Increased Reliability and Quality with the Assistance by IPC Standards!

EMPPS May 20, 2014

Lars-Olof Wallin

IPC European Representative

Association Connecting Electronics Industries

IPC®


Welcome!


Have we meet before?

Agenda

Part 1: Historical and future electronics.

Part 2: New Demands and Challenges?

Part 3: How can IPC assist?

Part 4: Need for an IPC Checklist?

Part 5: Summary and Conclusions.

Association Connecting Electronics Industries

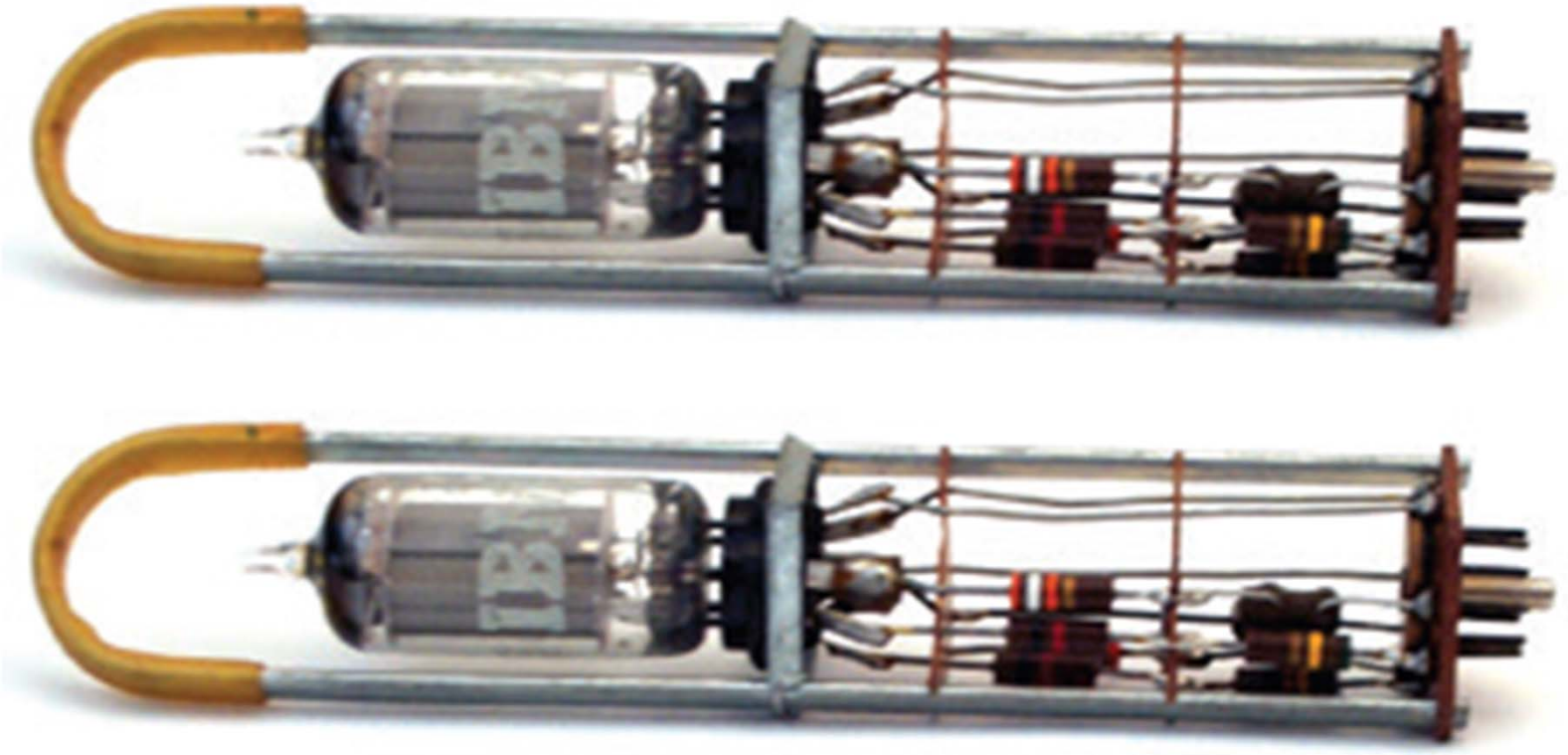
IPC®

IPC Part: 1

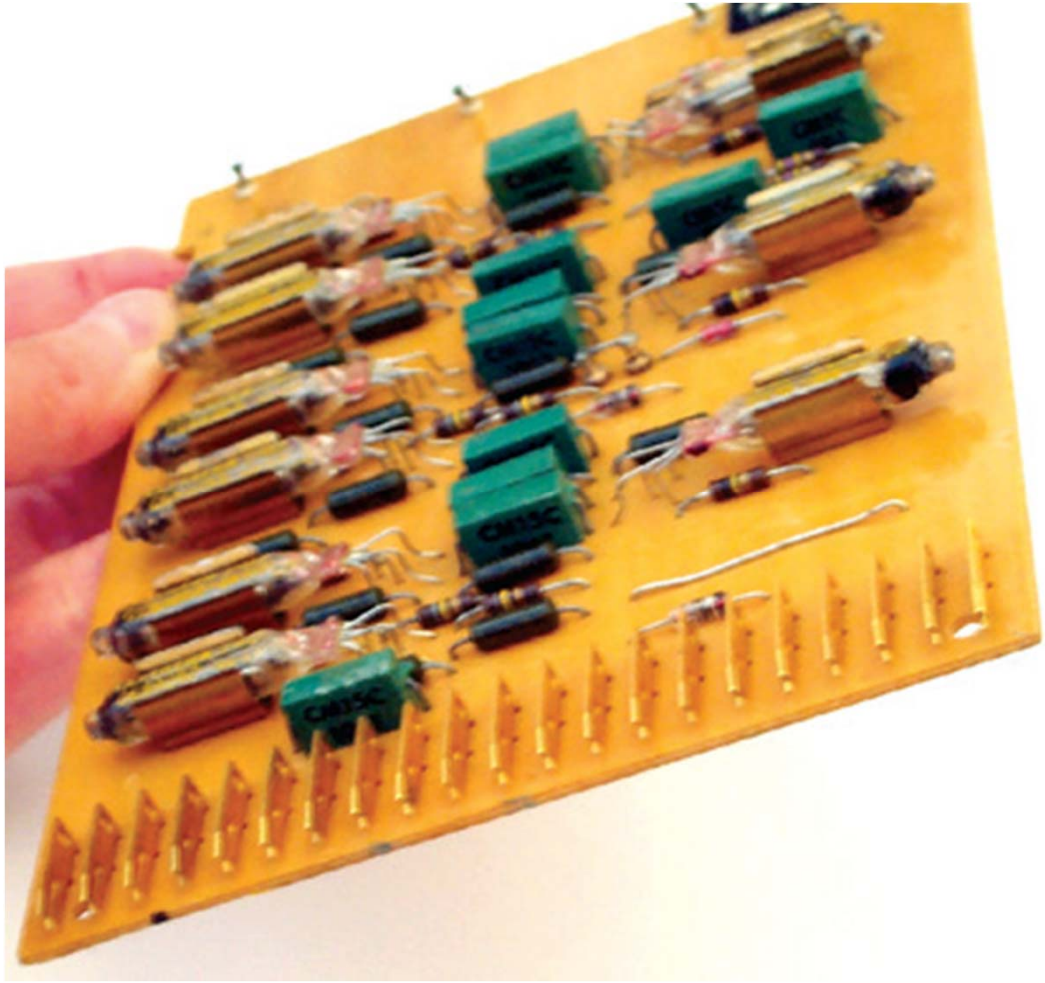
Historical and future electronics?

When will the development end?

1958



1960



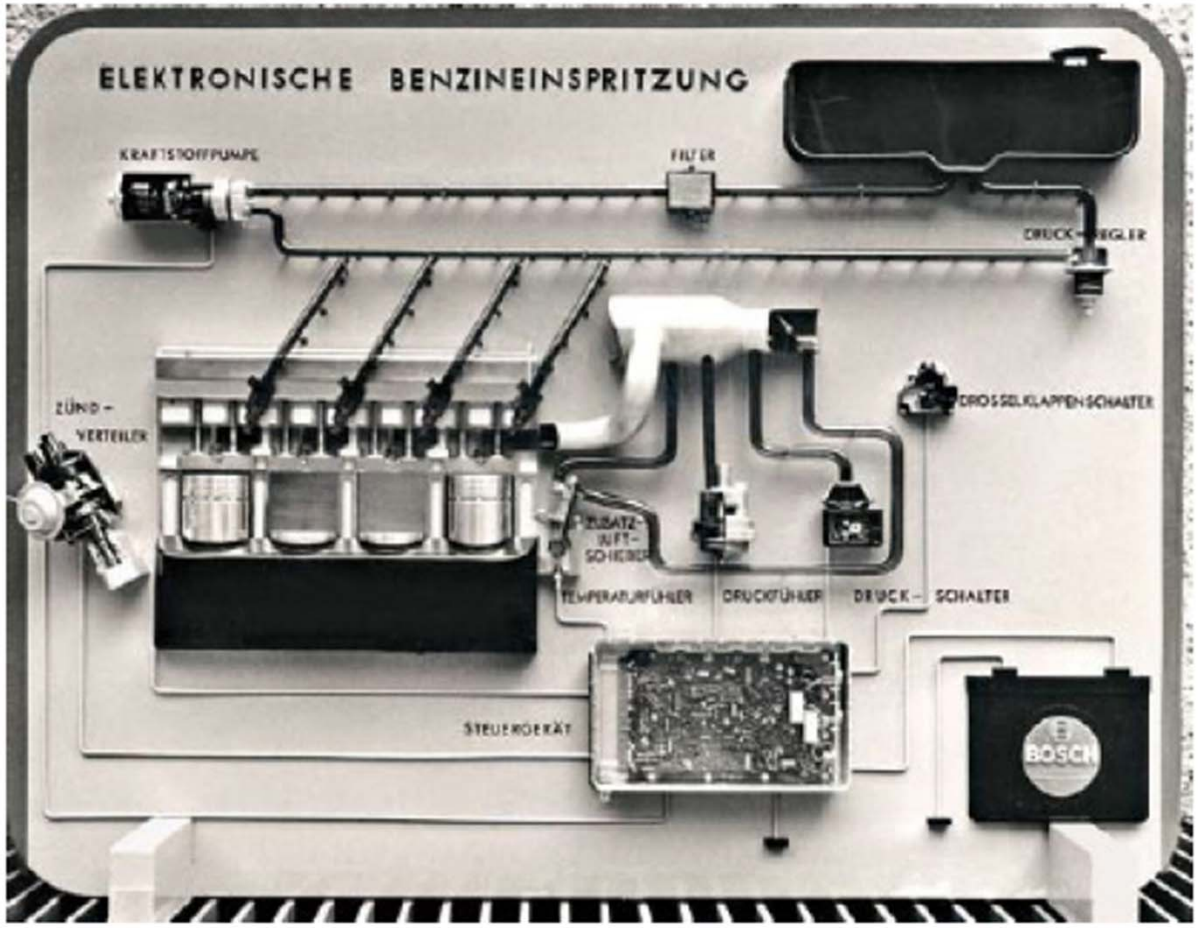
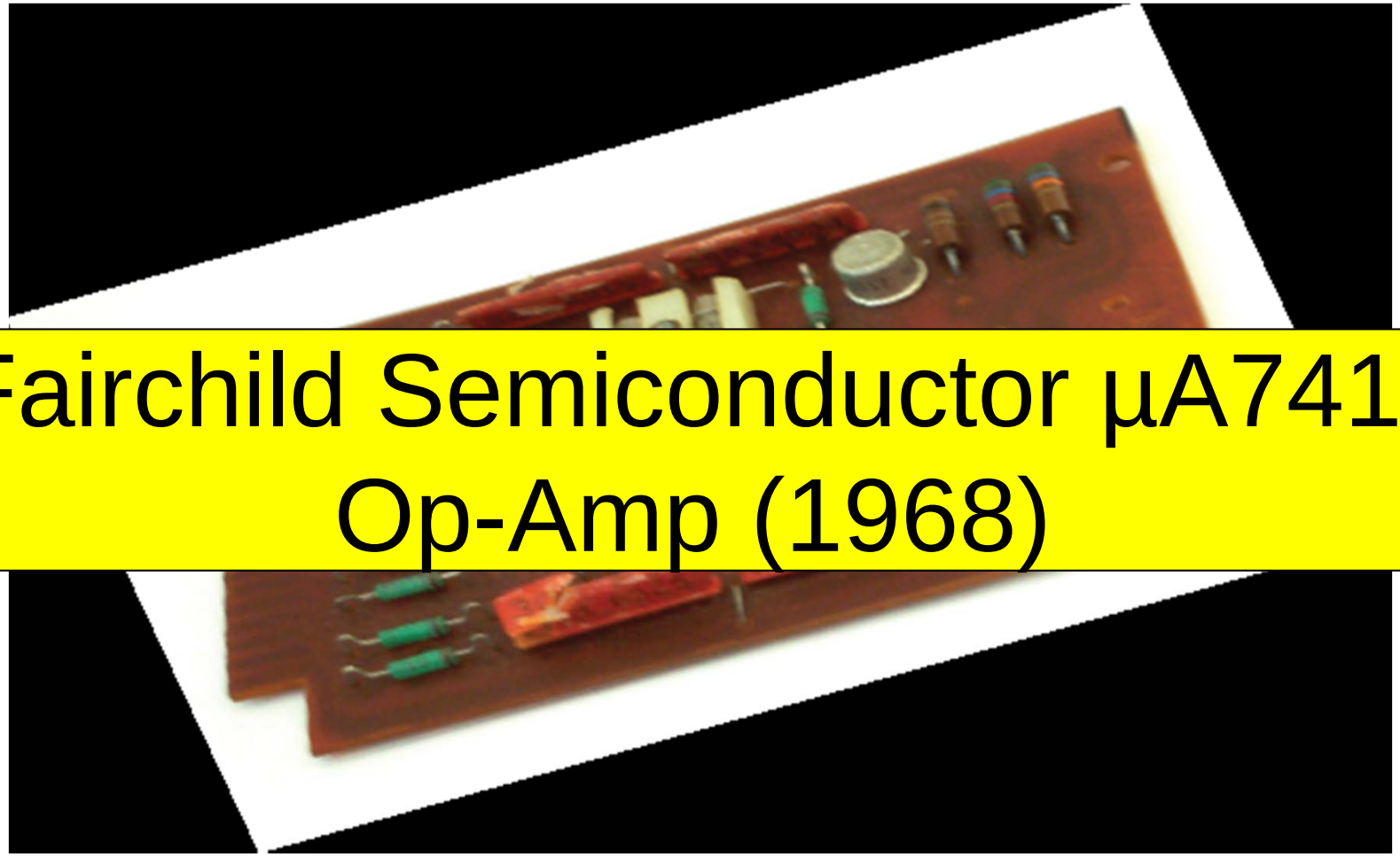


Figure A2-1 – Schematic of the 1967 Bosch "Jetronic" Electronic Gasoline Injection System

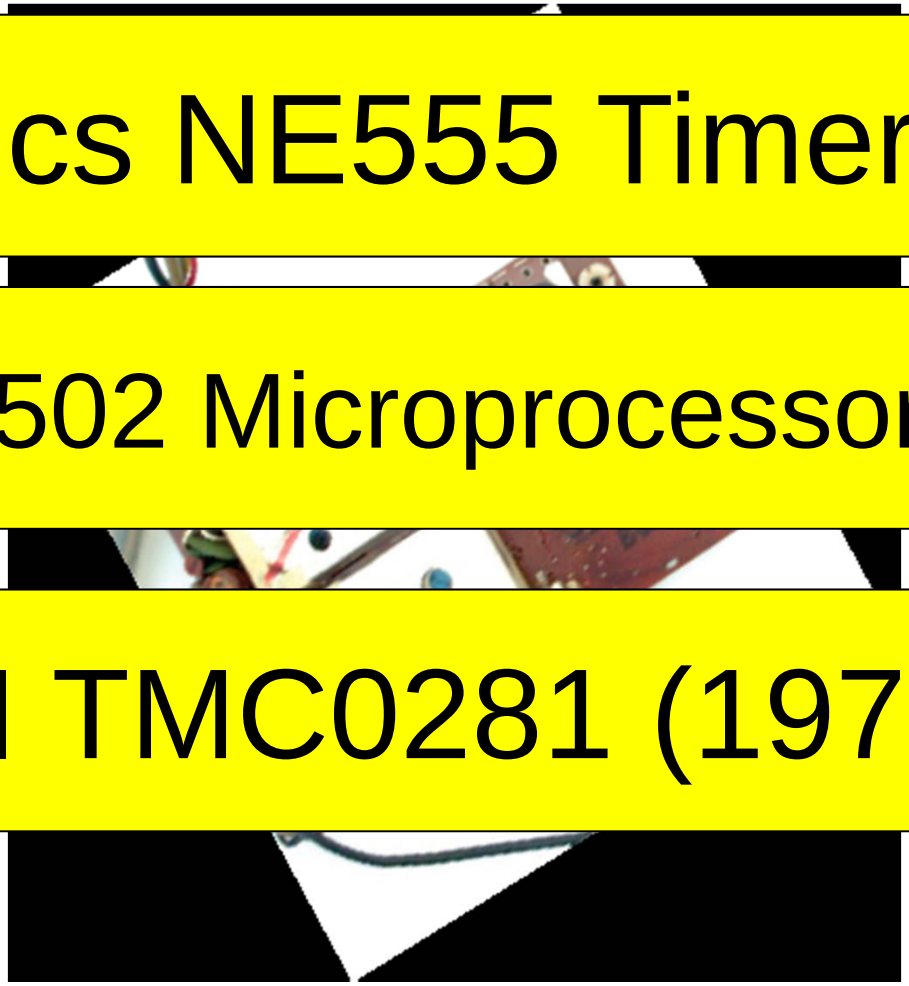
1962



Fairchild Semiconductor μA741
Op-Amp (1968)

1974

Signetics NE555 Timer (1971)



MOS 6502 Microprocessor (1975)

TI TMC0281 (1978)

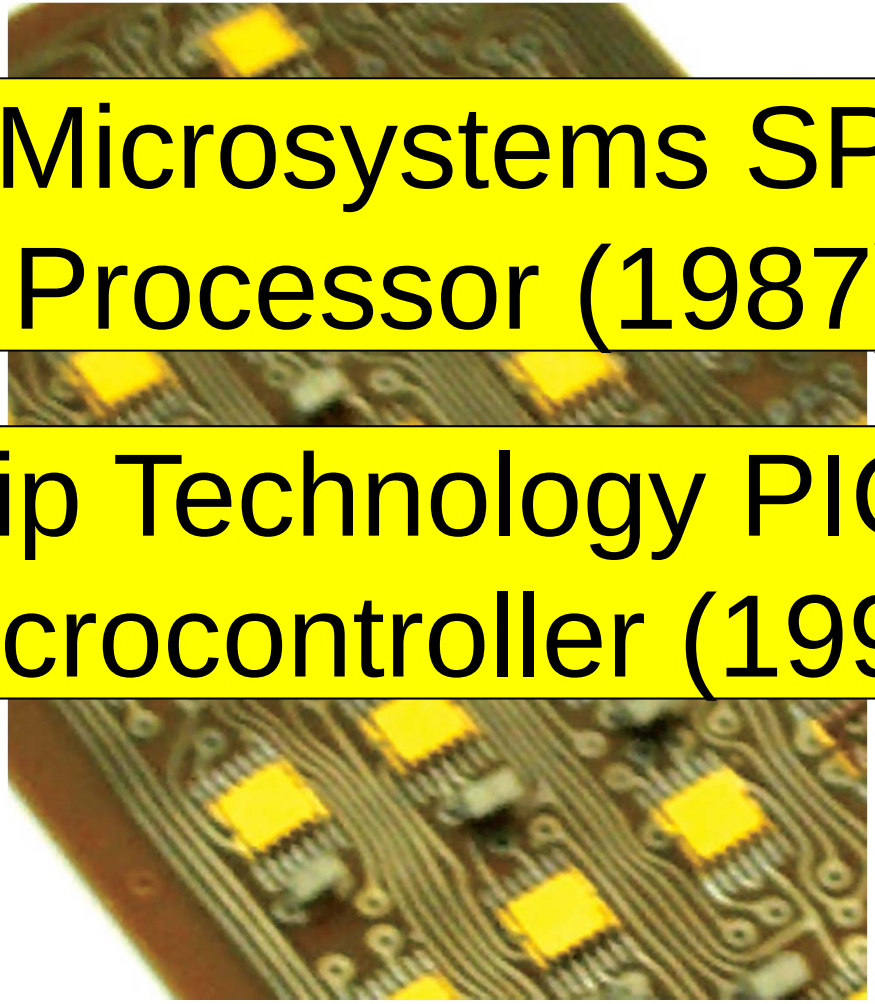
1981

Motorola MC68000 Microprocessor (1979)

Intel 8088 Microprocessor (1979)

TI TMS32010 Processor (1983)

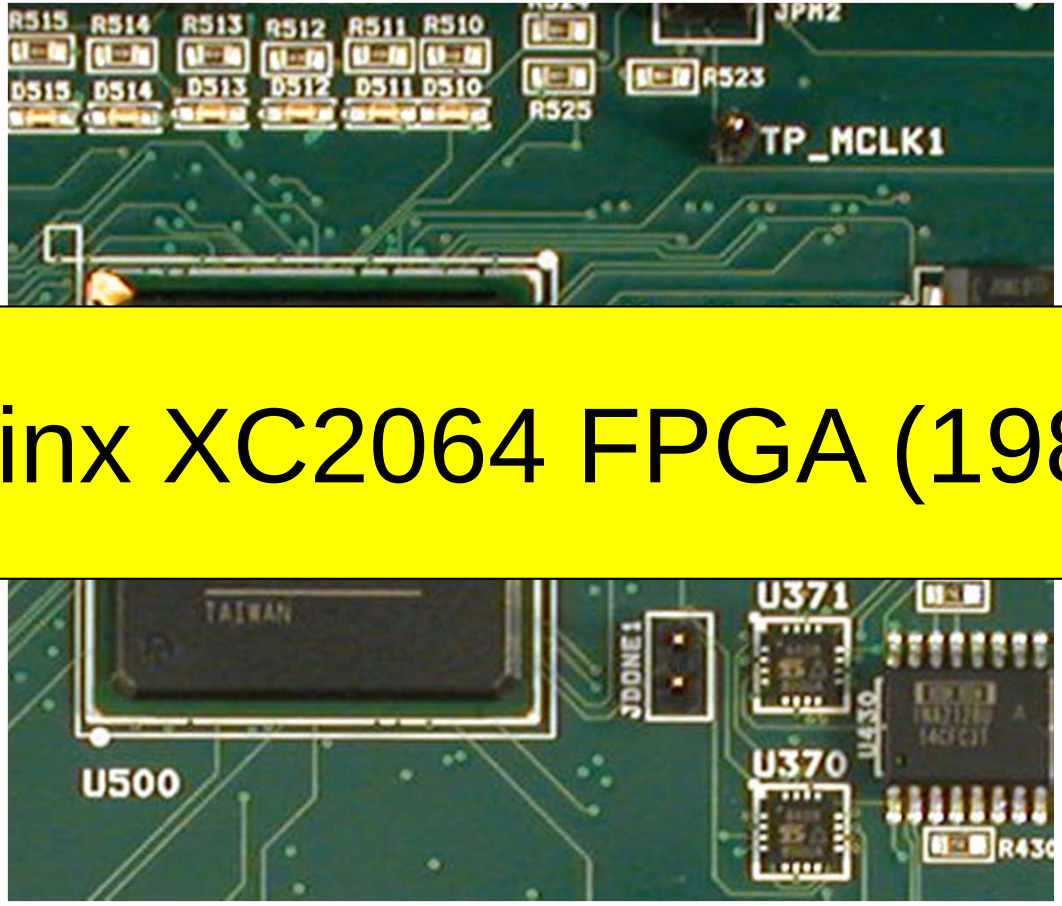
1991



Sun Microsystems SPARC Processor (1987)

Microchip Technology PIC16C84 Microcontroller (1993)

2012

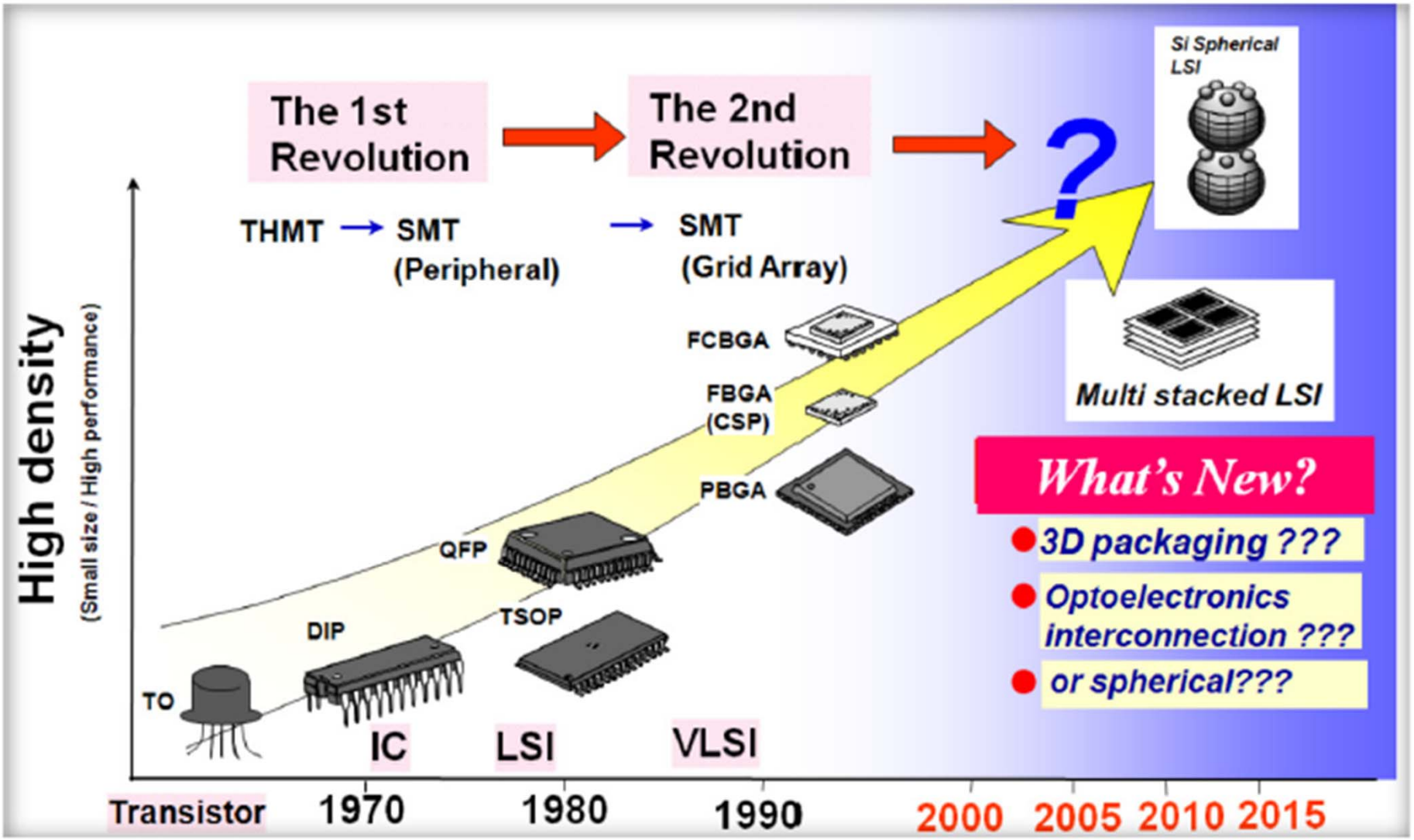


Xilinx XC2064 FPGA (1985)

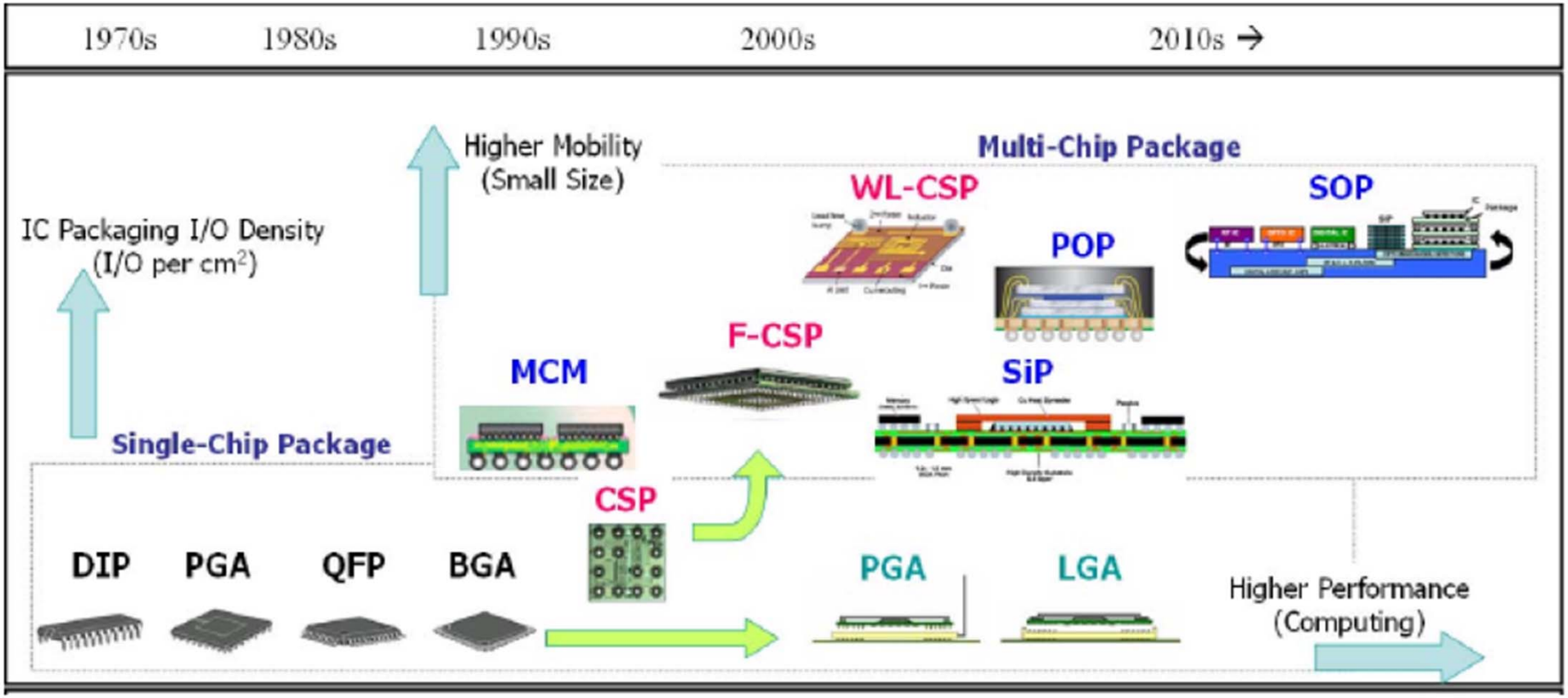
With New Components
we got new Electronics!

It will continue!

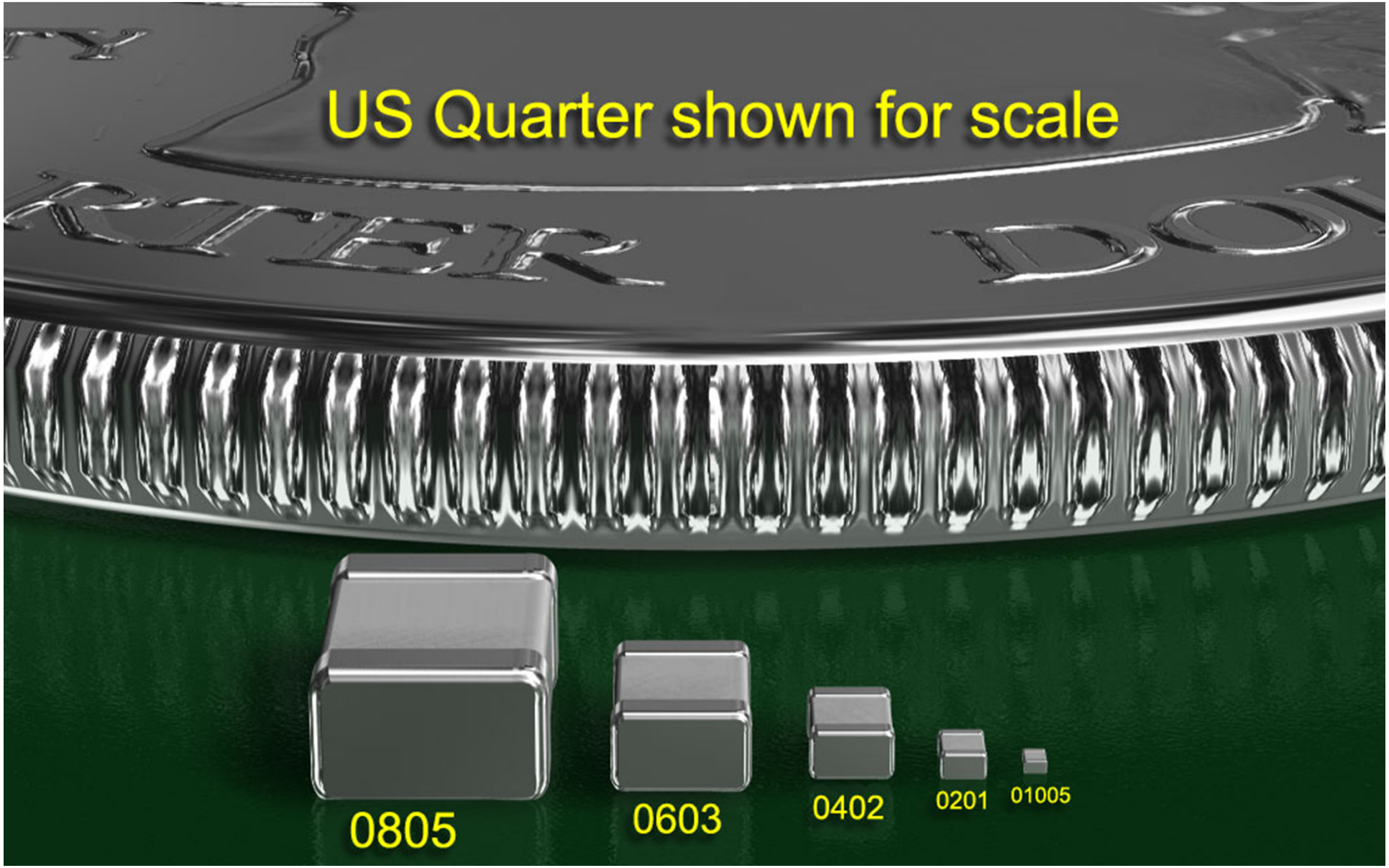
Japan Jisso Technology Revolution toward the 21st Century

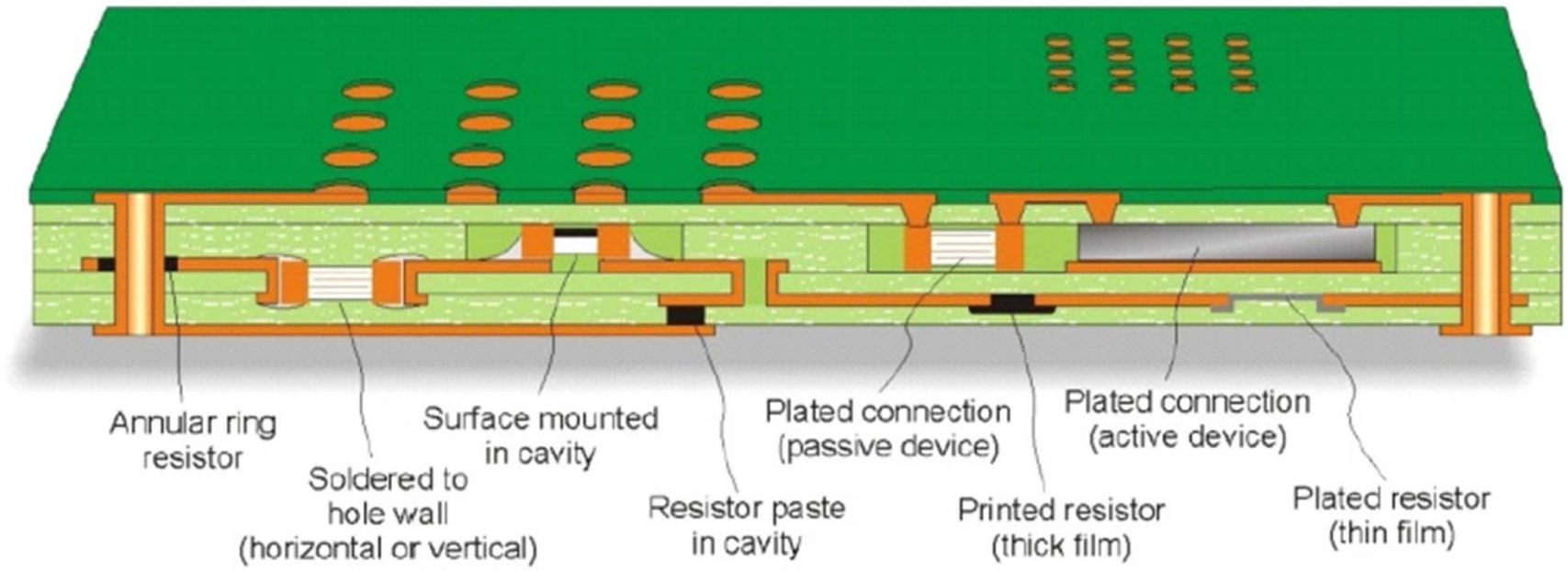


Electronic Packaging Evolution Trends

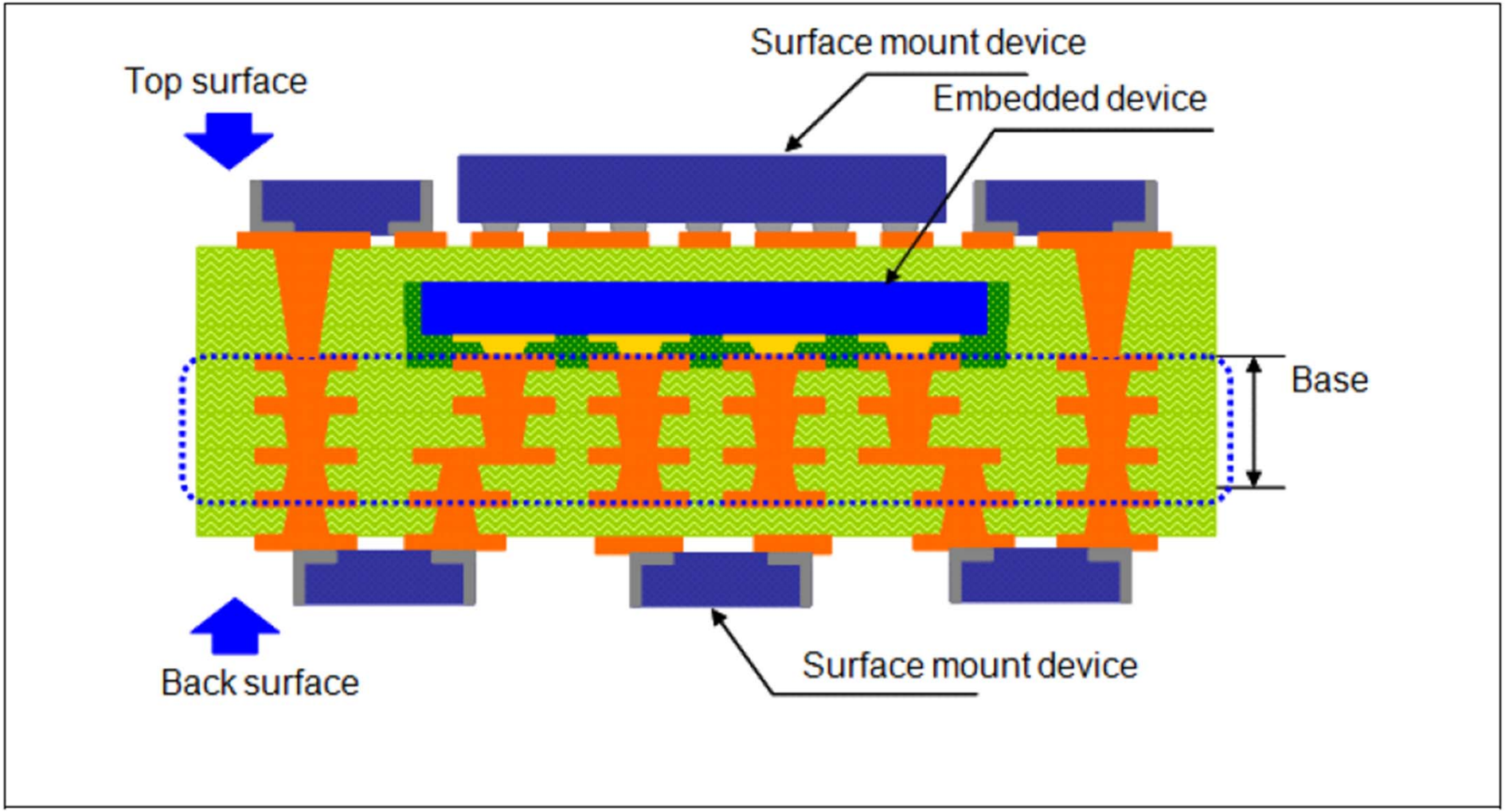


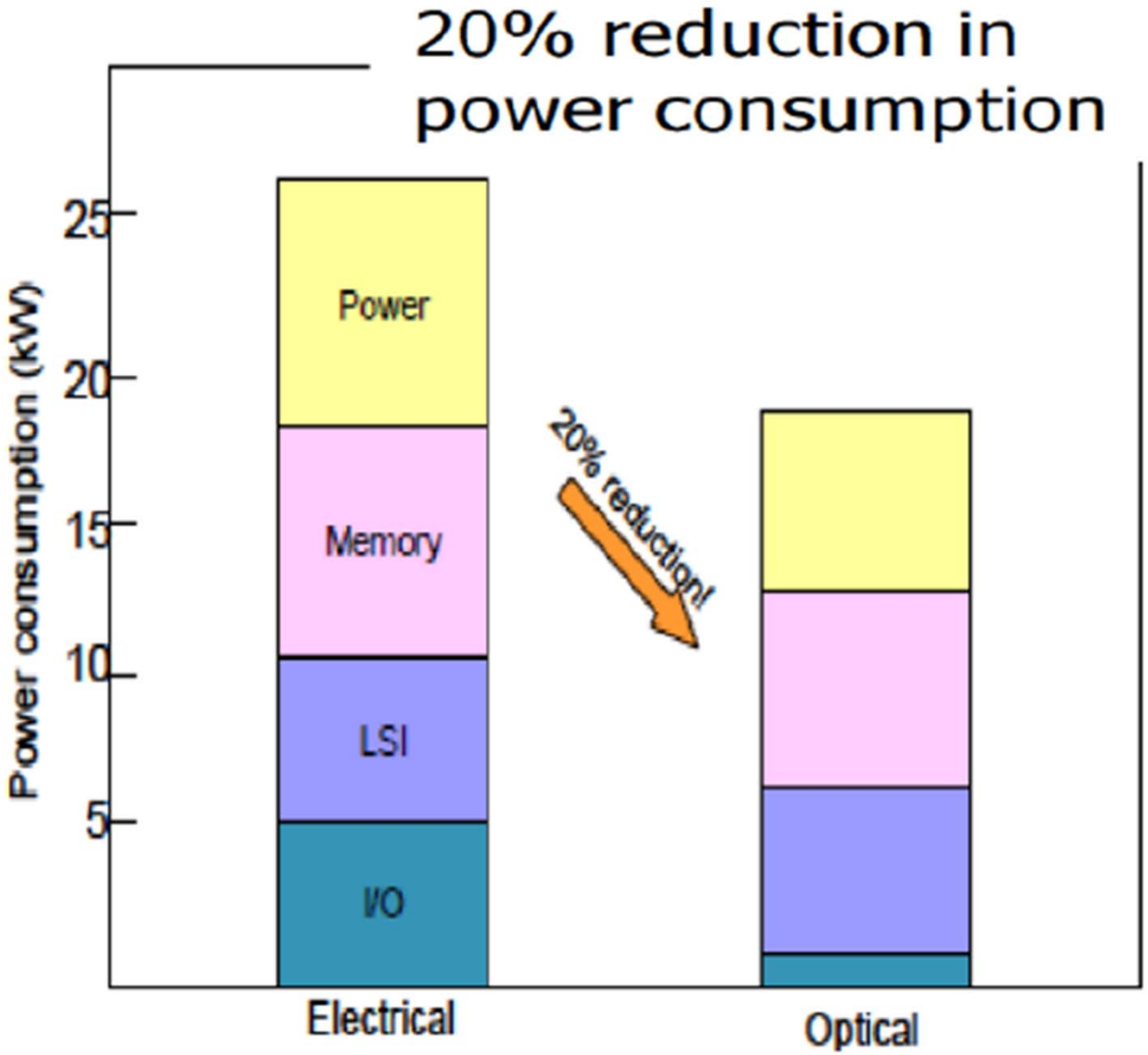
0201 Fysical Size




Annular ring resistor
Soldered to hole wall (horizontal or vertical)
Surface mounted in cavity
Resistor paste in cavity
Plated connection (passive device)
Printed resistor (thick film)
Plated connection (active device)
Plated resistor (thin film)

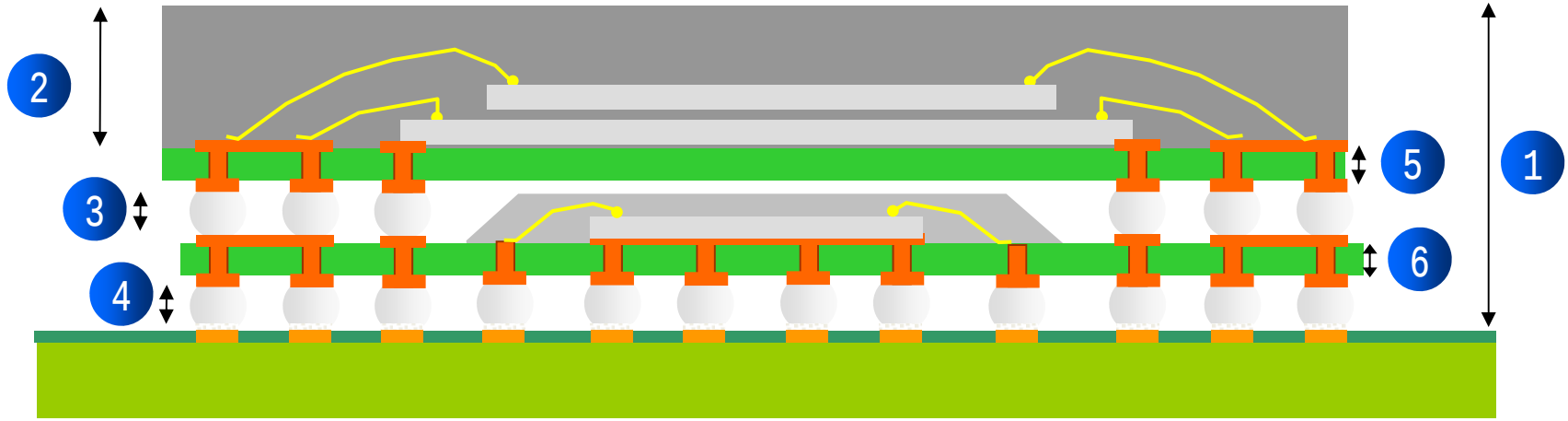
Typical structure of completed device embedded board




20% reduction in power consumption
Power consumption (kW)
25
20
15
10
5
Power
Memory
LSI
I/O
20% reduction!
Electrical
Optical


DRIVER
FRAGILE

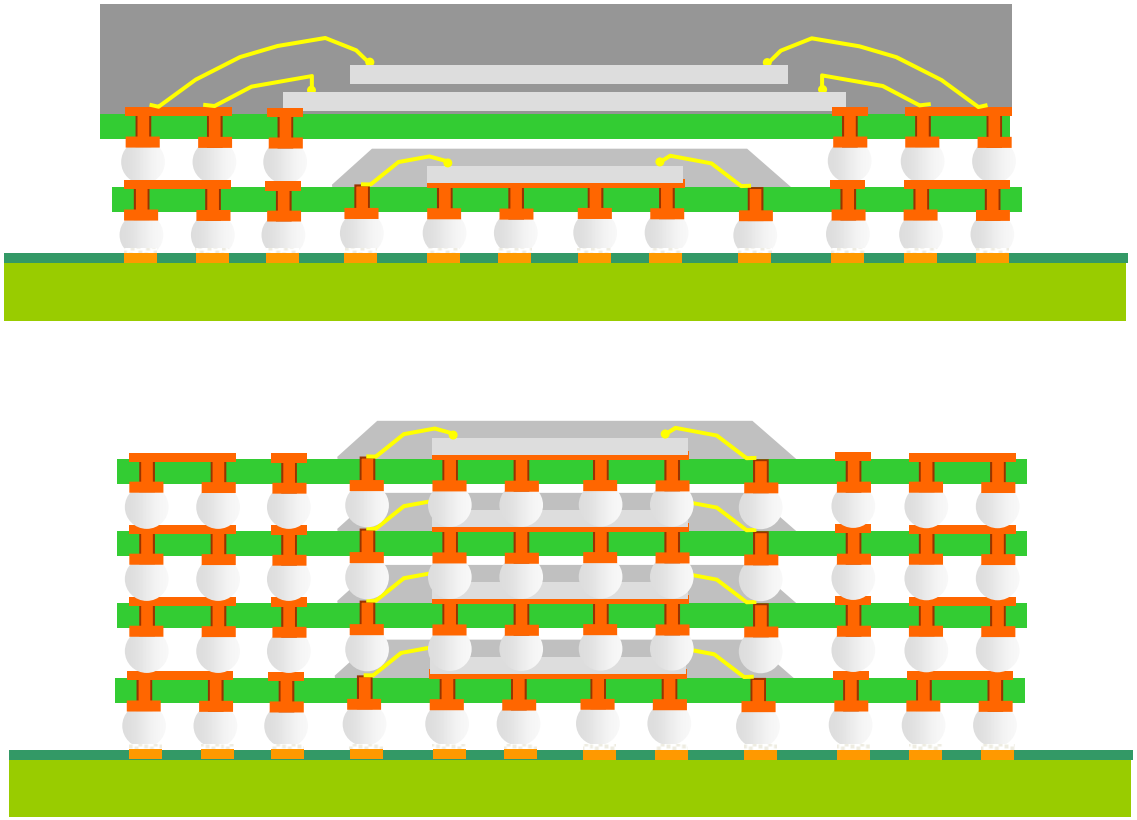
POP Package General Dimensions

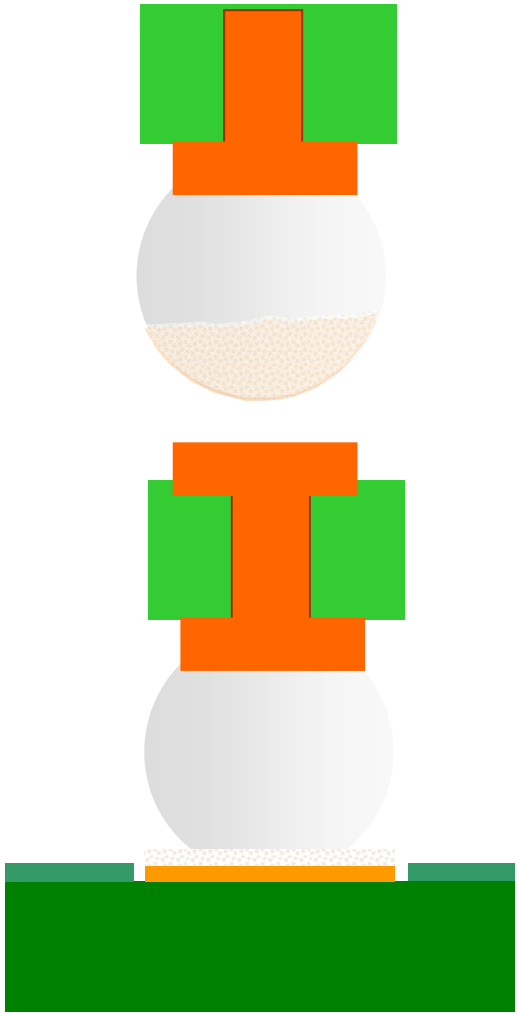


JEDEC 95

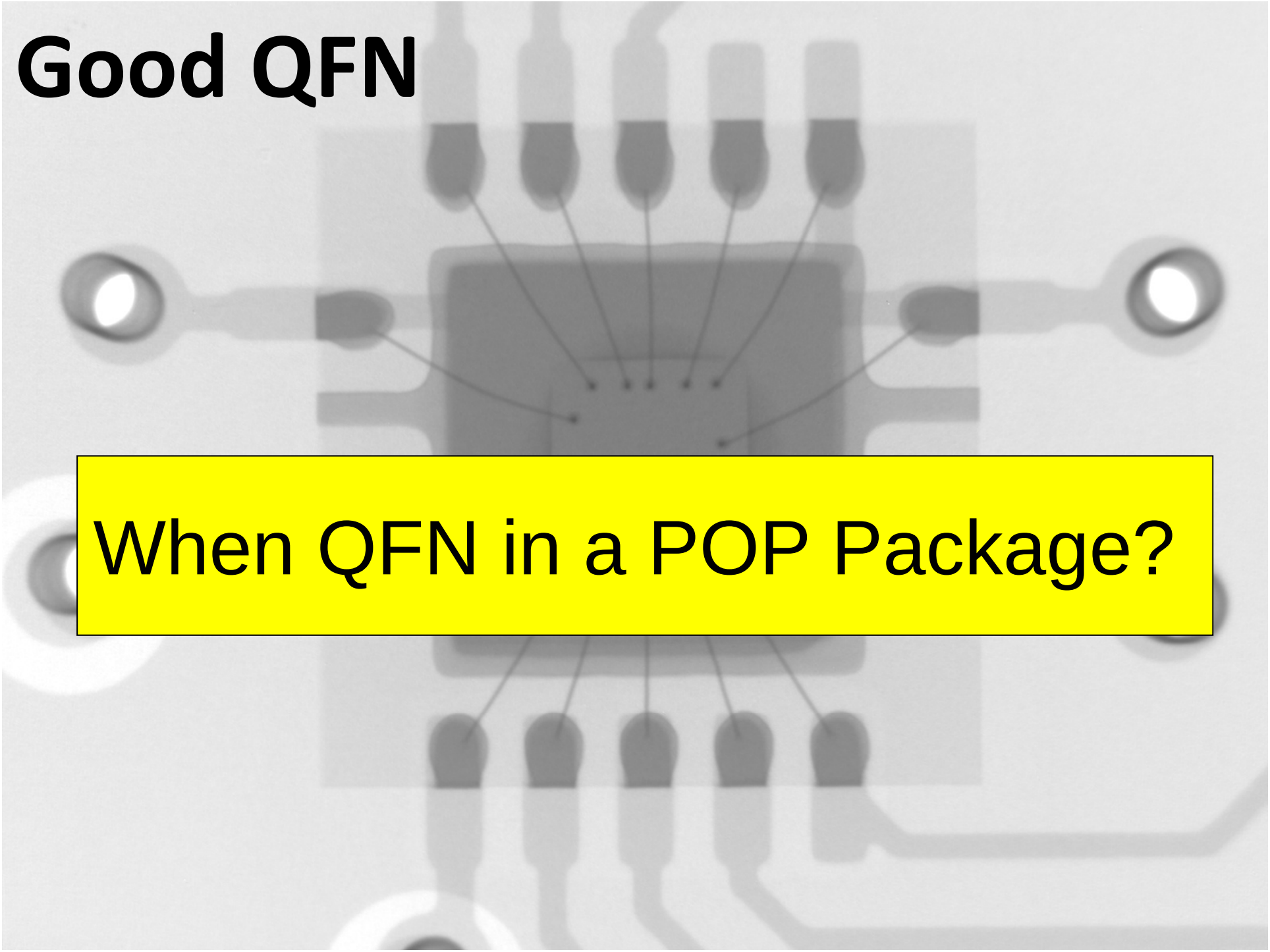
1. Package height 1.5mm 0.060”
2. Top package mould 0.46mm 0.018”
3. Second package ball height 0.30mm 0.012”
4. First package ball height 0.20mm 0.008”
5. Second package substrate 0.21mm 0.009”
6. First package substrate 0.30mm 0.012”

Assembly Process for POP Package on Package





Good QFN

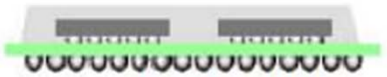
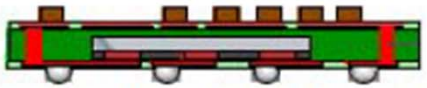


When QFN in a POP Package?

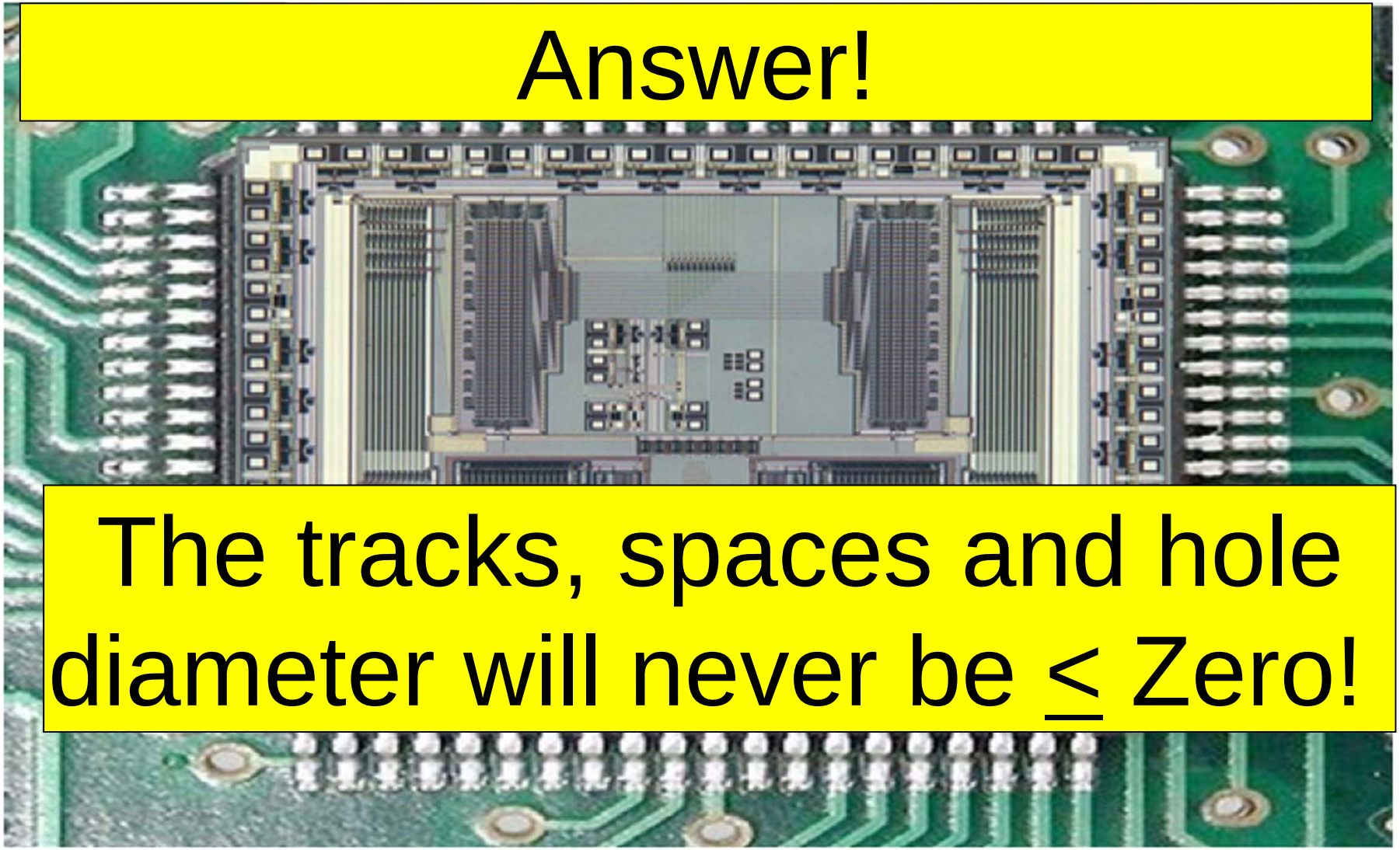
Components 1968-2008

- What progress have been done in 40 years?
  - 1968: 12 transistors in one IC.
  - 2008: 1 050 000 000 transistors in one IC.
  - 2013: More!
  - 2020: Many More!!

When will the development end?

Horizontal Placement	 
Interposer - less Type	 Terminal Through Via Type
Embedded Structure	 Chip(WLP) Embedded + Chip on Surface Type  3D Chip Embedded Type  WLP Embedded + Chip on Surface Type

Integrated Microcircuit Prior to Device Encapsulation



IPC Part: 2

New demands and challenges?

Which is the biggest challenge?

Product Description vs. End-Use Applications

End Use Application	Interposer	Module	Portable Board	Product Board	Backplane
1-Consumer	D	D	A/D	D	D
2-Computers and Peripherals	D	B	A/D	D	E
3-Telecomm	B	E	A	E	E
4-Commercial Aircraft	C	C	A/C	C/E	C/E
Compartment	B	B	A	E	E
6-Military (ground and shipboard)	C	C	A/C	C/E	C/E
7-Space	C	C	A/C	C/E	C/E
8-Military Aircraft	C	C	A/C	C/E	C/E
[illegible]	B/C	C	C	B/C	B/E
10- Bio Medical & Life support	B	B	A/E	B/E	B/E

A=Hand Held; B=High Performance; C=Harsh Environment;
D=Low cost/High Volume; E= Cost Performance

New Market Conditions!

- *Prior releases of the Roadmap had greater emphasis on military applications*

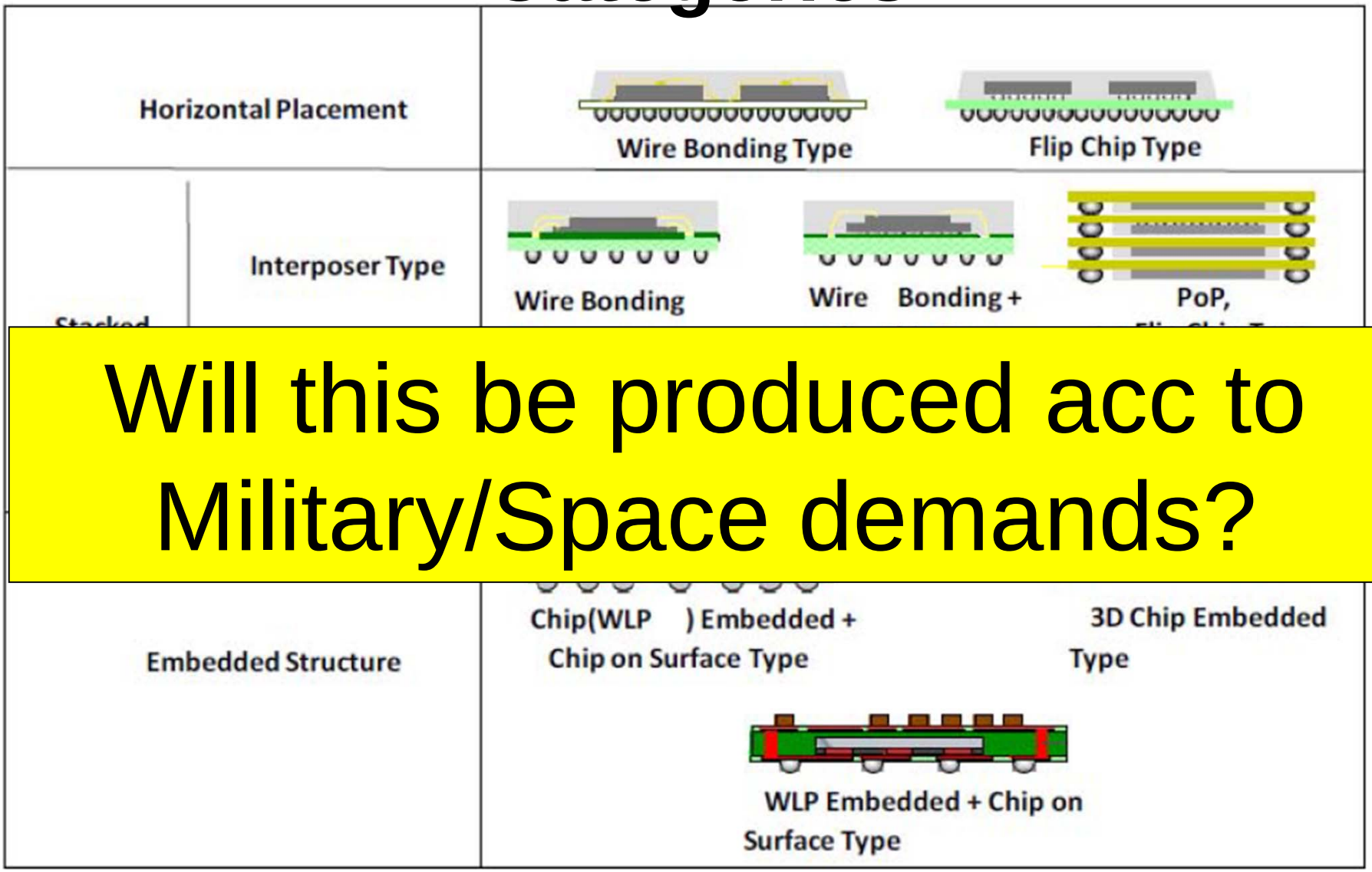
Which is the biggest challenge?

in advanced product development has declined. such that

Must the Space change to a lead free process??

Committee.

Representative SIP Types and Categories



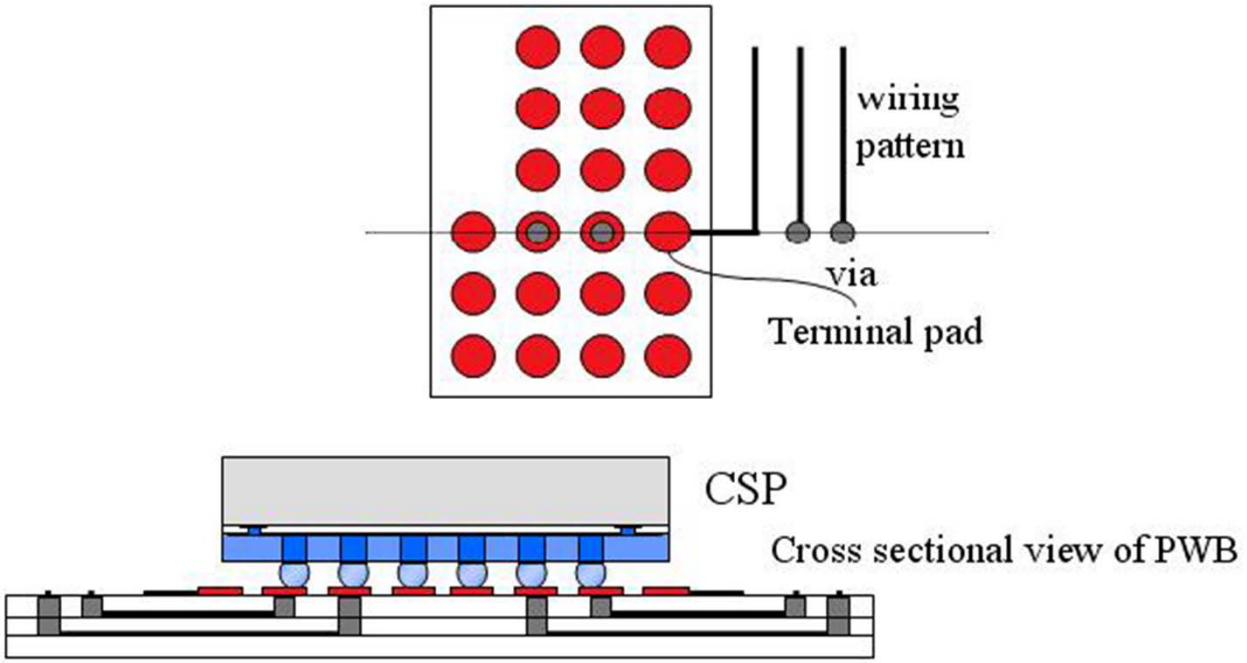
Space needs/demands on PCBs

1. Advanced functions ➡ Advanced Components
2. Advanced Components ➡ Advanced CAD
3. Advanced CAD ➡ Many layer and several via hole types (PTH, Micro, Blind and Buried)with

This will not match!!

4. Robust Design acc to IPC-2221B and IPC-222A means IPC Class 3 and Level A.
5. Footprints acc to IPC-7351B Level A and 1752
6. Base Material acc to IPC-4101D/xxx

High Density Interconnection using Via in Pad Technology



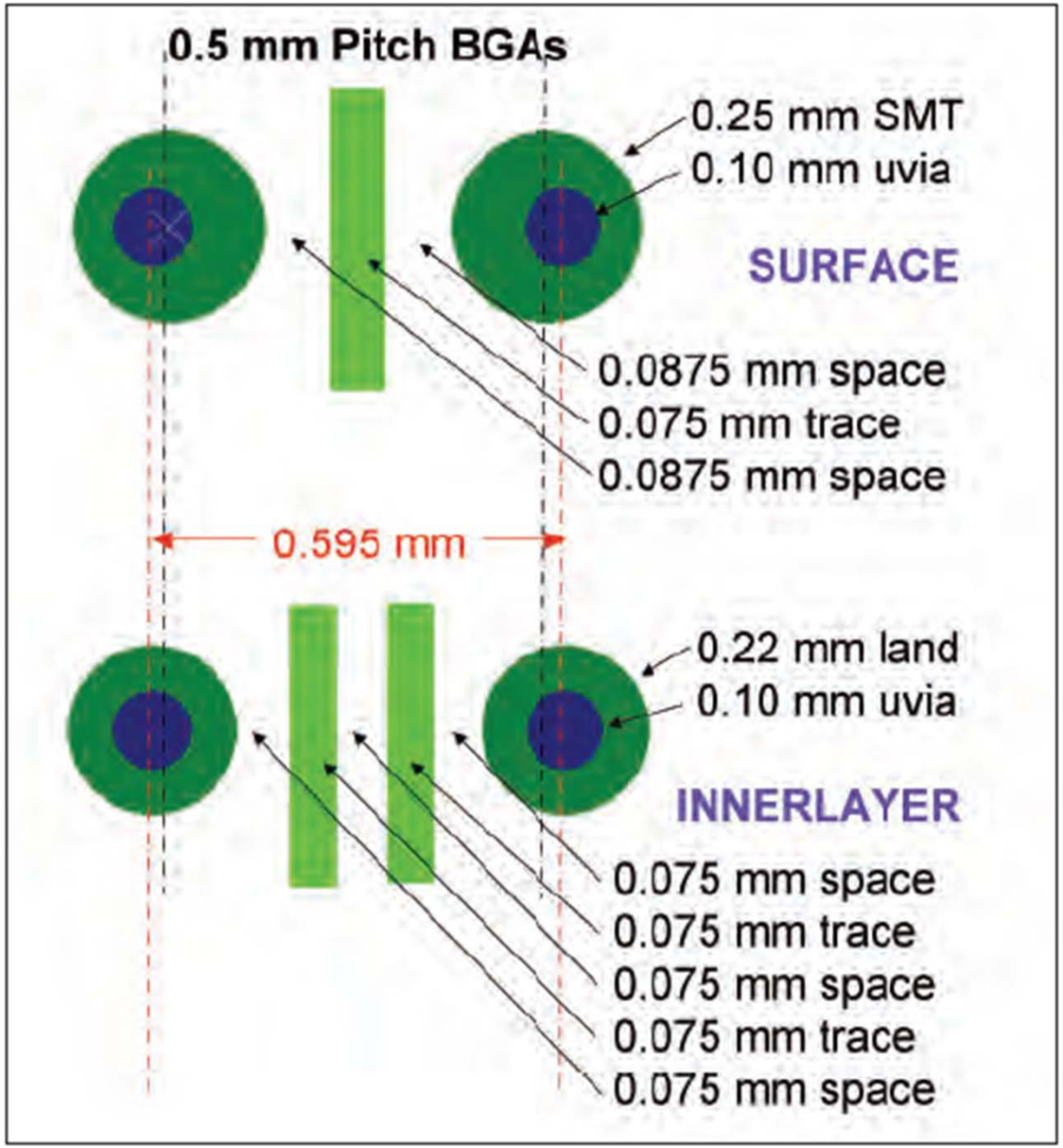


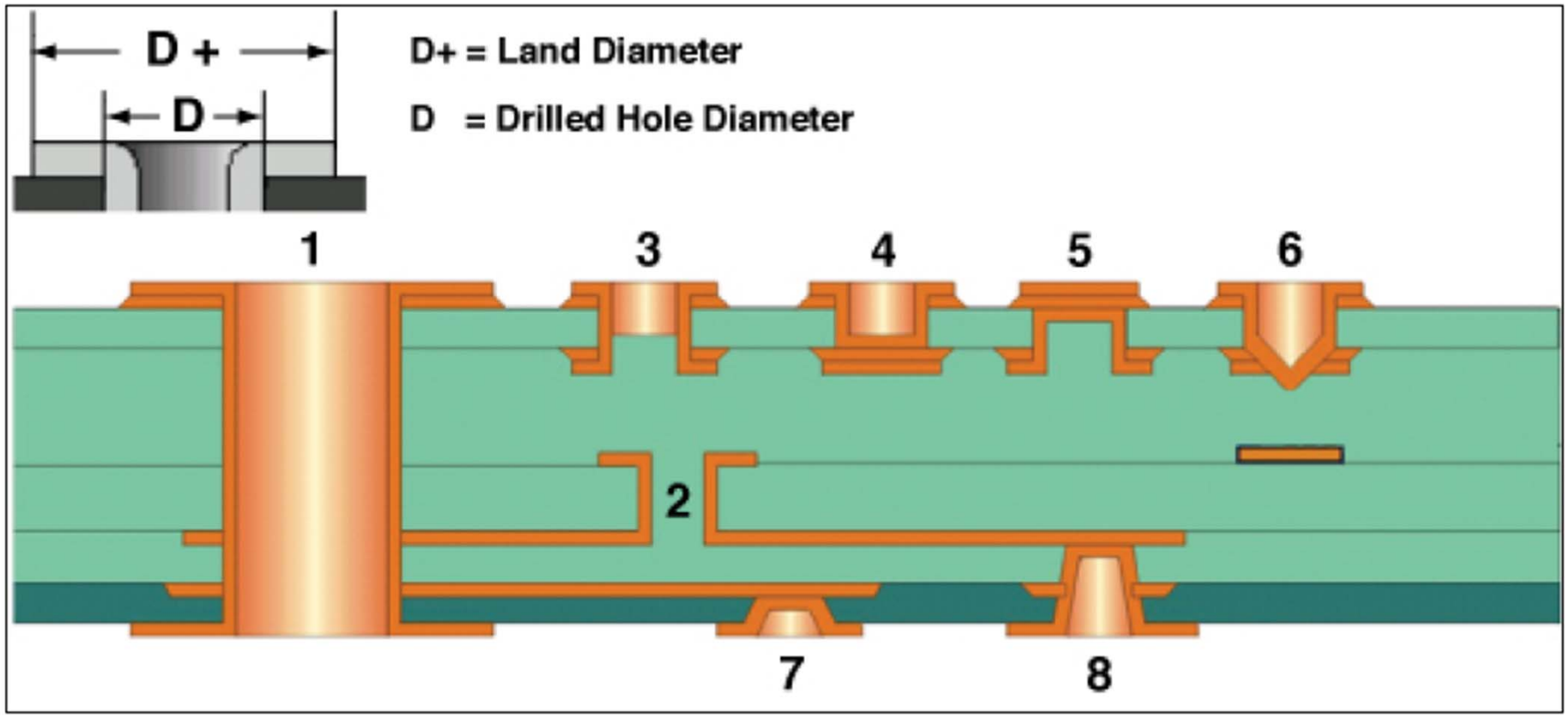
Illustration of the design spacing for a 0,5 mm pitch BGA

Source: Happy Holden

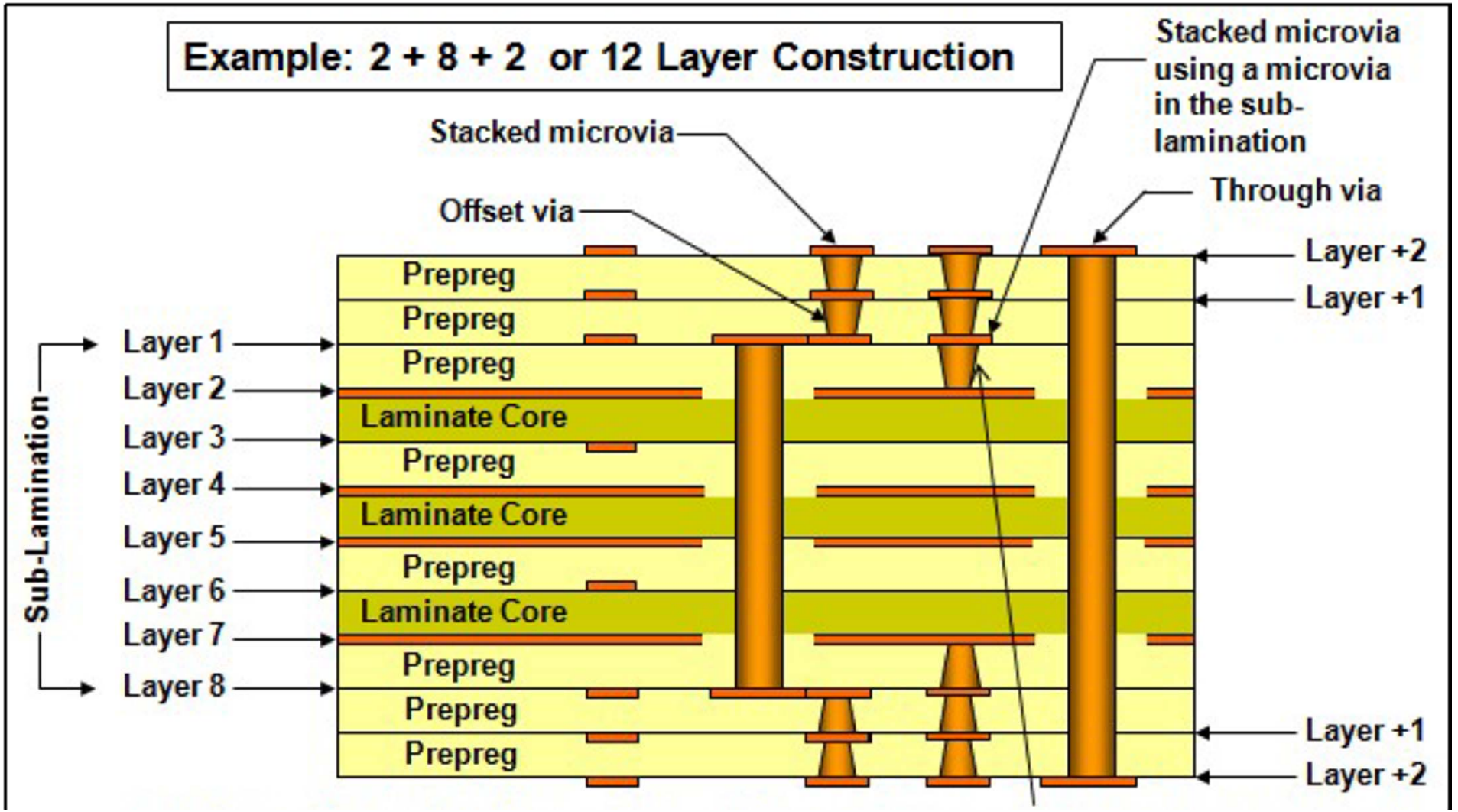
Military needs/demands on PCBs

1. Advanced functions ⇒ Advanced Components
2. Advanced Components ⇒ Advanced CAD
3. Advanced CAD ⇒ Many layer and several via hole types (PTH, Micro, Blind and Buried).
4. Robust Design acc to IPC-2221B and IPC-222A means IPC Class 3 and Level A.
5. Footprints acc to IPC-7351B Level A and 1752
6. Base Material acc to IPC-4101D/xxx.
7. PCB production acc to IPC-6012C Class 3.
8. Quality demands according to IPC-600H Class 3.

Hole Characteristics



1. Standard through-hole via
2. Standard buried via
3. Semi-blind (semi buried) via
4. Blind via (laser drilled)
5. Reverse blind via
6. Controlled depth drilled via
7. Photo defined micro via
8. Terpanned via (laser drilled)


Example: 2 + 8 + 2 or 12 Layer Construction
Stacked microvia
Stacked microvia using a microvia in the sub-lamination
Offset via
Through via
Layer +2
Layer +1
Prepreg
Prepreg
Prepreg
Laminate Core
Prepreg
Laminate Core
Prepreg
Laminate Core
Prepreg
Prepreg
Prepreg
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6
Layer 7
Layer 8
Sub-Lamination
Layer +1
Layer +2

Product Board Platform Roadmap

CHARACTERISTICS	PRODUCT BOARD 2013-2014	PRODUCT BOARD 2015-2016	PRODUCT BOARD 2017-2018	PRODUCT BOARD 2019-2023
Layers Range	4 to 36+	4 to 36+	4 to 36+	4 to 36+
Board Thickness	1.575 mm to 6.350 mm	1.575 mm to 7.7 mm	1.575 mm to 9.0 mm	1.575 mm to 9.0 mm
Board Size Range	75 mm to 400 mm per side	75 mm to 550 mm per side	75 mm to 700 mm per side	75 mm to 700 mm per side
Device Pitch	0.4 mm up to 1.5 mm	0.4 mm up to 1.5 mm	0.4 mm up to 1.5 mm	0.2 mm up to 1.5 mm
Typical Materials	FR4, HF FR4, Low-loss, Polyimide, Rogers, etc;SAC tolerant	FR4, HF FR4, Low-loss, Polyimide, Rogers, etc;SAC tolerant	FR4, HF FR4, Low-loss, Polyimide, Rogers, etc;SAC tolerant; RCC	FR4, HF FR4, Low-loss, Polyimide, Rogers, etc;SAC tolerant; RCC
Material Thickness	0.075 mm to 0.450 mm (not counting BC)	0.075 mm to 0.450 mm (not counting BC)	0.075 mm to 0.450 mm (not counting BC)	0.075 mm to 0.450 mm (not counting BC)
Via Stack	2	2	2; 4+ z stack	2; 20+ z stack
Buried Capacitance	YES, needed for Power Integrity	YES, needed for Power Integrity	YES, needed for Power Integrity	YES, needed for Power Integrity
Buried Components	EP resistors & capacitors	EP resistors & capacitors	EP resistors & capacitors	EP resistors & capacitors; optical paths
Power Dissipation	Can be very high, heat sinks-cooling schemes	Can be very high, heat sinks-cooling schemes liquid cooling	Can be very high, heat sinks-cooling schemes liquid cooling	Can be very high, heat sinks-cooling schemes liquid cooling
Voltages	Multiples up to 8	Multiples up to 8	Multiples up to 8	Multiples up to 12

Product Board Platform Roadmap

CHARACTERISTICS	PRODUCT BOARD 2013-2014	PRODUCT BOARD 2015-2016	PRODUCT BOARD 2017-2018	PRODUCT BOARD 2019-2023
Signal Integrity	Controlled impedances, long signal lengths; back drilling	Controlled impedances, long signal lengths; back drilling	Controlled impedances, long signal lengths; back drilling; z interconnect	Controlled impedances, long signal lengths; back drilling; z interconnect; optical interconnect
Typical Design Rules: L/S: Via/Pad:	0.075 mm to 0.150 mm/ 0.100 mm to 0.250 mm 0.100 mm to 0.250mm/ 0.200 mm to 0.450 mm	0.075 mm to 0.150 mm/ 0.075 mm to 0.250 mm 0.100 mm to 0.250mm/ 0.200 mm to 0.450 mm	0.075 mm to 0.150 mm/ 0.075 mm to 0.250 mm 0.100 mm to 0.250mm/ 0.200 mm to 0.450 mm	0.050 mm to 0.150 mm/ 0.050 mm to 0.250 mm 0.050 mm to 0.250mm/ 0.150 mm to 0.450 mm
Typical Through-holes	0.200 mm to 25.4 mm mounting & connectors	0.150 mm to 25.4 mm mounting & connectors	not used to 0.150 mm for signals up to 25.4 mm mounting & connectors	not used to 0.150 mm for signals up to 25.4 mm mounting & connectors
No. of Fabricators-Ww	~300 to 400	~320 to 450	~340 to 480	~350 to 500
Typical Components	Various, to large-high I/O BGAs of 2700 pins	Various, to large-high I/O BGAs of 2700 pins	Various, to large-high I/O BGAs of 2700 pins	Various, to large-high I/O BGAs of 2700 pins; optical support
Interconnect to Next Level Higher	Connector, pins, cables or fingers	Connector, pins, cables or fingers	Connector, pins, cables or fingers	Connector, pins, cables or fingers; optical cables
Typical Order Quantity	Few to Medium	Few to Medium	Few to Medium	Few to Medium

IPC Part: 3

How can IPC assist?

Demands for producing
IPC Class 3?

Which IPC Standards does is most known?

IPC-A-610E?

If yo rding to
Il ass 3
Does it mean eved IPC Class 3?

No!!


You promised Class 3!
But it is not IPC Class 3!!

IPC Class 3:

High Reliability or Harsh Operating Environment Electronic Products — Includes the equipment and products where continued performance or performance on demand is critical. Equipment downtime cannot be tolerated and must function when required such as in life support items or flight control systems. Printed boards in this class are suitable for applications where high levels of assurance are required and service is essential.

Please Observe that the final performance class for PCBA (PCBA=Assembled, Soldered, Cleaned and Tested) cannot be any greater than the performance class called out for the bare PCB.

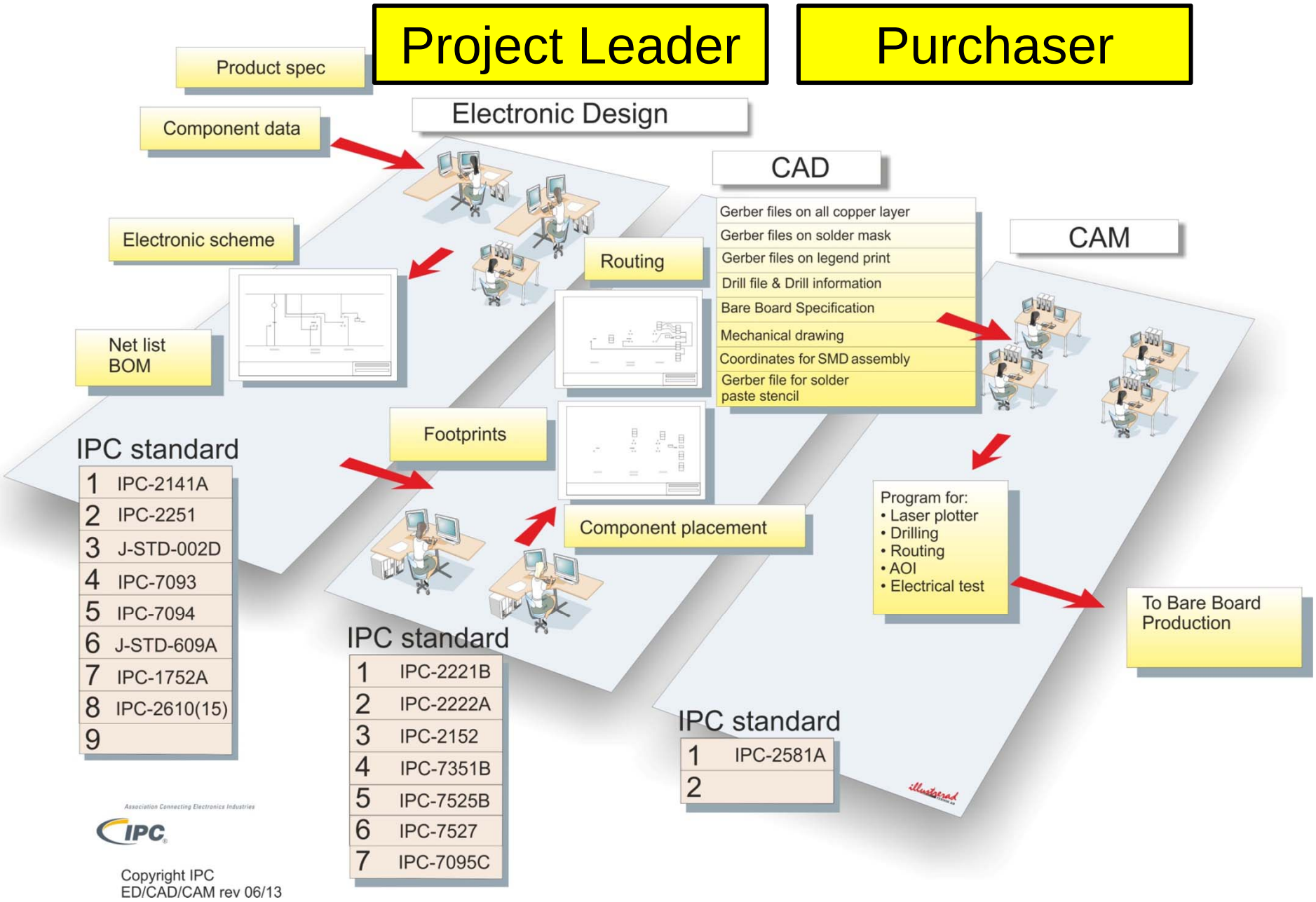
That is, in order to obtain a class 3 with the assembly (PCBA), one must first obtain an IPC class 3 recognition of the bare printed board (anything with a Class 2 or 1 with the PCB prevents obtaining a Class 3 with the PCBA).

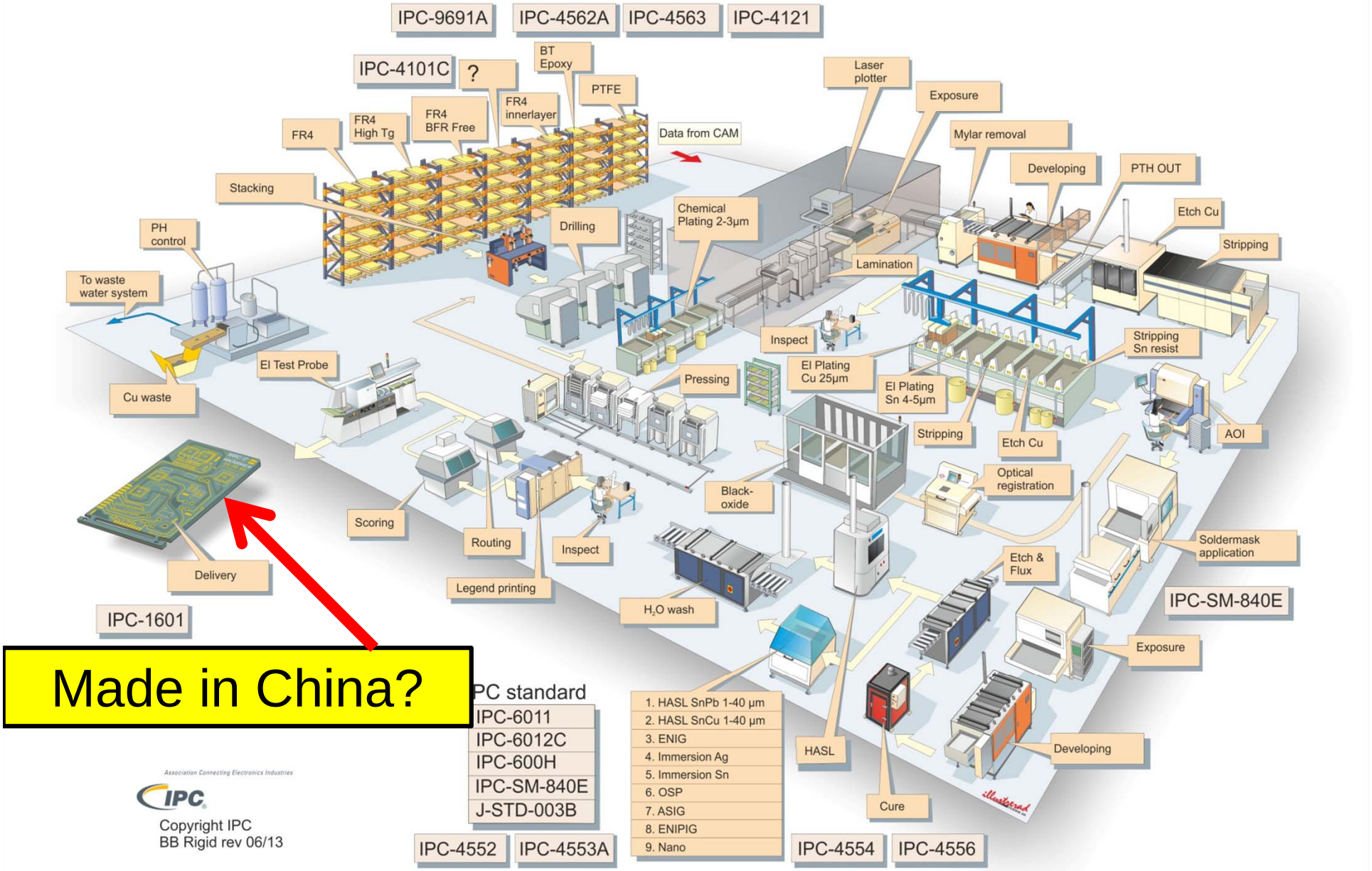
J-STD-001E examples

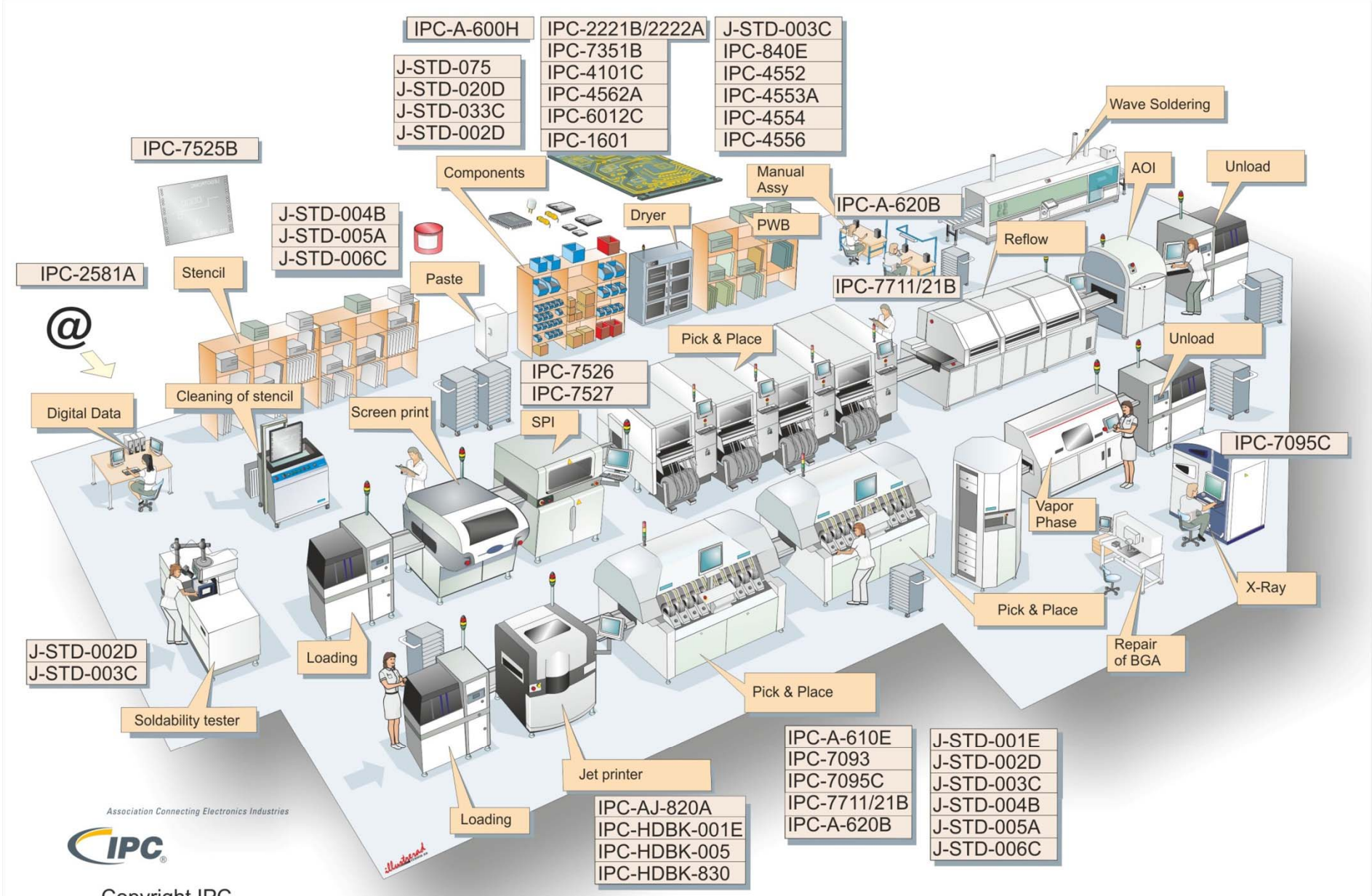
- Material and processes used to assemble/manufacture PCBAs **shall** [D1D2D3] be selected such that their use, in combination, produce products acceptable to this standard.
- Solder **shall** be accordance with J-STD-006C [D1D2D3].
- Flux **shall** be accordance with J-STD-004B [D1D2D3].
- Solder paste **shall** be accordance with J-STD-005A [D1D2D3].
- Machine control [N1D2D3].
- Solder Bath [N1N2D3].
- Reflow Soldering [N1D2D3].
- Solder Connection [D1D2D3].

Systematic use of IPC Standards!

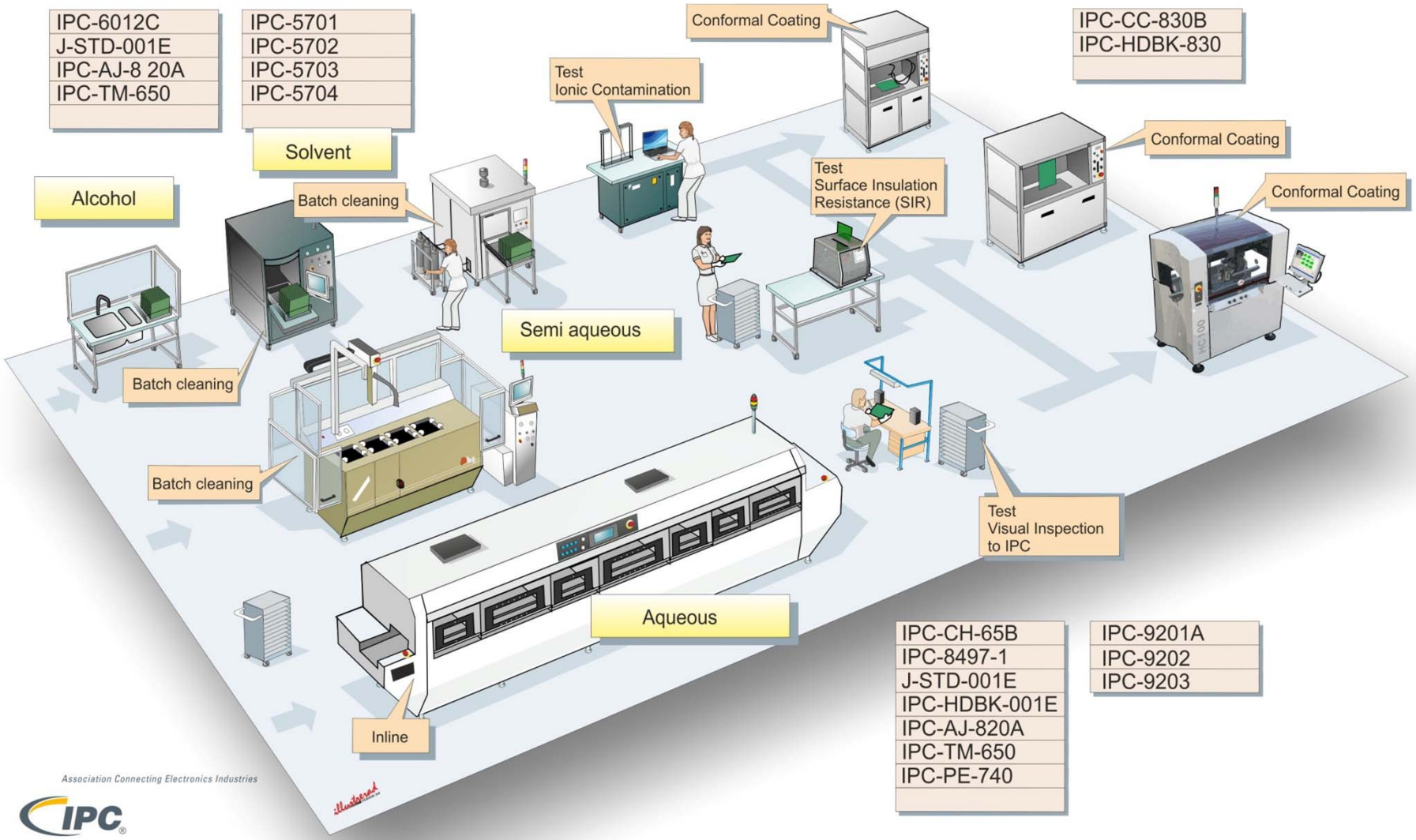
Conditions for achieving IPC Class 3!




IPC-9691A
IPC-4562A
IPC-4563
IPC-4121
IPC-4101C
?
BT Epoxy
PTFE
FR4 innerlayer
FR4 BFR Free
FR4 High Tg
FR4
Data from CAM
Laser plotter
Exposure
Mylar removal
Developing
PTH OUT
Etch Cu
Stripping
Stacking
Drilling
Chemical Plating 2-3µm
Lamination
PH control
To waste water system
Cu waste
El Test Probe
Inspect
El Plating Cu 25µm
El Plating Sn 4-5µm
Stripping Sn resist
Pressing
Stripping
Etch Cu
AOI
Optical registration
Black-oxide
Scoring
Routing
Inspect
Legend printing
H_2O wash
Soldermask application
Etch & Flux
IPC-SM-840E
Exposure
Delivery
IPC-1601
HASL
Cure
Developing
Made in China?
PC standard
IPC-6011
IPC-6012C
IPC-600H
IPC-SM-840E
J-STD-003B
1. HASL SnPb 1-40 µm
2. HASL SnCu 1-40 µm
3. ENIG
4. Immersion Ag
5. Immersion Sn
6. OSP
7. ASIG
8. ENIPIG
9. Nano
IPC-4552
IPC-4553A
IPC-4554
IPC-4556
Association Connecting Electronics Industries
IPC
Copyright IPC
BB Rigid rev 06/13



AST Rigid rev 06/13



Association Connecting Electronics Industries

IPC

Cleaning rev 07/13

	Test Board Number X	No: 1000
DEMAND on PCBA	**IPC Standards**	**Activity**
1 Compatible? RoHS 2? Level? EMC Demands? Repair allowed?	IPC-1752A	1
ding to IPC Class 3! Level A, B or C? tions?		2
ce finishes on Components? demands on Components?	J-STD-002D	3

ding to IPC Class 3! Level A, B or C? tions?		2
ce finishes on Components? demands on Components?	J-STD-002D	3
rements for impedance adaptation? Speed/Frequency?	IPC-2141A IPC-2251	4
nany Ampere in the Cu tracks? ng and Labeling?	IPC-2152 J-STD-609A	5
Components? Components?	IPC-7093 IPC-7095C	6

dans anpassning? eter/frekvenser?			
mpere i kopparledarna? skyltar?			
enter? enter?			
s on the PCB in form of: Materials, Electrical / Thermal Properties, Hole, drawings / documentation.	IPC-4101C IPC-2221B IPC-2615	7	

DEMAND on PCBA	IPC Standards	Activity
s according to Level A, B or C?	IPC-7351B + New	8
cc. To IPC Class 3 & Level A, B or C?	IPC-2221B	
	IPC-2222A	
. To IPC Class 3?	IPC-7095C	9
cil Design?	IPC-7525B	
or EMC adaptation?		10
rd Specification?		

g for EMC adaptation? oard Specification?		10
ıe supplier manage the BB Specification? at the BB PCB manufacturer?	IPC-6011 IPC-6012C	11
Material and Cu foil type?	IPC-4101C, 4562 IPC-9691A	12
r Mask? ce finish?	IPC-SM-840E IPC-4552, 53A, 54 & 56	13
col, Micro Sections and packaging? ıt and solder test?	IPC-6012C & IPC-1601 IPC-600H & J-STD-003C	14

Article	Test board number X	No:	1000

DEMAND on PCBA	IPC Standards	Activity
Incoming inspection of components and PCBs	IPC-6012C,-600H	15
Solder test with components?	J-STD-002D	
Solder test of Bare Boards?	J-STD-003C	16
What requirements must be placed on PCBA Production? IPC-Class 3!	J-STD-001E IPC-HDBK-001 IPC Training	17

Solder test of Bare Boards?	J-STD-003C	16
What requirements must be placed on PCBA Production? IPC-Class 3!	J-STD-001E IPC-HDBK-001 IPC Training	17
What requirements must be placed on the Digital Data? (Gerber files) IPC-Class 3!	IPC-2221B IPC-2222A IPC-7351B	
CAD acc to IPC Class 3 and Level A, B or C? Footprints acc to Level A, B or C?	IPC-7095C IPC-7093	18
CAD of stencil so it will meet IPC Class 3 ?	IPC-7525B	
Are the BB produced acc to IPC Class 3? Protocol? Packing and Storage?	IPC-6012C IPC-A-600H IPC-1601	19

DEMAND on PCBA	IPC Standards	Activity
emand, level and handling?	J-STD-033C	20
ısta, Alloy, Flux & Bal size?	J-STD-004B	21
lder (wave- & selektiv soldering) Alloy?	J-STD-005A J-STD-006B	
encil production technology?	IPC-7525B	
of the Stencil?	IPC-7526	
esult (Volume & Precision) acc to IPC SPI?	IPC-7527	22
xist BGA and or CSP components?	IPC-7095C	23
xist BTC (QFN) components?	IPC-7093	

encil production technology?	IPC-7525B	
of the Stencil?	IPC-7526	
esult (Volume & Precision) acc to IPC SPI?	IPC-7527	22
xist BGA and or CSP components?	IPC-7095C	23
xist BTC (QFN) components?	IPC-7093	
rocess (temperature), wave soldering components?	J-STD-020D J-STD-075 IPC-4101C	24
ase process and the components?		

DEMAND on PCBA	IPC Standards	Activity
nspection with the assistance of AOI. Can IPC Class 3 criteria be implemented?	IPC-610E	25
nspection with the assistance of operator. oes it exist valid CIS or CIT?	IPC-610E IPC Training	26
Rework, Repair & Touch up of PCB PCBA? Does it exist valid CIS or CIT?	IPC-7711/21B IPC Training	27

nspection of BGA/CSP with X-Ray. an IPC Class 3 criteria be implemented?	IPC-7095C IPC-610E	28
nspection of BGA/CSP with X-Ray Does it exist Voids? Before and after assembling and soldering?	IPC-7095C	29
epair of BGA/CSP. s it OK to repair BGA/CSP?	IPC-7095C IPC-610E	30
lux, Preheat & Process?	J-STD-004B & 006C	31
nspection by CIS and CIT.	IPC-610E	

DEMAND on PCBA	IPC Standards	Activity
Is Cleaning a Demand? If Yes? Is the PCBA designed for Cleaning?	IPC-2221B IPC-2222A	32
Is the PCB clean before cleaning? How clean should the PCBA be after cleaning?	IPC-6012C IPC-5701, 02, 03 & 04 J-STD-001E	33
Cleaning liquid and methode? How shall the cleanliness be messured?	IPC-65B & AJ-820 IPC-9201	34
Lackning of PCBA? Type of lack? Process? Inspection of the Lacking!	IPC-CC-830B IPC-HDBK-830	35

cleaning?	J-STD-001E	
Cleaning liquid and methode? How shall the cleanliness be messured?	IPC-65B & AJ-820 IPC-9201	34
Lackning of PCBA? Type of lack? Process? Inspection of the Lacking!	IPC-CC-830B IPC-HDBK-830	35
Cabling?	IPC-A-620B IPC Training	36
Production, inspection and test of enclosures for electronic?	IPC-A-630	37

What do We Now?

37 Points!!

Practical Advice

You need a Checklist!!

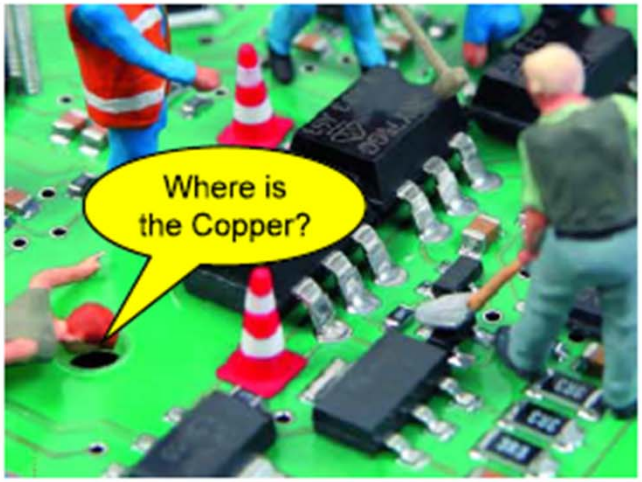
IPC Part: 4

Need for an IPC Checklist?

Pilots use Checklists!
Time for the Electronic industry?

IPC CHECKLIST

for producing Rigid PCBA's



Association Connecting Electronics Industries

IPC®

Developed by: Lars Wallin, IPC European Representative

It is many Steps!

From the start to the end of a military PCB!

Plus that many influence each other!!

A. Purpose of IPC Checklists

In the entire production chain of a completed Rigid PCBA (Printed Circuit Board Assembled) it exist the following number of parameters, see table below.

No	Rigid PCBA Parameters	Variables
1	Choice of Component Package	50
2	Choice of Surface Finish on Components. J-STD-002	12
3	CAD acc to IPC-2221 & 2222 Class 1, 2 or 3	3
4	CAD acc to IPC-2221 & 2222 Level A, B or C	3
5	Footprint/Land acc to IPC-7351 Level A, B or C	3
6	Design/CAD of QFN. IPC-7093	3
7	Design/CAD of BGA/CSP. IPC-7095	3
8	Design/CAD of stencils. IPC-7525	5
9	Placement of components	10
10	Choice of PCB base material. IPC-4101	11
11	Choice of PCB base material Cu foil. IPC-4562	2
12	Choice of PCB solder mask. IPC-SM-840	3

13	Choice of PCB Surface Finish. IPC-4552, 4553 or 4554	5
14	Choice of PCB Handling and Storage. IPC-1601	2
15	Age/Wetting of PCB. J-STD-003	3
16	PCB Process steps at supplier. IPC-6011 and 6012	20
17	Different stencil/printing options. IPC-7526 and 7527	5
18	Solder Paste/Stick/Wire options. J-STD-005 and 006	20
19	Flux with Solder Paste/Stick/Wire options. J-STD-004	5
20	Reflow/Vapor Phase/Wave/Selective/Hand options.	5
21	Choice of Soldering environments (O2 free, N2 or Air)	3
22	Choice of Lead or Lead free process.	2
23	Choice of process cycle. J-STD-020 and 075	10
24	Choice of Moisture Sensitive Level (MSL). J-STD-033	5
25	Choice of Cleaning Method. IPC-CH-65	4
26	Conformal coating	3
27	PCBA Requirements Class 1, 2 or 3. J-STD-001	3
28	PCBA Acceptability Class 1, 2 or 3. IPC-A-610	3
29	PCBA Touch up and Repair. IPC-7711/21	3
30	PCBA Requirements/Acceptability for Cable. IPC-620	3
	Total variables	212

Number of Combinations

4200 000 000 000 000 000 0

Too Many!!

How many BAD Solder Joints does it exist in electronic products per year?

10 years later

I have the answer!

Too Many!

10 years later

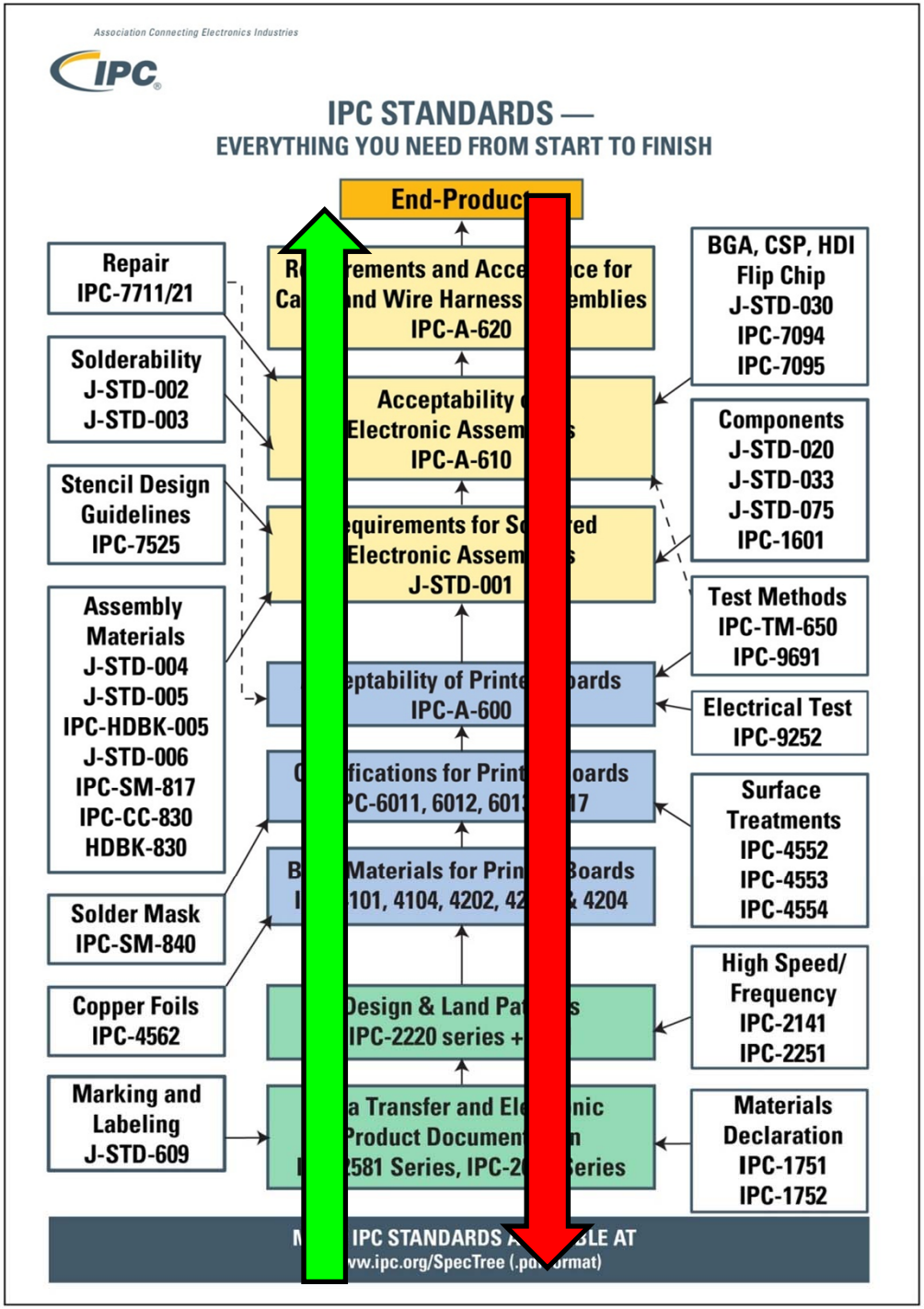
What do we need?

We need a Checklist!

IPC Part: 5

Summary and Conclusions

Will and Can the Electronic Industry meet the future quality demands?


Association Connecting Electronics Industries
IPC
IPC STANDARDS —
EVERYTHING YOU NEED FROM START TO FINISH
End-Product
Repair
IPC-7711/21
Solderability
J-STD-002
J-STD-003
Stencil Design
Guidelines
IPC-7525
Assembly
Materials
J-STD-004
J-STD-005
IPC-HDBK-005
J-STD-006
IPC-SM-817
IPC-CC-830
HDBK-830
Solder Mask
IPC-SM-840
Copper Foils
IPC-4562
Marking and
Labeling
J-STD-609
IPC-A-620
IPC-A-610
J-STD-001
IPC-A-600
IPC-6011, 6012, 601
Materials for Prin
101, 4104, 4202, 42
& 4204
Design & Land Pat
IPC-2220 series +
Product Documen
2581 Series, IPC-2
eries
BGA, CSP, HDI
Flip Chip
J-STD-030
IPC-7094
IPC-7095
Components
J-STD-020
J-STD-033
J-STD-075
IPC-1601
Test Methods
IPC-TM-650
IPC-9691
Electrical Test
IPC-9252
Surface
Treatments
IPC-4552
IPC-4553
IPC-4554
High Speed/
Frequency
IPC-2141
IPC-2251
Materials
Declaration
IPC-1751
IPC-1752
IPC STANDARDS
vw.ipc.org/SpecTree (.pd ormat)


We didn´t use Standards?


I didn´t use
IPC Standards!

If You want an IPC Checklist?

Please give me your business card!

OR

Send me an email!

THANK YOU!

Mobil: +46 70-212 74 39
Email: LarsWallin@ipc.org

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