



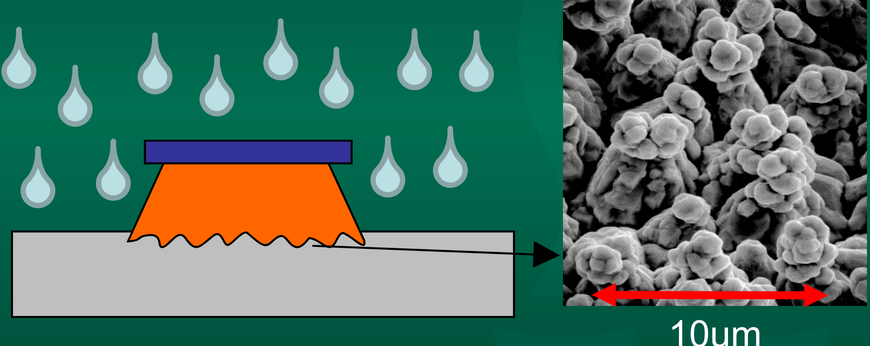
Item	Unit	P/E 0.5oz HVLP	MWB
Material	-	FX-2(s) Dk3.6	I-671 Dk3.6*
PCB Thickness	mm	6.2	
Drill Dia. (Dh)	mm	0.25	
Pad Dia. (Dp)	mm	0.40	-
Line width (L)	mm	0.080	0.065
Space L-L (SL)	mm	0.080	0.113
Space P-L (SP)	mm	0.080	-
Resistance	Ω/m	11.9	5.3
Crosstalk	%	9.8	2.5
Attenuation @3GHz	dB	-4.9	-4.6

* Nominal value for MWB structure

Comparison of Signal Shape

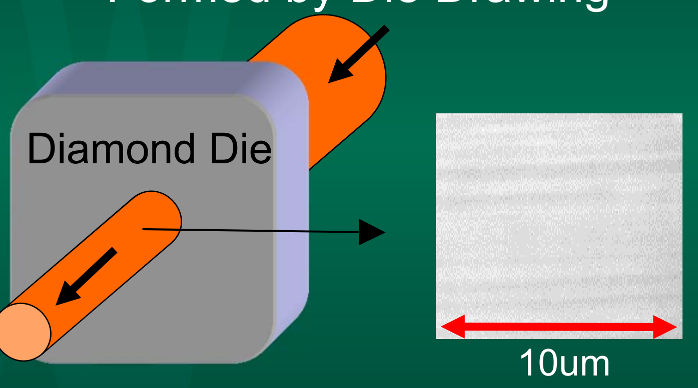
Print and Etch (P/E)

Formed by Etching Process



Multi-Wire (MW)

Formed by Die Drawing



P/E 0.08mm, 0.5oz	Compared item	MW 0.065mm
1	X-section size index Low resistance (Low attenuation)	2.3
+/- 0.010mm	Tolerance of Conductor Width Easy impedance control	+/- 0.003mm
~ 10um	Conductor Surface Roughness Low skin effect , Low attenuation in high frequency	~ 0.5um

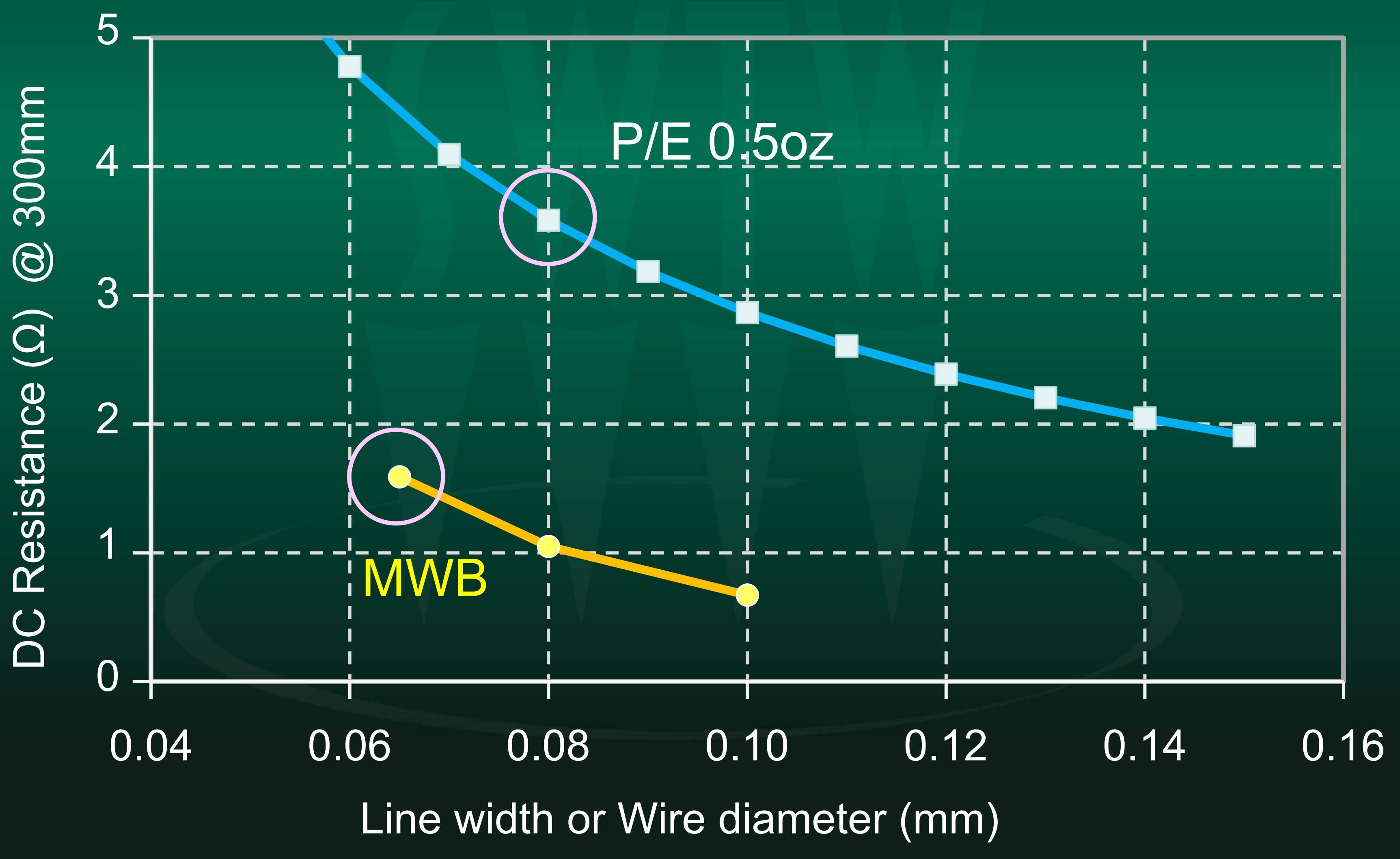
Design study for pair drive (2)

Item	P/E	MWB
Characteristic impedance (Zo)	Differential 100Ω	**Differential 100Ω**
Base material	FX-2(s) (Dk:3.6)	**I-671 (Dk:3.6*)**
Line width	0.080mm	**0.065mm**
Line thickness	0.018mm	
Structure	H 0.285mm 0.160mm	H 0.210mm 0.178mm
H	1.485mm	**0.550mm (63% reduced)**

* Nominal value for MWB structure

MWB can reduce total thickness with keeping high routing density

Signal Line Resistance comparison



Cross-talk (Backward) Comparison

Backward Crosstalk (%)

10
8
6
4
2
0

P/E 0.5oz

MWB Φ0.065

100 150 200 250

Line Pitch (mm)

(Condition) L : 300mm, Z_0 : 50Ω, Rise Time : 35ps

3GHz Signal attenuation

Material	FR4 E-679	Mid-Range HE-679G	High-end FX-2(s)	Standard I-671	Mid-Range HE-679G	High-end FX-2(s)
Cu Foil type	Standard	VLP	HVLP	MWB	MWB	MWB
Trace	Line width = 0.08mm, 0.5oz Foil			Wire diameter = 0.065mm		

Attenuation = Dielectric Loss (Dk, Df) + Conductor Loss (Re)

Summary of MWB technology

- Signal Density per layer of MWB is 2.5 times higher than P/E PCB by using cross over wires.
- Low resistance, Low crosstalk characteristics of MWB bring better signal integrity for high speed application.
- Compared with P/E PCB, MWB can reduce a insulation thickness with keeping high density routing and high electrical performance.

Hybrid MWB for advanced PCB

Target for Hybrid MWB

Suitable for standard P/E

High Speed

Lower Cost

Material

GOAL:
Bridge the gap between conflicting PCB requirements with the development of Hybrid MWB

Layer Count

PCB Thickness

Trace Width

Trace width

Yield

High Density

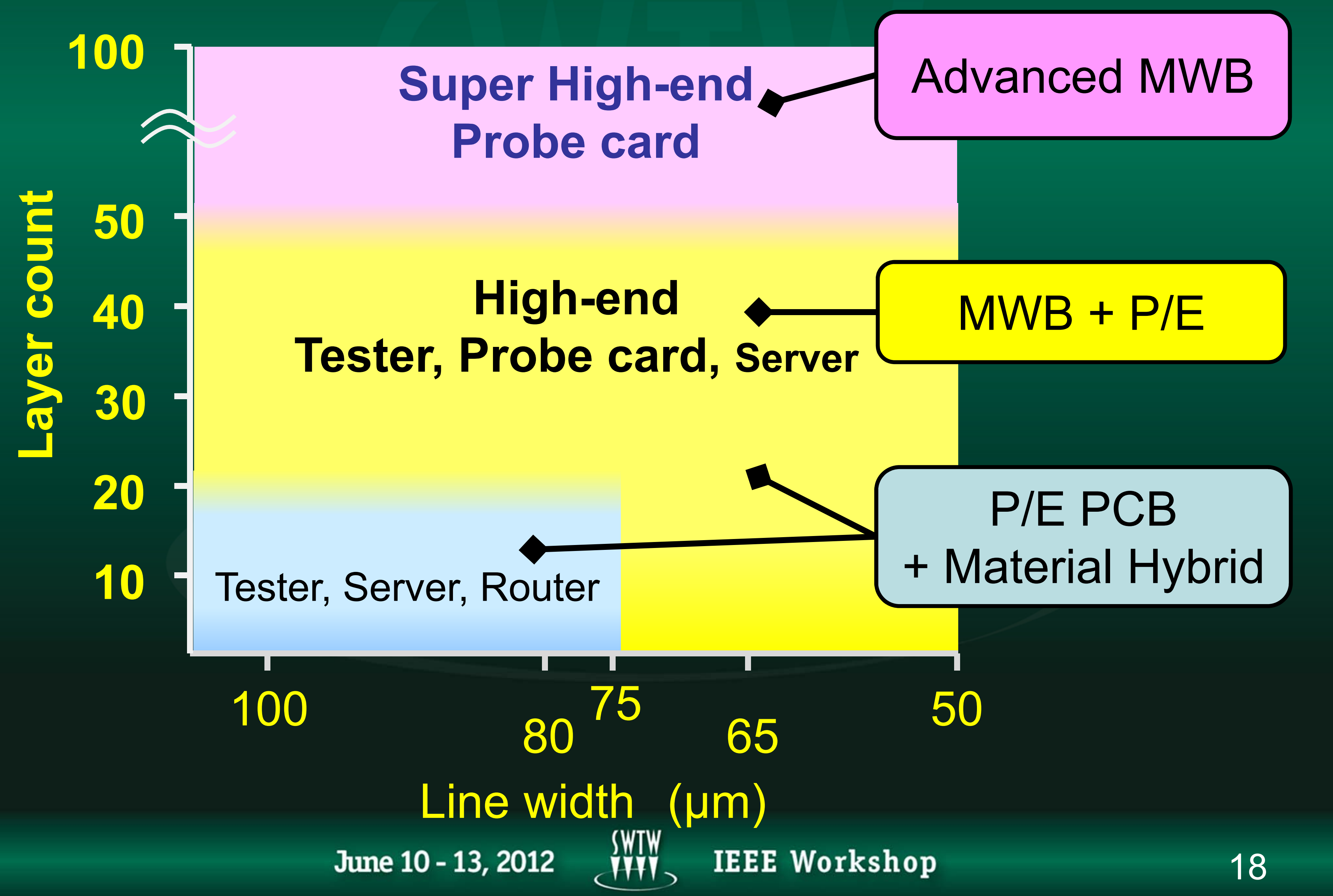
Fine pattern

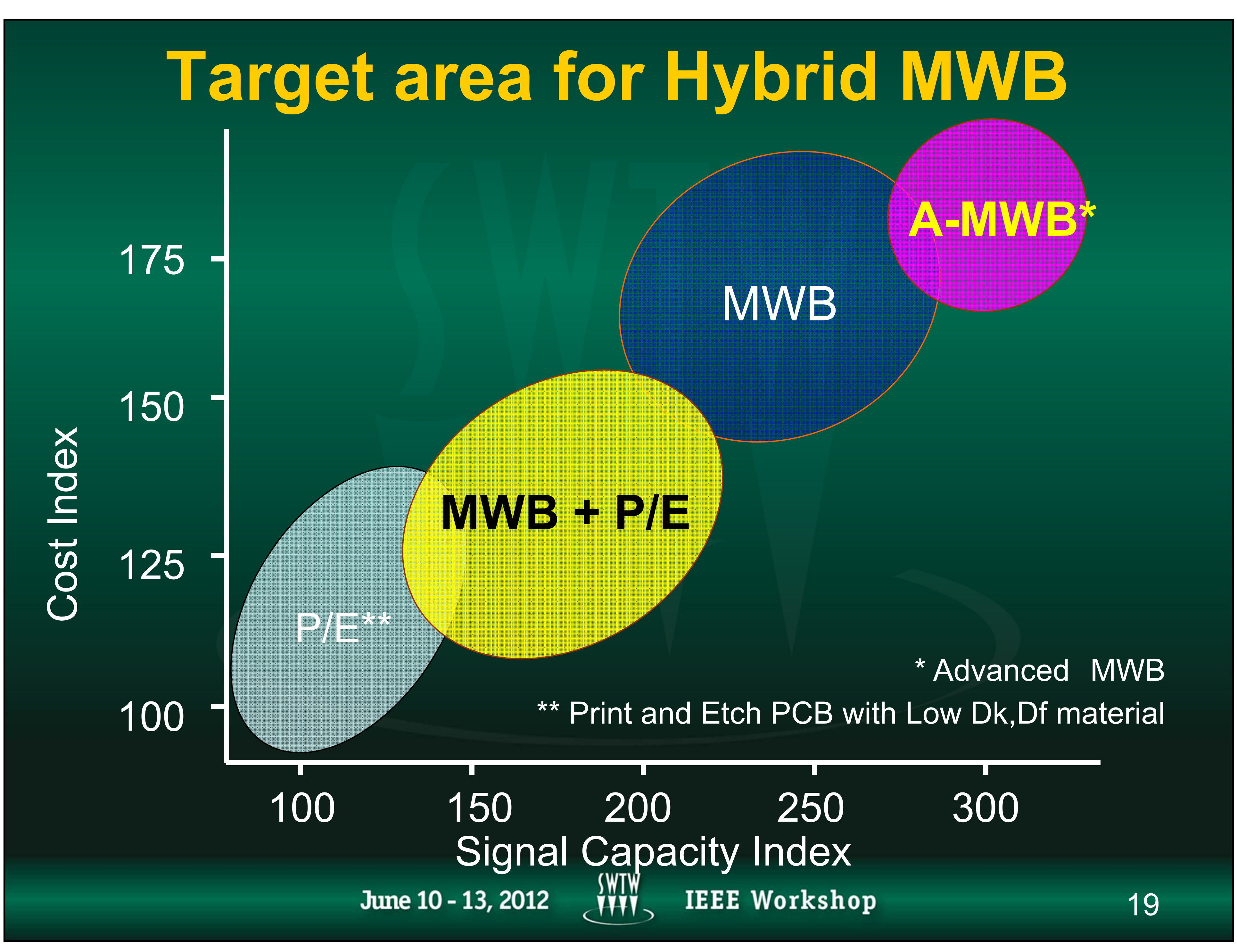
Routing density / Pin

Suitable for MWB

Suitable for HDI P/E

Application field for Hybrid MWB




Target area for Hybrid MWB
Cost Index
175
150
125
100
A-MWB*
MWB
MWB + P/E
P/E**
* Advanced MWB
** Print and Etch PCB with Low Dk,Df material
100
150
200
250
300
Signal Capacity Index
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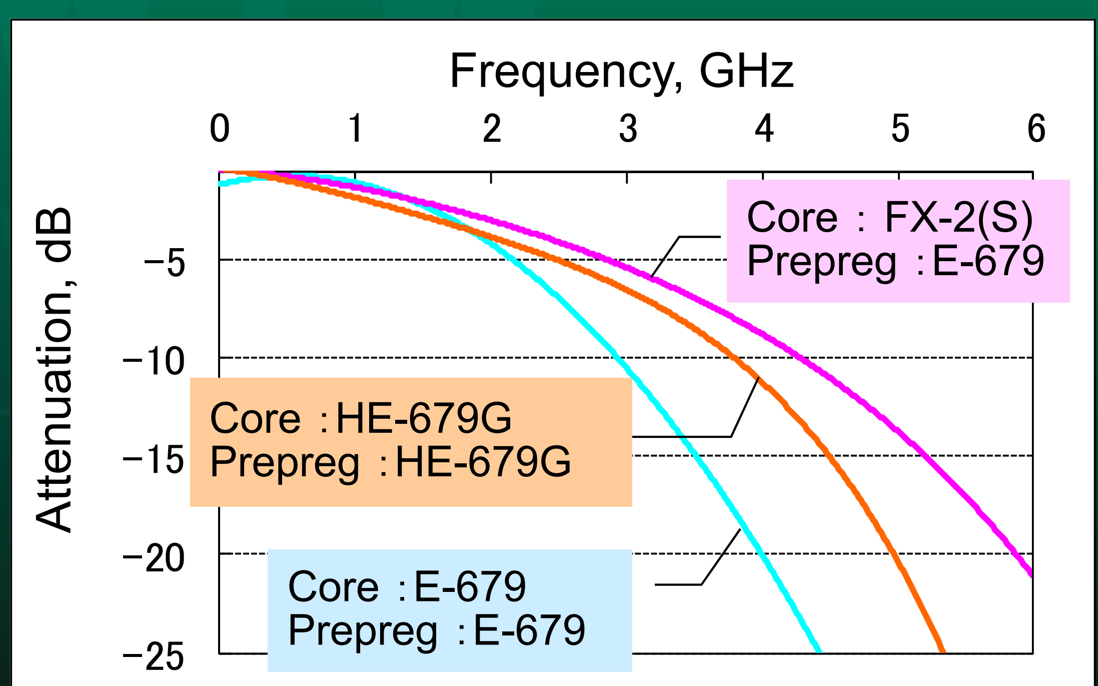
Material Hybrid

- Lower Dk, Df material for high speed signal layers
- Conventional FR-4 (high Dk, Df) for Power / GND layers

Power/GND
Core : E-679
Prepreg:E-679

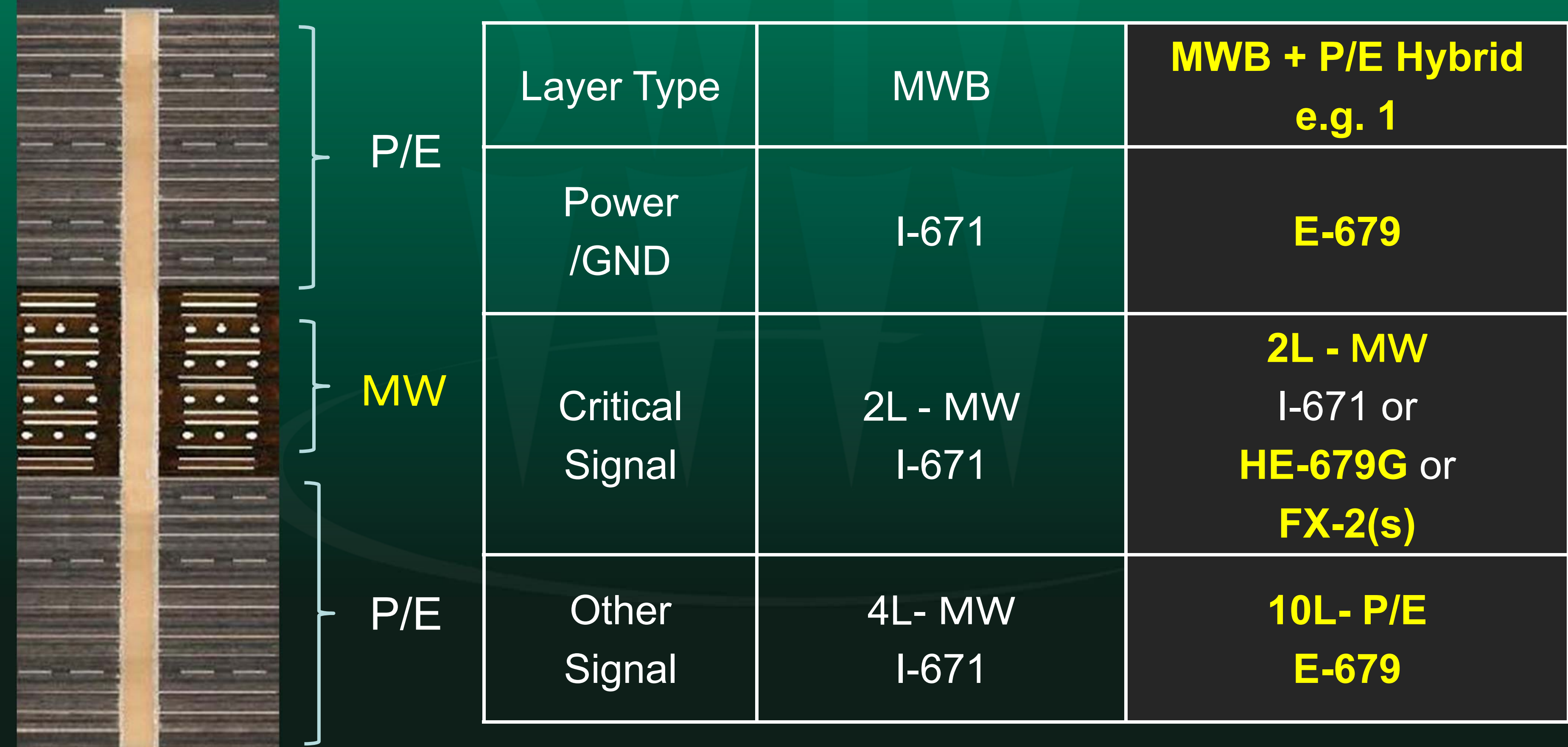
Signal
Core : FX-2(S)
Prepreg:E-679

Power/GND
Core : E-679
Prepreg:E-679



MWB + P/E Hybrid (e.g. 1)

- MW for critical signals (high speed, shortest, equal length, etc.)
- P/E for other signal layers (DC signal, etc.)
- P/E for Power / GND layers



Layer Type	MWB	MWB + P/E Hybrid e.g. 1
Power /GND	I-671	**E-679**
Critical Signal	2L - MW I-671	**2L - MW** I-671 or **HE-679G** or **FX-2(s)**
Other Signal	4L- MW I-671	**10L- P/E E-679**

MWB + P/E Hybrid (e.g. 2)

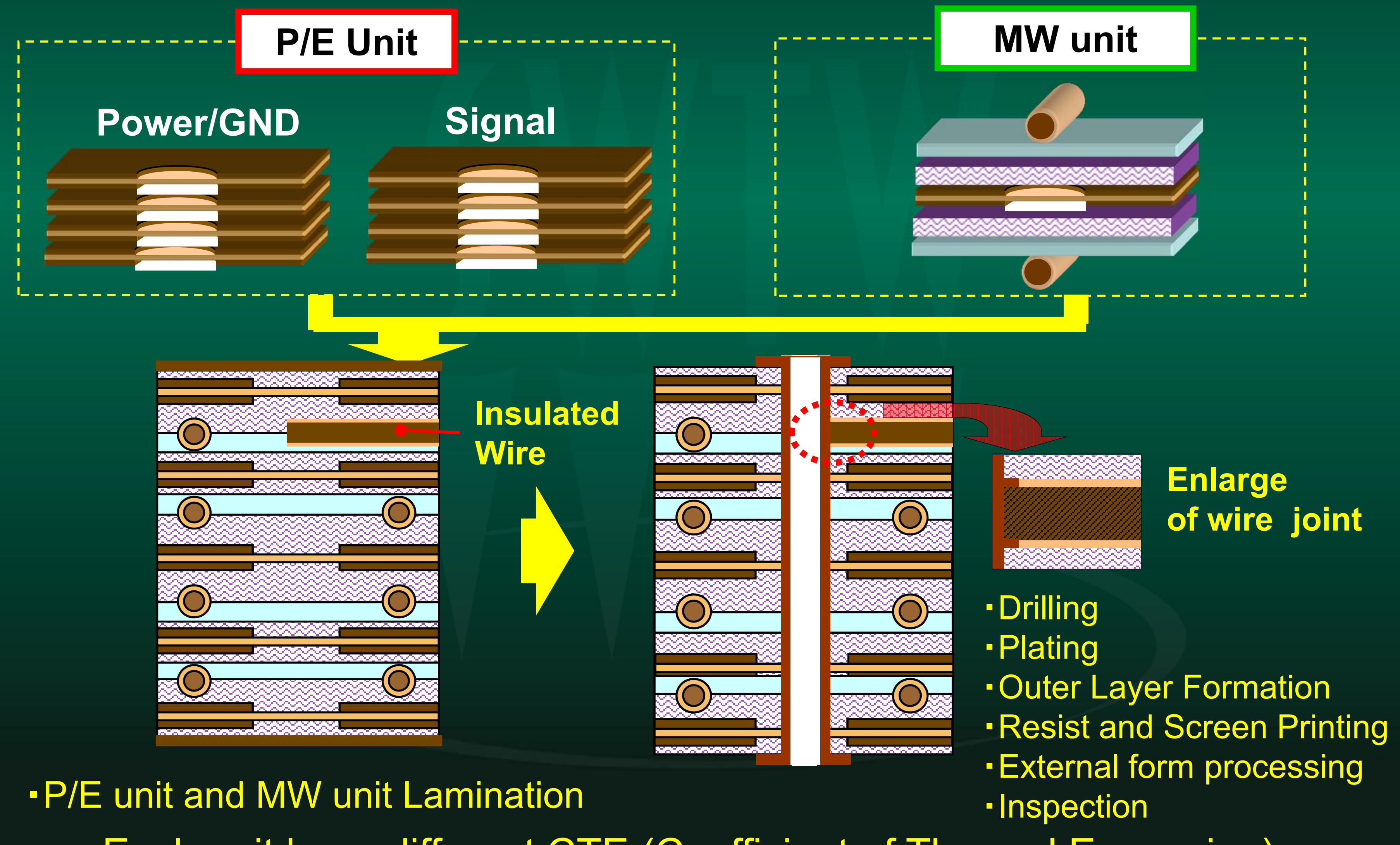
- P/E with lower Dk, Df material for critical signals
- Wider trace (lower density routing) is also applicable to improve electrical performance.
  -> Routing density decreases, However, MWB can cover it.

P/E

MW

P/E

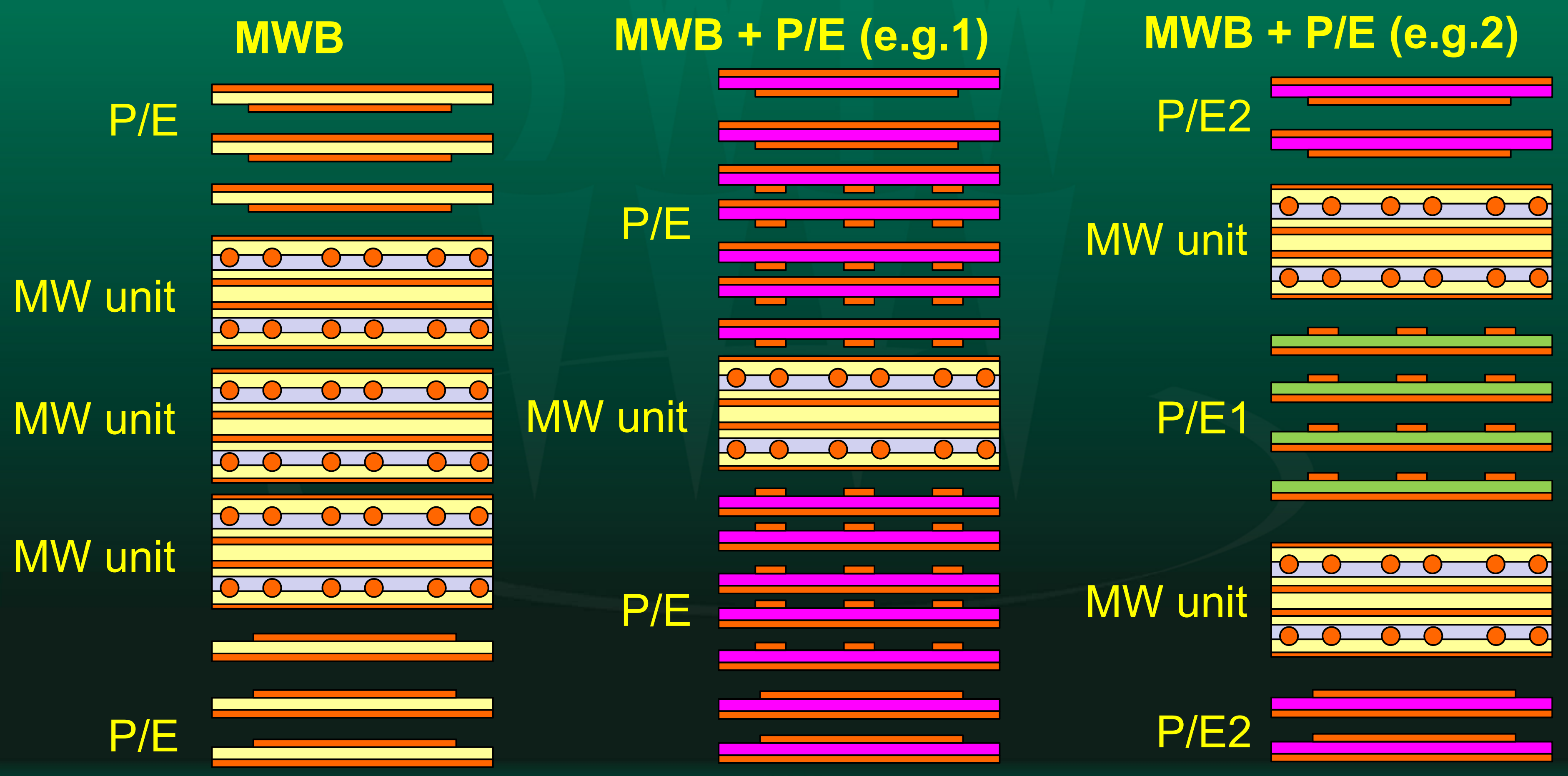
Layer Type	MWB	**MWB + P/E Hybrid e.g. 2**
Power /GND	I-671	I-671
Critical Signal	2L - MW I-671 2 wires / pin	**6L- P/E** **FX-2(S)** **1 trace / pin**
Other Signal	4L- MW I-671 2 to 5 wires/ pin	4L- MW I-671 2 to 5 wires/pin



Each unit have different CTE (Coefficient of Thermal Expansion) .
Key technologies which control CTE-related problem are required.

Key tech. (1) - Optimized stack up -

Concern : Bow / Twist
Key tech.: Optimized (Symmetrical) stack up



Key tech. (2) - Electroless Cu Plating -

Concern : Plated through hole reliability

Key tech.: Uniform (High throwing power) plating by electroless Cu plating

- Throwing Power *

A

B

Electroless
Φ0.30

Electrolytic
Φ0.30

Φ0.20 Φ0.25 Φ0.30 Φ0.70

Throwing Power, %

100
90
80
70
60

t 2.4 t 4.3 t 2.4 t 4.3

Electroless Electrolytic

*Throwing power ＝Plating thickness in the hole (B) / Plating thickness on the surface (A)

Reliability for Hybrid PCBs

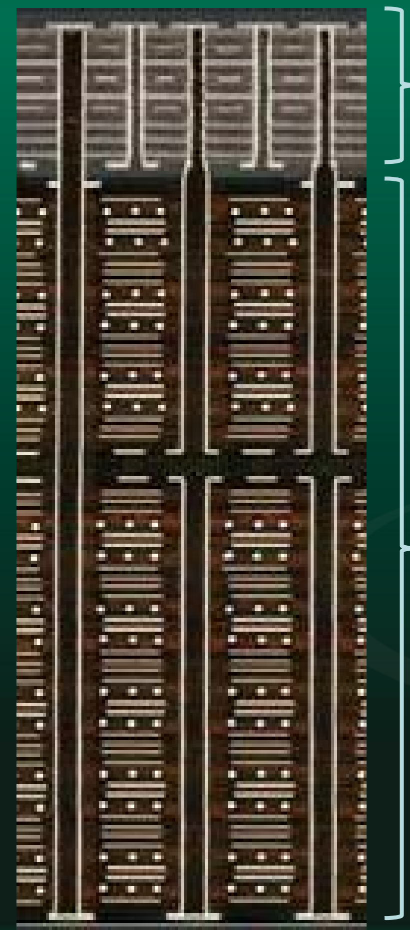
Hybrid MWB with electroless Cu plating has good reliability.

Test condition: 125℃/30min. ⇔ -65℃/30min.

PCB thickness : t6.35mm, Drill Diameter : Φ0.30mm

“A-MWB” Further advanced approach

- Assembly for Narrow Pitch Comps.
- Further more High Density (Addition of DUT count)



Sub Unit

MWB

Example for Sub Unit

Item	e.g. 1	e.g. 2
PCB Type	P/E HDI or P/E （Pitch converter）	MWB
Feature	Assembly for Narrow Pitch Comps.	Further more High Density

Summary

- Application of MWB provides one of the best solution for Higher density and Higher speed PCB.

- Hybrid PCB technology provides advanced characteristics.

MWB + P/E Hybrid structure provides cost- effective solution.

A-MWB Hybrid structure is a further advanced approach for super high density PCB.

Thank You!