The Proportional Land Dimensioning Concept

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- Current Calculation Concept
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- Terminal Types
- The Proportional Concept
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Why do we need a new Calculation Concept for SMT-Landpattern?

Previously

IPC-782

Publication	03/87
Rev. A	08/93
AM 1	10/96
AM 2	04/99

Tolerances were added
F-Tol = 0.2mm P-Tol = 0.2mm

Solder joint strength is greatly determined by solder volume.

The more solder
the more reliable Solder Joint

Current IEC

IEC-61188-5-xx

Publication 2002
no Revision till now
Stability Date 2017

Complies mostly with IPC-782A inclusive of AM 1 and AM 2

Implementation of 3-tier System Maximum - Median - Minimum

Assumption: The more solder the more reliable solder joint

IEC Package I0402 = M1005

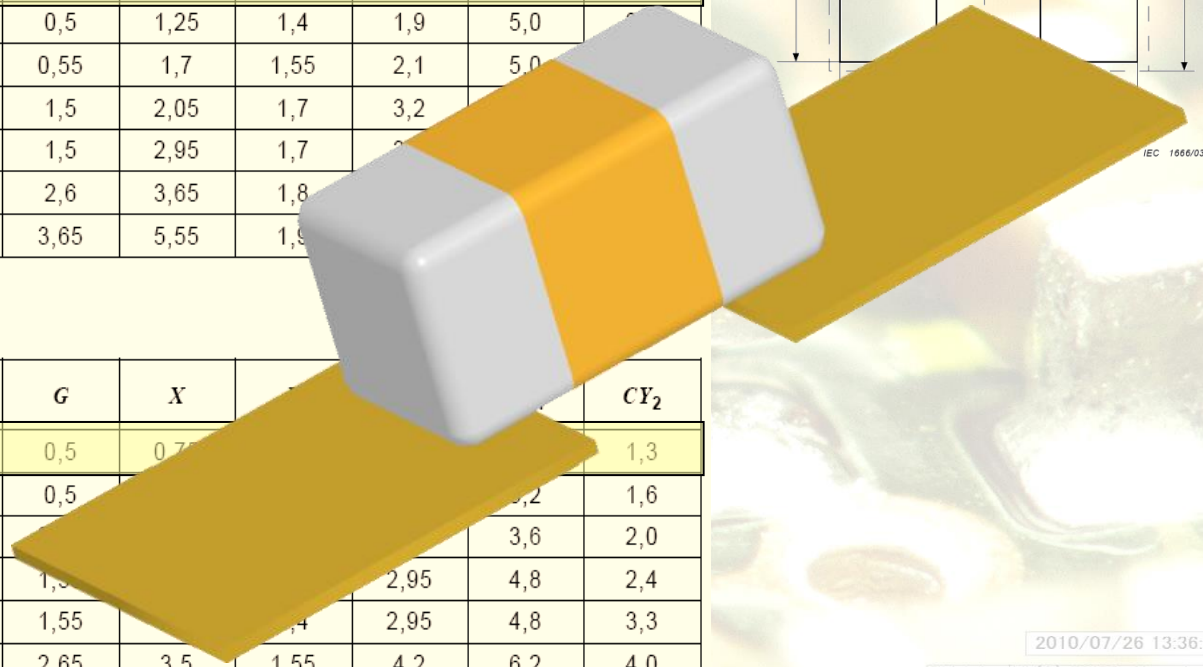
Level 1 **Maximum Land Size**

Dimensions in millimetres

	Pattern identifier	Component identifier	Z	G	X	Y	C	CY_1	CY_2
G0402	2040M	1005	2,55	0,5	0,85	1,05	1,55	4,0	2,0
	2041M	1608	3,25	0,5	1,25	1,4	1,9	5,0	
	2042M	2012	3,65	0,55	1,7	1,55	2,1	5,0	
	2043M	3216	4,85	1,5	2,05	1,7	3,2		
	2044M	3225	4,85	1,5	2,95	1,7			
	2045M	4530	6,2	2,6	3,65	1,8			
	2046M	5750	7,45	3,65	5,55	1,9			

Level 2 **Nominal Land Size**

	Pattern identifier	Component identifier	Z	G	X				CY_2
G0402	2040N	1005	2,05	0,5	0,7				1,3
	2041N	1608	2,65	0,5				,2	1,6
	2042N	2012	3,05					3,6	2,0
	2043N	3216	4,3	1,5			2,95	4,8	2,4
	2044N	3225	4,3	1,55		,4	2,95	4,8	3,3
	2045N	4530	5,7	2,65	3,5	1,55	4,2	6,2	4,0
	2046N	5750	6,95	3,7	5,45	1,65	5,35	7,5	6,0



Current IPC

IPC-7351

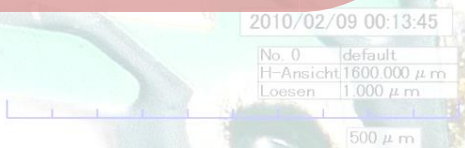
Publication	02/05
Rev. A	02/07
Rev. B	06/10

Rev. C in progress

Further Development of IPC-782
Implementation of Density Level

Combination with PCB Libraries
Landpattern Calculator

Reduced Tolerances
F-Tol = 0.1mm P-Tol = 0.05mm



IPC Package I0402 = M1005

Table 3-6 Rectangular or Square-End Components (Capacitors and Resistors) Smaller than 1608 (0603) (unit: mm)

Lead Part	Maximum (Most) Density Level A	Median (Nominal) Density Level B	Minimum (Least) Density Level C
Toe (J_t)	0.30	0.20	0.10
Heel (J_h)	0.00	0.00	0.00
Side (J_s)	0.05	0.00	-0.05
Round-off factor	Round off to the nearest two place decimal, i.e., 1.00, 1.02, 1.04, 1.06		
Courtyard excess	0.2	0.15	0.1
Chip Resistor **RESC** Construction and land pattern development are described in 8.1			
Chip Capacitor **CAPC** Construction and land pattern development are described in 8.2			
Chip Inductor **INDC** Construction and land pattern development are described in 8.3			

Table shows minimum dimensions of density level

Effective dimensions have to be calculated with IPC-7351 calculator

IPC-7351 Calculation Concept

$$Z_{max} = L_{min} + 2J_T + \sqrt{CL^2 + F^2 + P^2}$$

$$G_{min} = {}_{max} - 2J_H - \sqrt{C_S{}^2 + F^2 + P^2}$$

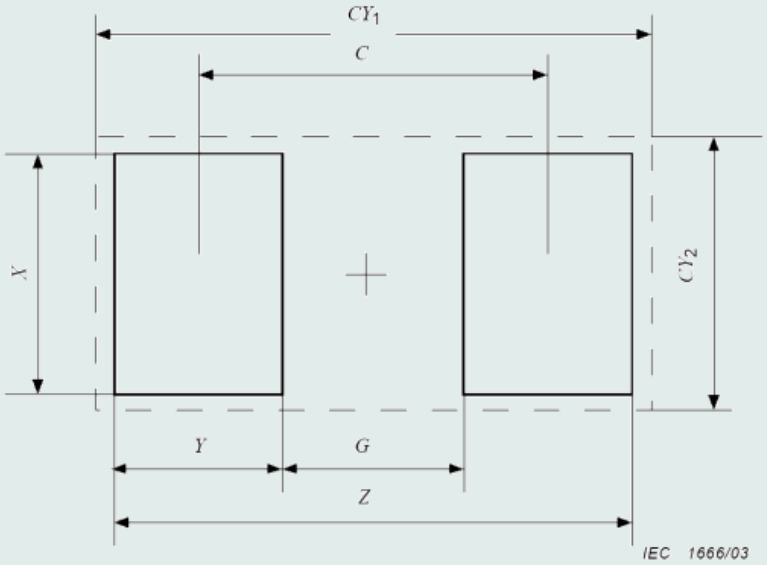
$$X_{max} = W_{min} + 2J_S + \sqrt{C_W{}^2 + F^2 + P^2}$$

Where:

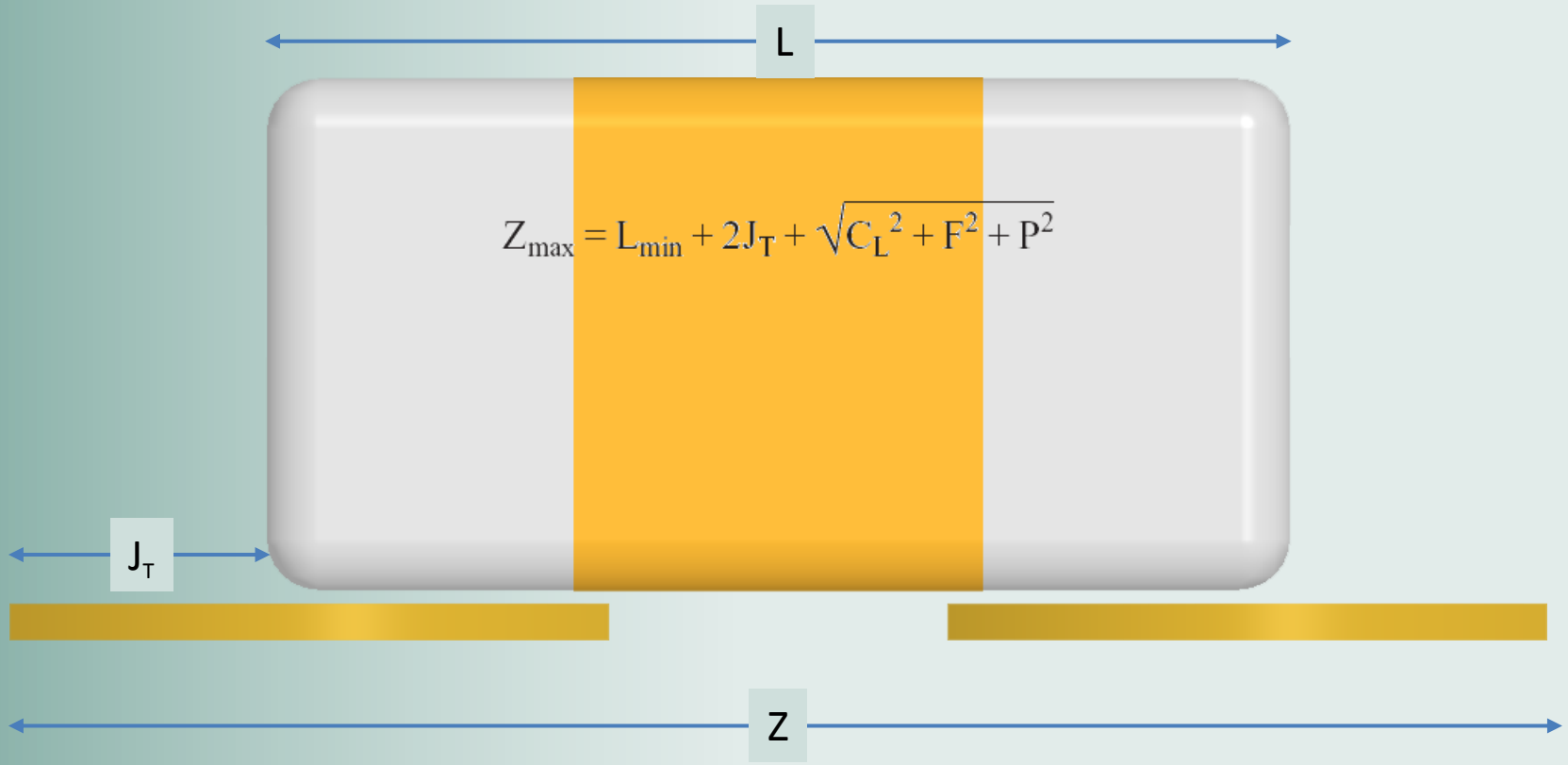
Z is the overall length of land pattern
G is the distance between lands of the pattern
X is the width of land pattern
L is the overall length of component
S is the distance between component terminations
W is the width of the lead or termination
J is the desired dimension of solder fillet or land protrusion:
J_T is the solder fillet or land protrusion at toe
J_H is the solder fillet or land protrusion at heel
J_S is the solder fillet or land protrusion at side

C is the component tolerances:
C_L is the tolerance on component length
C_S is the tolerance on distance between component terminations
C_W is the tolerance on the lead width

F is the printed board fabrication (land pattern geometric) tolerances
P is the part placement tolerance (placement equipment accuracy)

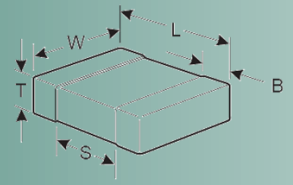


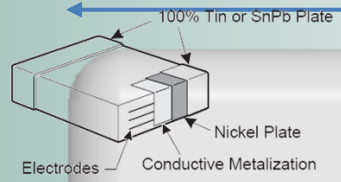
IPC-7351 Calculation Concept



IPC-7351 Calculation Concept 0402

Dimensions – Millimeters (Inches)





L

$$Z_{max} = L_{min} + 2J_T + \sqrt{C_L^2 + F^2 + P^2}$$

EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
0201	0603	0.60 (.024) ± 0.03 (.001)	0.30 (.012) ± 0.03 (.001)		0.15 (.006) ± 0.05 (.002)	N/A	Solder Reflow Only
0402	1005	1.00 (.040) ± 0.05 (.002)	0.50 (.020) ± 0.05 (.002)		0.30 (.012) ± 0.10 (.004)	0.30 (.012)	
0603	1608	1.60 (.063) ± 0.15 (.006)	0.80 (.032) ± 0.15 (.006)		0.35 (.014) ± 0.15 (.006)	0.70 (.028)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	

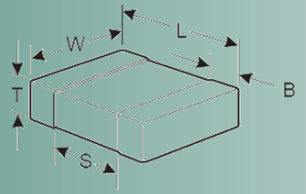
$$Z_{max} = 0.95 + 2x0.3 + \sqrt{0.01+0.01+0.0025} = 1,7$$

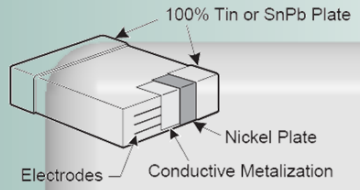
J_T

Z

IPC-7351 Calculation Concept

Dimensions – Millimeters (Inches)





$$G_{min} = S_{max} - 2J_H - \sqrt{C_S^2 + F^2 + P^2}$$

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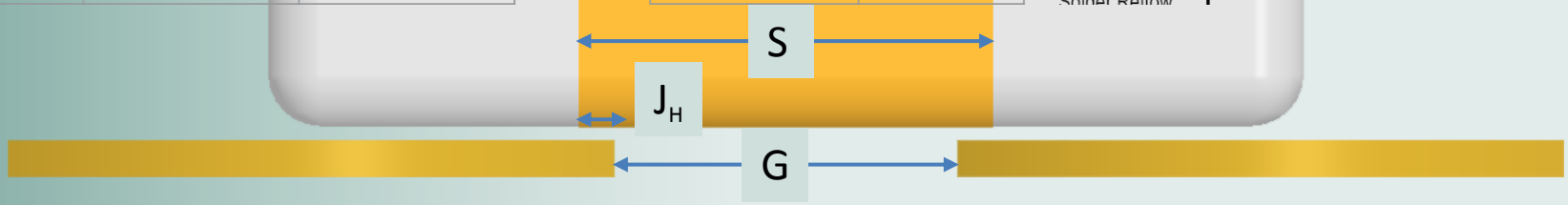
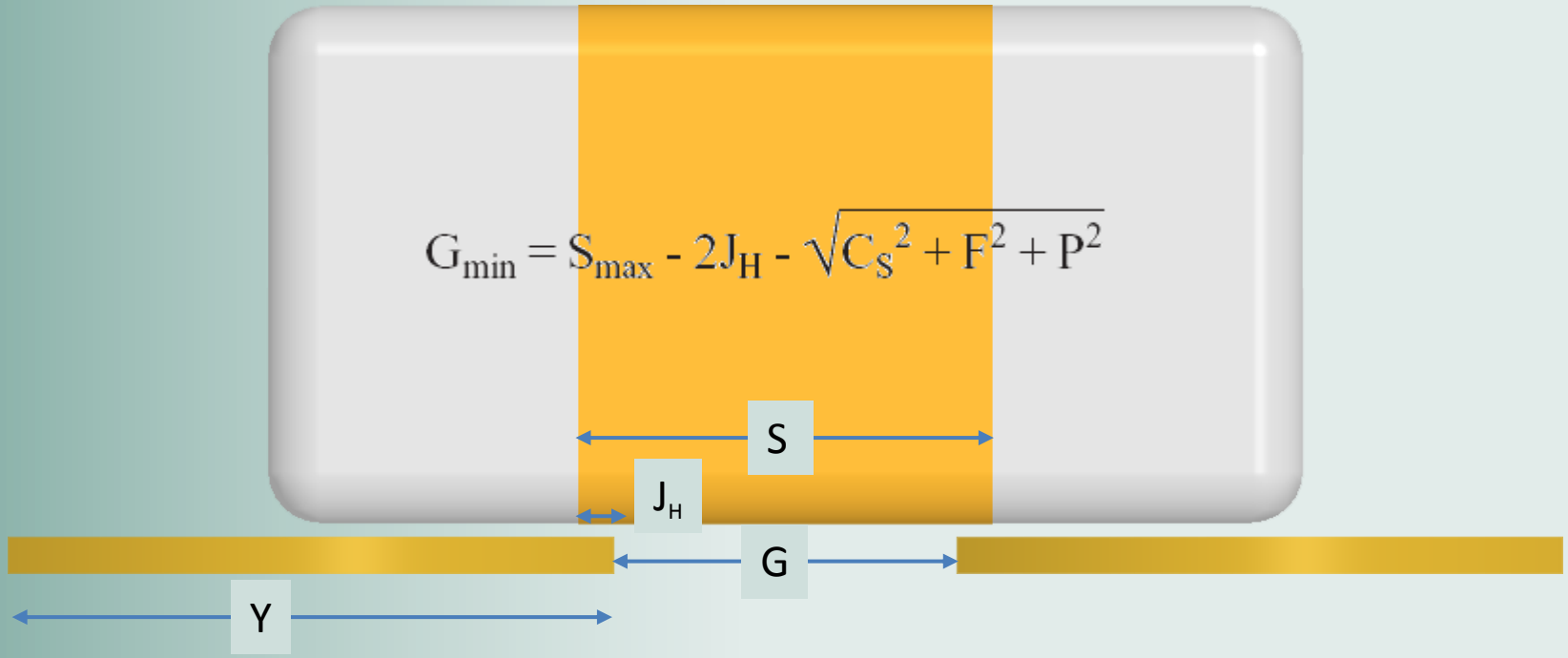


IPC-7351 Calculation Concept

Y = Land length = Z - G

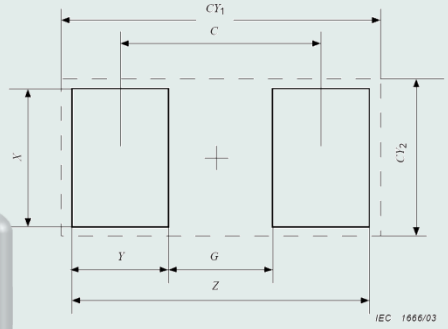
$$G_{min} = S_{max} - 2J_H - \sqrt{C_S^2 + F^2 + P^2}$$



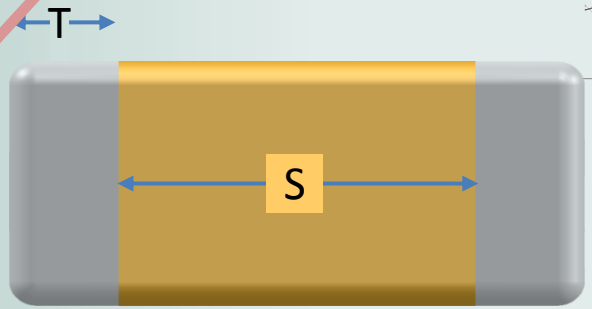
S_{max}/S_{tol}

$$G_{min} = S_{max} - 2J_H - \sqrt{C_S^2 + F^2 + P^2}$$

Y = (Z – G)/2



1. Method of Tolerance Calculation S (C_s)



$S_{max} = L_{max} - 2T_{min}$

$S_{max} = 1.05 – 2 \times 0.2 = 0.65$

$S_{min} = L_{min} – 2T_{max}$

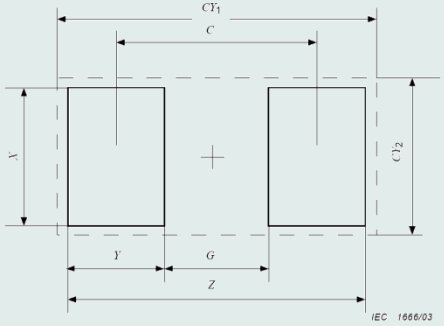
$S_{min} = 0.95 – 2x\ 0.4 = 0.15$

$C_s = S_{max} – S_{min} = 0.65 – 0.15 = 0.5$ (S-Tolerance)

S_{max}/S_{tol}

$$G_{min} = S_{max} - 2J_H - \sqrt{C_S^2 + F^2 + P^2}$$

Y = (Z – G)/2



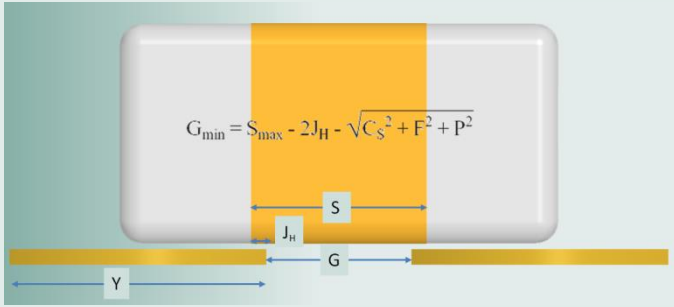
2. Method of Tolerance Calculation S (C_s)

$C_{s(RMS)} = \sqrt{\ } (L_{tol})^2 + 2(T_{tol})^2 = \sqrt{\ } 0.1^2+2x0.2^2= 0.3$

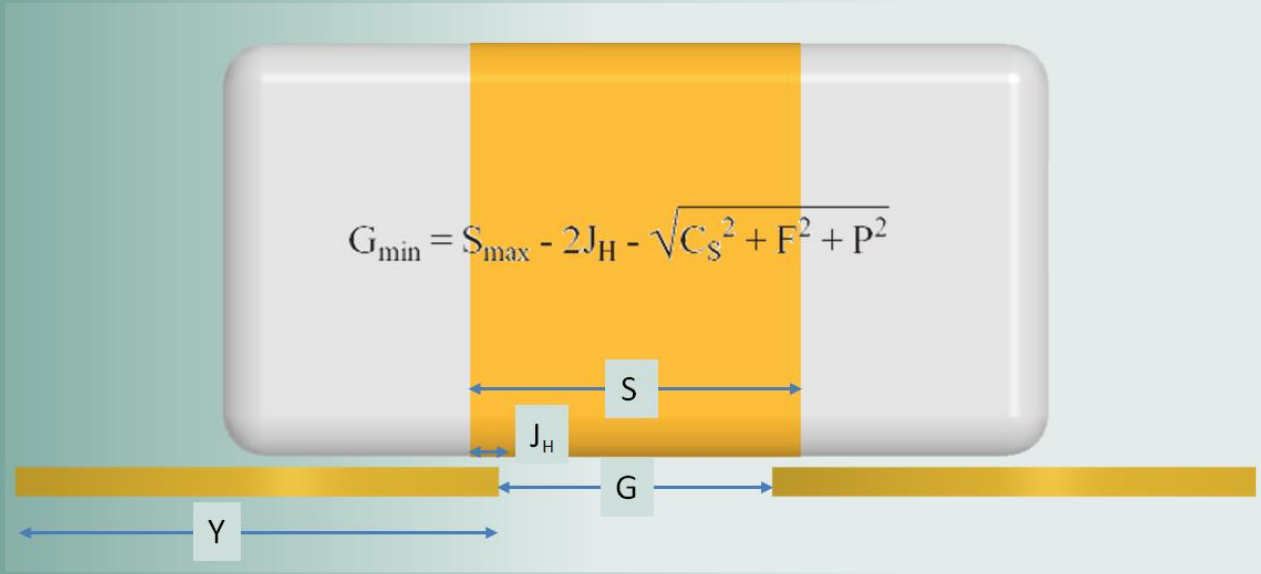
$C_{s(Diff)}= C_s – C_{s(RMS)} = 0.5 – 0.3 = 0.2$

$S_{max\ (New)} = C_{smax} - C_{s(Diff)}/2 = 0.65 – 0.1 = 0.55$

$S_{min\ (New)}) = C_{smin} + C_{s(Diff)}/2 = 0.15 + 0.1 = 0.25$



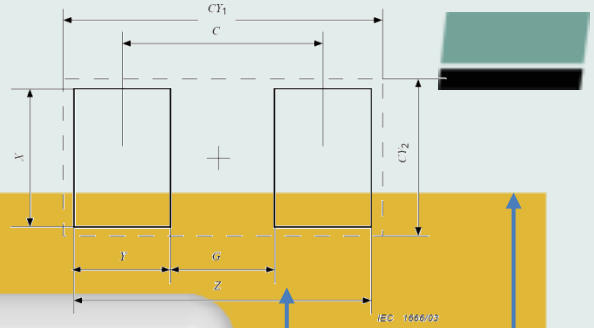
The smaller G the longer Y



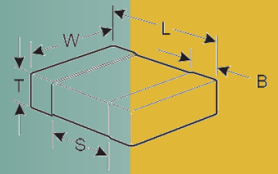
G = 0.55 - 2x0-$\sqrt{\ }$ 0.09+0.01+0.0025 = 0.55-0-0.32 = 0.23

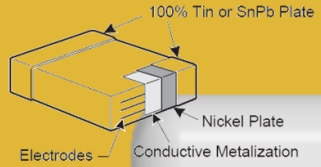
Y (0402) = (Z – G)/2 = (1.7 – 0.23)/2 = 0.735

IPC-7351 Calculation Concept



Dimensions – Millimeters (Inches)





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0805	2012	2.00 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Reflow

W

X

J_S

Xmax = 0.45 + 2x0.05 + $\sqrt{\ }$ 0.01+0.01+0.0025 = 0.7

$$X_{max} = W_{min} + 2J_S + \sqrt{C_W{}^2 + F^2 + P^2}$$

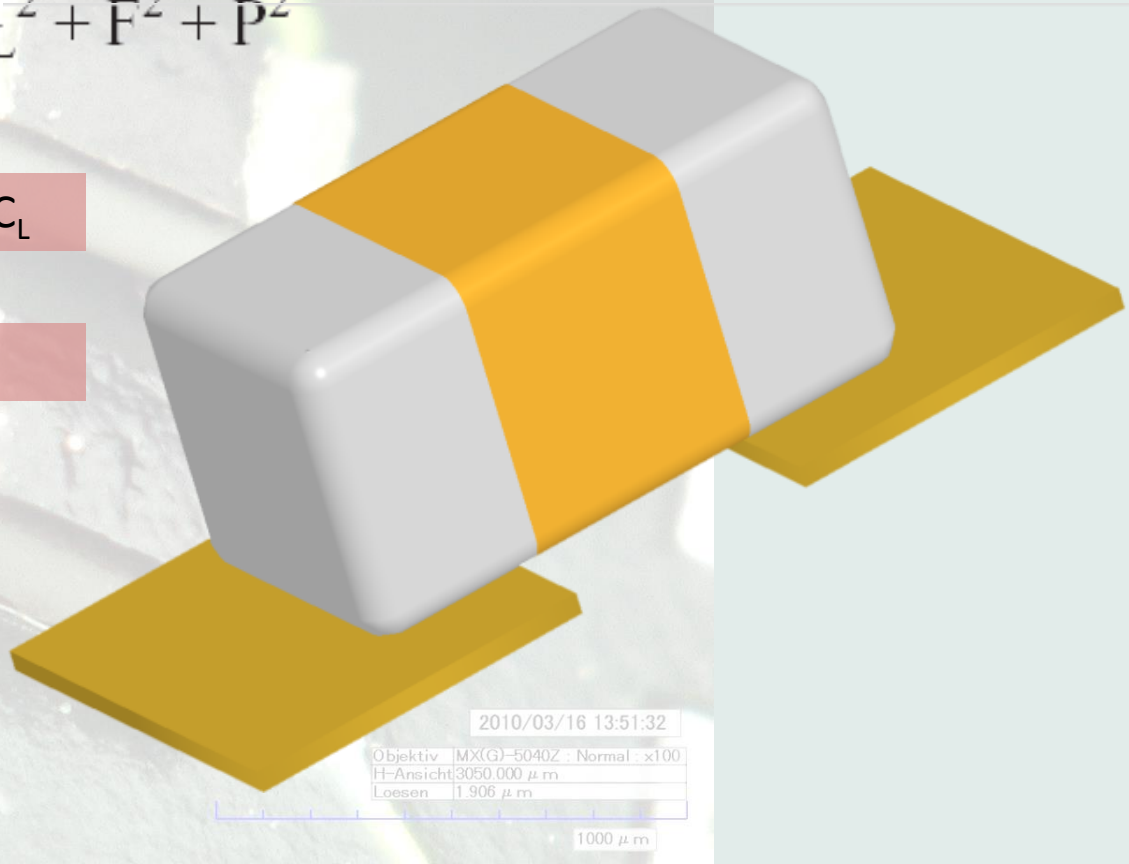
IPC-7351 Maximum

$$Z_{max} = L_{min} + 2J_T + \sqrt{C_L{}^2 + F^2 + P^2}$$

Component depending: L_{min} und C_L

Process Constants: F und P

Density Constant: J_T

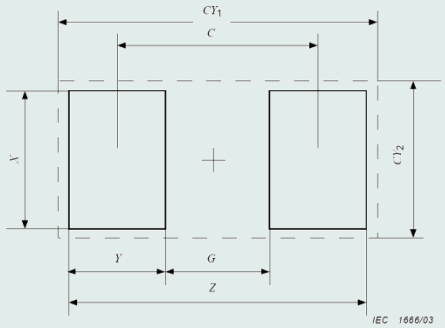


IPC-7351 Land Calculation Chip-Components

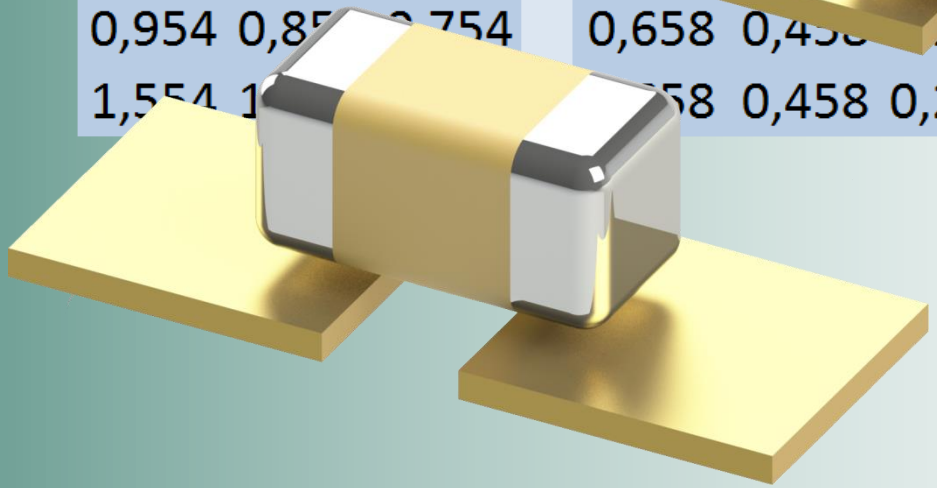
Bauform	Bauteilmaße									Toleranzen Bauteil			Fertigung	
	Länge (L)	Ltol	Breite (W)	Wtol	Anschluss	Ttol	Stol	Srms	Sdiff	CL	WL	TL	F	P
0201	0,60	0,03	0,30	0,03	0,15	0,05	0,26	0,15	0,11	0,06	0,06	0,10	0,10	0,05
0402	1,00	0,05	0,50	0,05	0,30	0,10	0,50	0,30	0,20	0,10	0,10	0,20	0,10	0,05
0603	1,60	0,15	0,80	0,15	0,35	0,15	0,90	0,52	0,38	0,30	0,30	0,30	0,10	0,05
0805	2,00	0,20	1,25	0,20	0,50	0,25	1,40	0,81	0,59	0,40	0,40	0,50	0,10	0,05
1206	3,20	0,20	1,60	0,20	0,50	0,25	1,40	0,81	0,59	0,40	0,40	0,50	0,10	0,05

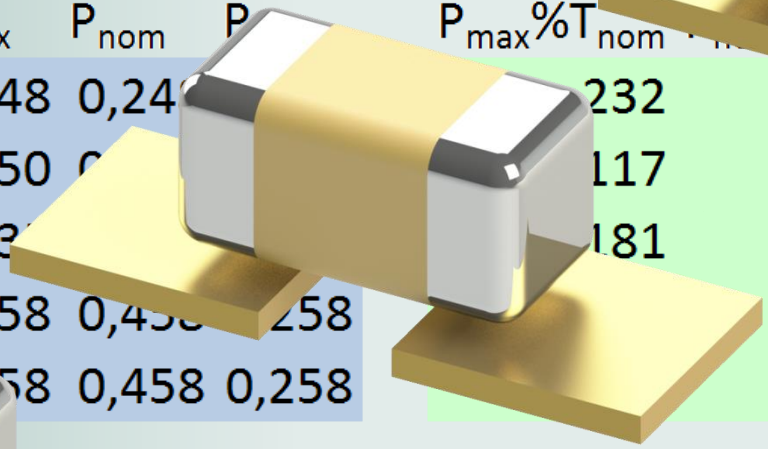
IPC-7351B Landpattern

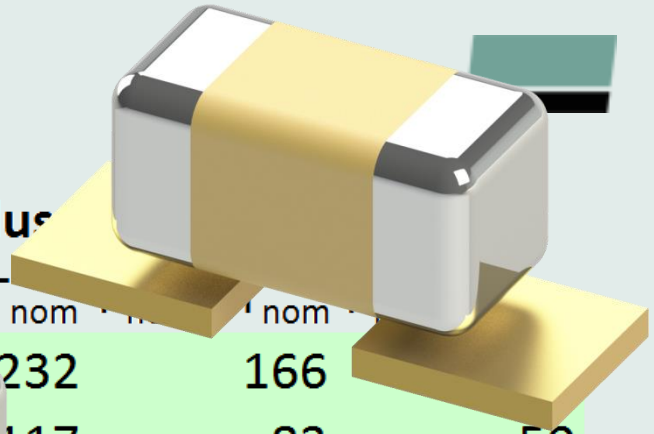
Zmost	Znom	Zmin	G	Ymax	Ynom	Ymin	Xmax	Xnom	Xmin
1,297	1,097	0,897	0,182	0,558	0,458	0,358	0,497	0,397	0,297
1,700	1,500	1,300	0,230	0,735	0,635	0,535	0,700	0,600	0,500
2,870	2,470	2,070	0,549	1,160	0,960	0,760	1,070	0,970	0,870
3,315	2,915	2,515	0,499	1,408	1,208	1,008	1,565	1,465	1,365
4,515	4,115	3,715	1,699	1,408	1,208	1,008	1,915	1,815	1,715



Pad Center			Protrusion			Anschlus		
$c/2_{max}$	$c/2_{nom}$	$c/2_{min}$	P_{max}	P_{nom}	P	P_{max} %T_{nom}		T_{nom}
0,370	0,320	0,270	0,348	0,24		232	166	
0,482	0,432	0,382	0,350			117	83	50
0,855	0,755	0,655	0,63			181	124	67
0,954	0,85	754	0,658	0,45	258		92	52
1,554	1		658	0,458	0,258		92	52

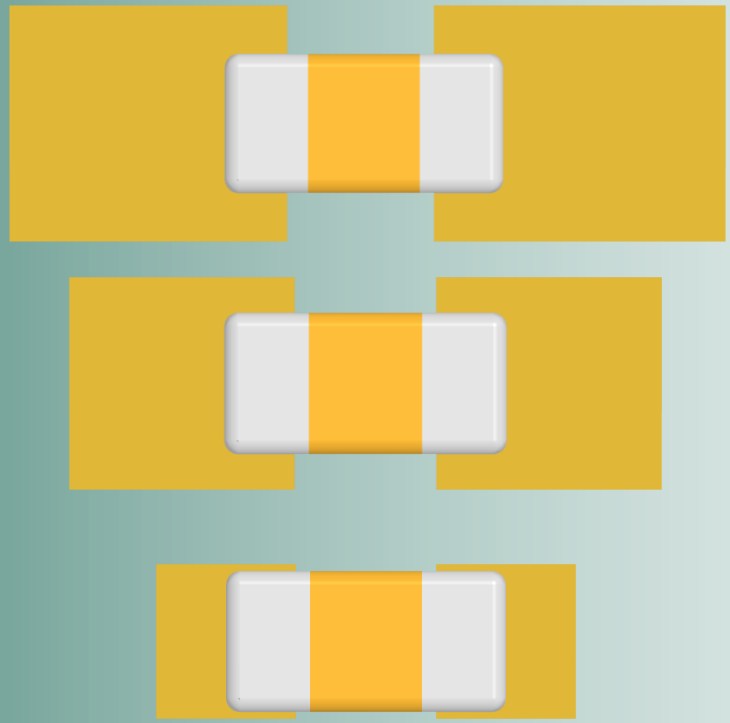




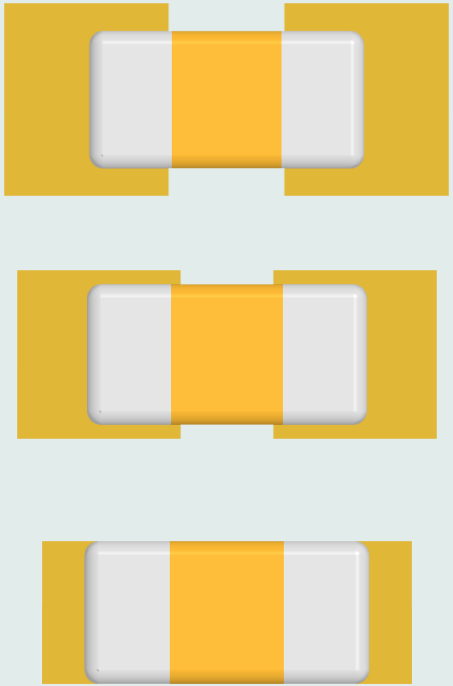


Comparison IEC ⇔ IPC

IEC 61188-5-2

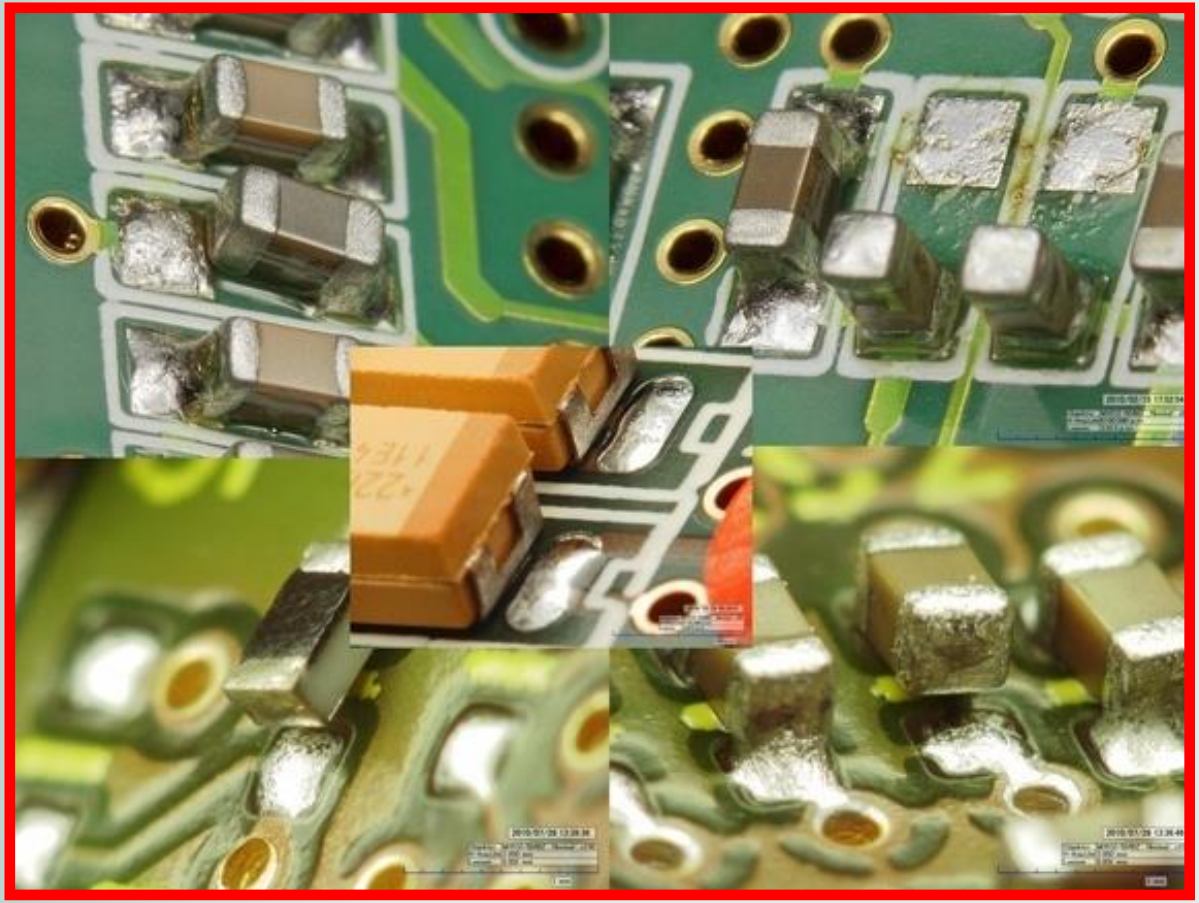


IPC 7351B



Consequences

- Twisting
- Shifting
- Tombstoning
- Open Solder Joints
- Trailers



Optional in IPC-7351B

“Individual tolerances for fabrication (‘‘F’’) and component placement equipment accuracy (‘‘P’’) are assumed to be as given in the IPC-7351 land pattern libraries.”

“These numbers may be modified based on user equipment capability or fabrication criteria. For example, many printed board fabricators will compensate for etch factors and increase or “swell” land features. In such instances, the combination of etch factor compensation by the printed board fabricator and the IPC-7351 default “F” tolerance results in what can be described as “double etch compensation” where the land size is increased beyond expectation. **In these instances, the fabrication tolerance in the “Calculator Settings” menu of the IPC-7351 LP Calculator should be set to 0.0 mm**.”

Constant land increase by F & P

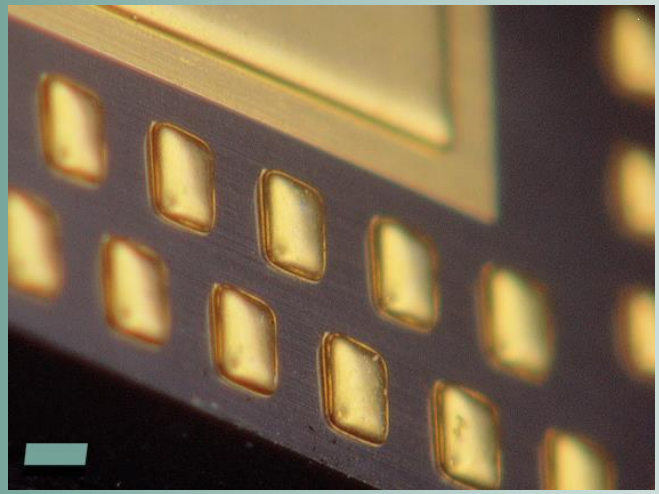
With F = 0.050 mm and P = 0.025 mm the resulting increase is of land in each dimension is 0.056 mm.
This is an absolute amount which leads to a significant expansion of land area for small components (0402, 0201 and less).

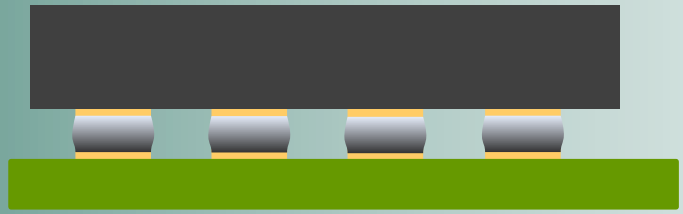
Further is important, whether the component dimensions are used with nominal or min/max. values.

The New Proportional Land Dimensioning Concept

Basic Idea

Two Terminal Classes





Facing wettable areas

Facing & vertical wettable areas

Terminal Type 1

Facing flat wettable areas

1:1 optimized stress distribution in solder joint – higher reliability

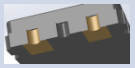
J-STD-001		Type	Land Size
7.5.3		Bottom Only Chip	1:1
7.5.12		Tall Profile Bottom Only	1:1
7.5.14		BGA	1:1
7.5.15		BTC	1:1

No protrusion required

Terminal Type 2

Flat facing and vertical wettable areas

Protrusion required

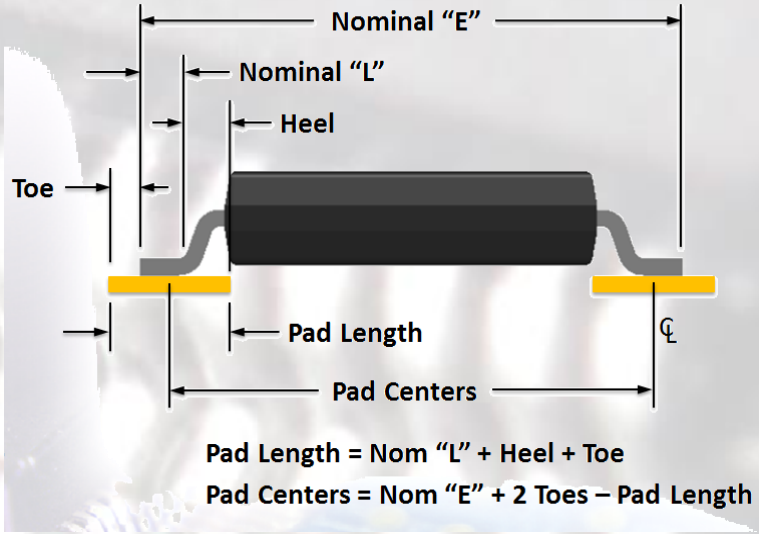
J-STD-001		Typ	Protrusion
7.5.4		Rectangular or Square End Chip	% Terminal Height
7.5.5		Cylindrical End Cap	% Terminal Diameter
7.5.6		Castellated	% Terminal Height
7.5.7		Gull Wing	% Leadframe Thickness
7.5.9		J-Leads	% Leadframe Thickness
7.5.11		Flat Lug Leads	% Leadframe Thickness
7.5.13		L-Inward	% Terminal Height

Solder Joint Requirements

Solder Joint Requirements according to J-STD-001 and IPC-A-610					
J-STD-001	Dim.	Description	Minimum Fillet Hight Requirement		
Termination Type			Class 1	Class 2	Class 3
7.5.3	F	Bottom Only Chip	Good wetting	Good wetting	Good wetting
7.5.4	F	Rectangular or Square End Chip	Good wetting on vertical surfaces		G+25%H max 0.50 mm
7.5.5	F	Cylindrical End Cap	Good wetting on vertical surfaces		G + 25%W max 1.00 mm
7.5.6	F	Castellated	Good wetting	G+25%H	G+50%H
7.5.7	F	Gull Wing - T < = 0.40 mm	Good wetting	G+T	G+T
7.5.7	F	Gull Wing - T > 0.40 mm	Good wetting	G+50%T	G+T
7.5.8	F	Round & Flattened Leads	Good wetting	G+50%T	G+T
7.5.9	F	J-Leads	G+50%T	G+50%T	G+T
7.5.10	F	I-Leads (Butt I)	0.50 mm	0.50 mm	NA
7.5.10.1	F	I-Leads Solder Charged	Hole is filled	Hole is filled	Hole is filled
7.5.11	F	Flat Lug Leads	Good wetting	Good wetting	G+T
7.5.12	F	Tall Profile Bottom Only	None	None	None
7.5.13	F	L-inward	Good wetting on vertical surfaces	G+25%H max 0.50 mm	G+25%H max 0.50 mm
7.5.14	F	BGA	None	None	None
7.5.15	F	BTC (QFN)	None	None	None
7.5.16	F	Bottom Thermal Plane	None	None	None
7.5.17	F	Flattened Post	Good wetting	Good wetting	NA
7.5.18	F	P-termination	Good wetting	25%H	25%H

Gullwing Pitch

Pitch	Package Example
1.27mm	SO-08, SO-14, SO-16 etc.
1.00mm	QFP
0.80mm	TQFP-44
0.65mm	TSSOP-16
0.50mm	MSOP-10
0.40mm	TQFP-100



Gullwing Solder Joint

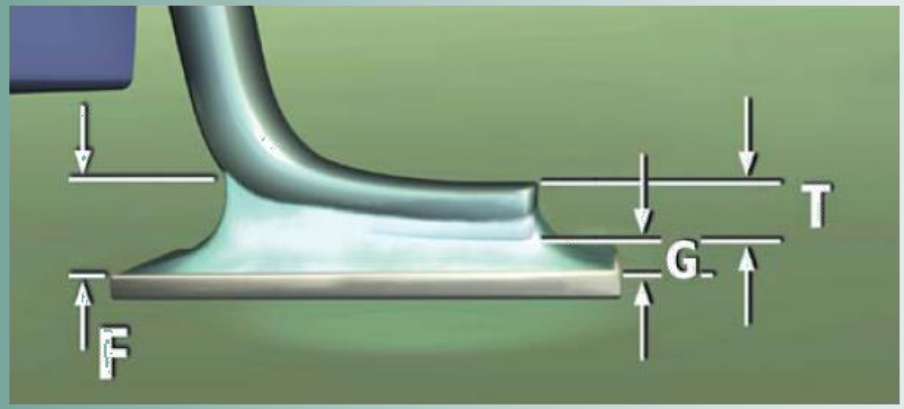


Figure 8-102

Acceptable – Class 3

- Minimum heel fillet height (F) is equal to solder thickness (G) plus lead thickness (T) at connection side.

A good heel fillet equals a wetting angle of approximately 45°
Toe of terminal mostly is not wettable, no solder joint requirement
Heel fillet is most important for reliablity
Thus heel protrusion should be more than toe protrusion

IPC-7351 Gullwing Tables

Table 3-2 Flat Ribbon L and Gull-Wing Leads (greater than 0.625 mm pitch) (unit: mm)

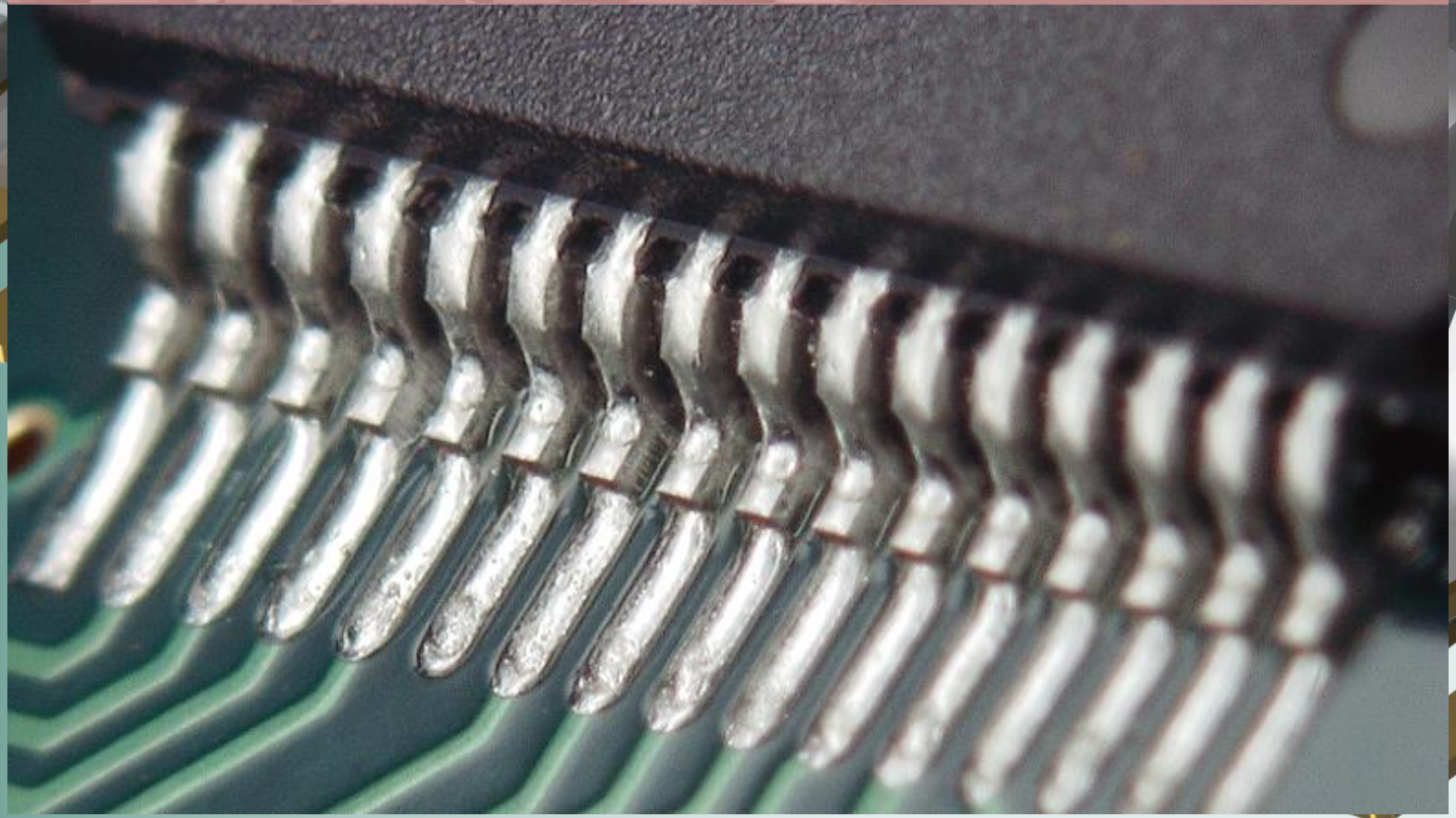
Lead Part	Maximum (Most) Density Level A	Median (Nominal) Density Level B	Minimum (Least) Density Level C
Toe (J_T)	0.55	0.35	0.15
Heel (J_H)[1]	0.45	0.35	0.25
Side (J_S)	0.05	0.03	0.01
Round-off factor	Round off to the nearest two place decimal, i.e., 1.00, 1.05, 1.10, 1.15		
Courtyard excess	0.5	0.25	0.1

Table 3-3 Flat Ribbon L and Gull-Wing Leads (less than or equal to 0.625 mm pitch) (unit: mm)

Only Difference: Side Protrusion J_S

Lead Part	Density Level A	Density Level B	Density Level C
Toe (J_T)	0.55	0.35	0.15
Heel (J_H)[1]	0.45	0.35	0.25
Side (J_S)	0.01	-0.02	-0.04
Round-off factor	Round off to the nearest two place decimal, i.e., 1.00, 1.05, 1.10, 1.15		
Courtyard excess	0.5	0.25	0.1

Example: TQFP-100



The Proportional Concept

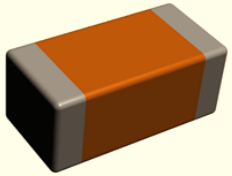
Proportional Land Dimensioning Calculations				Protrusion			
Description	Protrusion	Land Size	Calculation	Toe Limit	Toe	Side *	Heel
Bottom Only Chip	No	1:1	-		opt: 50µm	opt: 50µm	opt: 50µm
Rectangular or Square End Chip	Yes		Termination Height	0.50 mm	40%	10%	10%
Cylindrical End Cap	Yes		Termination Diameter	1.00 mm	60%	0%	5%
Castellated	Yes		Termination Height		50%	10%	10%
Gull Wing - T < = 0.40 mm	Yes		Leadframe Thickness		100%	10%	150%
Gull Wing - T > 0.40 mm	Yes		Leadframe Thickness		100%	10%	150%
Round & Flattened Leads	Yes		Lead Thickness/Diameter		100%	10%	150%
J-Leads	Yes		Leadframe Thickness		150%	10%	150%
I-Leads (Butt I)	Yes		Height Requirement		0.50 mm	0.25 mm	0.50 mm
I-Leads Solder Charged	Yes		Upper Hole Edge		50%	10%	50%
Flat Lug Leads	Yes		Leadframe Thickness		100%	10%	5%
Tall Profile Bottom Only	No	1:1	-		opt: 50µm	opt: 50µm	opt: 50µm
L-inward	Yes		Termination Height	0.50 mm	10%	10%	40%
BGA	No	1:1	-		opt: 50µm	opt: 50µm	opt: 50µm
BTC (QFN)	No	1:1	-		opt: 50µm	opt: 50µm	opt: 50µm
Bottom Thermal Plane	NoYes		Leadframe Thickness		100%	10%	150%
Flattened Post	Yes						
P-termination	Yes		Termination Hight		50%	20%	50%
						* Alternative to % in	
				opt: = optional		most cases 50% of	

Example Chip-Components

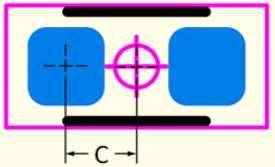
Proportional SMD Pad Stack										
Rectangular End Cap	Package Dimensions			Nom. Terminal	Toe (%)	Heel (%)	Side (%)	Land (Pad)		
Package Size	Length	Width	Height	Length	40	5	5	Length	Width	Center
Inch 01005, Metric 0402	0,40	0,20	0,25	0,10	0,100	0,013	0,013	0,21	0,23	0,194
Inch 0201, Metric 0603	0,60	0,30	0,30	0,15	0,120	0,015	0,015	0,29	0,33	0,278
Inch 0402, Metric 1005	1,00	0,50	0,50	0,30	0,200	0,025	0,025	0,53	0,55	0,438
Inch 0603, Metric 1608	1,60	0,80	0,50	0,35	0,200	0,025	0,025	0,58	0,85	0,713
Inch 0805, Metric 2012	2,00	1,25	0,60	0,50	0,240	0,030	0,030	0,77	1,31	0,855
Inch 1008, Metric 2520	2,50	2,00	0,65	0,50	0,260	0,033	0,033	0,79	2,07	1,114
Inch 1206, Metric 3216	3,20	1,60	0,70	0,50	0,280	0,035	0,035	0,82	1,67	1,473
Inch 1210, Metric 3225	3,20	2,50	0,70	0,50	0,280	0,035	0,035	0,82	2,57	1,473
Inch 1806, Metric 4516	4,50	1,60	0,75	0,50	0,300	0,038	0,038	0,84	1,68	2,131
Inch 1812, Metric 4532	4,50	3,20	0,80	0,60	0,320	0,040	0,040	0,96	3,28	2,090
Inch 2010 , Metric 5025	5,00	2,50	0,80	0,60	0,320	0,040	0,040	0,96	2,58	2,340
Inch 2512, Metric 6332	6,40	3,20	0,80	0,60	0,320	0,040	0,040	0,96	3,28	3,040
Inch 2920, Metric 7451	7,40	5,10	0,80	0,60	0,320	0,040	0,040	0,96	5,18	3,540
All dimensions are in mm										

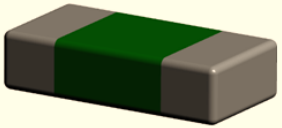
Component Families

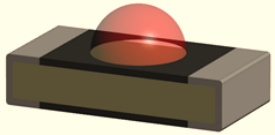
Capacitor
Diode
Ferrite Bead
Fuse
Inductor
LED
Resistor
Thermistor
Varistor

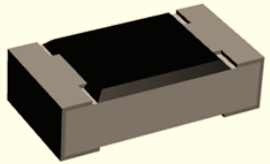


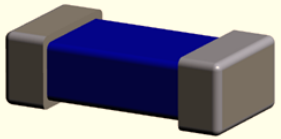
Pad Length = Package Tolerance, Nomimal Lead Length + Toe + Heel
Pad Width = Package Tolerance, Nominal Lead Width + Side
Maximum Courtyard Excess = 0.25 mm (user definable)











Advantages

Land dimensions are defined by

- Solder Joint Requirements
- Terminal Type
- Terminal Size
- New: Terminal Height

Proportional Gullwing

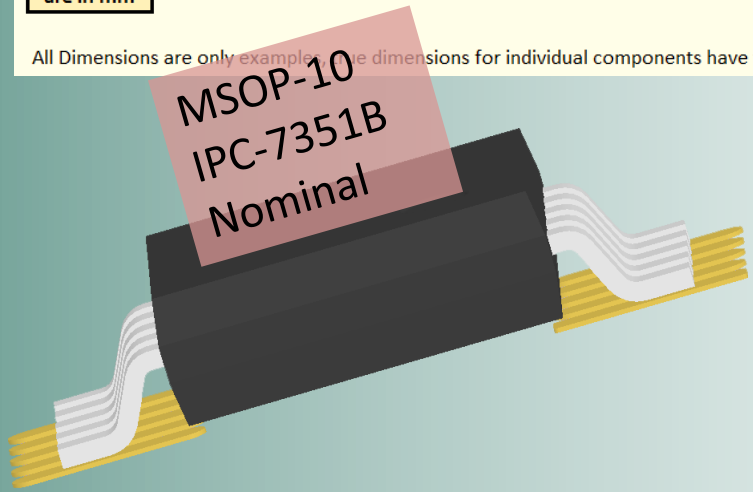
Proportional SMD Pad Stack

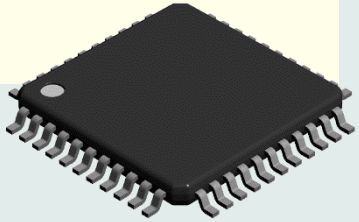
Gullwing	Package Example	Package Dimensions			Nominal Terminal			Toe (%TH)	Heel (%TH)	Side (%TH)	Land (Pad)		
Pitch		Length	Width €	Height	Length	Width	Height (c)*	100	150	5	Length	Width	Center
1,27	SO-14	8,65	6,00	1,75	0,800	0,50	0,25	0,250	0,375	0,013	1,425	0,525	2,538
0,95	SOT-23-6	2,80	2,90	1,00	0,450	0,40	0,12	0,120	0,180	0,006	0,750	0,412	1,145
0,80	TQFP-44	12,00	12,00	1,60	0,600	0,37	0,15	0,150	0,225	0,008	0,975	0,385	5,663
0,65	TSSOP-16	5,00	6,40	1,20	0,600	0,25	0,20	0,200	0,300	0,010	1,100	0,270	2,150
0,50	MSOP-10	4,90	3,00	1,10	0,550	0,22	0,18	0,180	0,270	0,009	1,000	0,238	2,130
0,40	TQFP-100	14,00	14,00	1,20	0,600	0,18	0,15	0,150	0,225	0,008	0,975	0,195	6,663

All dimensions are in mm

*Height = Leadframe Thickness

All Dimensions are only example. The dimensions for individual components have to be filled in from datasheet





Advantages

Easy scalable

Also for future components

Smoother Assembly

Less Risks

Higher Reliability

Additional Design Space

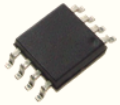
Disadvantages

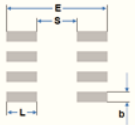
No Generic Footprints

FED Proportional Verification Projekt

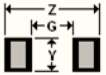
		Period	Starting Date
1	Creation of Library Parts	3 weeks	16.05.2016
2	Design of Testboard	3 weeks	06.06.2016
3	Testboard Production	3 weeks	27.06.2016
4	Assembly of Testboard	2 weeks	11.07.2016
5	Solder Joint Inspection & Documentation	3 weeks	01.08.2016
6	Präsentation of Results at FED-Conference		15.09.2016

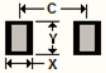
FED – IPC Reference Calculator





IPC Incremental SMD Reference Calculator





Current Sample
MSOP-10, pitch 0.5 mm
Vishay DG2034DQ-T1-E3

Samples

Rectangular End Cap

C0201	R0201
C0402	R0402
C0603	R0603

Gull Wing Examples

- SO-14 Pitch 1.27
- SOT-23 Pitch 0.95
- TQFP-44 Pitch 0.80
- TSSOP-16 Pitch 0.65
- MSOP-10 Pitch 0.50
- TVSOP-24 Pitch 0.40

Inward L

3216-18A	7343-31D

Cylindrical

MiniMelf	Melf

Flat Protruded

- SOT-563

Castellated

- TC-164

Enter Data:	
Emin	4,90
Emax	4,90
Etol =	0,00
Lmin	0,40
Lmax	0,70
Ltol =	0,30
bmin	0,17
bmax	0,27
btol =	0,10

Toe Goal	0,35
Heel Goal	0,35
Side Goal	-0,02
Place Rnd	0,02
Size Rnd	0,01
Fab Tol +/-	0,050
Place Tol +/-	0,025

Calculation:			
Stol =	0,60	Toe Tol =	0,11180
Stol (RMS) =	0,42	Zmax =	5,71180
Sdiff =	0,18	Heel Tol =	0,43875
Smax =	4,10	Gmin =	2,87338
Smin =	3,50	Side Tol =	0,15000
New Smax =	4,01	Yref =	0,28000
New Smin =	3,59		
		Place Round Factor =	50
		Size Round Factor =	100

Result:	
C =	4,30
X =	1,42
Y =	0,28

Toe Max =	0,41
Toe Min =	0,35
Toe Goal	0,35
Heel Max =	0,57
Heel Min =	0,35
Heel Goal	0,35
Side Max =	0,06
Side Min =	-0,02
Side Goal	-0,02

FED Proportional SMD Reference Calculator

Enter Data:	
Enom =	4,90
Lnom =	0,55
bnom =	0,22
cnom =	0,18
e (pitch) =	0,5

cnom = Terminal Thickness or Height

Goal Determination	
Toe Goal (%)	100
Heel Goal (%)	150
Side Goal (%)	5

Goals are a percentage of cnom

Calculation:	
Z =	5,26000
G =	3,26000
Y =	0,23800

Result:	
C =	4,26
C/2 =	2,13
X =	1,00
Y =	0,25

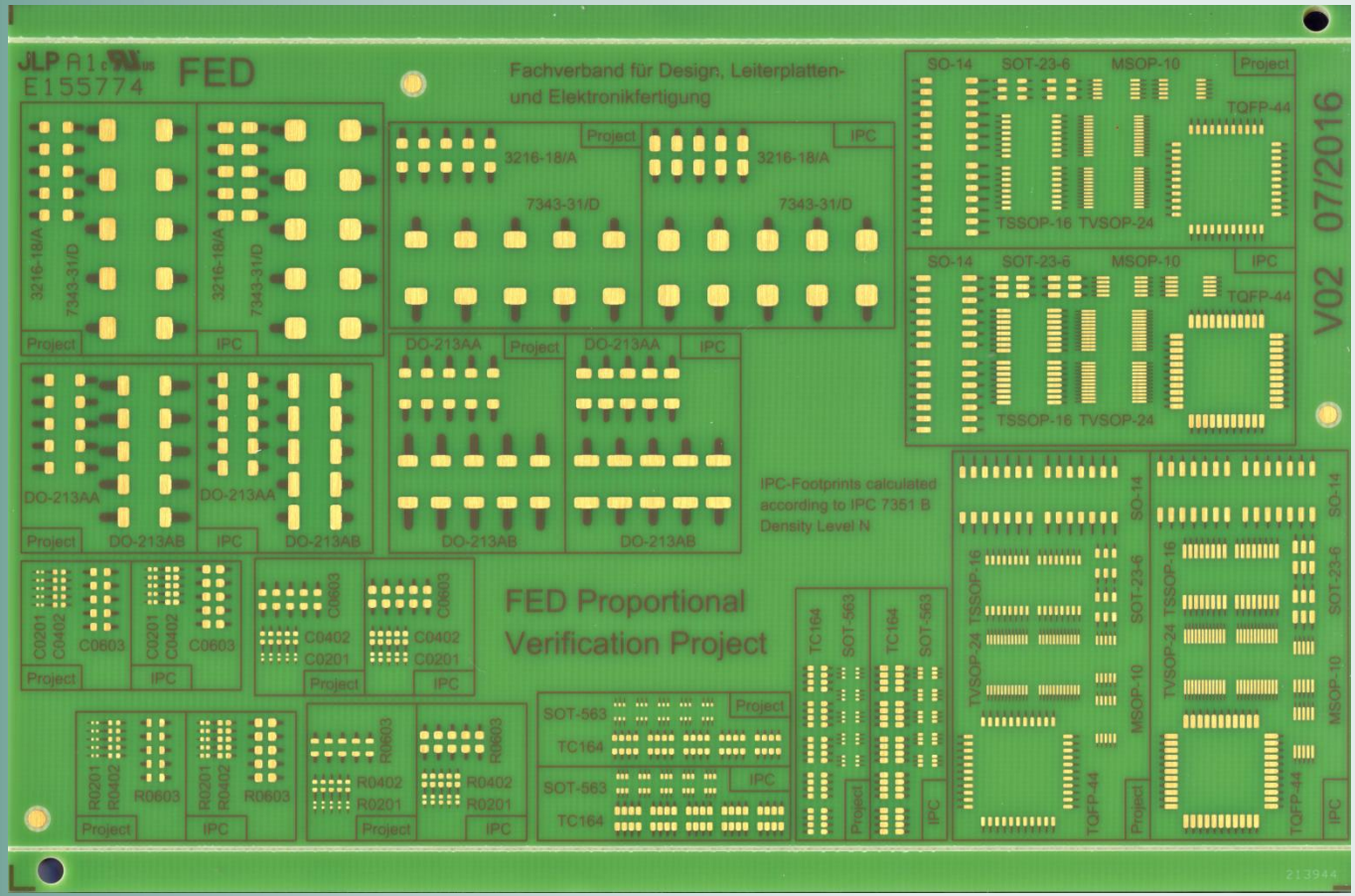
* if Y < pitch/2
Y= pitch/2

Risk observation	
Toe Max =	0,180
Toe Min =	0,124
Toe Goal =	0,180
Heel Max =	0,376
Heel Min =	0,157
Heel Goal =	0,270
Side Max =	0,040
Side Min =	-0,035
Side Goal =	0,009

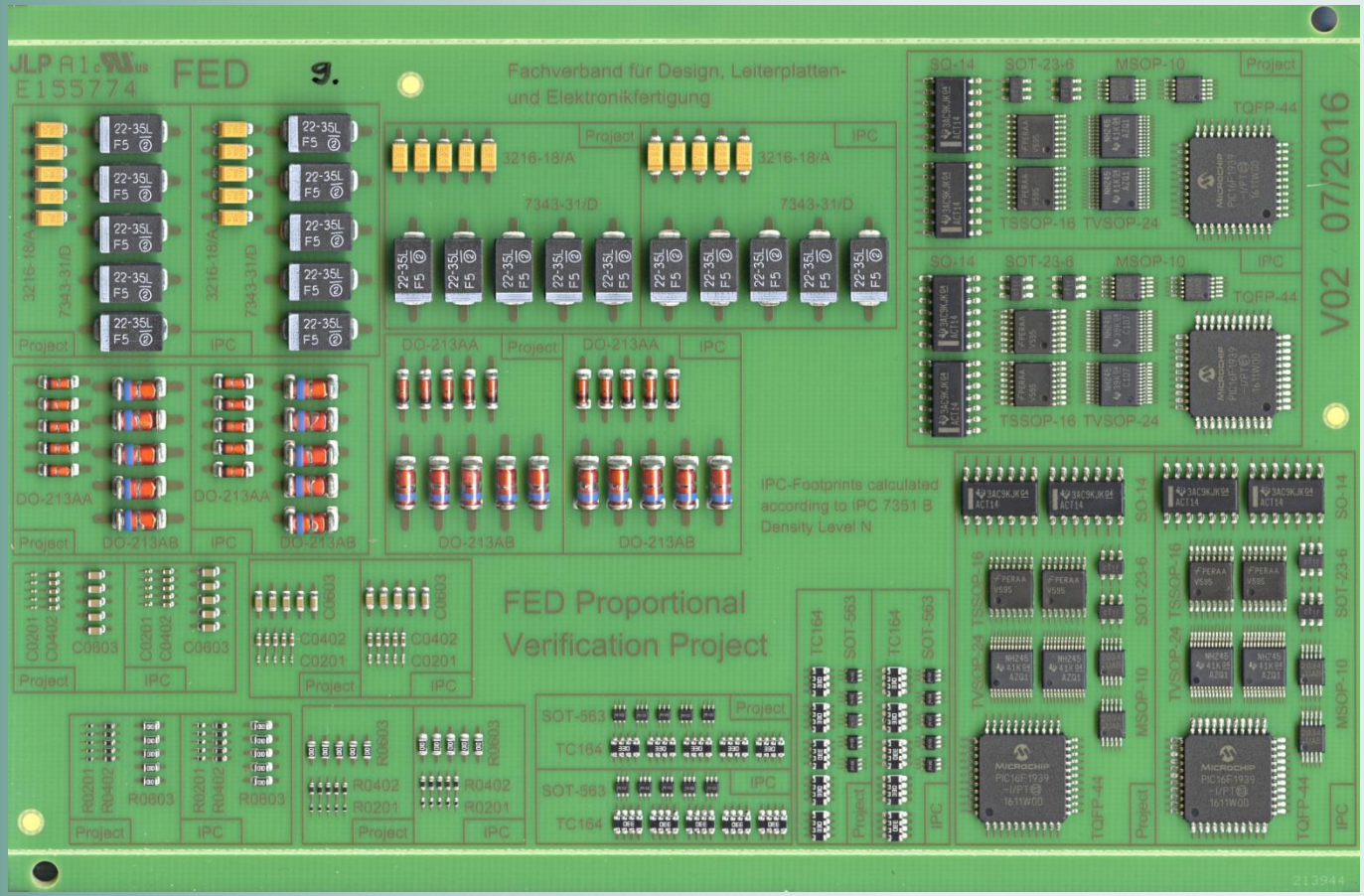
For Evaluation Purposes Only

PCB Libraries

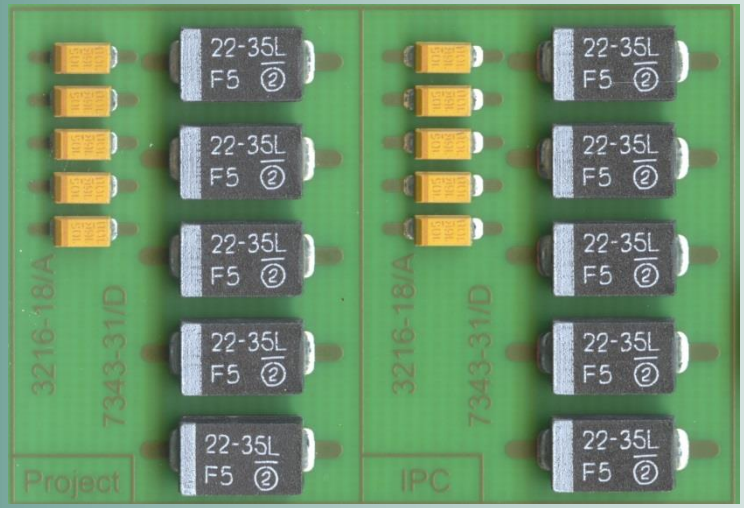
FED Verification Testboard

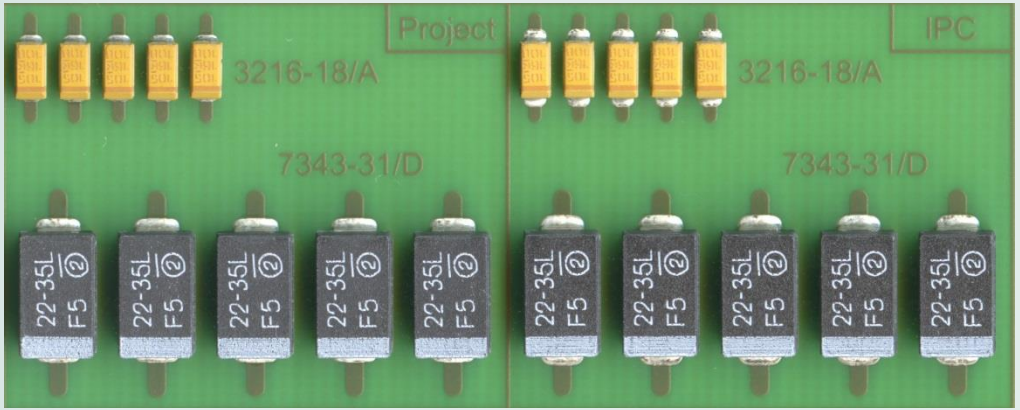


Testboard with Components

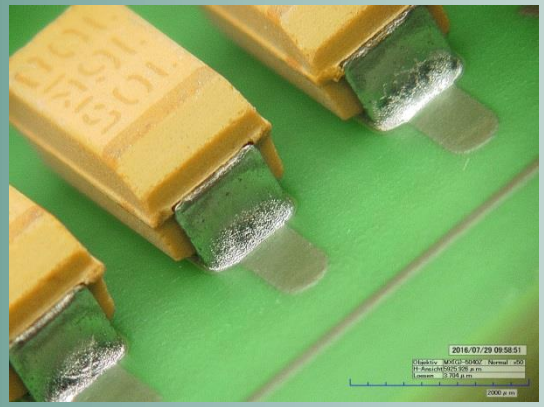


Group 1 – Inward L - Tantal A and D

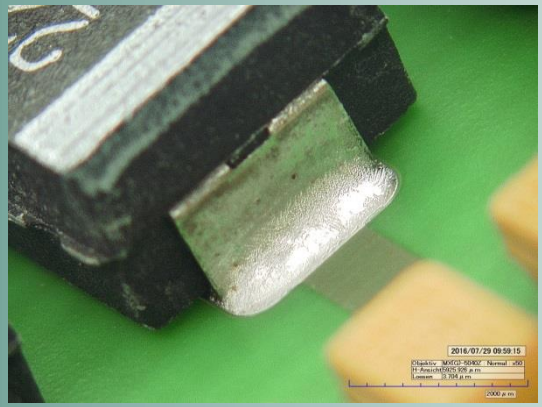




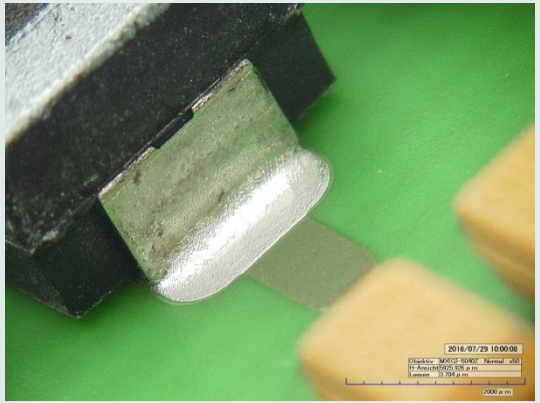
Group 1 – In-L -Tantal A and D solder joints



P I

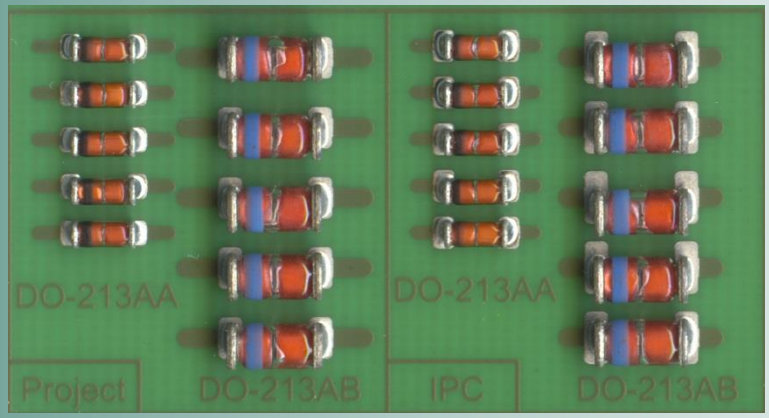


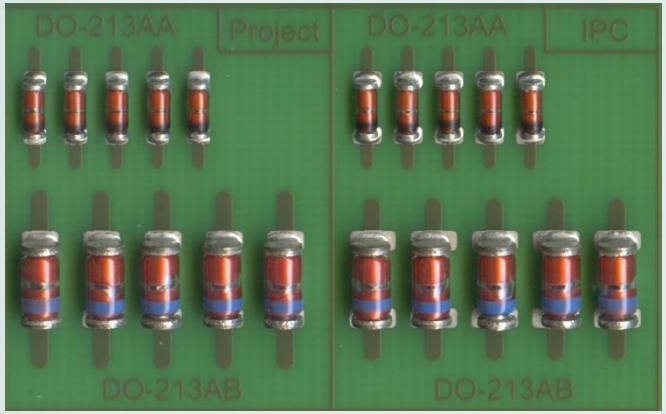
P I

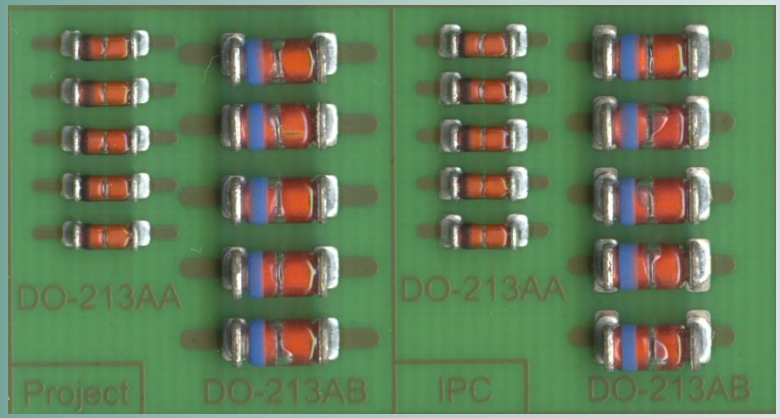


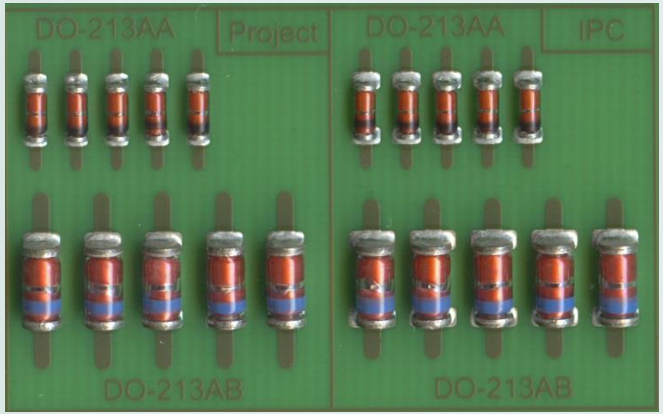
P= Proportional
I = IPC-7351

Group 2 – Cylindrical - MiniMelf and Melf



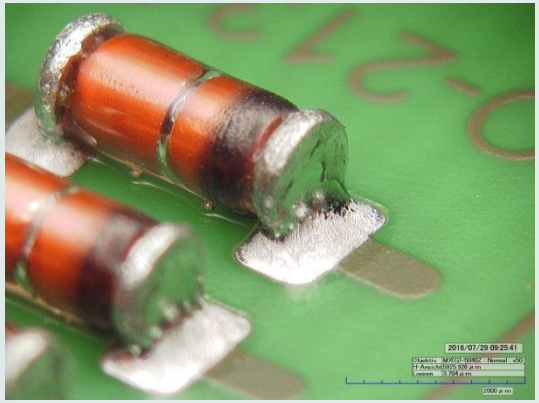






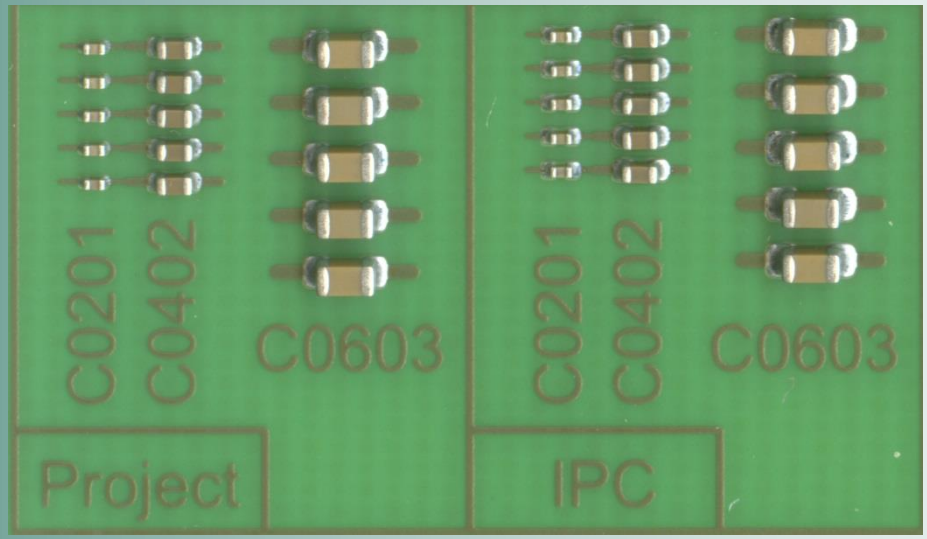
Group 2 – MiniMelf and Melf – solder joints

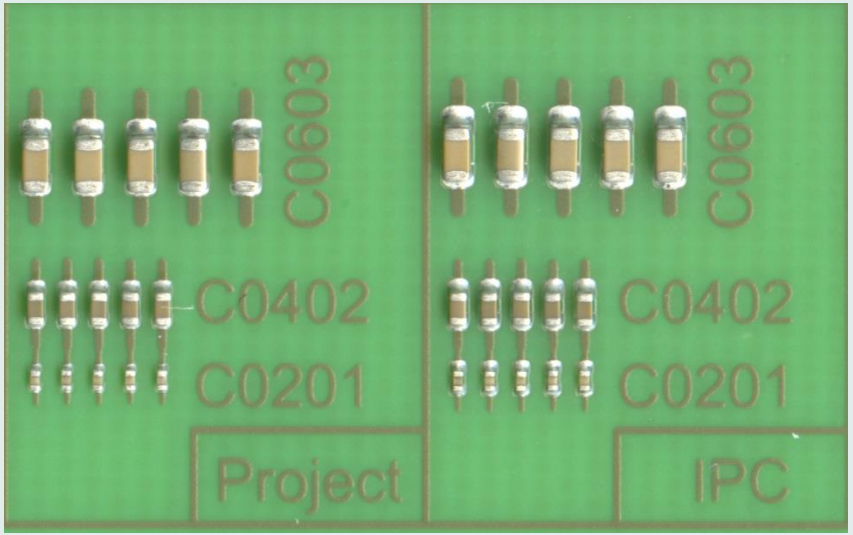
P I

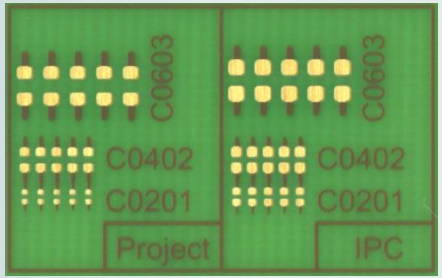


P I

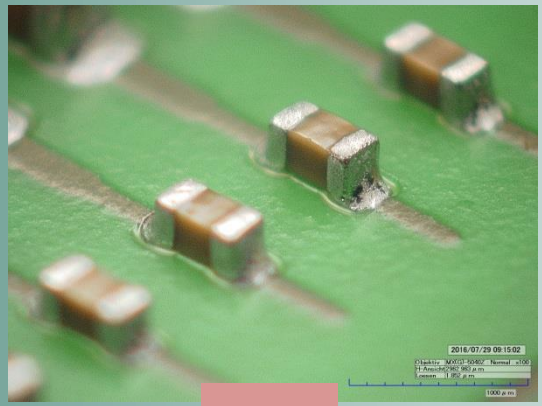
Group 3 – Rectangular/Square MLCC







Group 3 – MLCC solder joints



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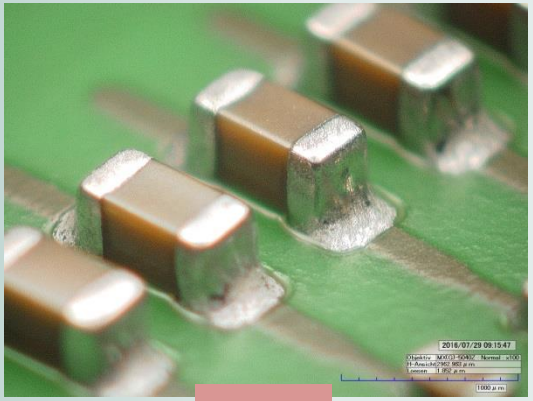

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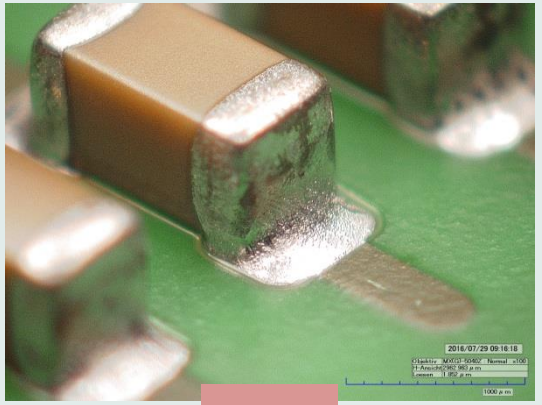

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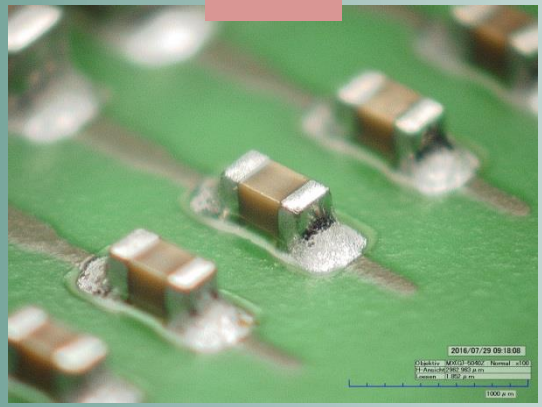
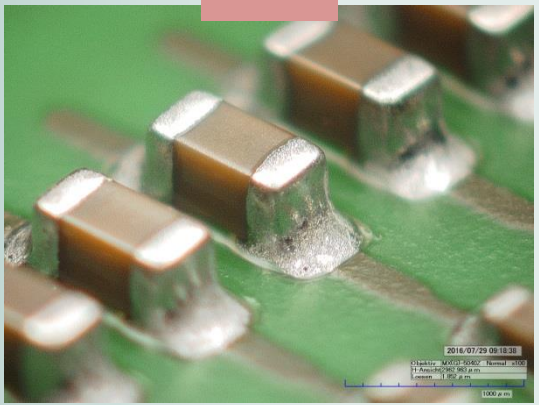
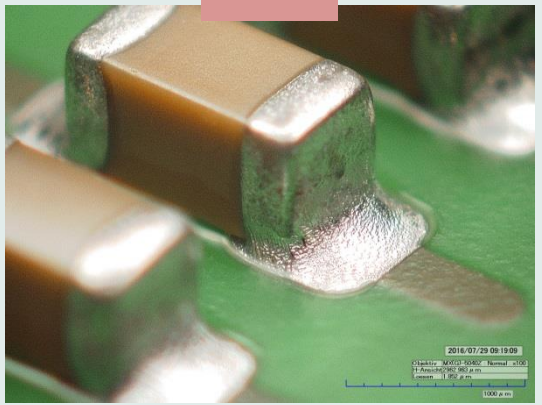
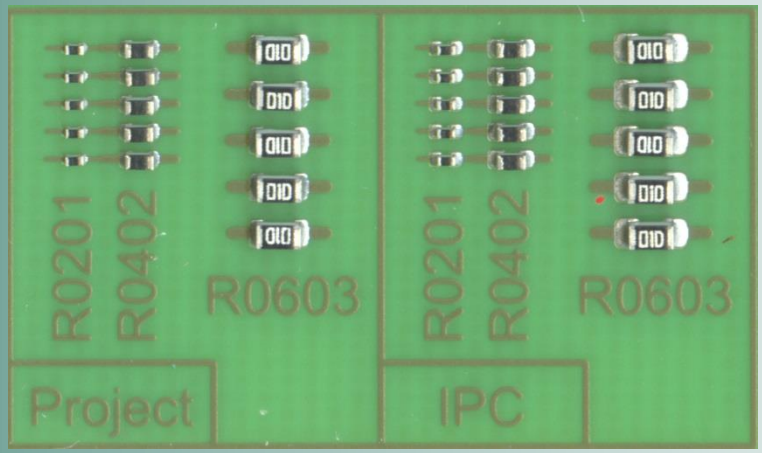
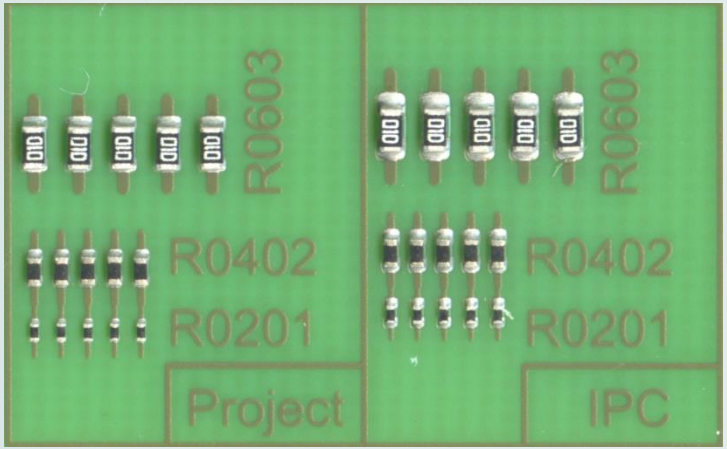




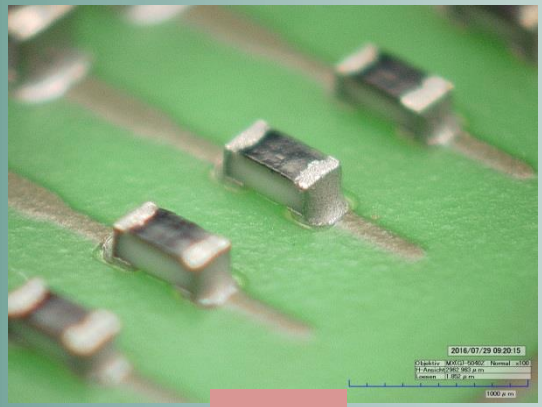


Group 4 – Rectangular/Square Resistor





Group 4 – Resistor solder joints



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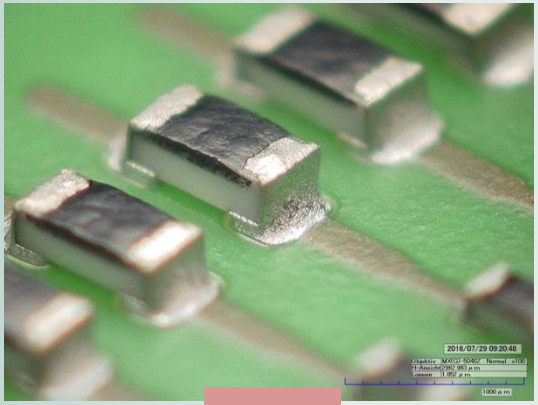

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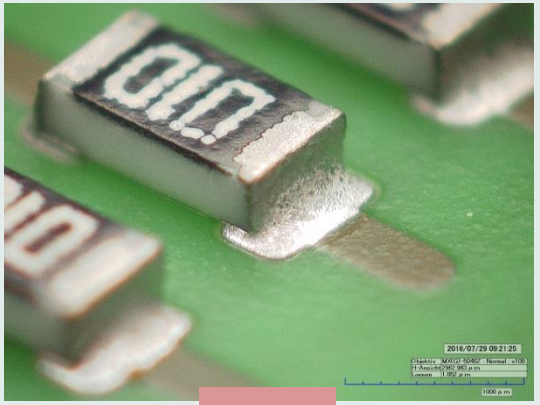

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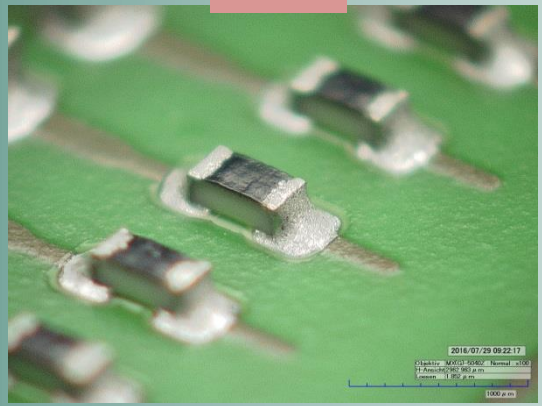
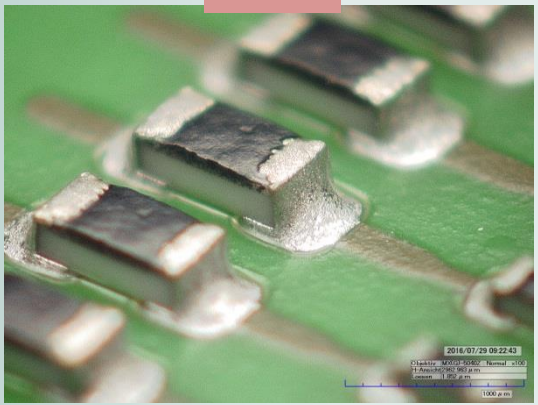
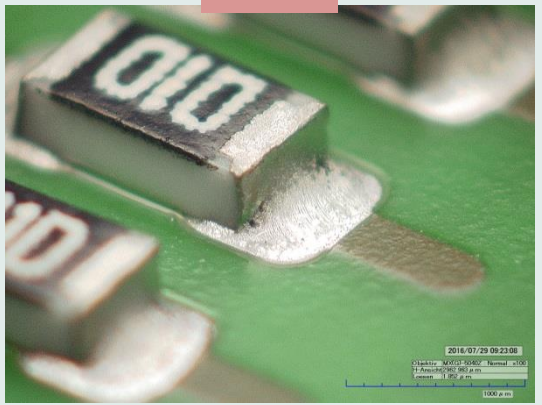
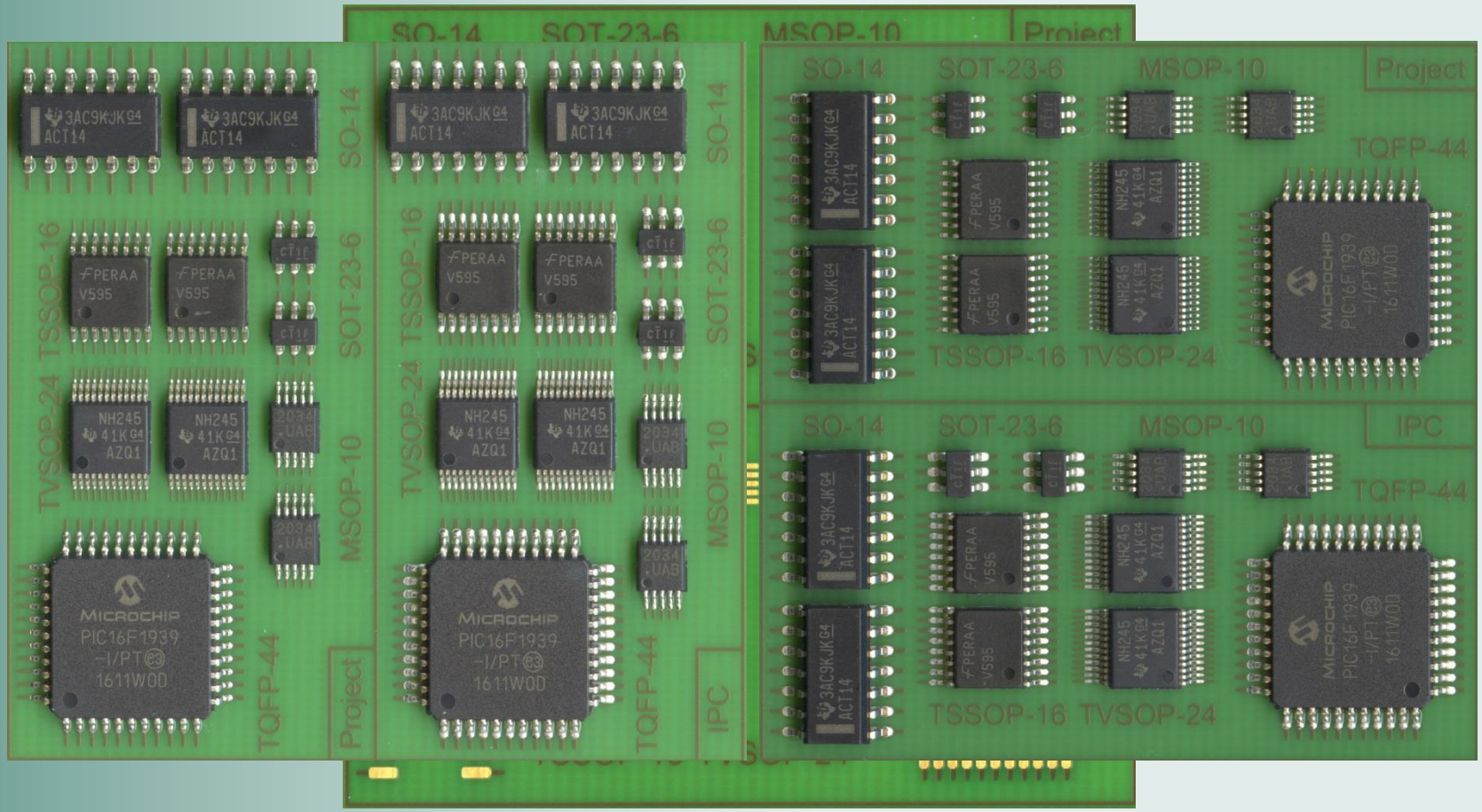


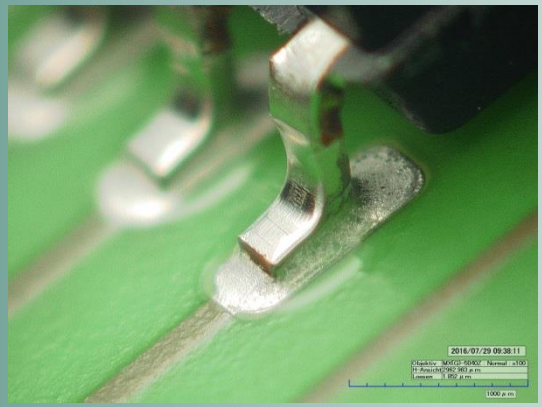


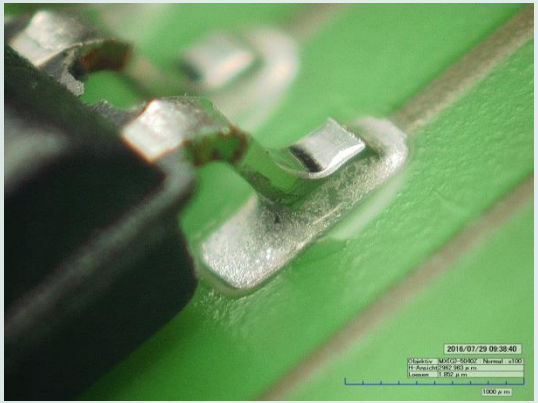


Group 5 – Gullwing



Group 5 – SO-14 solder joints – Pitch 1.27





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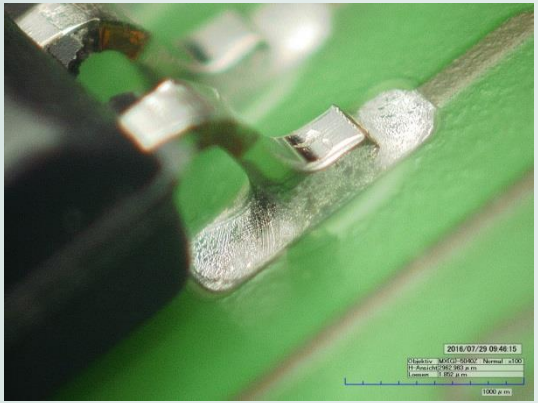
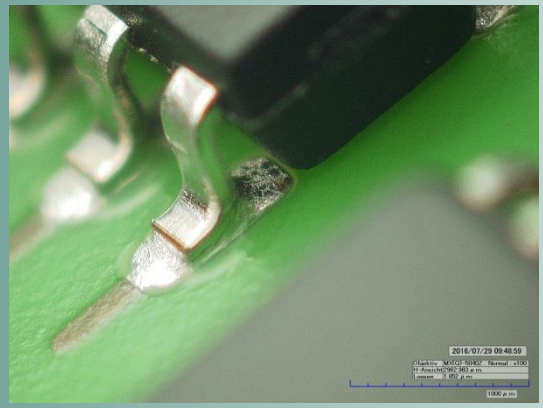
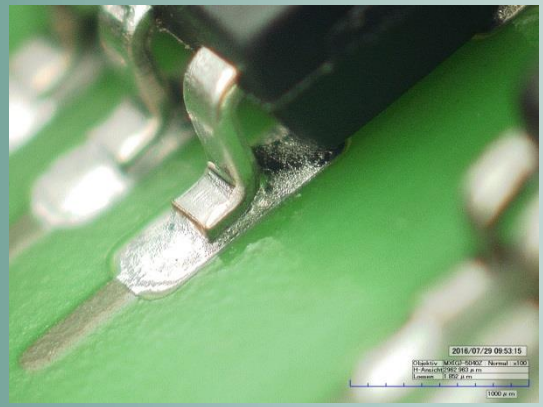


Group 5 – SOT-23-6 solder joints – Pitch 0.95





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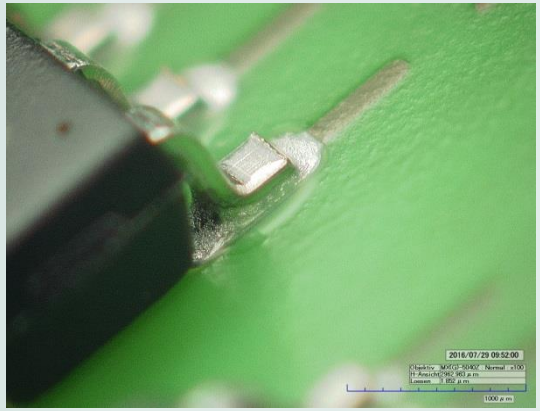
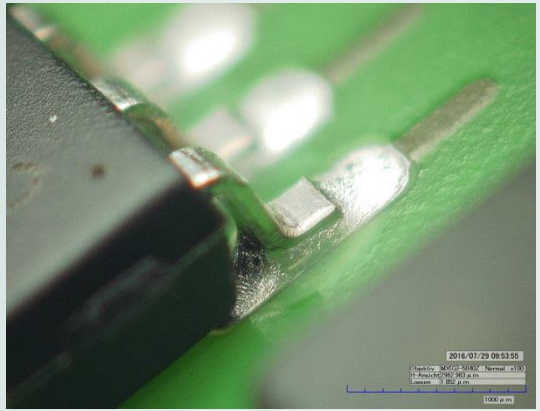
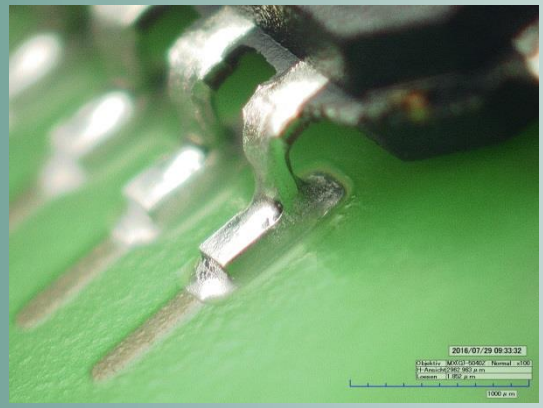




Group 5 – QFT-44 solder joints – Pitch 0.8



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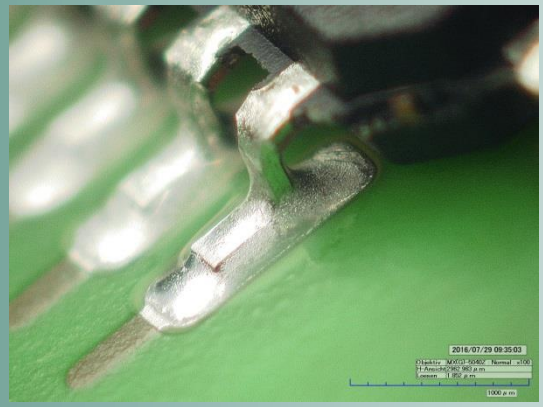
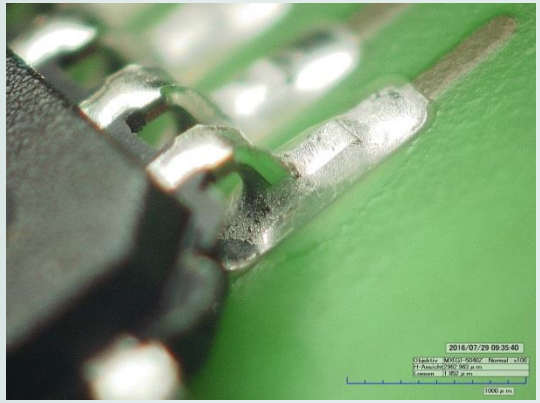
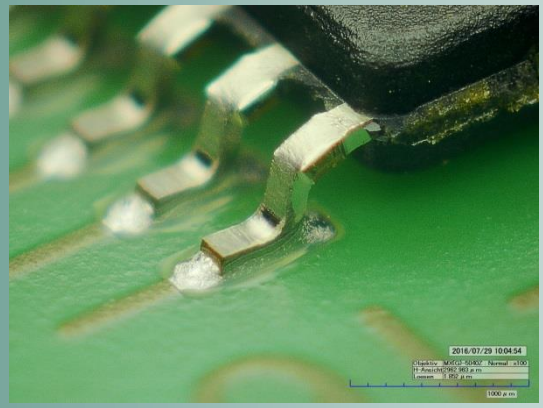
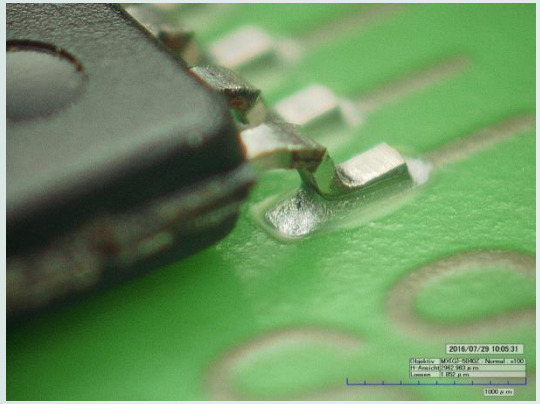




Gruppe 5 – TSSOP-16 gelötet – Pitch 0.65





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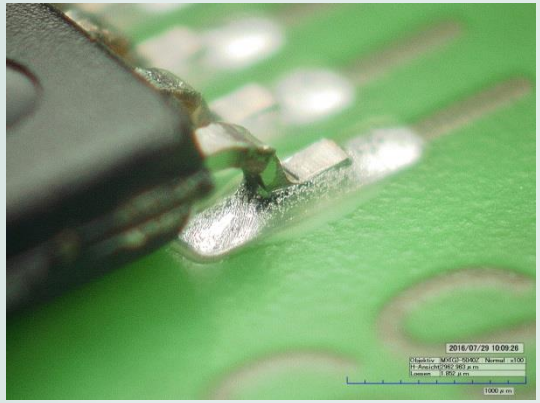
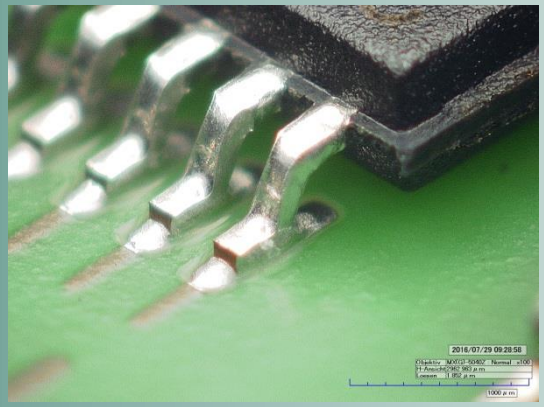
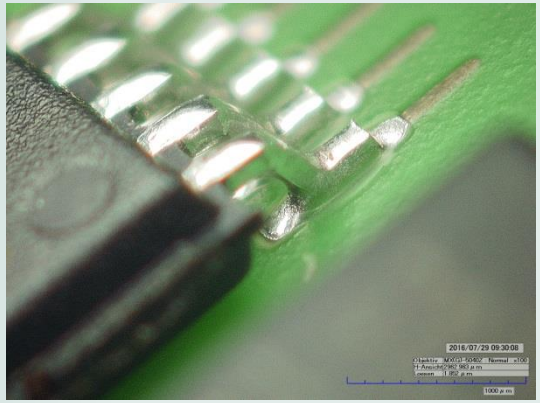


Group 5 – MSOP-10 solder joints – Pitch 0.5





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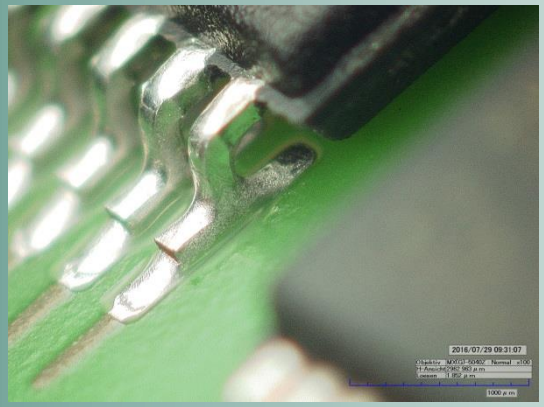
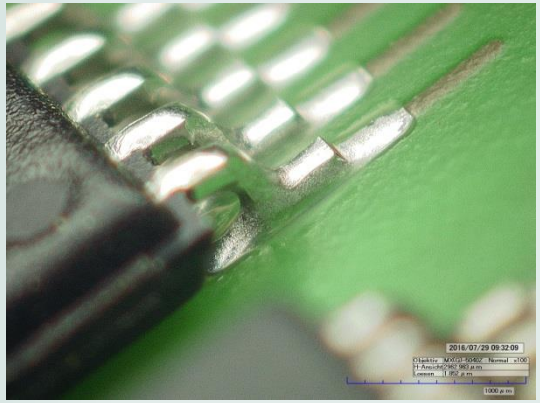
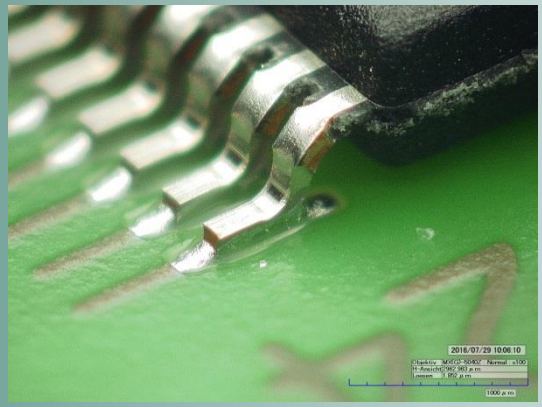
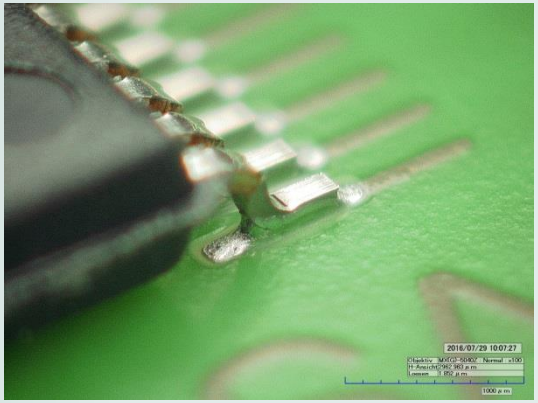




Group 5 – TVSOP-24 solder joints – Pitch 0.4





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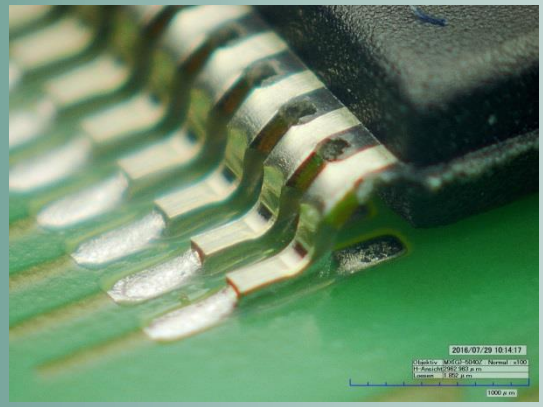
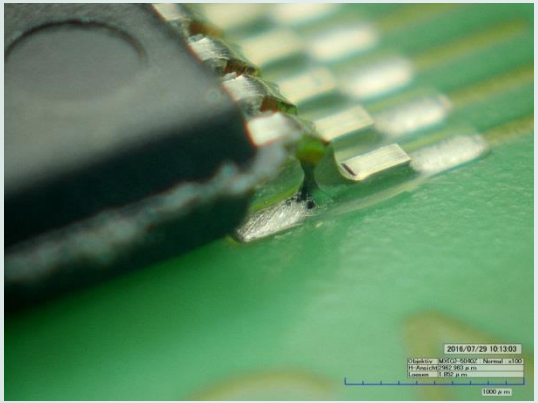
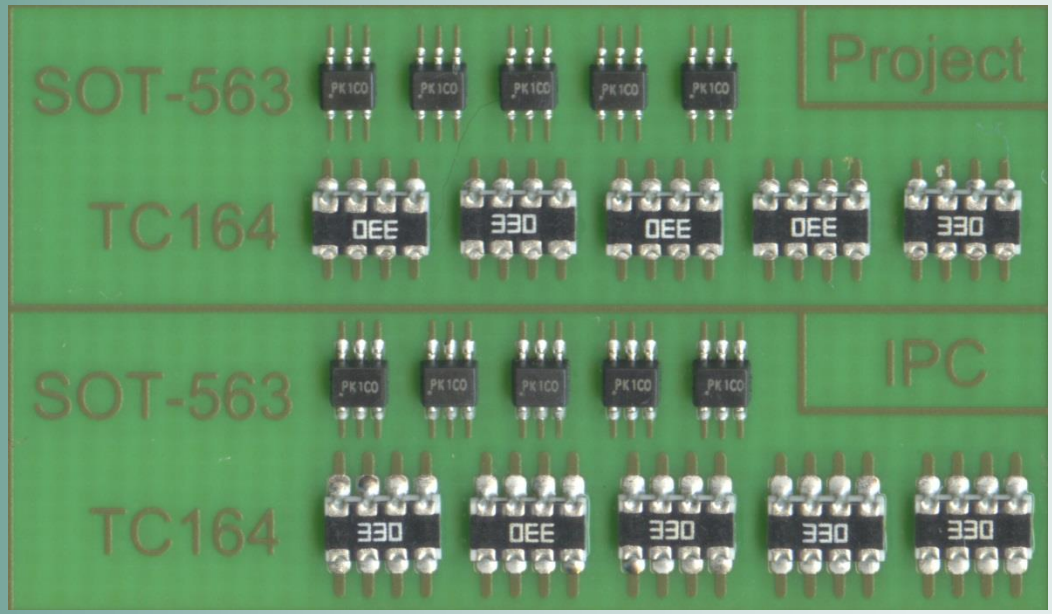
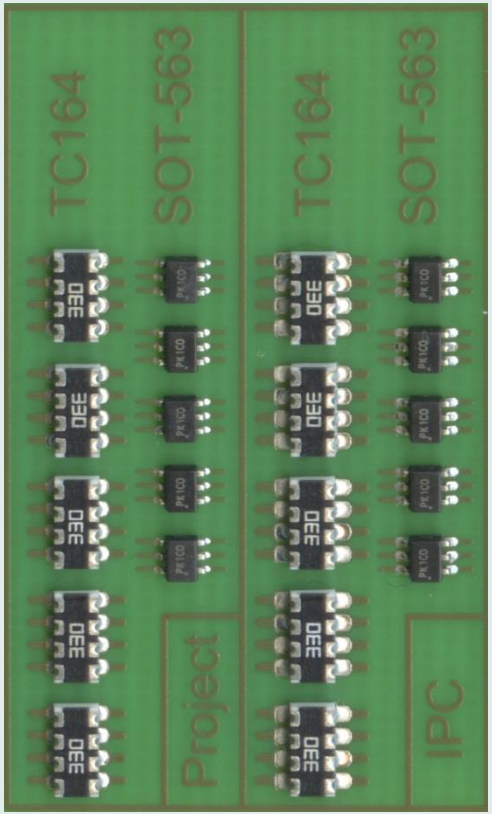


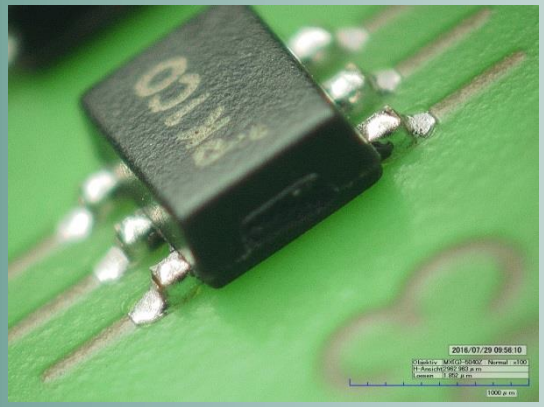


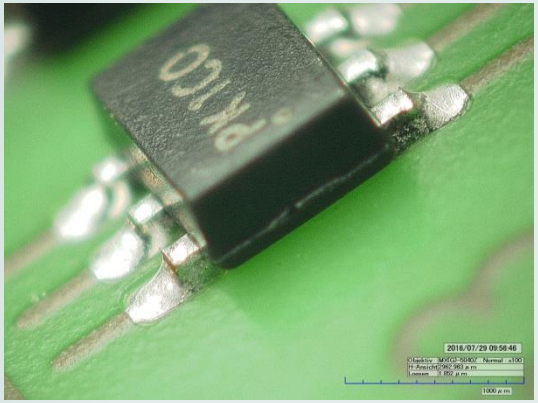
Group 6 – SOT-563 und TC164





Group 6 – SOT-563 und TC164 solder joints





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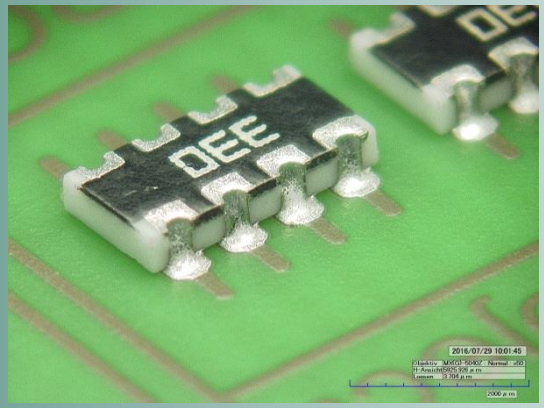
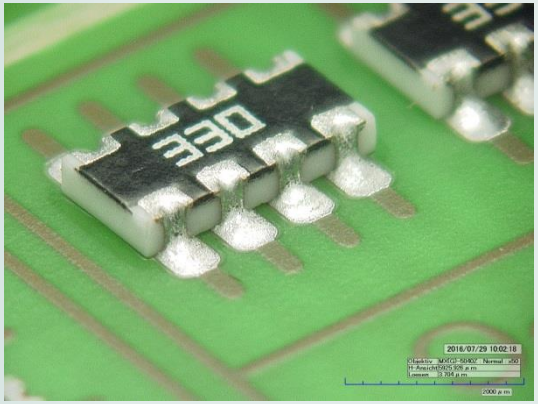
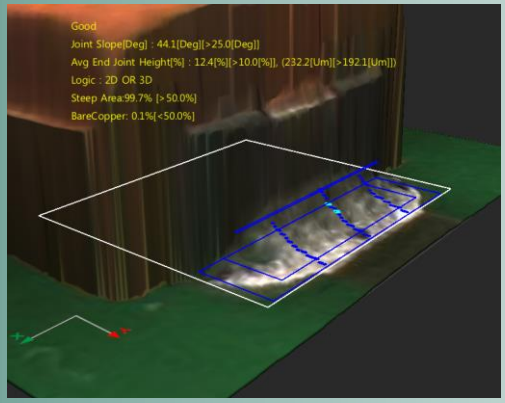




AOI– In-L -Tantal A und D



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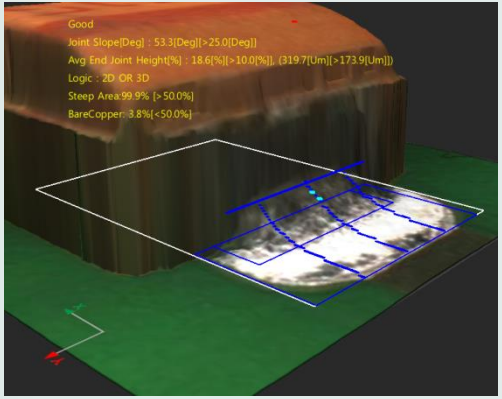

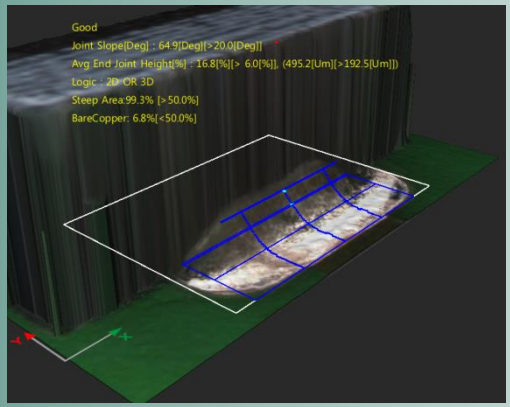

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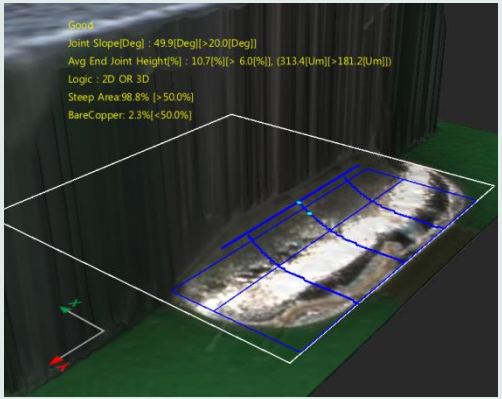
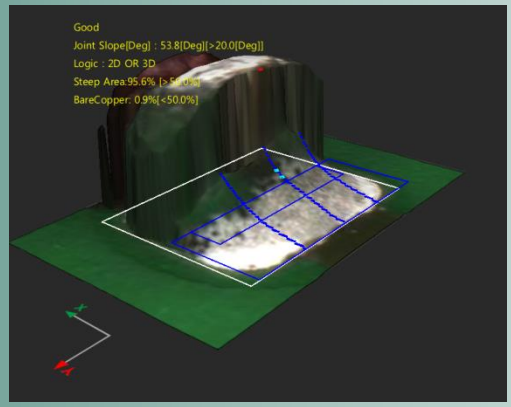


P= Proportional
I = IPC-7351

AOI– MiniMelf und Melf



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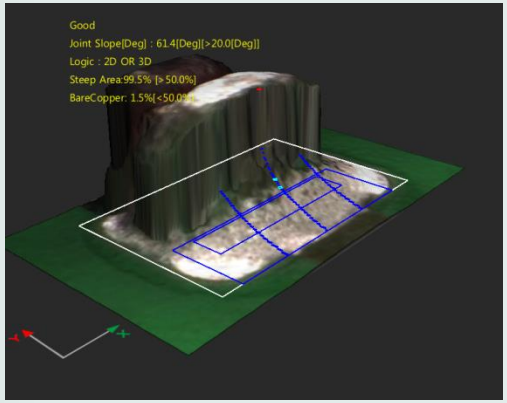

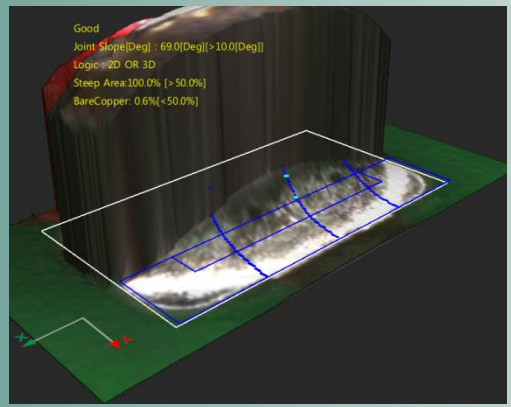

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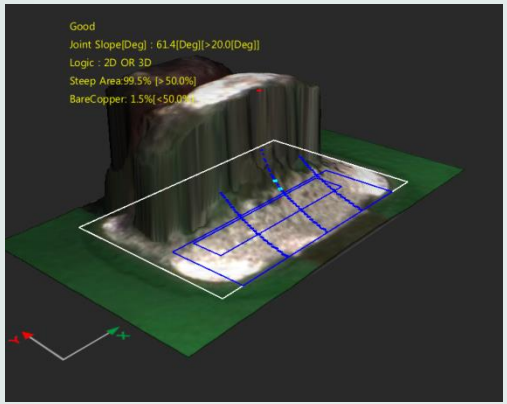
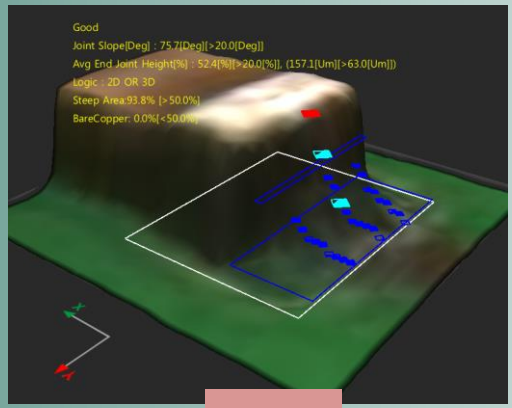


AOI – MLCC



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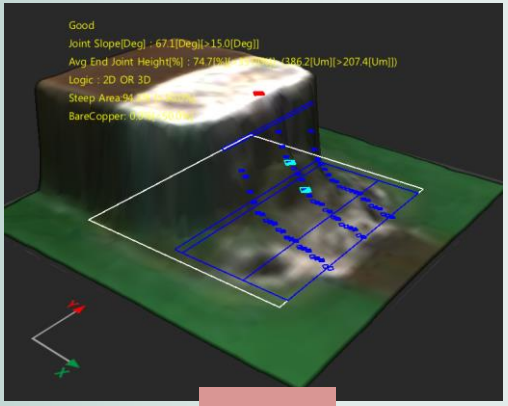

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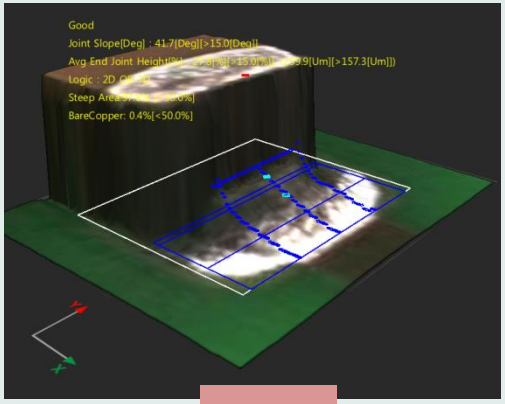

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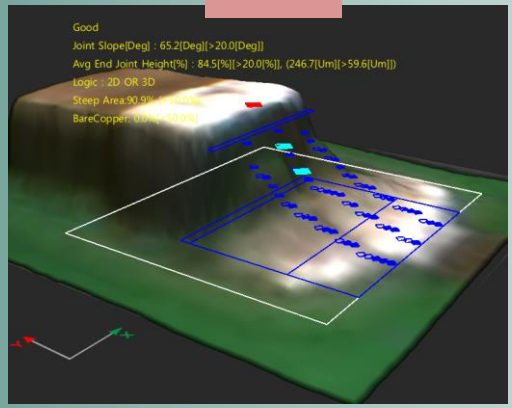

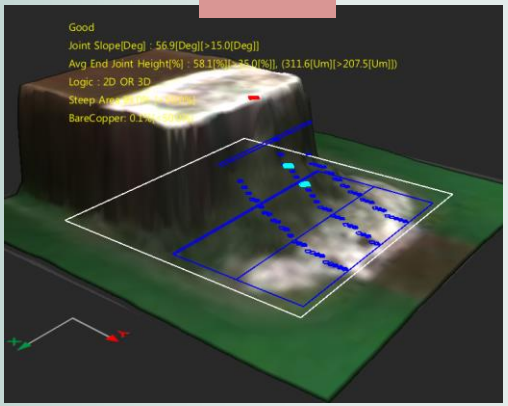

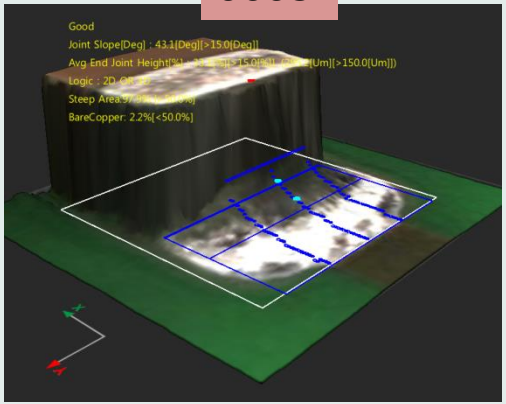

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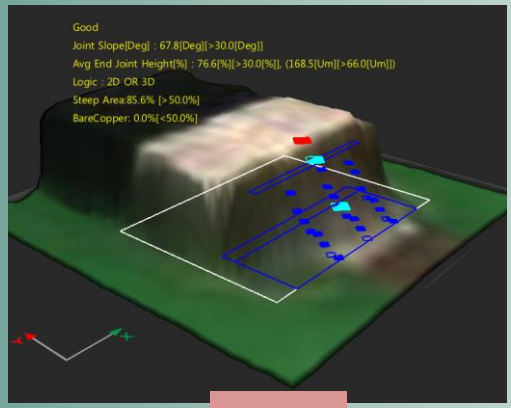
AOI – Resistor



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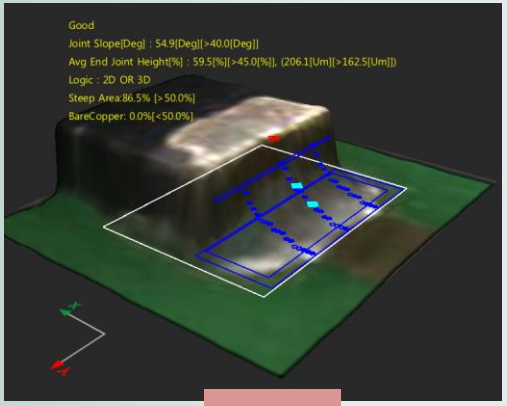

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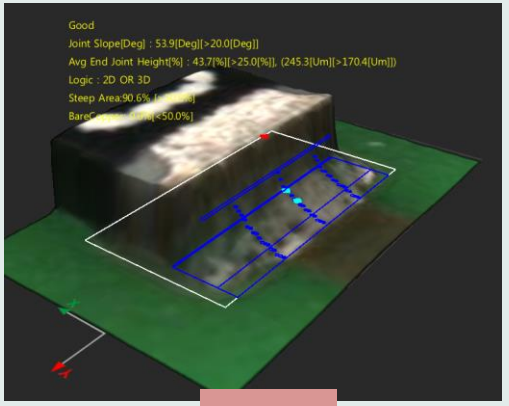

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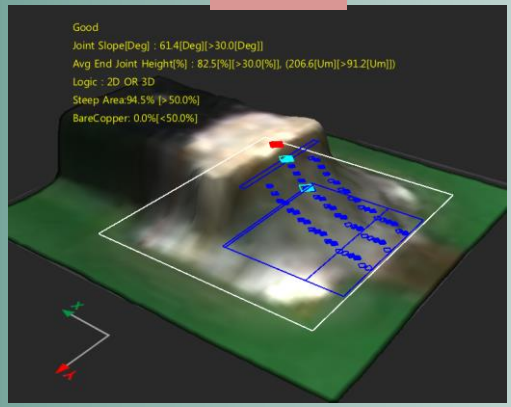
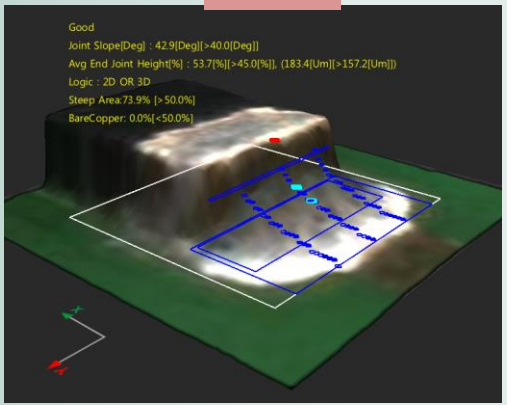
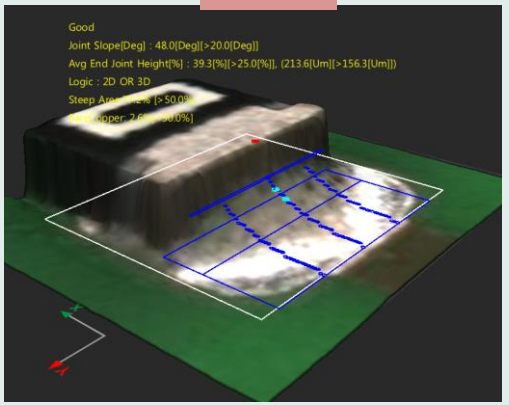


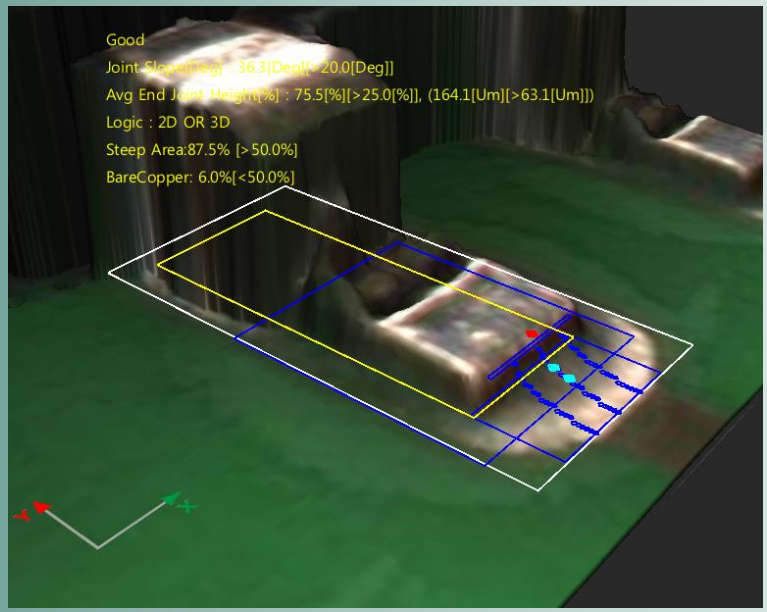




P

I

AOI– SO-14 – Pitch 1.27



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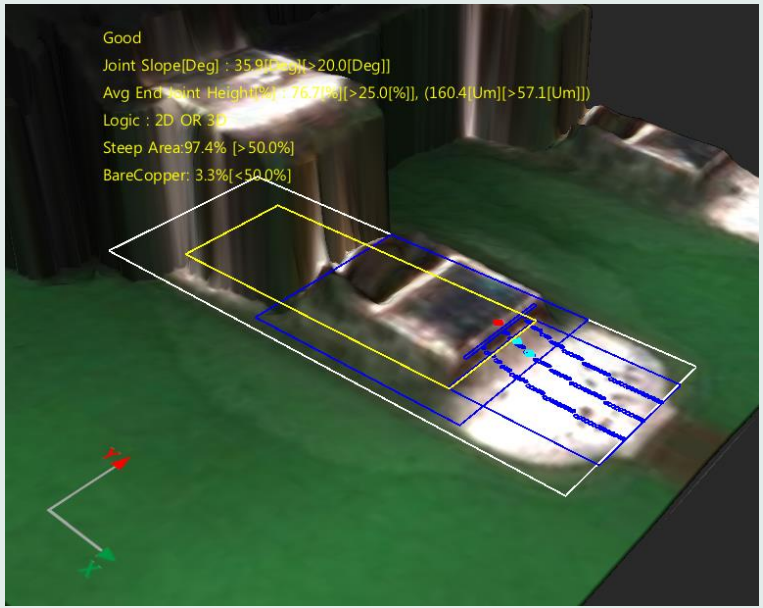
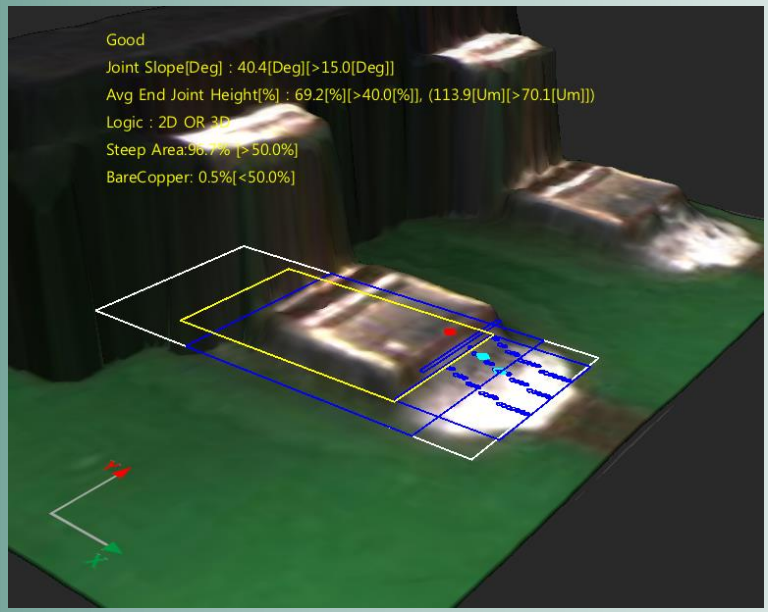


AOI– SOT-23-6 – Pitch 0.95



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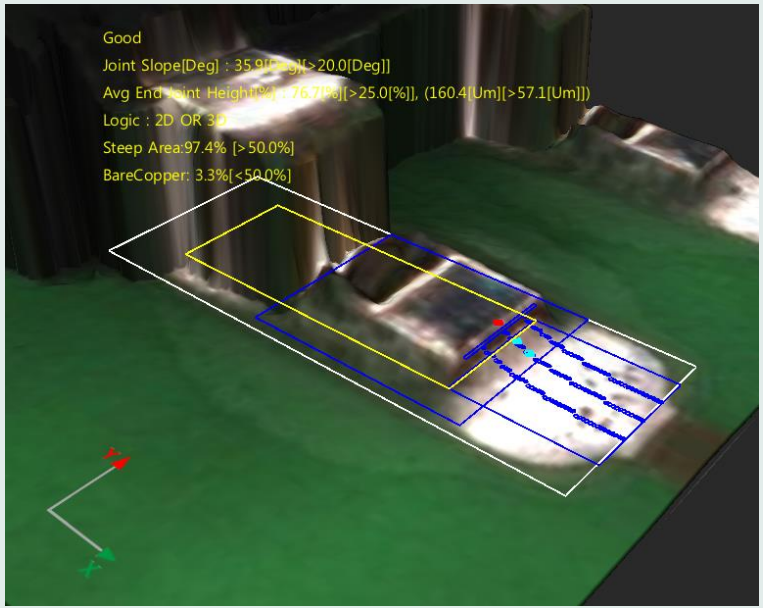
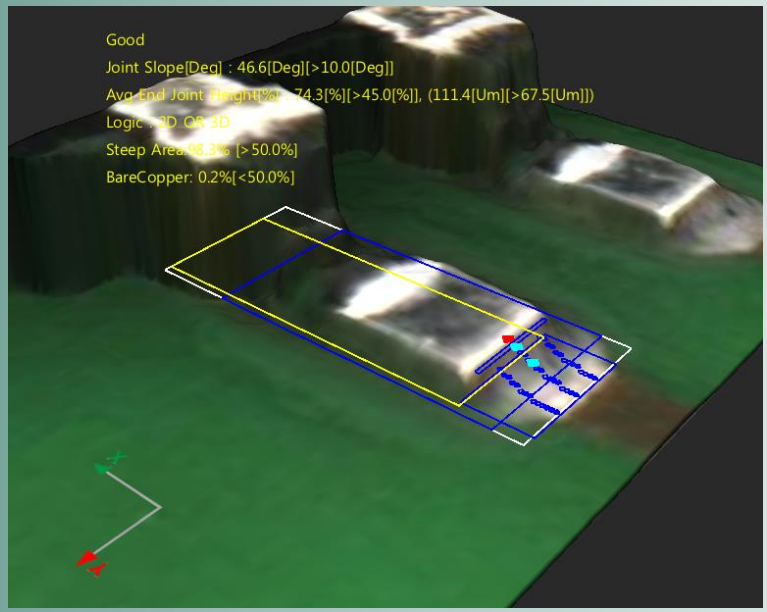
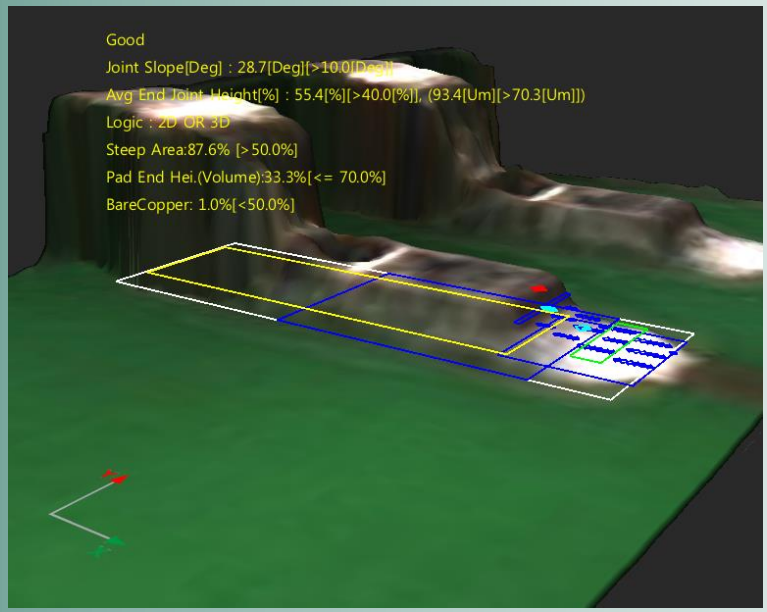


AOI– QFT-44 – Pitch 0.8



P I

AOI– TSSOP-16 – Pitch 0.65



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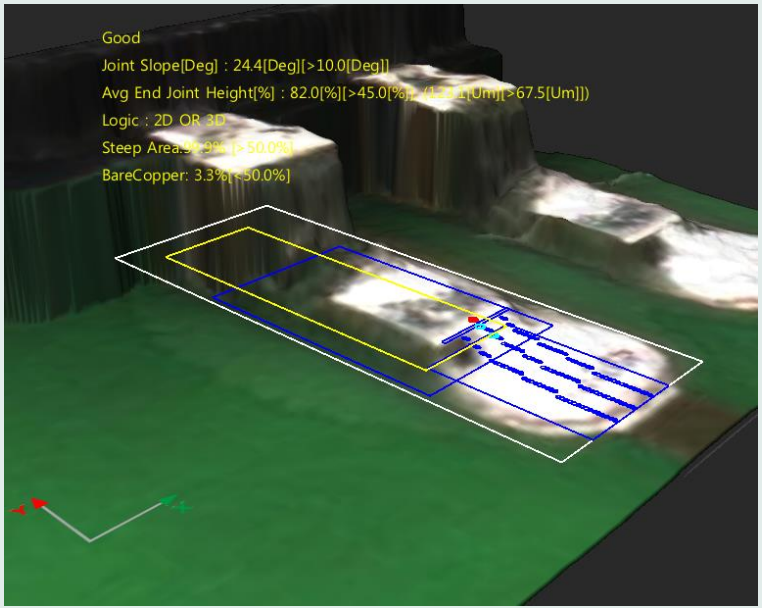
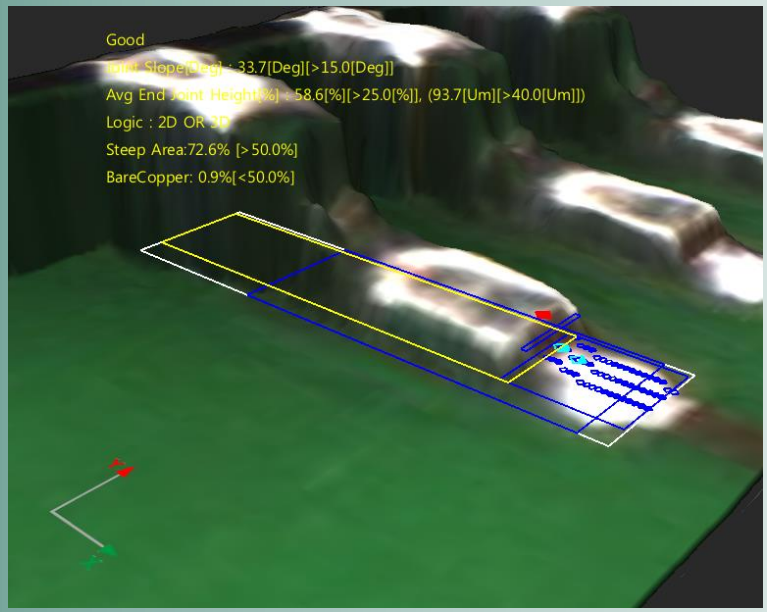


AOI– MSOP-10 – Pitch 0.5



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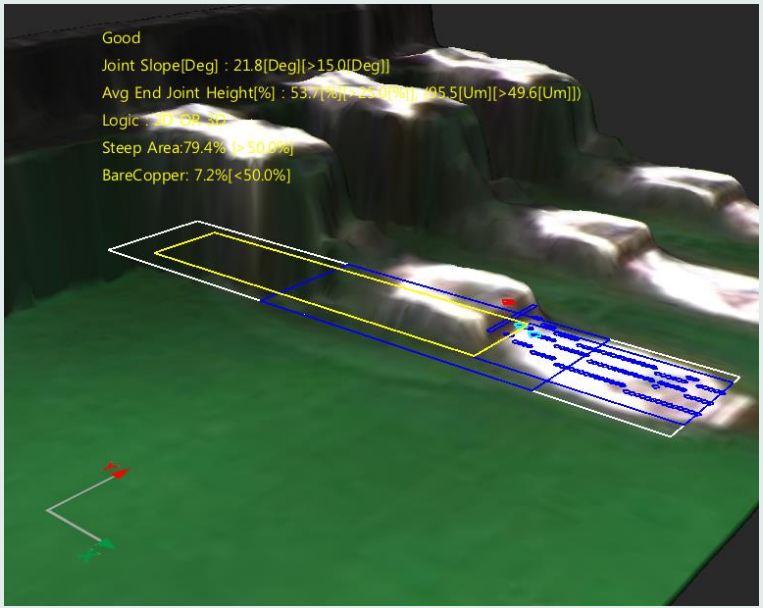
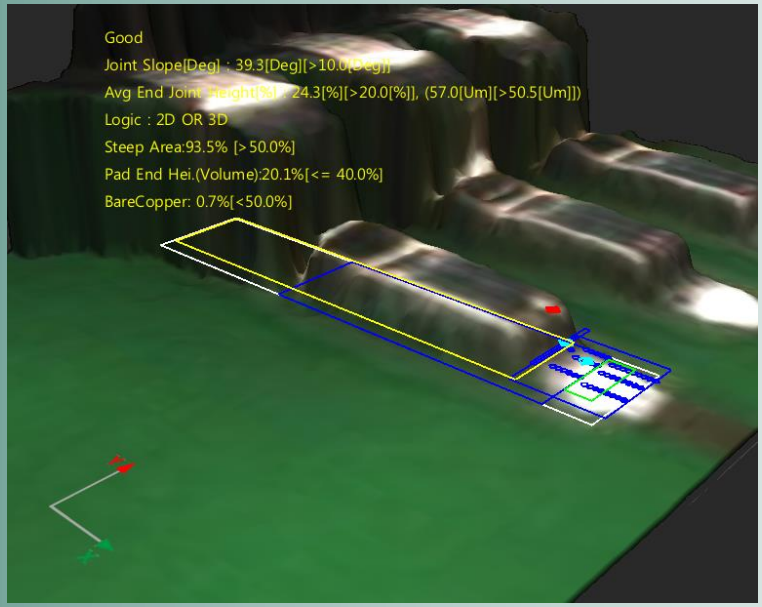


AOI– TVSOP-24 – Pitch 0.4



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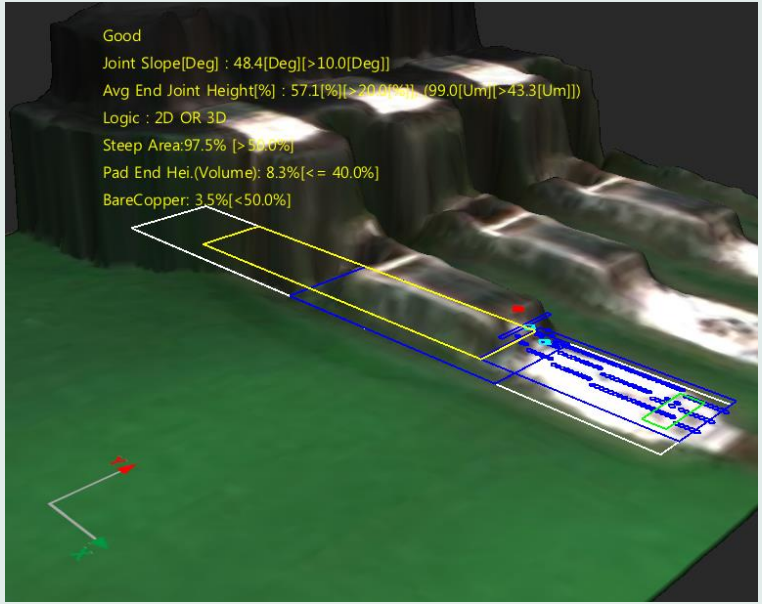
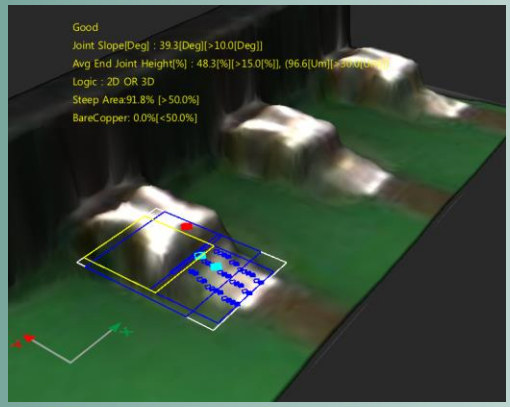
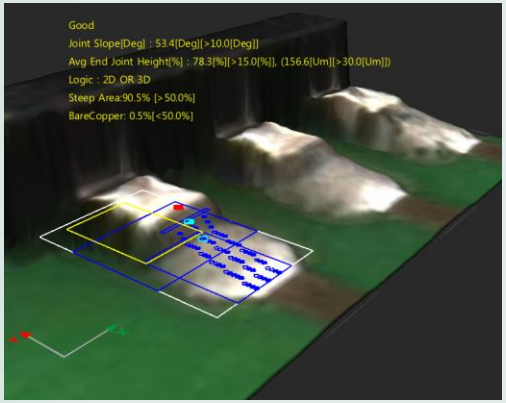


AOI – SOT-563 und TC164





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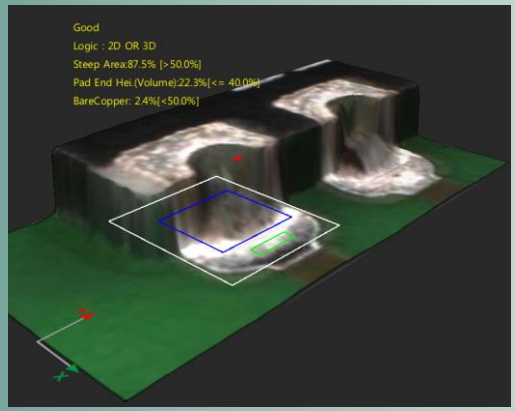
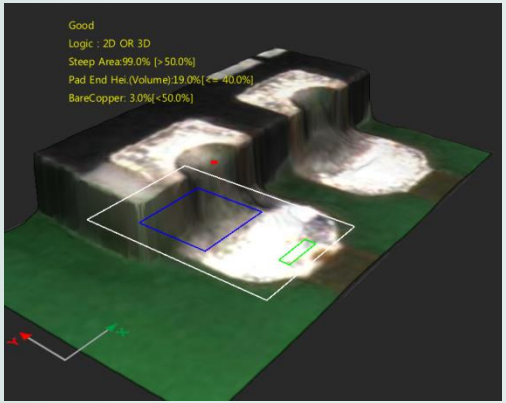




Investigation results of Marco Huber

3. Feststellung

3. Findings

The results of the investigation concerning placement and solder joints and their wetting behaviour are acceptable and fulfil the requested geometries (with little exceptions Melf)

Based on the total pictures the 4 assemblies of Taube and Prettl are very similar. Also the solder joints do not show significant differences – all components are properly processed.

4.

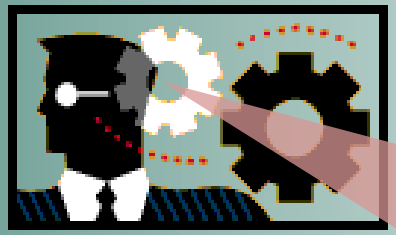
4. Recommendations

The results under 3. allows to document the accomplished pad definitions und to implement them in practical design or to publish them in a FED-guideline.

Marco Huber

Results

- Requirements of IPC-A-610 Class 2 & 3 fulfilled
- except Cylindrical – additional solder volume required
- AOI-results will follow



Do we have to run reliablity test to verify the proportional concept?

Acknoledgement

Thanks to all who supported the Proportional Project, especially to

Wolfgang Kühn for the perfect project plan

Olaf Hollinger, Carl Zeiss AG in Jena for the patience designing the testboard

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