Quick and Easy Land Pattern Creation

Introduction

- Quick part creation
- What are we doing
  - Determine land size
  - Determine land locations (Pattern)
- What's important
  - Devices can be attached to the PCB
    - Land size falls within manufacturability tolerances
    - Device leads land on lands

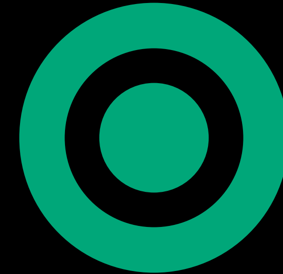
- This presentation is not designed to replace in-depth understanding of the PCB assembly process

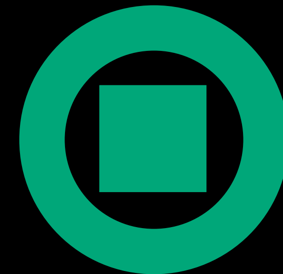
Over View

- Through hole pad stacks
- Through hole quick look
- SMC pads *rounded pads*
- Solder joint strength
- Surface Mount ICs
- BGA
- Chip Devices / leadless / Chip Scale
- Connectors
- Silkscreen
- Placement keep outs (courtyard)

Through Hole Lands

- Through hole pad stacks
- Lead size versus hole size
- Hole should be larger than lead to allow solder to flow
  - 16 mils over lead diameter
- Square leads are dimensioned on the side
  - Square lead diameter is measured on the diagonal
- Use recommended hole size
  - Always round up
- Annular ring
  - 10 mils is safe
  - Larger means easier hand soldering
- Thermal relieve all plane connection
- Anti-pads diameter is 30 mils over drill





Through Hole Parts

- Dual Inline Part (DIP)
  - Pins count counter clockwise from pin 1
    - – Pin 1 indicated with square pad
  - 300 mil and 600 mil row pitch with 100 mil pin spacing
  - Through hole pad stack has a 60 mil pad with a 40 mil hole
    - – Parts have spring tension built into leads
    - – Prevents floating during wave solder
- Holes in land pattern does not line up with lead
- Silk screen image max dimension plus 20 mils
- Polarity mark in silk screen

Through Hole Parts

Find the data you need!

400 mil body length

Count in counter clockwise direction from pin 1

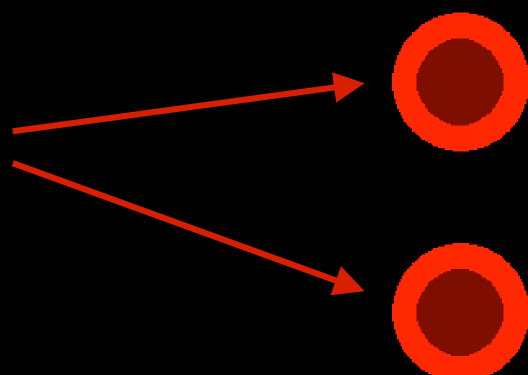
100 mil centers

25 mils over 300 to help hold the part in place

0.373 – 0.400
(9.474 – 10.16)
0.090
(2.286)
8 7 6 5
0.092
(2.337) DIA
PIN NO. 1 IDENT
OPTION 1
0.250 ± 0.005
(6.35 ± 0.127)
1 2 3 4
0.280
(7.112) MIN
0.030
(0.762) MAX
0.040
(1.016) TYP
0.300 – 0.320
(7.62 – 8.128)
20° ± 1°
0.039
(0.991)
0.130 ± 0.005
(3.302 ± 0.127)
95° ± 5°
0.065
(1.651)
0.125 – 0.140
(3.175 – 3.556)
0.009 – 0.015
(0.229 – 0.381)
0.125
(3.175)
DIA
NOM
90° ± 4°
TYP
0.018 ± 0.003
(0.457 ± 0.076)
0.325 +0.040 −0.015
(8.255 +1.016 −0.381)
0.100 ± 0.010
(2.540 ± 0.254)
0.045 ± 0.015
(1.143 ± 0.381)
0.060
(1.524)
0.050
(1.270)

Through Hole Parts

Actual land pattern might look like this



Polarity mark

Square pin 1

100 mil pin spacing

300 mil row pitch

Through Hole Parts

- Power components
  - TO-220 (EMI Hot tip)
  - TO-3
- Build the land pattern
  - Hole diameter and pin spacing\pattern
    - Center of pad stack lines up with center of leads
  - Polarity markings
  - Silkscreen part image to assist assembly
- Heat sink attach and image

Through Hole Parts

Find the data

100 mil centers

Pin 1 location

55 mil max shoulder width

37 mil max pin width

3-Lead TO-220
NS Package Number T03B

Through Hole Parts

Actual land pattern might look like this

Polarity mark

Square pin 1

100 mil pin spacing

Through Hole Parts

- .1” spacing headers
  - Pins at 100 mil spacing
  - Row pitch of 100 mils
  - Data sheet needed for part image
  - Keying plastics
- Capacitors
  - Lead diameter and pin spacing
  - Image
  - Polarity (sometimes)
- Resistors
  - Lead diameter and pin spacing
  - image
- Inductors
  - Lead diameter and pin spacing
  - Image
  - Polarity (sometimes)

Through Hole Parts

Actual land patterns might look like this

Surface Mount Lands XeTel Story

- One of the earlier SMC manufacturers
- Goal of zero solder defects
- Factors in their control
  - Land patterns
  - Solder paste
  - Process understanding
- Changes made
  - Reduce solder volume
  - Paste opening smaller than pads
  - Custom paste opening to place paste where it is needed most
  - Smaller pads for all land patterns
- Land pattern shapes to work with solder in its liquid state

Surface Mount Lands

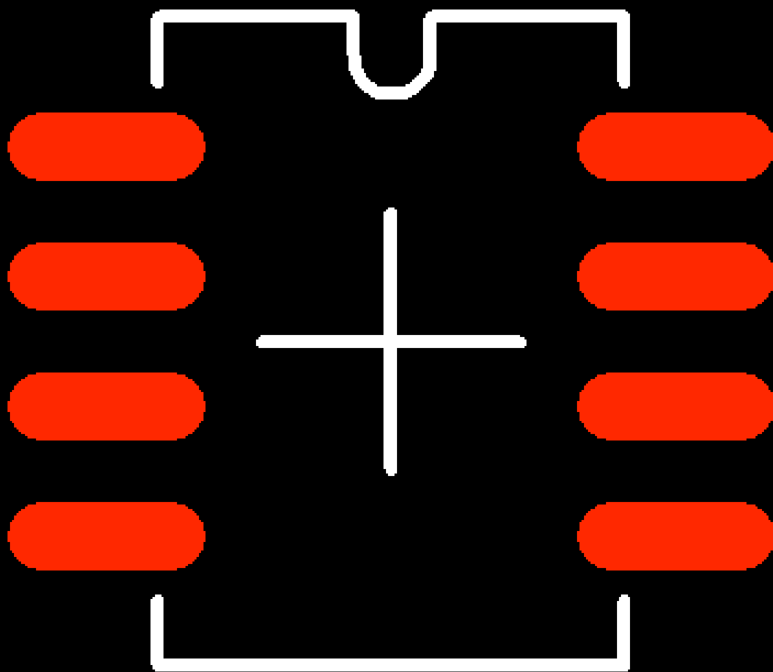
Incomplete wetting of lands

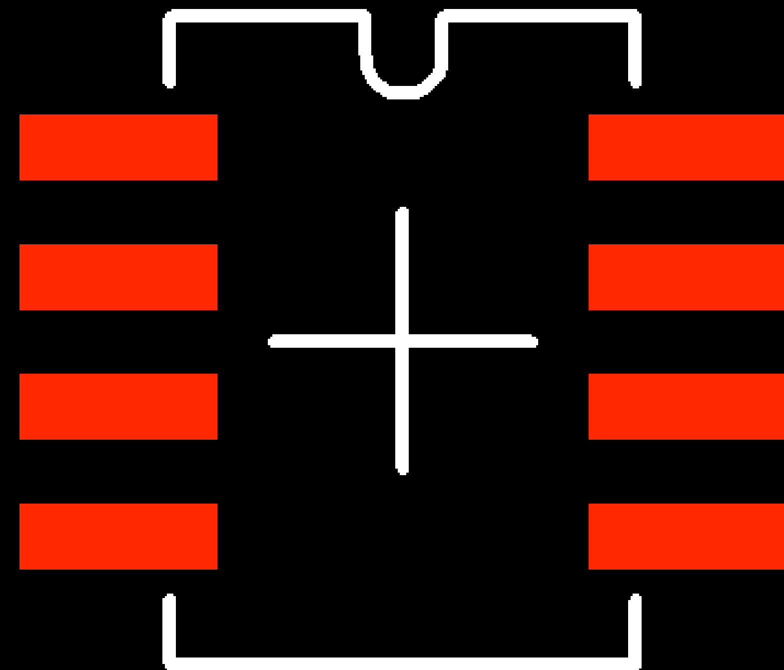
Solder is rounded on top

Solder is rounding on ends

Surface Mount Lands

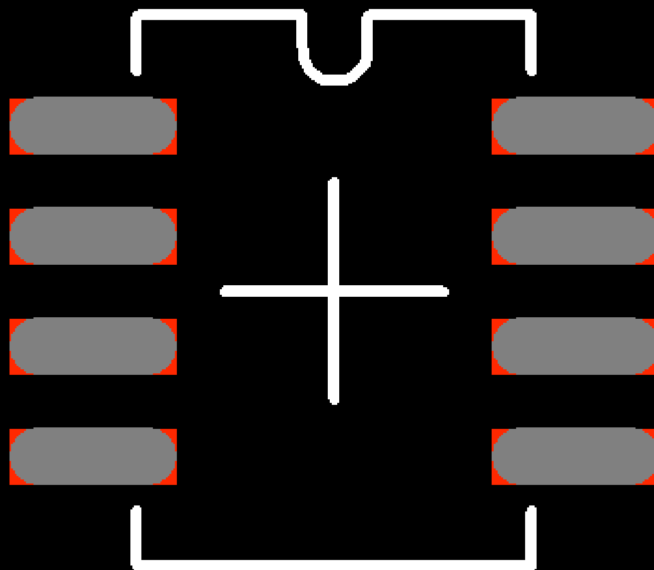
- Square corner lands versus rounded corner lands
- Rounded end pads look smaller





Rounded Surface Mount Lands

- Benefits
  - Clean release from solder paste stencil
  - Reduces solder volume
  - A more natural shape for solder in its liquid form
  - Concentrates solder where it is most needed
  - Improved solder wetting when using organic protective coating



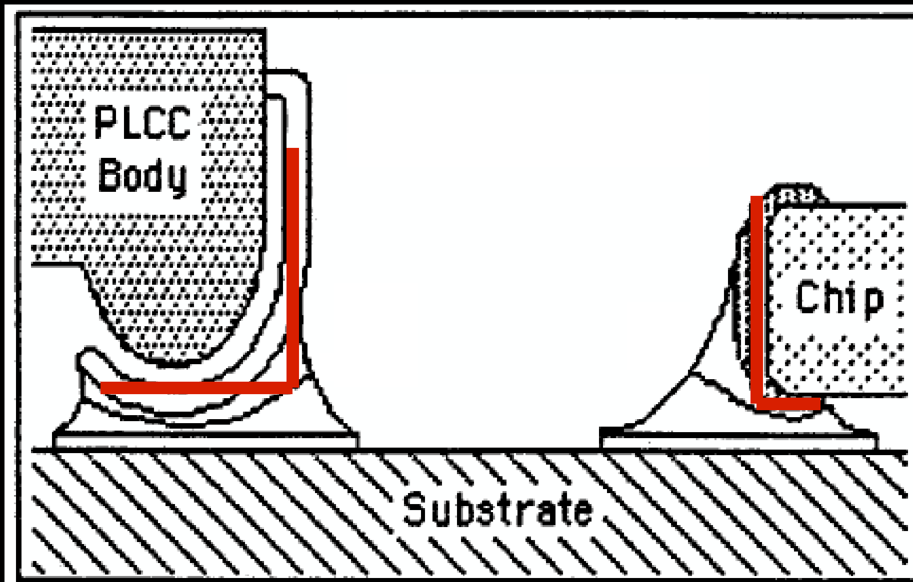
Rounded Surface Mount Lands

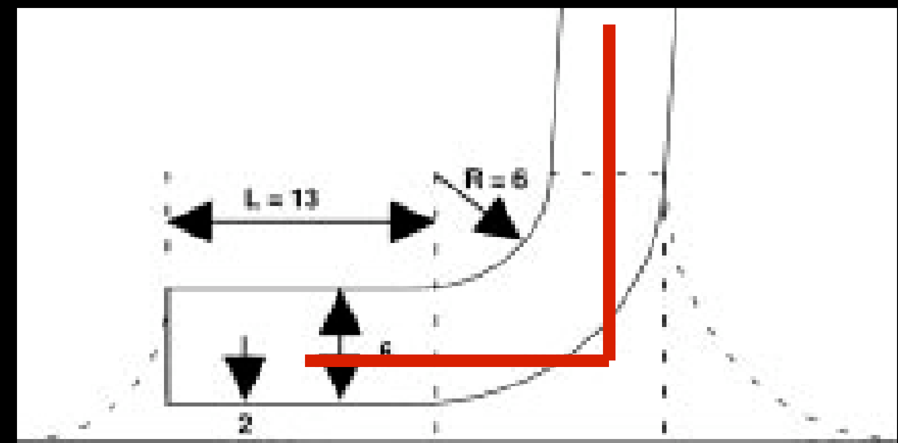
- Routing and advantages

- 50 mil pitch, 5 mil trace & space, 25X75 mil pads, 25 mil via

Surface Mount Lands Anatomy

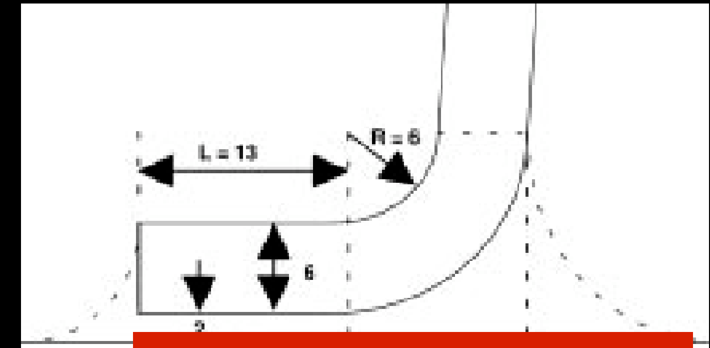
- Solder filets
  - Heel
  - Toe
  - Side
- The heel is the strength of the solder joint
- Heel faces in on gull wing parts
- Heel faces out on PLCC and Chip components



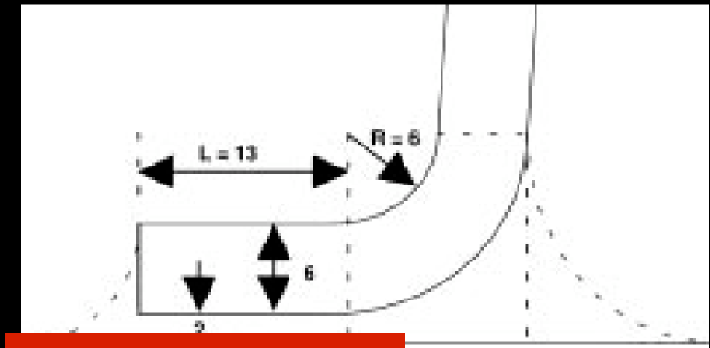


Surface Mount Lands Anatomy

- Relative pad location
- A land with little or no toe fillet is OK
- A land with little or no side fillets is OK



- A land with little or no heel fillet is a problem



Surface Mount Land Calculation

- Basic formula
- Nominal lead size is the median of the min and max
  - nominal lead length plus 40 mils, nominal lead width plus 10 mils
    - Length is measured heel to toe
  - Round off numbers based on process
- Solder mask same as pad size (determined by manufacturer)
- Paste mask same as pad size (determined by assembler)
- Locate land relative to the lead center
  - Subtract nominal lead length from part nominal width to find row center
  - Round off numbers based on process
  - Always round toward heel
- Origin of the land pattern is centered relative to the part
- Silkscreen image of part with polarity when necessary
- This method uses the same approach as through hole parts
- Quick and Easy

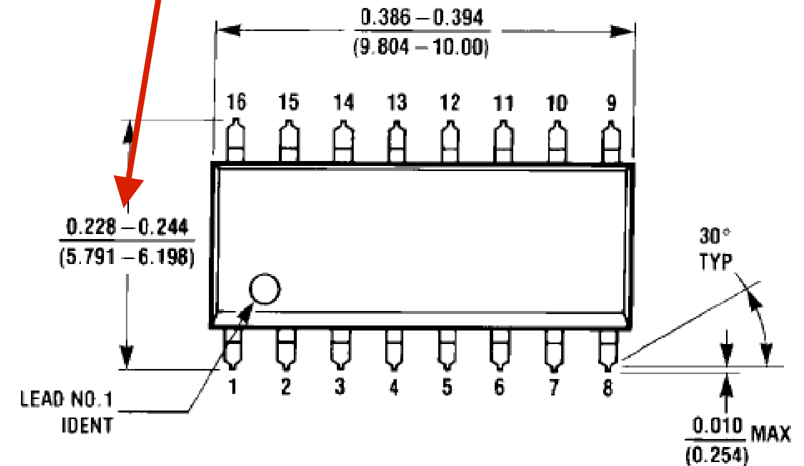
Surface Mount Land Calculation

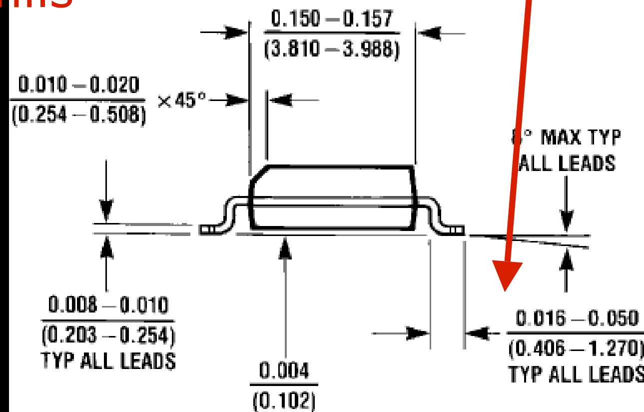
Nominal lead length 33 mils

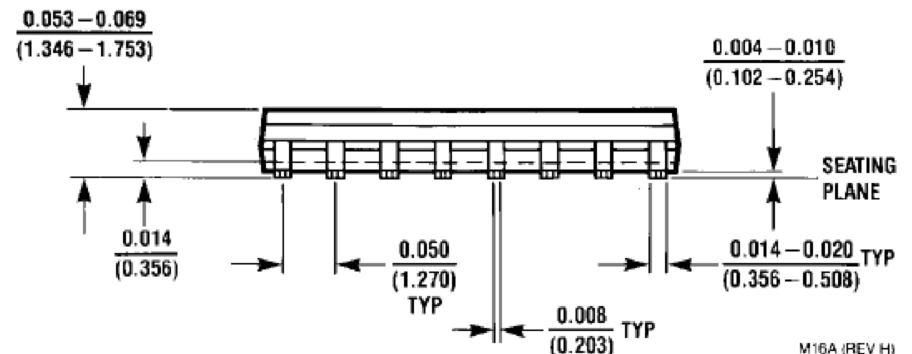
Nominal width 234 mils

Nominal lead minus nominal width equals center to center of 200 mils

Nominal lead size plus 40 mils to the length and 10 mils to the width equates to a pad size of 25X75 mils







Surface Mount Land Calculation

Actual land pattern might look like this

Polarity mark

Pad size is 25X75 mils

50 mil pin pitch

200 mil row pitch

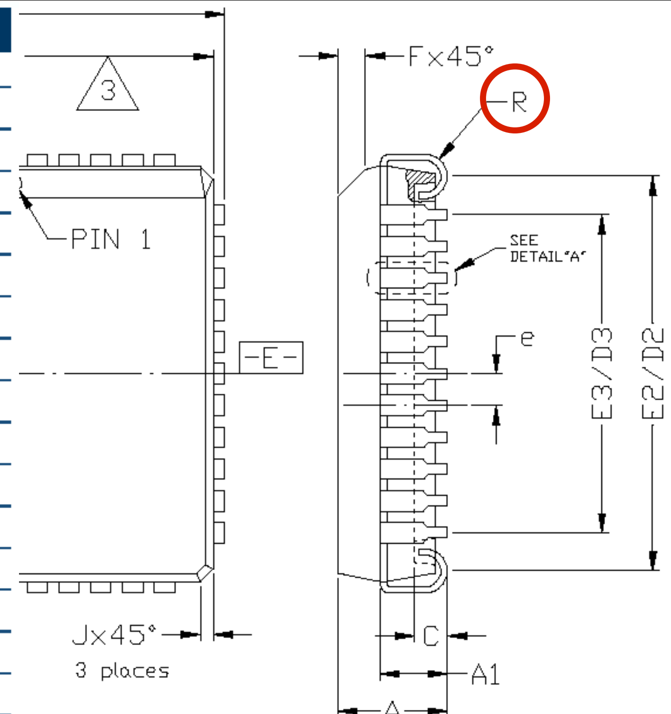
Surface Mount ICs

- Surface Mount ICs
- SO or gull wing packages, 50 mil pitch
- PLCC or J-lead packages, 50 mil pitch
  - Above packages can all use 25X75 mil pads
- SSO or QFP gull wing packages
  - .8mm lead pitch use 20 mil wide pads
  - .65mm lead pitch use 16 mil wide pads
  - .5mm lead pitch use 14 mil wide pads
- All of these packages have counter clockwise pin order

Surface Mount

- J lead parts use the 2 times the lead radius for lead size
- Row centers are given so no calculations are necessary

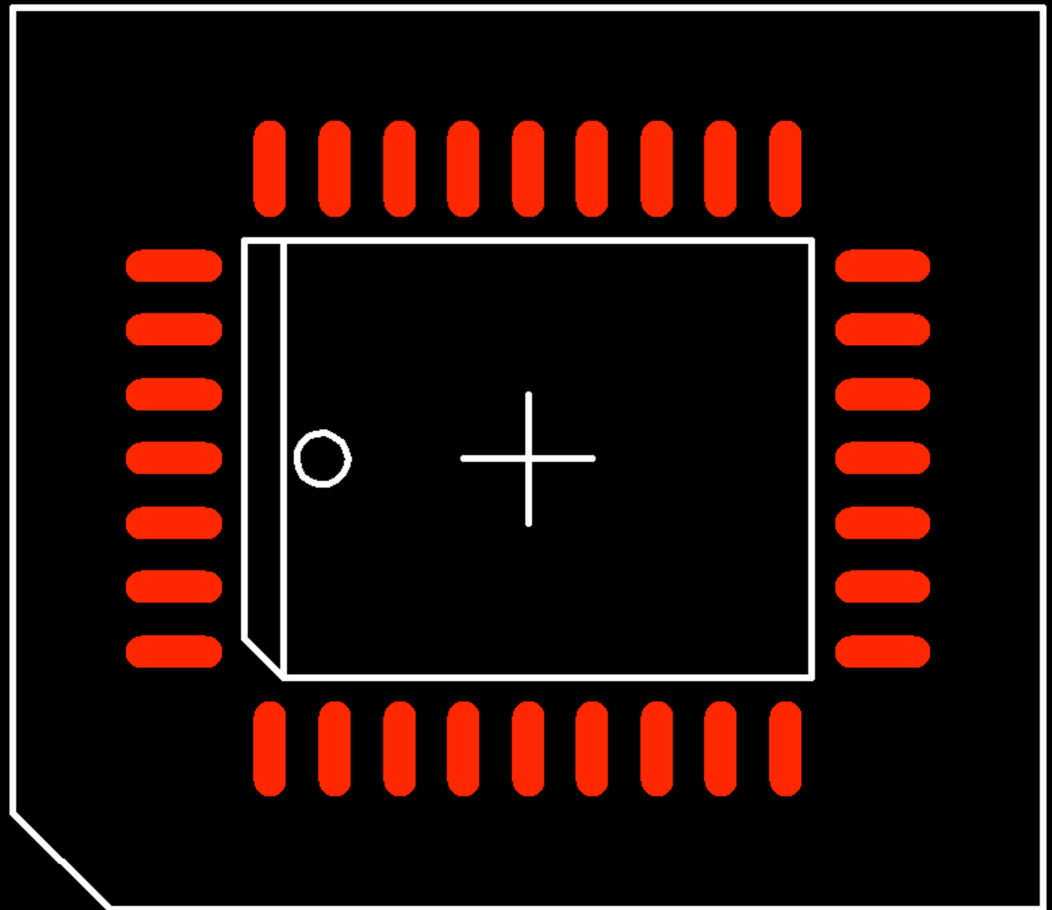
	28L Min-Max	Remark
A	0.160 min - 0.190 max	Overall Package Height
A1	0.090 min - 0.130 max	Lead Height
B	0.013 min - 0.021 max	Lead Width, Narrow Portion
B1	0.026 min - 0.032 max	Lead Width
B2	0.025 min	Lead Length - Narrow Portion
C	0.020 min - 0.045 max	Lead End Height
D/E	0.485-0.495	X/Y Span
D1/E1	0.450-0.456	X/Y Body Size
D2/E2	0.390-0.430	X/Y at Seating Plane 'C' Contact Points
D3/E3	0.300 REF	X/Y Between Two End Leads
e	0.050 BSC	Lead Pitch
F	0.042-0.056	Top of the Package Notch
G	0.042 min - 0.048 max	Index Corner Notch
J	0.000-0.020	Other Three Corners Notch
R	0.025 min - 0.045 max	Lead Radius
ccc	0.004 max	Coplanarity



Surface Mount

Actual land pattern might look like this

Note the socket outline

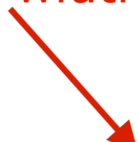


Some J lead sockets can use the same land pattern as the stand alone part.

Surface Mount

- SOT-23
- Beware the pin numbering!

99 mil pin width



75 mil pin pitch

17 mil pin width

15 mil lead length

.115±.005 [2.92±0.12]

.051±.004 [1.3±0.1]

.0375 [0.953]

.075 [1.91]

(.037) [0.93]

.0005-.0040 [0.025-0.102] TYP

.0175±.0025 TYP [0.445±0.063]

(.090) [2.29]

(.030 TYP) [0.76]

(.030 TYP) [0.76]

(.0375) [0.95]

LAND PATTERN RECOMMENDATION

R.004 MIN TYP [0.1]

R.004 MIN TYP [0.1]

.005±.002 TYP [0.13±0.05]

.008 [0.2] GAGE PLANE

0°-8° TYP

SEATING PLANE

.015±.002 [0.39±0.05]

CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

Surface Mount

Actual land pattern might look like this

40 mil round pad

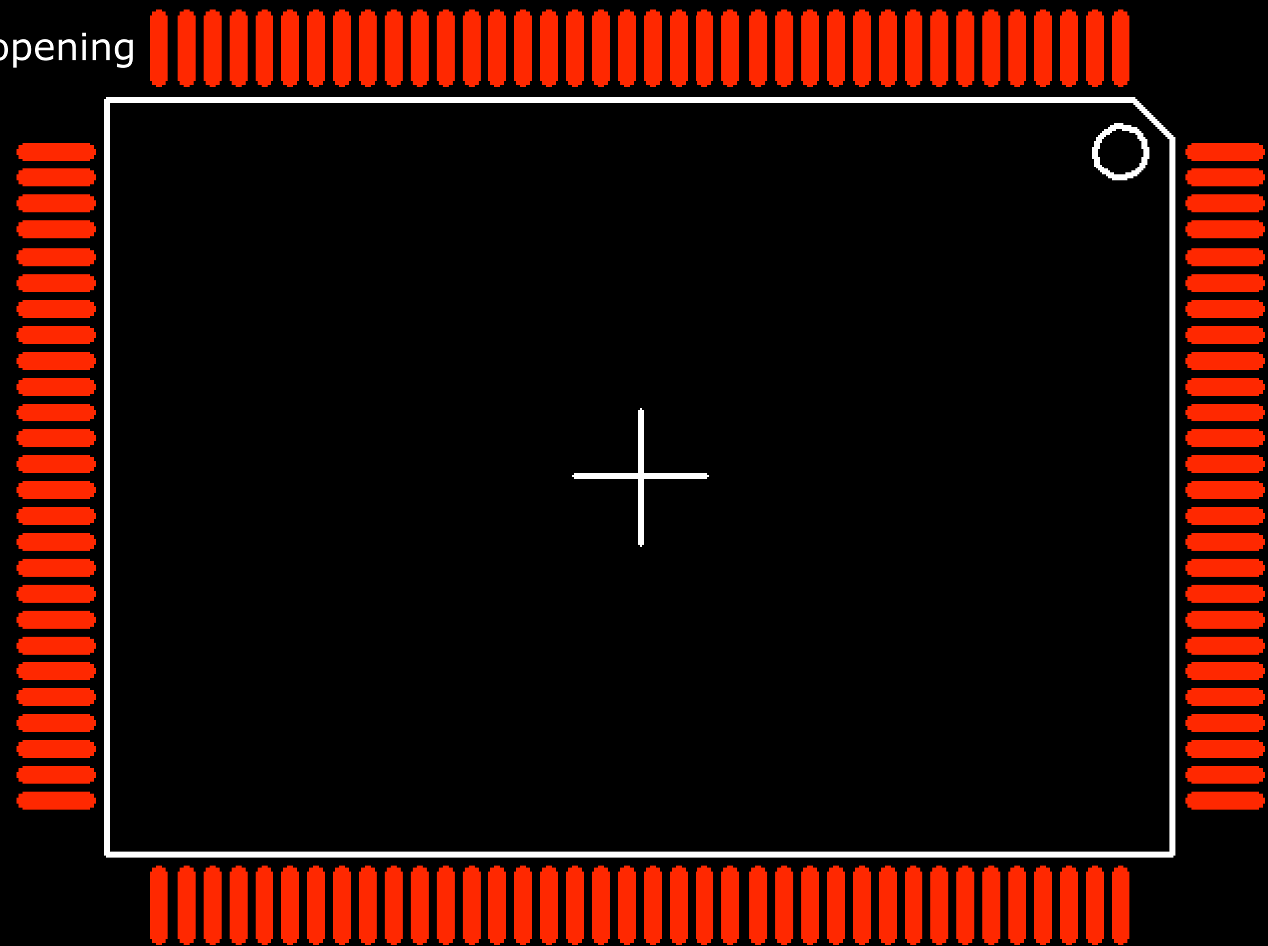
80 mil row pitch

70 mil pin pitch

Surface Mount

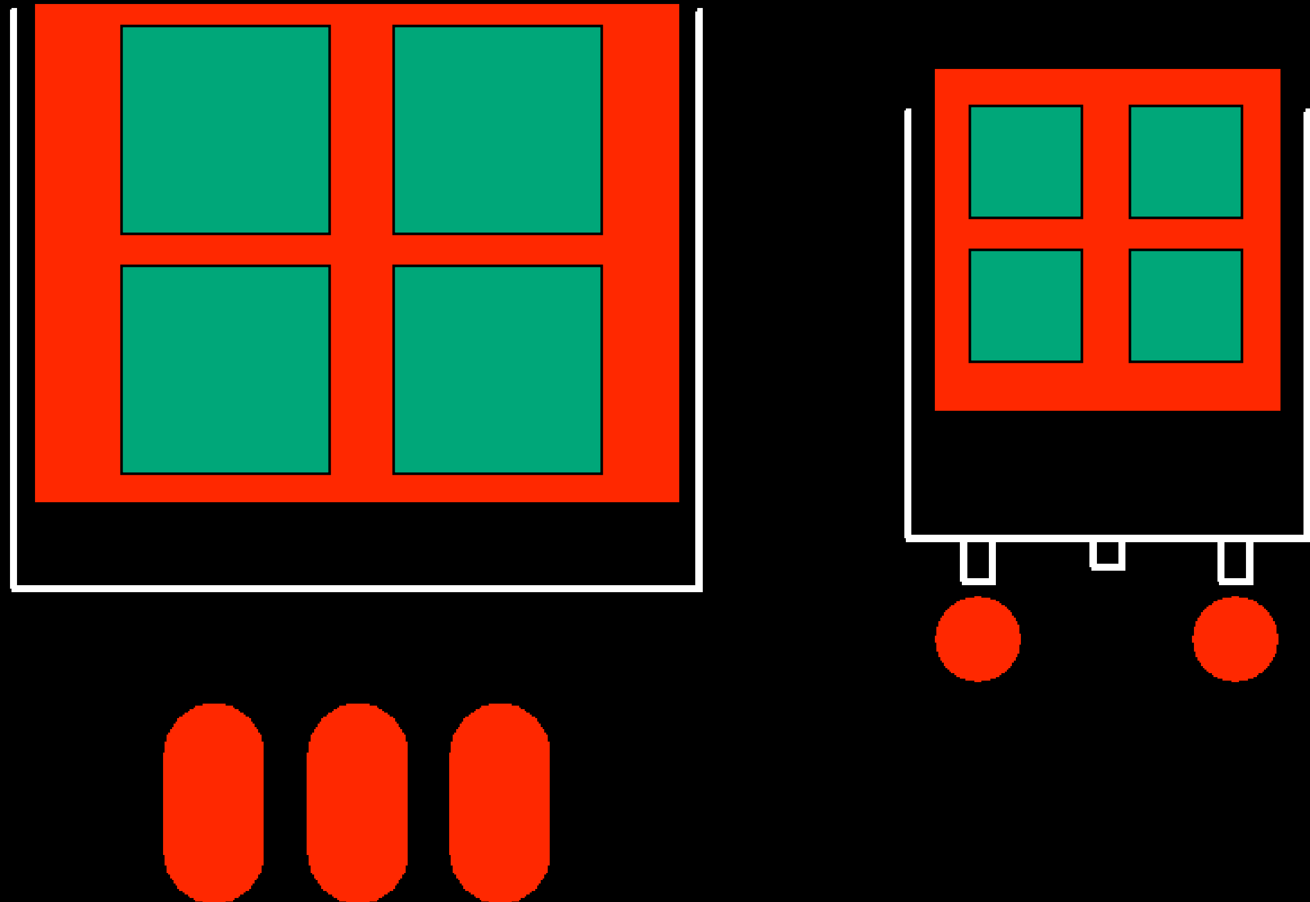
Actual land pattern might look like this

- 128 pin QFP
- .5mm pitch
- Use continuous mask opening



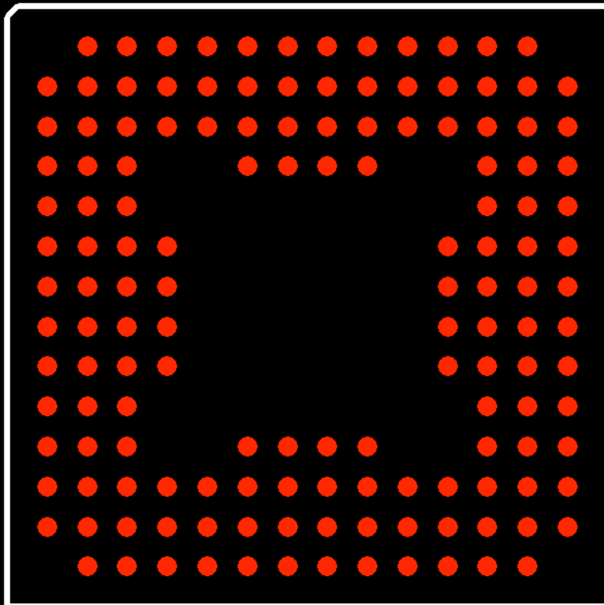
Surface Mount

- It is not practical to use rounded end pads on large lands
- Help the assembler out by breaking paste mask it to 4 parts

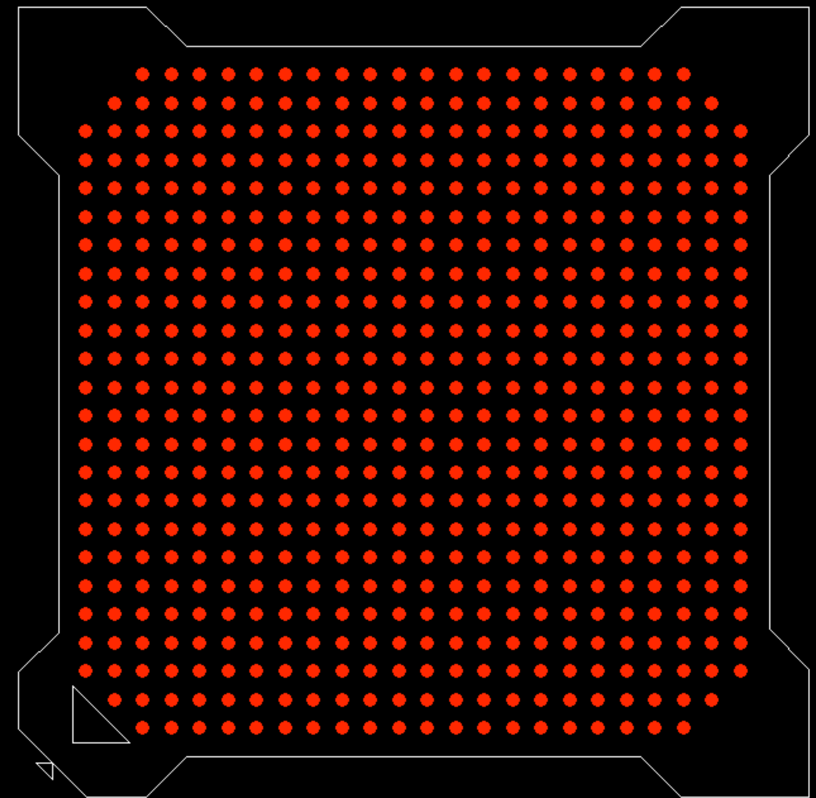


Surface Mount Parts

- BGAs
- Find you ball size on the chart (next page)
- Round to match your trace and space requirements
- Set your grid to the ball pitch
- Match the ball pattern
- BGAs are self centering



144 pin .8mm pitch



564 pin 50 mil pitch

Land Pattern Approximation

Nominal Ball Diameter (mm)	Reduction	Nominal Land Diameter (mm)	Land Variation (mm)
29 mils 0.75	25%	0.55 22 mils	0.60 - 0.50
24 mils 0.60	25%	0.45 18 mils	0.50 - 0.40
20 mils 0.50	20%	0.40 16 mils	0.45 - 0.35
18 mils 0.45	20%	0.35 14 mils	0.40 - 0.30
16 mils 0.40	20%	0.30 12 mils	0.35 - 0.25
12 mils 0.30	20%	0.25 10 mils	0.25 - 0.20

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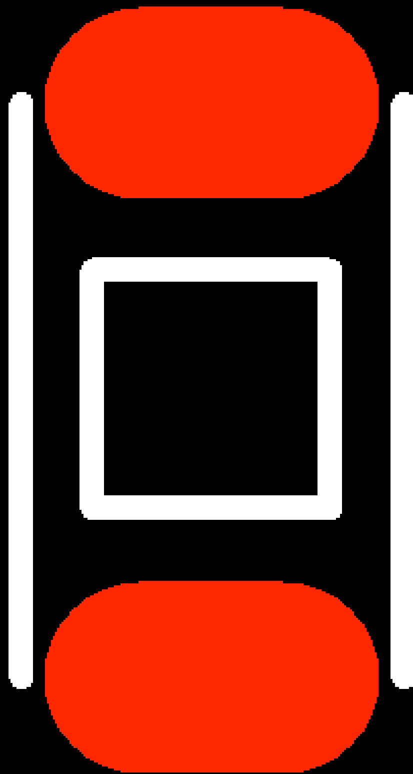
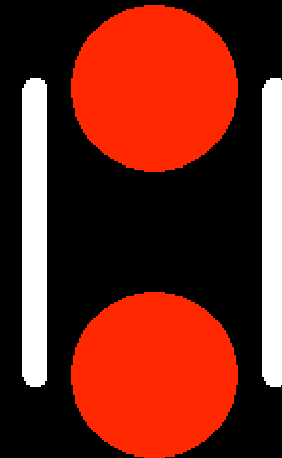
Chip Devices

- 1206 pad is 40X70
- 0805 pad is 36X60
- 0603 pad is 35 round





Connectors Through Hole

- Connectors
- Build with convenient mechanical reference
- Change origin after land construction to logical alignment point

12.62
[.497]

ø1.02(25X)
[.040]
2.77
[.109]
ø3.10(2X)
[.122]
1.39
[.055]
1.42
[.056]
2.84
[.112]
47.04
[1.852]

RECOMMENDED P.C.B. LAYOUT

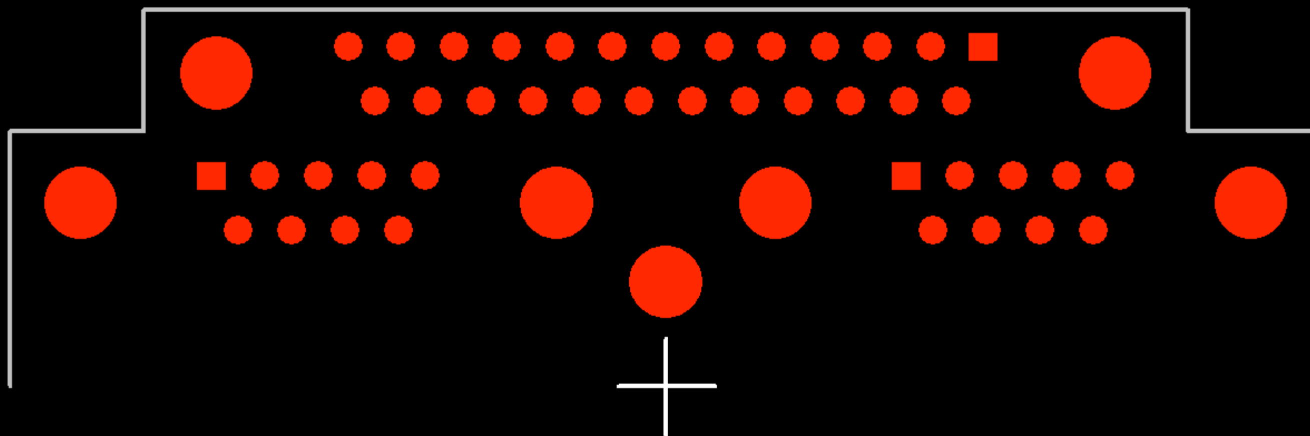
47.04
[1.852]
38.35
[1.510]
4-40 UNC
(2X)
2.77
[.110]
2.84
[.112]
7.87
[.310]
53.04
[2.088]

6.15
[.242]
12.42
[.489]
3.18
[.125]
6.27
[.247]
8.08
[.318]

5.00
[.197]
5.97
[.235]
5.54
[.218]
4-40UNC
4-40UNC
5.55 max.
[.218]
Female Screw Lock

Connectors Through Hole

- DB25 dual serial combo connector
- Origin is edge of board alignment and centered on the connector
- Make the part origin a useful tool



Silkscreen

- Tons of useful information can be place in the silkscreen
- Part outline is larger than the part
- Tick marks to count pins
- Label strategic pins
- Mark land pattern origin
- Switch settings
- Jumper settings
- Label pins on bottom of board for engineers
- Mark ground vias with a silkscreen circle
- Part manufacturers phone number

Summary

- Pad size
- Pin pitch
- Row pitch
- Pattern
- Quick and Easy