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DEFINITION OF DUMMY

Dummy Components are low-cost mechanical packages which handle, place and solder just like electrically functional parts.



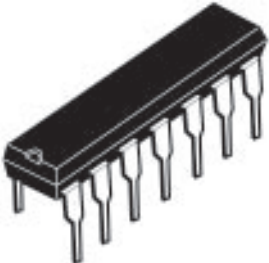
APPLICATIONS USING DUMMY COMPONENTS:

- a.** simulation of assembly process
- b.** pick and place machine demonstrations
- c.** acceptance testing of machinery
- d.** employee training
- e.** rework practice
- f.** trade shows
- g.** assembly of prototypes
- h.** Thermal testing
- i.** destructive testing
- j.** soldering machines
- k.** props and artwork
- l.** education
- m.** evaluation

SMD LEAD STYLES

TYPE	DRAWING	COMPONENTS
Gull-wing		SOIC QFP TSOP
J-lead		PLCC SOJ
Ball		BGA Chip Scale Flip Chip (Bump)
Metalized Terminations		Capacitors Resistors Ferrites

THROUGH-HOLE LEAD STYLES

TYPE	DRAWING	COMPONENTS
Axial	 A 3D perspective drawing of an axial lead component. It consists of a central cylindrical body with a light gray band on one end, and two long, thin leads extending horizontally from the center of the cylinder.	capacitors resistors inductors diodes
Radial	 A 3D perspective drawing of a radial lead component. It features a small, square, light gray body with two long, thin leads extending vertically downwards from the bottom corners.	capacitors crystals inductors transistors
DIP	 A 3D perspective drawing of a DIP (Dual In-line Package) component. It is a long, black, rectangular package with two rows of pins extending downwards from the bottom edge.	Integrated Circuits

MEASUREMENTS

Mils and millimeters are often used interchangeably.

$$1 \text{ mil} = 1/1000 \text{ inch } (.001'')$$

$$1 \text{ mm} = .0393 \text{ inch}$$

$$1 \text{ inch} = 25.4 \text{ mm}$$

CONVERSION RULES

- * To convert millimeters into inches, multiply millimeters by .0393
- * To convert inches into millimeters, divide inches by .0393
- * To convert mils into inches, multiply mils by 1000
- * To convert mils into millimeters, divide mils by 39.3

POPULAR DIMENSIONS

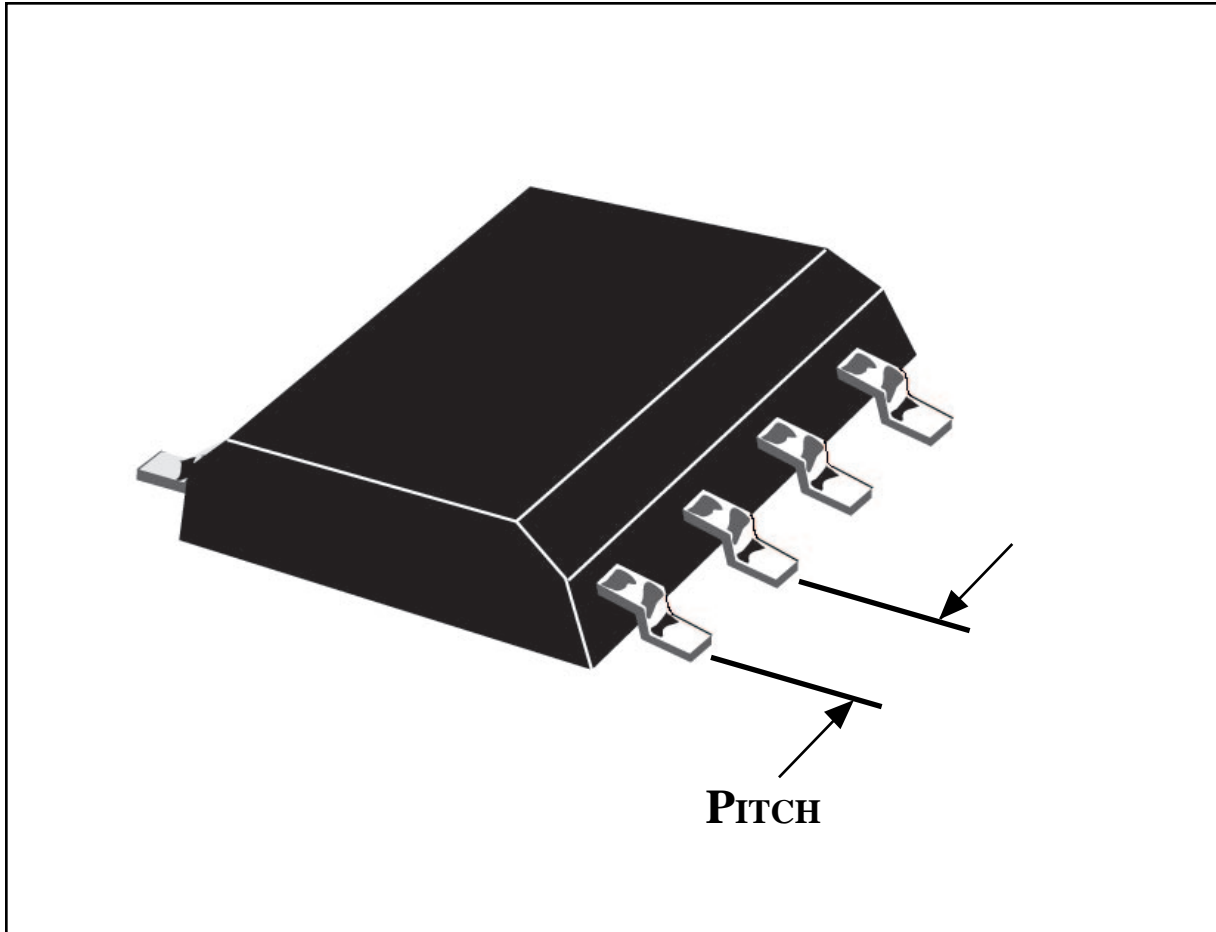
EXACT MEASUREMENT			MILS* ROUNDED	COMPONENT TYPE
INCHES	MILS	MILLIMETER		
.2"	200mils	5.08mm	200mils	Throughhole
.1"	100mils	2.54mm	100mils	DIP & Throughhole
.05"	50mils	1.27mm	50mils	SOIC, PLCC
	39.3mils	1.00mm	40mils	QFP TSOP SSOP
	31.5mils	0.8mm	30mils	
	25.6mils	0.65mm	25mils	
	25.0mils	0.636mm	25mils	
	19.7mils	0.5mm	20mils	
	15.7mils	0.4mm	15mils	
	11.8mils	0.3mm	12mils	

*Caution: Most SMD components are built to the metric (mm) standard. Engineers sometimes mistakenly express dimensions by rounding mils. It is more acute to use 0.65mm instead of 25mils and 0.5mm in place of 20mils.

PITCH

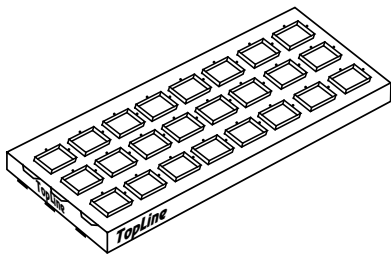
Lead pitch is always measured from center to center of the leads.

Pitch is never considered the air gap between the leads.

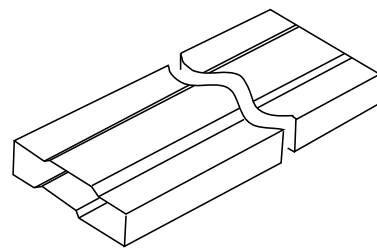


COMPONENT PACKAGING

The purpose of packaging is to protect the component from damage during transport and to facilitate automated handling during board assembly.



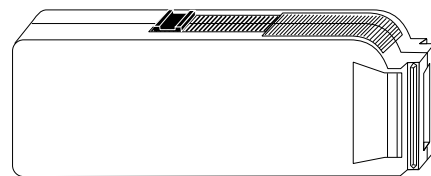
TRAYS



TUBES



TAPE & REEL



BULK FEED CASSETTES

TAPE MATERIAL

Carrier Tape is made of either paper or plastic.

Paper tape has punched windows.

Plastic tape has embossed pockets.

Here are some advantages and disadvantages between paper and plastic tape:

MATERIAL	ADVANTAGES	DISADVANTAGES
PAPER	Costs less for Chip Caps and Resistors	Subject to moisture in humid areas Might cause dust in machine
PLASTIC	Pockets can be shaped to fit and protect components Saves trees	Not biodegradable Costs more Recycling laws

REELS

Reels are made of either paper (cardboard) or plastic.

Plastic Reels are often used for 13" size.

STANDARD REEL DIAMETERS*



4"
PATENTED
MINIREEL



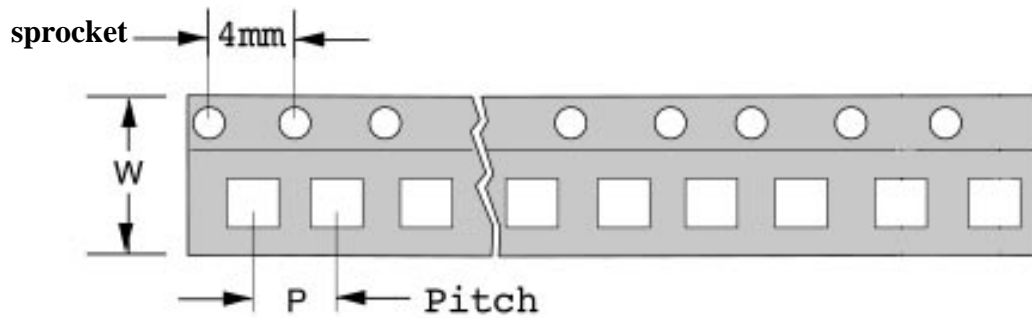
7" (180MM)



13" (330MM)

*Note spindle hole is same for each reel size.

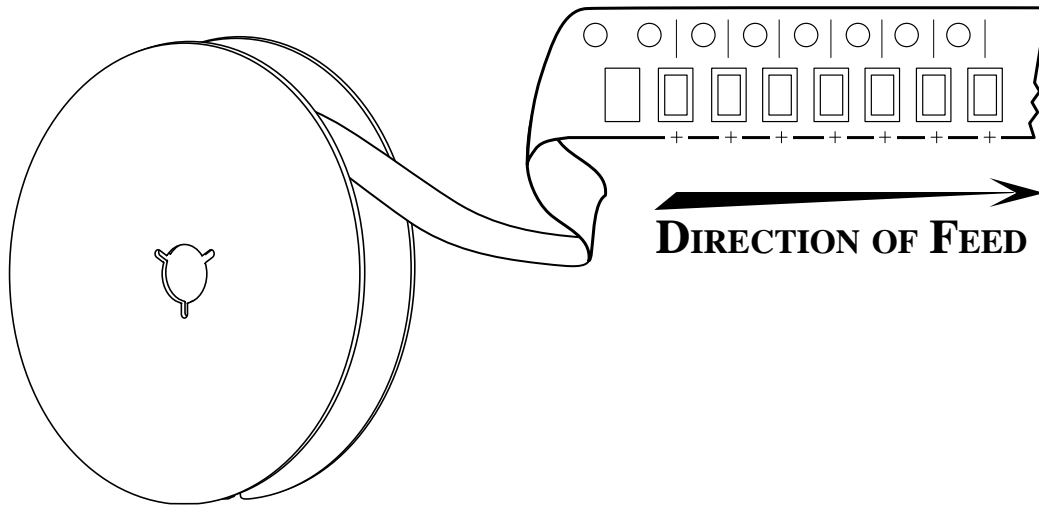
TAPE DIMENSIONS



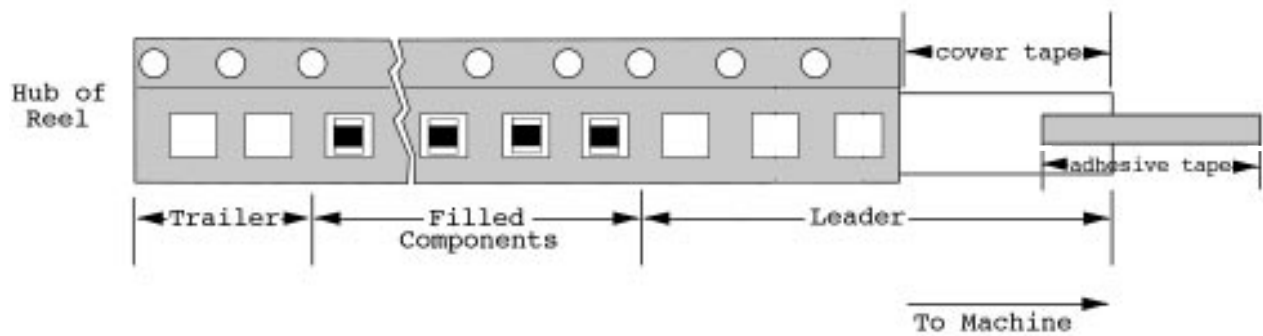
STANDARD (W) TAPE WIDTHS	POPULAR PITCH (P) *
8mm	2mm (for 0402 components)
8mm	4mm (for 0603~1210 components)
12mm	4mm or 8mm
16mm	8mm or 12mm
24mm	12mm, 16mm or 24mm
32mm	12mm, 16mm or 24mm
44mm	24mm, 32mm or 40mm

*other pitches available depending on component dimensions.

TAPE DIRECTION

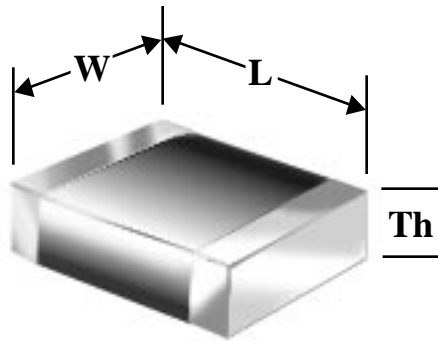


LEADER & TRAILER



CHIP COMPONENTS

The size of chip components (ceramic capacitors and resistors) are defined by a 4-digit size code which approximates its footprint. Thickness is not relevant in the size code.



EXAMPLE:
(INCH)

12	06
<u>LENGTH</u>	<u>WIDTH</u>
.12"	.06"

EXAMPLE:
(METRIC)

32	16
<u>LENGTH</u>	<u>WIDTH</u>
3.2MM	1.6MM

INCH VS. METRIC CODES

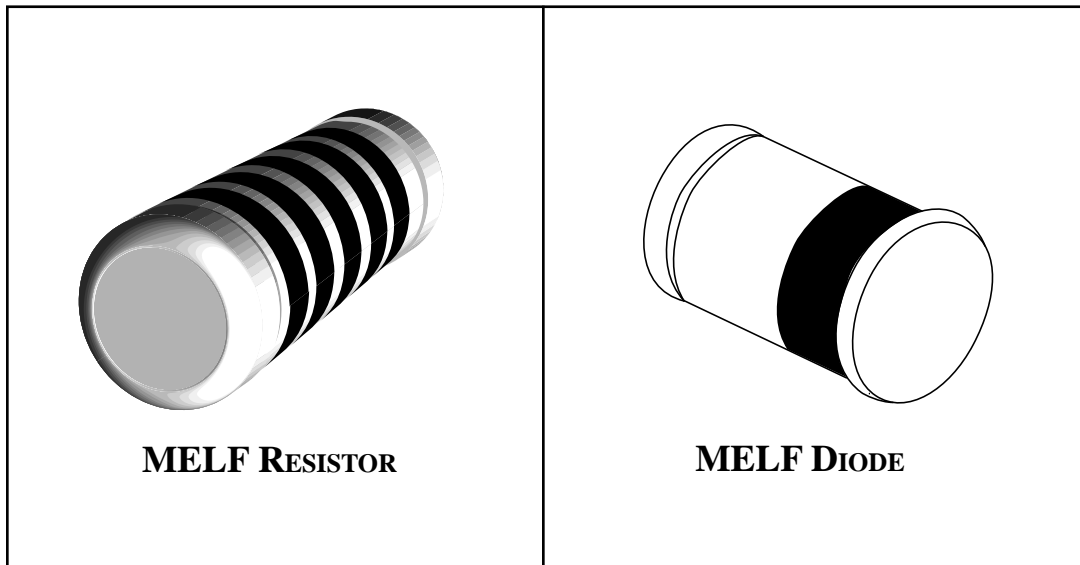
In the USA and most parts of Europe, chip size codes are defined in Inches.
In Japan, and some places in the orient, chip size codes are defined in millimeters.

SIZE CODE		APPROXIMATE SIZE	
INCH	METRIC	INCH	METRIC
0402	1005	.04" x .02"	1.0 x 0.5mm
0603	1608	.06" x .03"	1.6 x 0.8mm
0805	2012	.08" x .05"	2.0 x 1.2mm
1206	3216	.12" x .06"	3.2 x 1.6mm
1210	3225	.12" x .10"	3.2 x 2.5mm
1812	4532	.18" x .12"	4.5 x 3.2mm

MELF (CYLINDRICAL)

Melf components are cylindrical.

Cylindrical components are not very popular and have a tendency to roll on the board during the assembly process.



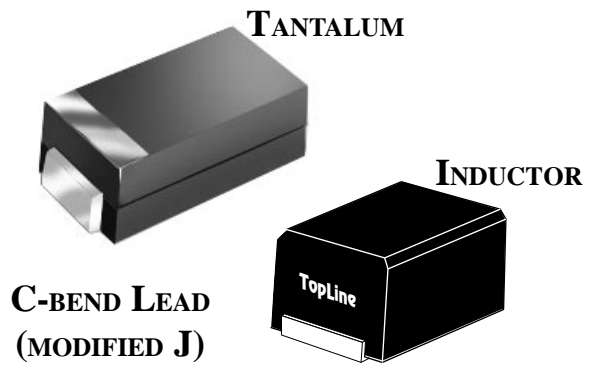
SIZE DEFINITIONS		
NAME	INCH CODE	APPROXIMATE METRIC (D x L)
MELF	-	2.5 x 5.0mm
mini-MELF	1206	1.6 x 3.2mm
micro-MELF	0805	1.1 x 2.2mm

MOLDED COMPONENTS

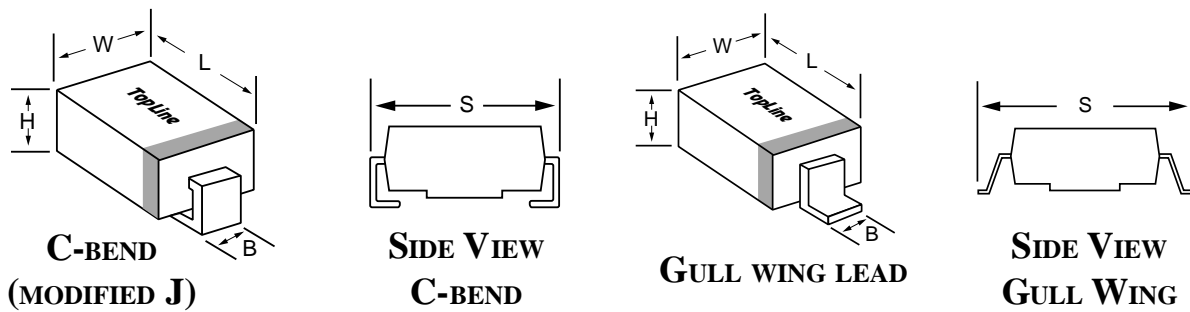
Tantalum capacitors, inductors and some diodes (also called rectifiers) are built in rectangular, epoxy molded cases.

TANTALUMS & INDUCTORS

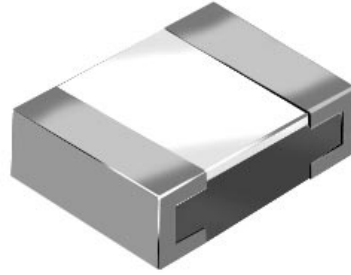
CODE	EIA	FOOTPRINT
A	3216	3.2 x 1.6mm
B	3528	3.5 x 2.8mm
C	6032	6.0 x 3.2mm
D	7343	7.3 x 4.3mm



RECTIFIERS



CHIP RESISTORS



Chip resistors are the lowest cost dummy components available. They are usually packaged on paper. However, some customers prefer bulk feeder cassettes for high speed chip shooter machines.

The footprint dimensions are specified by a 4-digit size code.

SIZE CODE INCH	SIZE CODE METRIC	STANDARD 7" REEL QTY.	STANDARD 10"~13" REEL QTY.
0402	1005	10,000 pcs.	50,000 pcs.
0603	1608	5,000 pcs.	10,000 pcs.
0805	2012	5,000 pcs.	10,000 pcs.
1206	3216	5,000 pcs.	10,000 pcs.

ZERO OHM JUMPER

To perform continuity testing after assembly, use zero ohm resistors (sometimes called Jumpers).

The terminal to terminal resistance is 0 Ohms (completely shorted).

CHIP CAPACITORS

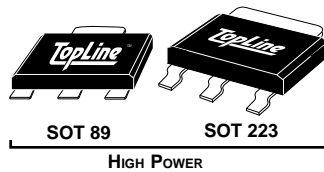
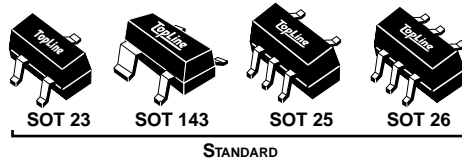
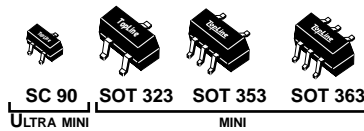


Ceramic chip capacitors are relatively low cost. Sizes are similar to chip resistors. Available on both plastic and paper carrier tape.

SIZE CODE* INCH	SIZE CODE* METRIC	STANDARD 7" REEL QTY.	TAPE MATERIAL
0402	1005	10,000	paper
0603	1608	4,000	paper
0805	2012	3,000~5,000	paper or plastic
1206	3216	3,000~4,000	paper or plastic

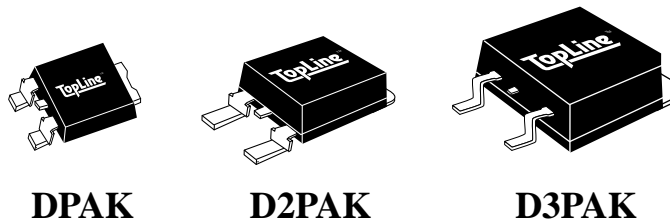
SOT

Diodes, transistors and some simple Integrated circuits are often packaged in molded cases with a SOT nomenclature. The SOT23 is the most popular case. A miniature version, known as the SOT323 is gaining popularity. Some SOT devices are called out by a “TO” size according to JEDEC standards.



DPAK

DPAK is used for high power applications.



Dummy Class 101

Pop Quiz #1 for pages 1-20

Your Name _____

Date _____

Match the answer on the right to the question on the left.

- | | |
|-----------------------|----------------|
| ___ 1. Gull Wing Lead | A. Cylindrical |
| ___ 2. Solder Balls | B. Throughhole |
| ___ 3. J-lead | C. 1/1000 inch |
| ___ 4. DIP | D. Chip Size |
| ___ 5. 50mils | E. QFP |
| ___ 6. Pitch | F. .12" x .06" |
| ___ 7. 0805 | G. PLCC |
| ___ 8. MELF | H. 1.27mm |
| ___ 9. 1 mil | I. BGA |
| ___ 10. 1206 | J. Lead Space |

Convert Dimensions below:

Write answer here

- | | |
|--------------|-----------|
| 11. .2 inch | _____mm |
| 12. 25.6mils | _____mm |
| 13. 19.7mils | _____mm |
| 14. 100mils | _____mm |
| 15. 1mm | _____Inch |

Interpret the following chip component size codes:

16. A-case Tantalum _____ millimeters
17. 3528 _____ case code
18. 0805 _____ inches
19. 7343 _____ case code
20. 0402 _____ metric size code
21. C-case Tantalum _____ EIA code
22. 3216 _____ inch code
23. mini-MELF _____ inch code

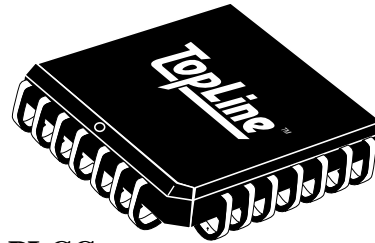
Answer True or False.

- ___ 24. SOT devices are usually resistors.
- ___ 25. 0402 chip resistors come standard on 10,000pcs 7" reels.
- ___ 26. 1608 size is the same as 0603.
- ___ 27. Zero Ohm jumpers are capacitors.
- ___ 28. C-bend leads are modified J-leads.
- ___ 29. A-case tantalums are 0603 size.
- ___ 30. Metric codes are never used in the USA.
- ___ 31. Leader tape feeds into the machine.
- ___ 32. 2mm pitch is standard for 0402 chips.
- ___ 33. Paper tape is used mostly for chip components.
- ___ 34. Reels are standard in 5 inch and 12 inch diameters.
- ___ 35. Trays are used for storing components.

Circle the term which doesn't belong:

- | | | | |
|-----|-----------|------------|-----------|
| 36. | Gull-wing | J-lead | Tray |
| 37. | Resistor | Diode | Rectifier |
| 38. | Pitch | Lead Space | J-lead |
| 39. | SMD | Axial | Radial |
| 40. | Footprint | 1206 | DPAK |

PLCC

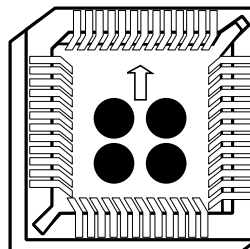


PLCC

The PLCC (Plastic Leaded Chip Carrier) is the first SMD package to use the J-lead on 4-sides.

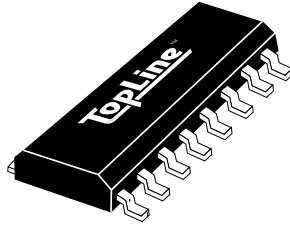
The pitch is 50mils (1.27mm). PLCC devices are usually soldered directly to the PC board; however, they can also be mounted in a socket for replacement in the field.

PLCC SOCKETS



PLCC SOCKET

SOIC



Small Outline Integrated Circuits come with two lead styles:
Gull wing and J-lead.

Refer to SOJ page for details on J-lead version.

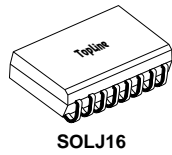
The Gull-wing version comes in body widths 150mils to 450mils
(4.0mm to 11mm) with 50mil (1.27mm) lead pitch.

Standard packaging is tube or tape and reel.

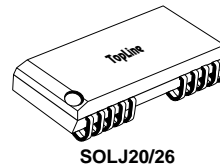
TopLine assigns different part numbers to distinguish the various body widths.

PART SERIES	BODY WIDTH		NOTES
	MILS	METRIC	
SO	150	4.0mm	Standard for 8-16 lead
*SOP	208	5.3mm	Popular in Japan only
SOM	220	5.6mm	Standard for resistor network
SOL	300	7.6mm	Popular for 20-28 leads
SOW	330	8.4mm	
SOX	400	10.0mm	
SOY	450	11.1mm	

*Note: In Japan “SOP” often means “SOIC” in general



SOJ



The J-lead version Small Outline Integrated Circuit has 50 mil (1.27mm) lead pitch.

The J-lead version may be soldered directly to the PC board or mounted in socket for removal in the field.

Some SOJ devices have leads missing from the center. In such cases, the part number indicates a dual lead count. For example the SOLJ20/26 means 26 lead body size with 20 leads (3 leads are missing on each side).

Standard packaging is Tube or Tape and Reel.

TopLine assigns different part numbers to distinguish the various body widths.

PART SERIES	BODY WIDTH	
	MILS	METRIC
SOLJ	300	7.6mm
SOXJ	400	10mm

SSOP, QSOP AND TSSOP

Gull wing ICs are also available in “shrink” packages with 0.5mm (25mil) lead pitch.

A few versions have 0.8mm lead pitch.

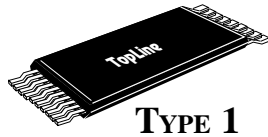
The body length of the SSOP “shrink” version is approximately half the size of the standard 50mil pitch SOIC.

Standard packaging is Tube or Tape and Reel.

TopLine assigns different part numbers to distinguish the various body.

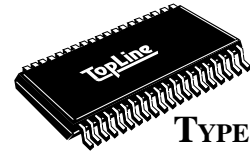
<u>PART SERIES</u>	<u>BODY WIDTH</u>		<u>LEAD COUNTS</u>	<u>NOTES</u>
	<u>MILS</u>	<u>METRIC</u>		
SSOP	208	5.3mm	8-30	1.75mm height
TSSOP	173	4.4mm	8-28	1.0mm height
*QSOP	150	3.8mm	16-28	1.6mm height

*Note: Lead pitch on QSOP is built to 25.0mil standard.



TYPE 1

TSOP



TYPE 2

The Thin Small Outline Package comes in Type 1 and Type 2.

Type 1 have leads extending from the narrow ends of the body.

Type 2 have the leads protruding from the wide side of the body.

The measurements for Type 1 include the leads (tip to tip).

The measurements for Type 2 excludes the leads (body only).

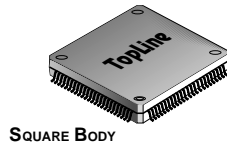
Maximum seated height of Type 1 is 1.0mm and Type 2 is 1.2mm.

Sometimes, the center leads are missing.

In such cases, the part number indicates a dual lead count. For example TSOP40/44 means 44 lead body size with 40 leads (2 leads missing from each side).

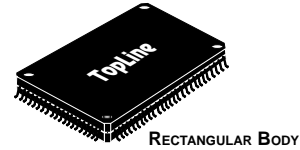
Standard packaging is trays; however, tape and reel is gaining popularity.

TSOP Type	Popular Lead Pitch		
	.5mm	.8mm	1.27mm
Type 1	X		
Type 2		X	X



QFP

QUAD FLAT PACK



Quad Flat Packs have gull-wing leads on four sides. The body material is molded epoxy known as “plastic”.

Ceramic body Quad Flat Packs are also available on special order (CQFP and CERQUADS).

Most QFPs are square; however, they are also available in a 14mm x 20mm rectangular package.

TopLine uses the QFP designation; however, the industry may call them MQFP (Metric Quad Flat Pack).

Standard thickness of QFP is 2.0mm to 3.8mm. For thinner versions, refer to TQFP and LQFP pages.

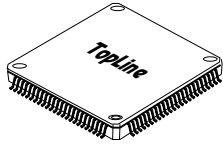
The same body size and lead count is usually available with 2 or 3 different lead length footprint adders.

The footprint adder twice the actual lead length. For example a 3.9mm adder has 1.95mm leads on each body side.

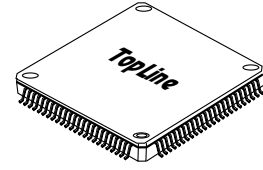
For example, a 28mm square body with a 3.9mm adder actually measures 31.9mm from lead tip-to-tip.

Standard packaging is in trays, however, tape and reel is becoming more popular.

STANDARD BODY	POPULAR LEAD PITCH					LEAD COUNT
	1.0MM	0.8MM	0.65MM	0.5MM	0.4MM	TYPICAL
10MM SQUARE		X	X			44 - 52
14MM SQUARE	X	X	X			44 - 80
14 x 20MM	X	X	X			64 - 100
28MM SQUARE		X	X	X	X	120 - 256
32MM SQUARE			X	X		184 - 240
40MM SQUARE				X		304



LQFP AND TQFP



Quad Flat Packs are also available in “Thin” versions.

The TQFP is 1.0mm thick and the LQFP is 1.4mm thick.

Some Japanese manufacturers use SQFP (Shrink Quad Flat Packs) for thin parts.

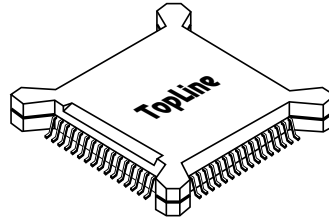
TQFP and LQFP are available in a wide range of body sizes and lead pitch.

The footprint adder for TQFP and LQFP is usually 2.0mm (1.0mm leads on each side.)

In most dummy applications, TQFP and LQFP may be used interchangeably.

POPULAR BODY SIZE	LEAD PITCH AVAILABLE					LEAD COUNT RANGE
	0.8MM	0.65MM	0.5MM	0.4MM	0.3MM	
7MM SQUARE	X	X	X	X		32 - 64
10MM SQUARE	X	X	X	X		44 - 80
12MM SQUARE			X			80
14MM SQUARE	X	X	X	X	X	64 - 168
14 x 20MM		X	X			100 - 128
20MM SQUARE			X			144 - 176
24MM SQUARE			X			160 - 216
28MM SQUARE			X	X		208 - 256

BQFP



The BQFP is a version of Quad Flat Pack with corner bumpers to protect the leads during transport and handling.

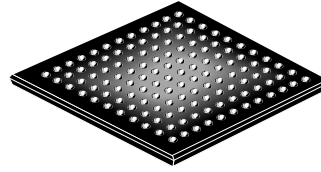
The BQFP is no longer popular.

The lead pitch of BQFP is a true 25.0 mils instead of the metric 0.65mm.

Because the lead pitch is not built to metric standards, it is subject to errors in circuit board design.

The bumpered corners allow BQFPs to be packaged in tubes, however, trays are more popular. Also available on tape and reel.

BGA



The leads of Ball Grid Arrays are actually spherical solder balls.

BGAs offer several advantages over other high lead count devices such as QFP.

ADVANTAGES

1. Solder ball leads are not as fragile as QFP gull wing leads.
2. During soldering, BGA leads are self aligning.
3. BGAs have higher lead count than QFP.

DISADVANTAGES

1. Requires an x-ray machine for inspection of leads after soldering.

BGAs are available with lead pitch of 1.0mm, 1.27mm and 1.5mm.

Ball Grid Arrays are also available in a variety of case materials.

<u>SERIES</u>	<u>TYPE</u>	<u>POPULARITY</u>
*BGA	Plastic	Most popular, common usage
CBGA	Ceramic	High temperature applications
TBGA	Tape	High power dissipation
*Sometimes called PBGA		

BGA (CONT'D)

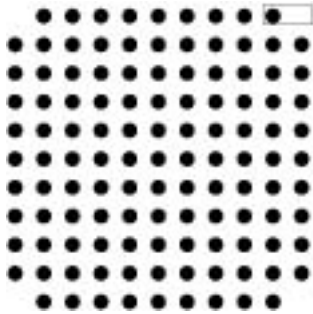
The material of the solder ball is usually eutectic 63/37 SnPb for assembly onto normal epoxy FR4 laminate PC Boards.

However, high temperature 10/90 balls are available for assembly onto ceramic substrates.

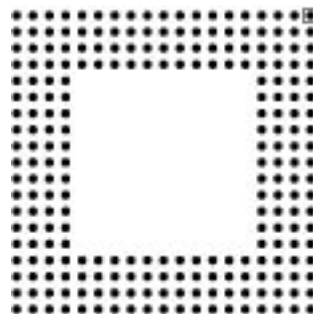
TopLine supplies a wide assortment mechanical dummy BGA with Daisy Chain Patterns for continuity testing after assembly.

BGAs are packaged in trays and tape and reel.

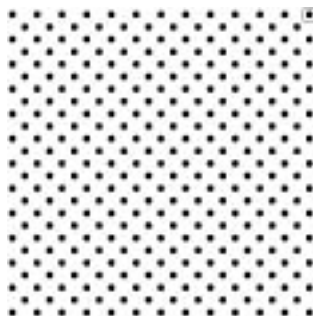
BGA ball patterns come in a variety of configurations.



FULL GRID



PERIPHERAL



STAGGER



THERMAL VIA

FLIP CHIPS

Flip Chips are die sized components with the bumps attached to the die.

The bumps come in 3-popular materials: Eutectic 63/37 SnPb solder, gold and nickel.

Eutectic bumps are preferred when mounting the flip chip to FR4 laminate circuit boards.

Nickel is preferred for soldering to high temperature ceramic substrates (circuit boards).

Often the bumps are spherical, however, square and rectangular bumps are available.

Flip Chips are quite small since there is no extra packaging covering the die.

The bump pitch is very small and is measured in microns (μm) rather than millimeters.

1000 (μm) microns = 1 millimeter.

There is no industry standard die size or pitch for flip chips.

Each design is specific to customer applications.

TopLine offers mechanical (dummy) flip chips from open tooled customer design with daisy chains.

CHIP SCALE PACKAGES

Chip Scale Packages (CSP) are a cross between BGAs and Flip Chips.

By definition, the maximum footprint dimension of a Chip Scale Package is no greater than 1.2 x the die itself.

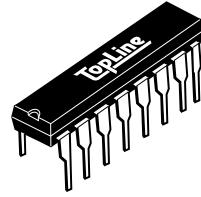
Different kinds of Chip Scale Packages are being developed.

The most popular (at the time of this writing) is the Tessera μ BGA[®] available in 46 and 188 bumps.

Other manufacturers such as Citizen and FCT have developed unique Chip Scale designs.

CATEGORY	TYPE	MANUFACTURER
Flex Circuit Interposer	TAB/Flip Chip	GE, IZM, KME, Mitsubishi, NEC, Rohm, Sony, Tessera and licensees
	Wire Bonding	Amkor/Anam, Fujitsu, Hiatchi, LSI Logic, Mitsubishi, Sharp TI Japan, Toshiba
Rigid Substrate	FlipChip	Citizen Watch, Fujitsu, Matsushita, Motorola, Oki Electric, Sony
	Wire Bonding	Amkor/Anam, Cypress, Fujitsu, LSI Logic, Motorola, National Semi., NEC, Rohm, Sony, Toshiba
Lead Frame	Wire Bonding	Amkor/Anam, Fujitsu, Hitachi Cable, LG Semicon, Matsushita, TI Japan, Toshiba
Wafer-Level Assembly	Redisdribution	ChipScale, EPIC, FCT, NEC, Sandia Nat'l. Labs
	Substrate	ChipScale and licensees, ShellCase, Tessera, 3-D Plus

DUAL INLINE PACKAGE



DIP ICs are throughhole devices introduced in the 1960's.

The lead pitch is .1" (100mils or 2.54mm).

The body width is typically 300mils and 600mils (however, 400mils and 900mils is available).

The most popular DIP package is 8, 14 and 16 leads.

The body is molded epoxy, referred to as "plastic."

Ceramic body CERDIP packages are available for high temperature and military applications.

Standard packaging is in tubes.

Dummy Class 101

Pop Quiz #2 for pages 24-36

Your Name _____

Date _____

Answer True or False:

- _____ 1. BQFP is built to metric standard.
- _____ 2. PLCC can be inserted into sockets.
- _____ 3. SOL has J-leads.
- _____ 4. BGA has solder bumps
- _____ 5. TSSOP and TSOP have gull-wing, 1 ea.
- _____ 6. QFP are always square.
- _____ 7. TQFP and LQFP are generally interchanged.
- _____ 8. SOJCs generally come packed in trays.
- _____ 9. QFPs generally come packed in tubes.
- _____ 10. TSOP Type 1 measurement includes 1 ea.

Fill in the blank

The lead pitch for PLCC is _____ mils.

The body width for SOL is _____ mils.

The lead style for SOLJ is _____.

The maximum seated height for TSOP Type 1 is _____ mm.

A 10mm sq. QFP with 2.6 mm footprint adder has _____ mm lead length per side.

Match the answer on the right with the question on the left:

- | | | |
|----------|-----------------------|-----------------------|
| _____16. | 100 mil lead pitch | A. Ceramic |
| _____17. | Eutectic | B. Flip Chip |
| _____18. | 1.0mm thick | C. 1.2 x max die size |
| _____19. | High temp solder | D. BQFP |
| _____20. | Packaging for TSOP | E. 63/37 SnPb |
| _____21. | Die with solder bumps | F. .45mm |
| _____22. | CBGA | G. BGA |
| _____23. | 450 μ m | H. DIP |
| _____24. | Self aligning | I. Trays |
| _____25. | True 25 mil pitch | J. TQFP |
| _____26. | CSP | K. 10/90 SnPb |

Convert the following dimensions:

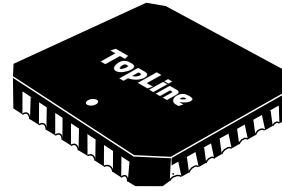
- | | | |
|-----|-----------|--------------|
| 27. | 1.27 mm | _____ mils |
| 28. | 300 mils | _____ inches |
| 29. | 25.6 mils | _____ mm |
| 30. | 1250 mm | _____ mm |
| 31. | .5 mm | _____ mils |
| 32. | .4 mm | _____ mils |

Circle the one that doesn't belong:

- | | | | | |
|-----|-------------|------------------|-------------|------------|
| 33. | PLCC | SOM | SOLJ | SOXJ |
| 34. | TQFP | BQFP | TSOP | SOXJ |
| 35. | Type 1 | TSOP | QFP | 1.0mm high |
| 36. | SOLJ 20/26M | TSOP 40/44E13A30 | SOL20M | |
| 37. | Tray | Bumpers | Tape & reel | Tubes |
| 38. | SOL | SSOP | TSSOP | QFP |
| 39. | CSP | BGA | BQFP | Flip Chip |
| 40. | CERDIP | DIP | CERQUAD | CBGA |

LCC

LEADLESS CHIP CARRIER



LCC package was developed in the '70's and still enjoy limited usage today, particularly for defense, aerospace and high temperature applications.

LCC packages are made of ceramic and are quite rugged.

There are no "leads" to bend or damage.

LCC packages use metalized castellations on four sides of the body which are solderable to the PC board.

The castellations are usually gold or solder coated.

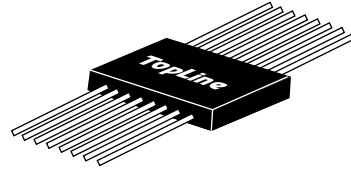
The pitch of LCC is either 40mils (1.0mm) or 50 mils (1.27mm).

There are well over 100 different lead count, pitch, and body size combinations; however, the most popular LCCs have 50 mil pitch with lead count and body size that match standard PLCC plastic packages.

LCC dummy packages are available with and without lids. Lids hermetically seal the die inside of the LCC cavity. Lids are usually gold plated, but ceramic lids are also available.

Standard packaging is tubes, trays or simply bulk packed in bags.

FLAT PACK

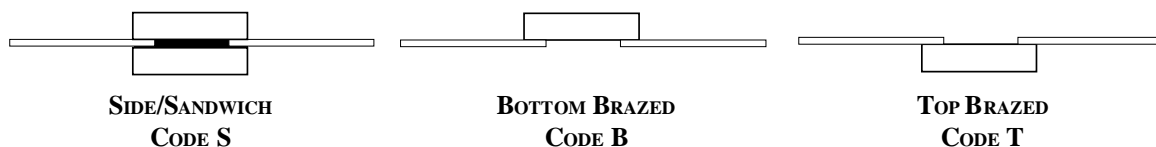


Flat Packs were developed in the late '60's and still enjoy limited usage today, mainly in military and aerospace applications.

As the name suggests, flat packs have unformed, flat leads which must be protected in a carrier prior to assembly.

Flat Packs are either ceramic or plastic with either gold plated or solder coated leads.

Depending on the cavity location and case construction, the leads extend either from the middle, bottom or top side of the body.



The lead pitch of flat packs are usually 50mils (1.27mm).

During construction, the leads are built on lead frames which hold the leads straight.

After excising (cutting) the Flat Pack must be mounted into an individual plastic carrier to prevent lead damage.

Immediately prior to the assembly, the Flat Pack goes into a lead forming tool (or machine) which bends the leads into a Gull-wing shape and the excess is cut off.

Flat Packs are used for integrated circuits and resistor networks.

Flat Packs are available with and without lids.

TO PACKAGES

TRANSISTOR OUTLINE

Transistor packages are designed by a TO number which is assigned by JEDEC, a joint industry standards committee.

Leaded (throughhole) TO packages were developed in the early '60's and '70's.

Leaded transistor packages are either metal or plastic.

For example, the TO3, TO5, TO18, TO39 and TO99 are metal.

TO92, TO126 and TO220 are plastic.

SMD transistor packages are only plastic, such as the TO236AB (same as SOT-23) and TO252 (same as DPAK).

Early designed Integrated Circuits were often placed into multiple lead, metal TO packages such as the TO99 with 8 leads, the TO75 with 6 leads and the TO100 with 10 leads.

Multiple lead TO packages are usually mounted in a plastic carrier to protect the leads prior to assembly.

The TO5 and TO99 are still used in military applications.

The TO39 is easily substituted for the TO5, with the only difference being the length of the leads.

TO39 have shorter leads than TO5 packages. Since the excess lead is always cut off, either TO39 or TO5 will do the same job.

The TO92 is a low cost, leaded plastic package for commercial use. It is available either bulk for assembly by hand or tape and reel for machine assembly.

Standard bulk packed TO92 have unformed leads with .05" (1.27mm) pitch between each lead.

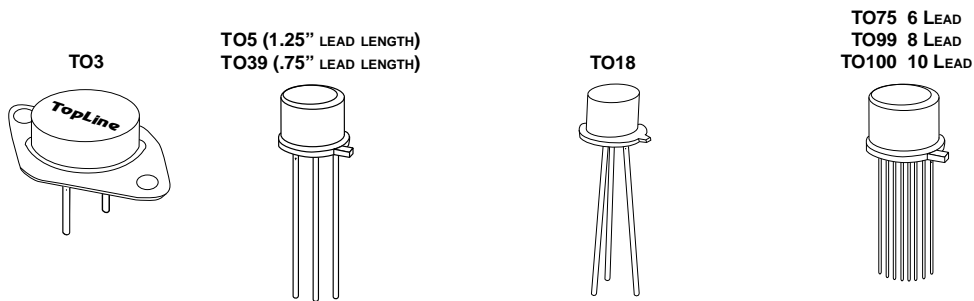
TO PACKAGES (CONT'D)

Most TO92 on tape and reel have the leads formed (prior to taping) with .1" (2.54mm) pitch between the leads.

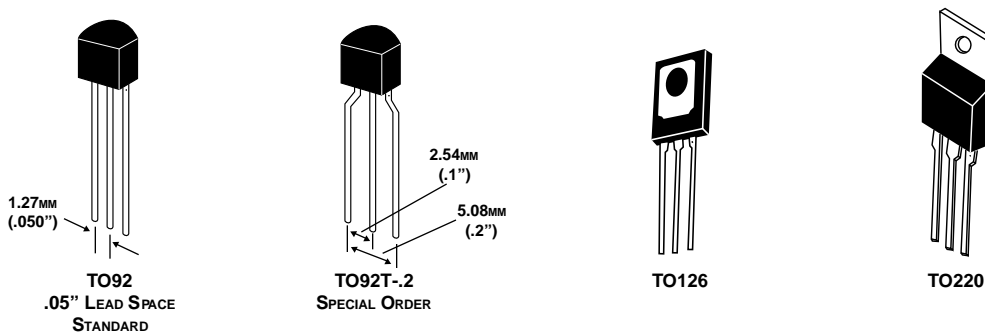
Some TO packages such as TO3 and TO220 are available in tubes for machine assembly.

The standard TO220 has 3 leads, however a 4-lead and 5-lead version is available.

METAL CASE



PLASTIC CASE



DO PACKAGE DIODE OUTLINE



Diodes and rectifiers are designated by a DO number which is assigned by JEDEC, a joint industry standards committee.

Leaded (throughhole) DO packages were developed in the '60's and '70's.

Diodes and rectifiers are fundamentally the same.

By industry convention, diodes are considered low power devices rated below 1.0 AMP and rectifiers are high powered devices rated 1.0 AMP and up.

Popular, low power diodes such as 1N4148 are hermetically sealed in a cylindrical glass case with axial leads, designated DO35.

Popular rectifiers such as the 1N4001 series and higher lowered zener diodes are assembled in the DO41 molded plastic case.

Some surface mount diodes/rectifiers have DO designation such as DO215AA (same as SMBG) and DO214AA (same as SMBJ).

Leaded DO packages are available bulk packed for assembly by hand or on tape and reel for machine assembly (and lead forming).

LEADED RESISTORS



Through-hole resistors have axial leads and are grouped by into size categories by their power rating

For example, all 1/4 Watt resistors are the same size, regardless of part number.

The industry refers to “1/4 Watt size” as .1” x .25” (.1” diameter by .25” long).

“1/8 Watt size” means .062” x .145”.

The old carbon composition resistor such as the military RC07 and RCR07 is out of production even though it is still used today for solder practice.

Leaded resistors are available bulk packed for assembly by hand or tape and reel for machine assembly.

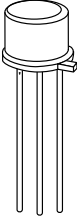
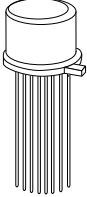

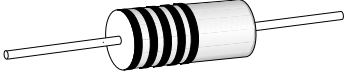
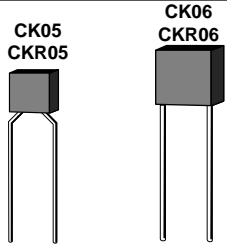
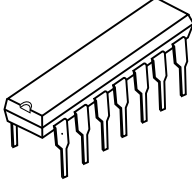
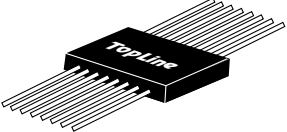
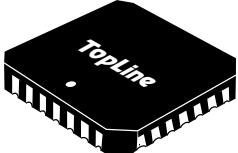
POPULAR THROUGHHOLE FOR MILITARY

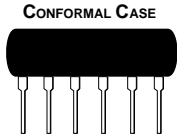
The military and aerospace industries still use component packages which were designed 20 or even 30 years ago.

This is not surprising when you consider the amount of time some government projects take to get approved.

Listed below are popular throughhole component packages which are still used by the military for solder practice and certification of technicians.

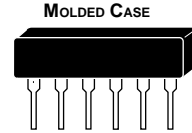
POPULAR MIL SPEC COMPONENTS

TOPLINE PART #	DESCRIPTION	DRAWING
TO5 TO39	Transistor	<p>TO5 (1.25" LEAD LENGTH) TO39 (.75" LEAD LENGTH)</p> 
TO99	Integrated Circuit	
CS2	Tantalum Capacitor CS13/CSR13	
RC07 RCR07	Resistor	
CK05 CKR05 CK06 CKR06	Ceramic Capacitor	<p>CK05 CKR05</p> <p>CK06 CKR06</p> 
CERDIP	Ceramic Dual Inline Package	
Flat Pack	Flat Pack	
LCC	Leadless Ceramic Chip Carrier	



SIP

SINGLE INLINE PACKAGE



SIP packages are used for resistor networks and some Integrated Circuits.

The lead pitch is .1" (100mils or 2.54mm).

SIP components may be molded or conformally coated, also called dipped (not to confused with DIP dual inline).

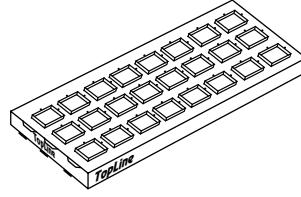
The conformally coated case offers the lowest cost and is the most popular for commercial use.

Pin counts from 4 to 12 are available; however, 6, 8 and 10-pins are the most popular.

Bulk packaging may be used for hand assembly. Tubes, tape and reel or ammo is used for machine assembly.

In the case of tape and reel (or ammo packed) only 3 leads are attached to the tape which must be excised during assembly by the insertion machine.

TRAYS



TopLine supplies a limited range of trays. Trays are used to protect components during transportation and assembly. Trays are usually grouped into two categories: bakable and non-bakable.

Bakable trays may be subjected to maximum temperatures of 150°C and are suitable in situations where the parts must be baked prior to assembly.

Component manufacturers recommend that TSOP and BGA components be baked at 125°C for 24 hours prior to assembly to remove any moisture trapped inside the plastic case. Baking eliminates the “popcorn” effect of cracking.

Also, components may be “burned in” prior to assembly to weed out potentially defective components.

Unless specifically requested by the customer, TopLine will supply non-bakable trays.

Most JEDEC standard trays are 136mm x 316mm (about 5.375” x 12.5”).

It is recommended that a cover tray (most trays are stackable and interlocking, so the cover tray is just a regular tray) always be placed on top of the stack of trays.

The stack must be bound tightly with heavy-duty rubber bands or velcro straps.

As extra precaution, the stack of trays should be vacuum sealed in moisture-barrier ESD bags.

Even exercising the above precautionary steps, it is possible for trays to separate just enough during rough handling to allow the components to shift off their protective pedestals inside the tray cavities, causing damage to the leads.

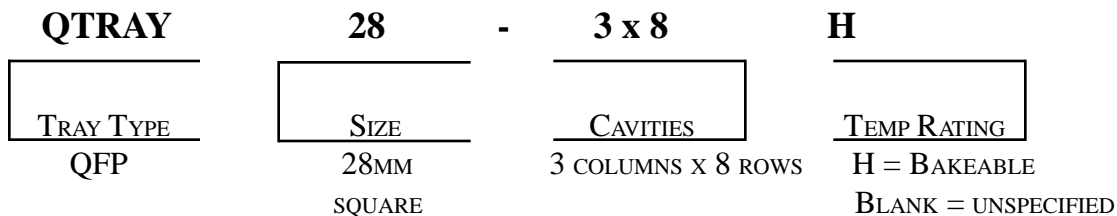
TRAYS (CONT'D)

Here is a list of trays offered by TopLine:

COMPONENT	TOPLINE TRAY DESIGNATION
QFP	QTRAY
LQFP	LQTRAY
TQFP	TQTRAY
TSOP Type 1	TTRAY
TSOP Type 2	T2TRAY
BGA	BGATRAY
PLCC	PLCCTRAY

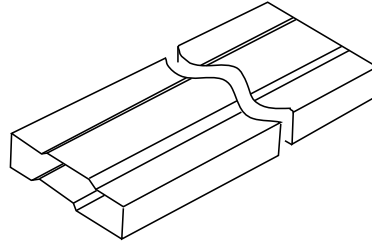
TopLine's tray part numbering system includes the size of the component and the cavity matrix.

Example:



QTRAY

TUBES



Tubes (sometimes called sticks or magazines) hold PLCC, SOIC, DIP, SIP and LCC components.

Tubes are approximately 20” long (500mm), but may range from 18” to 23”

Rubber-end plugs or plastic push-in pins prevent the components from falling out of the tube during transit.

During assembly, the components are gravity-fed by positioning the tube vertically or at a steep incline.

The machine often vibrates the tube to assure the components fall out at even speed.

The interior of the tube is designed to conform to the shape of the component without causing lead damage.

It is quite common to see the same component type (example: PLCC20) be packaged in various tube quantities (example: 46, 47, 48, 49 or 50), based on the actual length of the tube and the type of end plug used.

CT REEL EMPTY CARRIER TAPE



TopLine offers a wide selection of empty carrier tape on 7-inch and 13-inch reels for applications not requiring filled components.

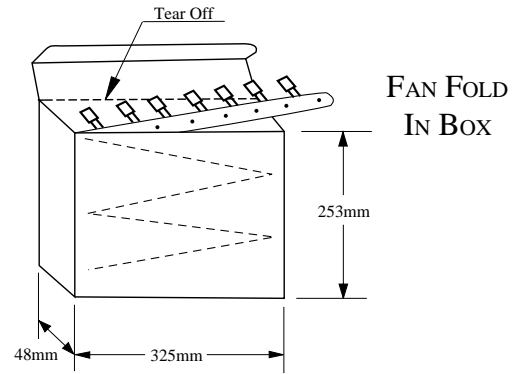
CT Reels have a sealed cover tape.

CT reels are a low cost solution to perform “dry” machine runs without the need to pick up and remove components from the carrier tape.

DUMMY COMPONENT ORDERING INFORMATION

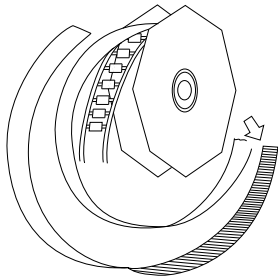
TAPE INFO		TAPE MATERIAL	TYPICAL CAVITY SIZE	PART NUMBER	NBR CAVITIES
WIDTH	PITCH				
7" REEL DIAMETER					
8mm	2mm	Paper	0402 Chip	CTREEL7x8mm-P2P	5000
8mm	2mm	Plastic	0402 Chip	CTREEL7x8mm-P2E	4000
8mm	4mm	Paper	0805 Chip	CTREEL7x8mm-P4P	5000
8mm	4mm	Plastic	0805 Chip	CTREEL7x8mm-P4E	4000
12mm	4mm	Plastic	2010 Chip, MELF, SM1	CTREEL7x12mm-P4	4000
12mm	8mm	Plastic	1812 Chip, Tant-C, SO8	CTREEL7x12mm-P8	1000
16mm	4mm	Plastic	8x0805 R-Array	CTREEL7x16mm-P4	4000
16mm	8mm	Plastic	SO14, SO16	CTREEL7x16mm-P8	500
13" REEL DIAMETER					
8mm	2mm	Paper	0402 Chip	CTREEL13x8mm-P2P	10,000
8mm	2mm	Plastic	0402 Chip	CTREEL13x8mm-P2E	10,000
8mm	4mm	Paper	0805 Chip	CTREEL13x8mm-P4P	10,000
8mm	4mm	Plastic	0805 Chip	CTREEL13x8mm-P4E	10,000
12mm	4mm	Plastic	2010 Chip, MELF, SM1	CTREEL13x12mm-P4	10,000
12mm	8mm	Plastic	1812 Chip, Tant-C, SO8	CTREEL13x12mm-P8	2500
16mm	4mm	Plastic	8x0805 R-Array	CTREEL13x16mm-P4	2500
16mm	8mm	Plastic	SO14, SO16	CTREEL13x16mm-P8	2500
16mm	12mm	Plastic	SOL16	CTREEL13x16mm-P16	1000
24mm	4mm	Plastic	R-Network	CTREEL13x24mm-P4	1000
24mm	8mm	Plastic	Ø4mm Al-Cap, Crystal	CTREEL13x24mm-P8	1000
24mm	12mm	Plastic	SOM16, SOL20	CTREEL13x24mm-P12	1000
24mm	16mm	Plastic	PLCC28, PLCC32	CTREEL13x24mm-P16	500
24mm	24mm	Plastic	D3PAK	CTREEL13x24mm-P24	500
32mm	16mm	Plastic	SOW32	CTREEL13x32mm-P16	500
32mm	24mm	Plastic	PLCC44	CTREEL13x32mm-P24	500
32mm	32mm	Plastic	BGA121, BGA169	CTREEL13x32mm-P32	250
44mm	16mm	Plastic	SOL40	CTREEL13x44mm-P16	250
44mm	24mm	Plastic	QFP	CTREEL13x44mm-P24	250
44mm	32mm	Plastic	PLCC68	CTREEL13x44mm-P32	250
44mm	36mm	Plastic	SOCKET PLCC68	CTREEL13x44mm-P40	250
56mm	40mm	Plastic	SOCKET PLCC84	CTREEL13x56mm-P40	100

AMMO PACK THROUGHHOLE COMPONENTS



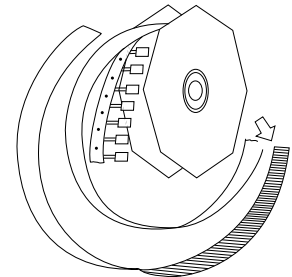
Ammo is quite popular in Asia and is very similar to tape and reel, except the tape is fan folded in a box instead of rolled onto a reel.

Ammo packaging consumes considerably less volumetric space and weighs less than tape and reel.



**AXIAL COMPONENTS
ON TAPE AND REEL**

TAPE & REEL FOR THROUGHHOLE COMPONENTS



**RADIAL COMPONENTS
ON TAPE AND REEL**

Both axial and radial lead components may be packaged on tape and reel.

The reel is constructed with 14~15 inch (355~380mm) cardboard flanges mounted to a cardboard, hollow code, tubular hub. A metal insert holds the flanges to the hub.

The flanges may be circular or octagon shaped.

Axial lead components are mounted between two continuous strips of adhesive tape.

Radial lead components are mounted to a continuous cardboard strip and held in place by an adhesive tape.

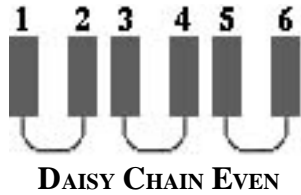
The insertion machine will cut (excise) the leads from the tape and form the leads (if necessary) prior to assembly into holes on the PC board.

COPLANARITY

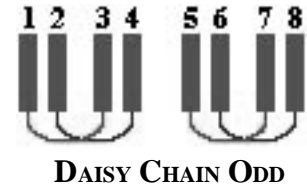
Layman's description: Think of sitting on a wobbly stool or at a wobbly table which rocks because all the legs don't touch the floor at the same time. The amount of **gap** between the floor (PC board) and the leg (component lead) is called coplanarity.

Technical definition: a setting plane formed by the first 3-leads touching the surface. All other leads are measured from this plane.

To assure good solderability, the maximum coplanarity allowance must be as small as possible. For example, most QFP components have a maximum guaranteed coplanarity of 4 mils (0.1mm). This means that no lead on the QFP will be more than 4 mils (0.1mm) off the PCB (about the thickness of a single sheet of paper).



DAISY CHAIN



Continuity testing requires dummy components to contain internal daisy-chain connections.

Daisy Chaining is also known as stitching.

For QFP, SOIC, PLCC, LCC and TSOP type components, the daisy-chain is wire-bonding of the leads inside of the component.

For BGA components, the daisy chain is usually made on the substrate.

The standard daisy chain pattern for non-BGA Integrated Circuits is “EVEN”, designated by a DE suffix at the end of TopLine’s part number (example PLCC68M-DE).

Daisy chain “ODD” is available on special order with part number suffix DO (example PLCC68M-DO).

There is no industry standard daisy chain pattern for BGA, Chip Scale and Flip Chip components.

TopLine has open tooled daisy chain patterns for BGA components which are fully described in the BGA Daisy Chain Pattern Book, now available on TopLine’s website at <http://www.toplinedummy.com/bgabooklet.pdf>.

Dummy Class 101

Pop Quiz #3 for pages 40-56

Your Name _____

Date _____

Match the answer on the right to the question on the left:

- | | | |
|-----------|------------------|----------------------|
| _____ 1. | LCC | A. Continuity test |
| _____ 2. | 1 amp rating | B. Diode |
| _____ 3. | Resistor | C. .1" x .25" |
| _____ 4. | T05 | D. SIP package |
| _____ 5. | 1/4 watt size | E. Bakable to 150° C |
| _____ 6. | Coplanarity | F. Taping in box |
| _____ 7. | DO215AA | G. Castellated |
| _____ 8. | Tray | H. Axial lead |
| _____ 9. | Straight leads | I. Rectifier |
| _____ 10. | Resistor network | J. Transistor |
| _____ 11. | Daisy chain | K. Setting plane |
| _____ 12. | Ammo | L. Flat pack |

Answer True or False:

- _____ 13. Special handling of LCC is required to prevent lead damage.
- _____ 14. Diodes are high powered rectifiers.
- _____ 15. T05 and T039 are similar.
- _____ 16. 1/4 watt resistors are axial leaded.
- _____ 17. Lead pitch for SIP is usually 1/4 inch.
- _____ 18. T099 is an 8-lead IC package.
- _____ 19. Most trays are stackable.
- _____ 20. Flat packs are state of the art.
- _____ 21. Coplanarity is unimportant.
- _____ 22. TO92 is expensive.

Fill in the blanks:

Internal connections is known as _____.

Maximum coplanarity allowance for QFP is _____ mils.

Two styles of taping for radial through hole components are _____ and _____.

BGAs and TSOPs should be baked at 125° C for _____ hours prior to assembly.

SIP resistor networks usually have _____ inch lead pitch.

The ceramic version of the dual inline package is known as _____.

Do through hole packages usually have _____ leads?

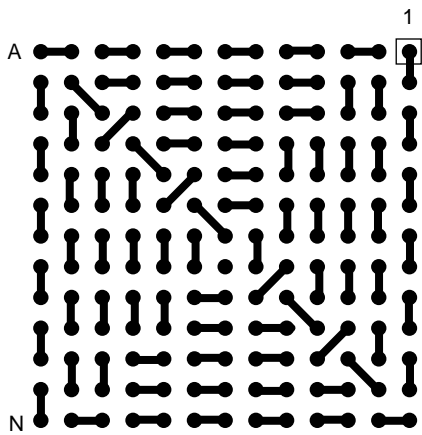
Castellations are found on this type of component _____.

Circle the one which doesn't belong:

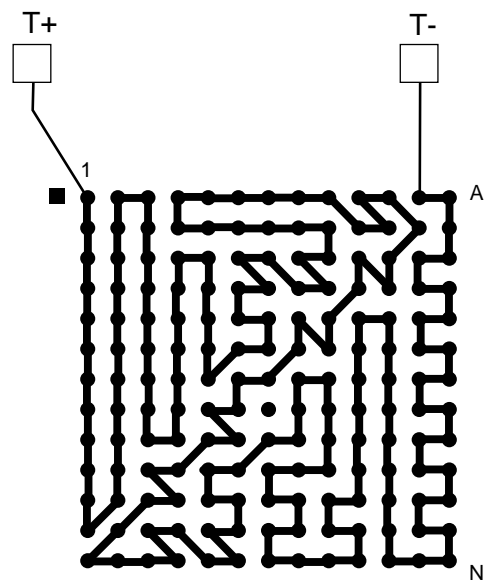
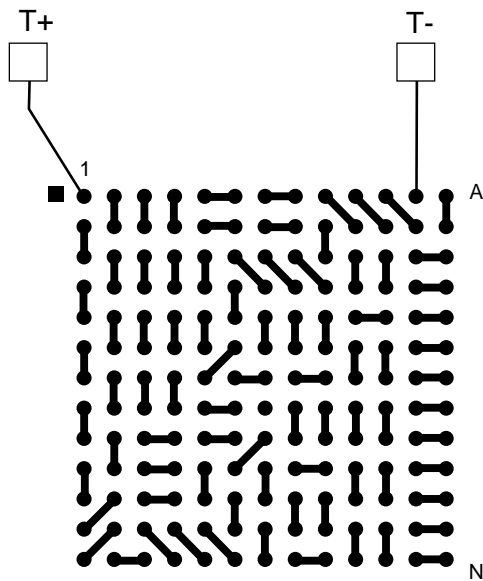
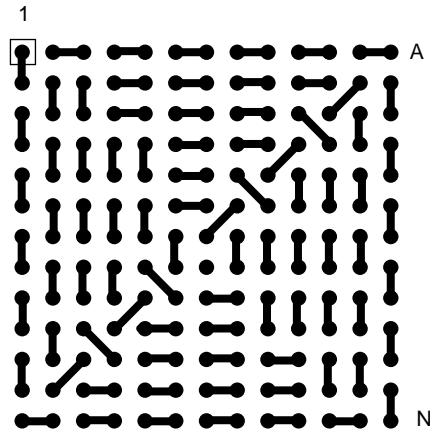
- | | | | | |
|-----|----------------|---------------|-------------|-------------|
| 31. | LCC | BGA | PLCC | |
| 32. | gold | solder coated | axial | |
| 33. | 50 mils | 0.5 inch | 1.27 mm | |
| 34. | .1" | 1000 mils | 2.54 mm | |
| 35. | TQFP | TSOP | TBGA | |
| 36. | Bulk packed | Resistors | QFP | |
| 37. | Ammo | Tape & reel | Pitch | |
| 38. | JEDEC | Standards | Tape & Reel | |
| 39. | Popcorn effect | TSOP | Baking | Daisy chain |
| 40. | T05 | T092 | T099 | |

Example of a BGA daisy chain pattern:

VIEW OF BUMPS



X-RAY VIEW



PCB PADS

AFTER MOUNTING TO TEST BOARD

PRACTICE KITS

TopLine offers a family of over 50 different placement and solder practice kits for all skill levels - from beginner to the most advanced.

Kits are convenient and include PC boards plus enough dummy components to populate one side of the PC board.

Most TopLine PC Boards are double-sided, allowing the second side to extend the usefulness of the kit.

There are two categories of kits:

1. Hand Assembled Kits
2. Machine Assembled Kits

Hand Assembled Kits include bulk or singularly packed components in carriers to protect the leads from damage.

Machine Assembled Kits have components which are mounted on tape and reel, in trays or tubes

Unless specified by the customer, Machine Run Kits predominately include components on tape and reel. Customers preferring components in tubes or in trays are encouraged to clearly state their requirements.

Gerber files and parts placement data are offered as an accessory on 3.5" floppy diskettes

PC BOARD STANDARDS

Unless otherwise stated in TopLine's Kit Catalog, most kit PC Boards conform to the following specifications:

Board Material: FR4 epoxy class laminate

Board Size: 5.5 x 4 inch (140mm x 100mm)

Layers: Double-sided with 2-front sides, eliminating the need for separate front and back stencils.

Metalization: 1-ounce copper

Board Thickness: .062-inch (1.5mm)

Solder Mask: Green LPI (Liquid Photoimageable)

Silk Screen: White ink nomenclature

Tinning: HASL (Hot Air Soldering Level)

Tool Holes: .125-inch (3.0mm) in 4-places

Fiducial Marks: SMEMA (metalized circle with solder mask clearance)

PC BOARD MATERIAL

PC Boards are sometimes called substrates and are available as rigid or flexible.

I. Rigid Substrates

A. Laminate Material

1. **FR4** epoxy glass is the industry's most popular laminate for construction of PC Boards for commercial use. TopLine uses FR4 boards in most kits
2. **Polyimide** is a high temperature material which is available on a special order basis. Polyimide is used for applications requiring high temperatures for extended periods of time. (example: burn-in)

B. Ceramic Substrate: A limited number of TopLine boards are ceramic. Ceramic affords long life to high heat; however, ceramic substrates are expensive and brittle.

II. Flexible Boards: Flex boards are made from very thin laminate material and are used in applications where the circuit must conform around corners of a case (such as inside camcorders).

Currently, TopLine has no kits offering flexible PC Boards.

PC BOARD FINISHING

HASL: TopLine uses Hot Air Soldering Leveling (HASL) on most PC boards. The HASL process gives boards a controlled plating flatness which assures coplanarity for fine-pitch components.

Bare Copper: On special order basis, TopLine will supply PC Boards with the bare copper protected by an OSP covering (Organic Solderability Preservative) such as **Entek**. Bare copper offers the flattest surface. OSP is a clear protective coating which delays bare copper for approximately 6-months, prior to assembly. It is recommended that assembly be completed within 24 hour after commencing, since soldering will dissolve the OSP covering.

Gold: TopLine offers a limited selection of PC Boards with gold plating. Gold offers flatness as well as long shelf life. However, gold is more expensive than HASL and should only be used if absolutely required.

SOLDER MASK

TopLine uses green LPI (liquid photoimageable) solder mask on most boards. Solder mask is used to protect circuitry (tracings) on the PC board and reduce solder bridging during assembly and rework. Solder mask covers all surfaces of the board including the area **between** the pads too.

On a special order basis, TopLine can supply solder mask in different colors.

While solder mask is aesthetically appealing, it is not required on throughhole boards.

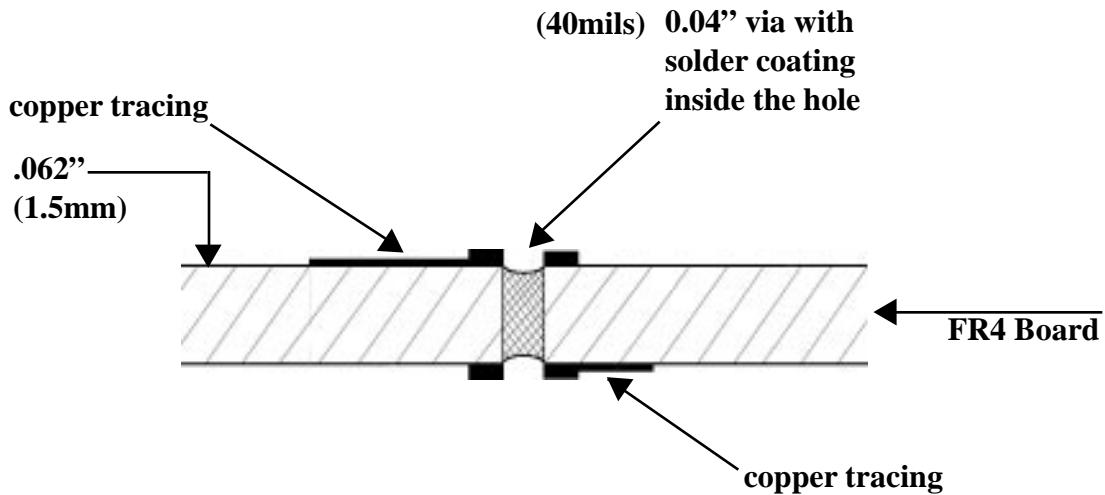
Without solder mask, FR4 epoxy glass PC Boards are milky white in color.

PLATED THROUGHHOLE

TopLine uses plated throughholes for mixed technology and boards requiring leaded components. The inside and top/bottom rim of the hole is plated with solder.

Plated Throughholes ensure a good solder connection of the component's lead.

Plated Throughholes are also used to connect the circuitry on the top side of the PC Board to the circuitry on the bottom side.



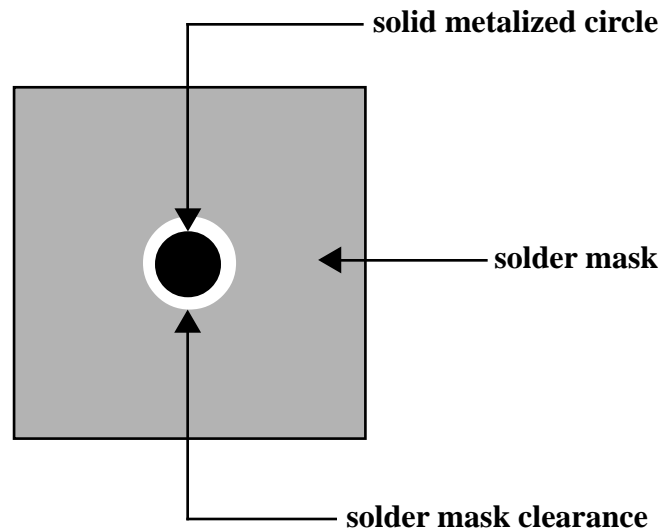
FIDUCIAL MARKS

Fiducial marks are used by vision equipment to locate the component's centroid position on the PC Board.

There are over 10 different fiducial patterns used in the industry, including round, donut, square, diamond, binary cross, triangle, etc.

Not **all** vision equipment are able to recognize **all** fiducial patterns.

The SMEMA (Surface Mount Equipment Manufacturer Association) standard (solid metalized circle within a solder mask clearance) is used on most TopLine PC Boards.



GLOBAL FIDUCIALS

Layman's Definition: Think of global fiducials as two fixed points (such as light houses) to guide ships into port. From these two known points, vision equipment are able to determine locations on a PC Board.

Technical Explanation: A minimum of two global fiducials are provided for correction of translational offsets (x and y positions) and rotational offsets (theta on z-axis) located diagonally opposed as far apart as possible on the PC Board or panel.

LOCAL FIDUCIALS

Local fiducials are typically located at the centroid of an individual component on the PC Board.

Typically, only fine-pitch components such as QFP and TSOP require local fiducial marks on the PC Board.

GERBER DATA

Gerber is a machine language for designing and fabricating PC Boards.

A typical single-sided PC Board requires the following **layers** of instruction:

1. Metalization (copper pads and circuitry)
2. Silkscreen Nomenclature
3. Solder Mask
4. Routing (cutting)
5. Drilling Hole Locations

Double-sided boards require twice as many instructions for the front and back side.

Multilayer boards require additional instructions.

TopLine provides Gerber Data on 3.5" floppy disks **only** for the metalization layer to allow fabrication of solder paste stencils.

TopLine is also able to send the Gerber Data by e-mail in zip format (requires WinZip to decompress).

CAUTION: The Gerber Data must match the latest TopLinePC Board Revision.

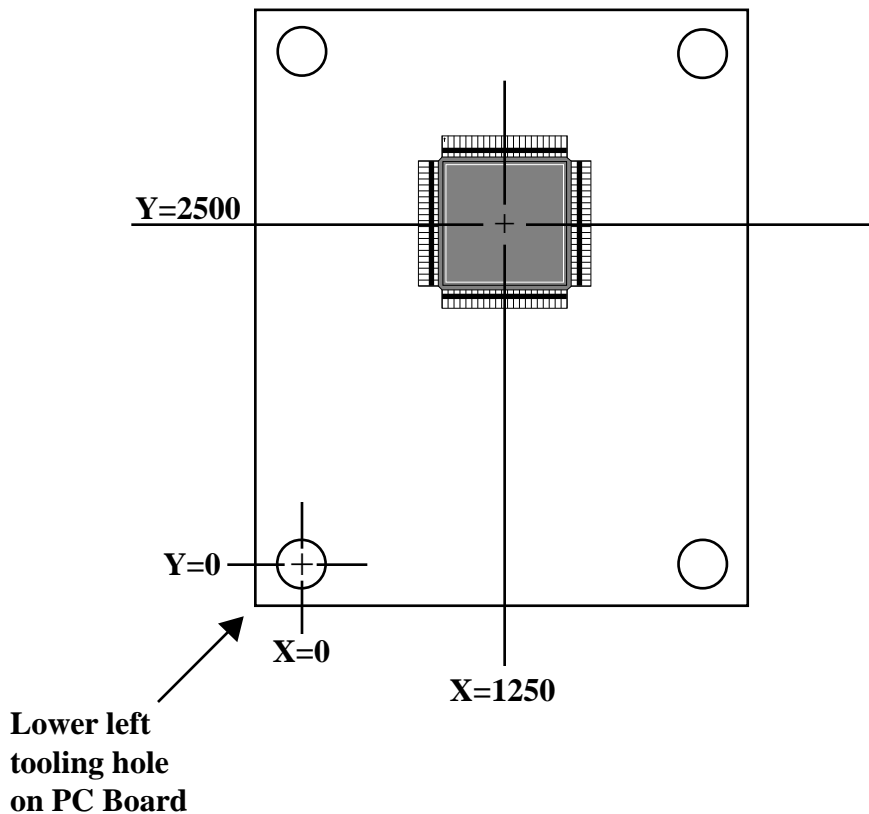
PARTS PLACEMENT DATA

Parts placement data for X, Y and theta coordinates are provided in ASCII format on 3.5" floppy disk.

These coordinates instruct pick and place machines where to place the component on the PC Board. Theta θ is the rotation required on the Z axis.

Measurements on the X and Y axis are in relationship to the center of the lower left tooling hole on the TopLine PC Board.

For example, if a component is to be placed 1.25" east and 2.50" north of the lower-left tooling hole, the X-coordinate is 1250mils and the Y-coordinate is 2500mils.



STENCILS

Stencils are used to spread solder paste on the PC Board.

Stencils are metal plates with apertures (openings) that match the metalization layer (pads) on the PC Board.

Solder paste is pushed through the aperture with a squeegee. Automatic machines are called stencil printers or screen printers.

The stencil is fabricated using the same Gerber Data as used to fabricate the metalization layer of the PC Board.

Small corrections to the aperture are made, depending on the size of the pad, pitch of the component and thickness of the stencil plate.

Apertures on the metal plate are created by chemically etching or laser cutting the metal plate.

The stencil plate is mounted in on frame according to the type of machine used.

TopLine provides a Metal Mask Stencil Questionnaire which must be completed prior to ordering stencils.

The questionnaire is used to instruct the stencil manufacturer how to build and mount the stencil.

Dummy Class 101

Pop Quiz #4 for pages 59-71

Your Name _____

Date _____

Answer True or False:

- _____1. FR4 is a popular laminate material for PC Boards.
- _____2. HASL is a soldermask.
- _____3. Polyimide PC Boards are used for high-temperature applications.
- _____4. Bare copper boards require an OSP protective coating prior to assembly.
- _____5. Solder mask covers the copper pads for protection.
- _____6. Plated Throughholes are for SMD components.
- _____7. Fiducial Marks are recognized by vision equipment to locate components.
- _____8. Global Fiducials are located as close as possible to the component.
- _____9. All components require Local Fiducials.
- _____10. Theta θ is rotation required on the Z-axis.

Circle the one that doesn't belong:

- | | | | |
|-----|--------------|-----------|----------------------|
| 11. | Soldermask | Drilling | LPI |
| 12. | FR4 | Copper | Polyimide |
| 13. | DIP | Fiducial | Throughhole |
| 14. | Gerber | OSP | Stencil |
| 15. | X-Y-Theta | Fiducials | Parts Placement Data |
| 16. | Tooling Hole | Routing | SMEMA |
| 17. | Aperature | Stencil | Parts Placement |

Match the answer on the right to the question on the left:

- | | |
|----------------------------------|--------------------------|
| _____ 18. Silkscreen | A. Board cutting |
| _____ 19. Aperature | B. Parts Placement Data |
| _____ 20. SMEMA | C. Stencil |
| _____ 21. Gerber | D. Openings on stencil |
| _____ 22. X-Y Theta | E. Global Fiducial |
| _____ 23. Local Fiducials | F. LPI |
| _____ 24. Solderpaste Applicator | G. Protective Coating |
| _____ 25. Soldermask | H. Solder leveling |
| _____ 26. HASL | I. Centroid |
| _____ 27. Routing | J. Squeegee |
| _____ 28. Entek | K. Machine language |
| _____ 29. Laser cut | L. Equipment Association |
| _____ 30. Fixed points on board | M. Nomenclature |

TOOLS & ACCESSORIES

TopLine offers a selection of unique tools and accessories for use in the lab and production floor.

A. Tools

1. Vacuum Pick up Tools
2. QFP Lead Straightener
3. SMD Tape Splicer

B. ESD Products

1. Tray Straps
2. Grounding Wrist Band
3. Heel Grounders
4. Workstation Grounding Mats

C. Chemicals & Cleaners

1. Cleaner Sprays
2. Freeze Sprays

D. Software

1. ClipArt - Illustrations of Components

F. Books

1. BGA Technology
2. Component Identification
3. SMD Nomenclature

TOPLINE WEBSITE

TopLine's website (www.TopLineDummy.com) provides visitors with a host of services and information.

1. **Online Catalog** in PDF format may be downloaded or viewed on screen. This catalog requires Adobe Acrobat Reader which is distributed free of charge on TopLine's website. The PDF catalog on the web is identical to TopLine's printed catalog.
2. **Price List.** TopLine's entire product offering is listed on the web. The price list also shows inventory levels in stock at TopLine and is updated twice daily (12noon and 6pm California time).
3. **Distributor List.** TopLine's international distributor network is listed on the web. Local telephone and fax numbers are displayed in addition to the distributor's e-mail address and website, if available.
4. **Reference Books.** TopLine offers free reference materials which may be downloaded or viewed online in PDF format. Such reference materials include:

SMD Nomenclature
BGA Daisy Chain Patterns
Dummy Class 101

In the future, TopLine will add Gerber Data and component drawings to the web.

5. **Members Only** requires a password and is used by TopLine distributors.
6. **InstaCredit.** Up to \$500 of credit is offered to USA companies who complete and sign an instaCredit application.

SYNONYMS

The following terms are synonyms and may be used interchangeably.

- | | | | |
|----|-----------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------|
| 1. | Dummy
Dummies
Dummy Components
Mechanical Packages
Mechanical Sample | 8. | Tape & Reel
T & R |
| 2. | Circuit Board
PCB
PC Board
Printed Circuit Board
PWB
Printed Wiring Board
Substrate
Vehicle Test Board | 9. | Eutectic
63/37 SnPd Solder |
| 3. | Leaded Component
Throughhole Component | 10. | 1/4 Watt Resistor Size
.1" x .25" |
| 4. | Tube
Stick
Magazine | 11. | Drawing
Print |
| 5. | Potentiometer
Trimmer | 12. | Solder Balls
Solder Bumps |
| 6. | Diode
Rectifier | 13. | Land Pattern
Solder Pad
Coupon |
| 7. | SMD
Surface Mount
Surface Mount Device | 14. | Exhibition
Fair
Trade Show |
| | | 15. | Gerber Data
Gerber File |
| | | 16. | X, Y, Theta
Parts Placement Data |
| | | 17. | Assembled Board
Populated Board |

INTRODUCTION TO ESD

ELECTROSTATIC DISCHARGE

Layman's explanation - Think of static electricity as non-moving electrons waiting for an opportunity to arc to ground. When static electricity arcs to ground we see and feel it as a "spark".

Static electricity will destroy "live" semiconductor components such as integrated circuits and computer modules, etc.

During storage, sensitive electronic components are protected from static in tubes, tape and reel or in trays.

Precautions on the production floor must be taken to assure that static electricity is safely grounded to prevent damage to live components.

For example workers should wear grounding wrist straps, heel grounders in their shoes, and work at ESD safe work stations with static dissipative flooring, etc.

ESD SAFE PRODUCTS

TopLine offers a limited range of ESD Safe products for storing, handling and assembly.

I. Storage

1. antistatic tubes
2. static dissipative reels
3. antistatic reels
4. conductive trays

II. Handling

1. Vampire Vacuum Pick up Tool
2. Wafer Vampire
3. Tweezers
4. QFP Lead Straightener

III. Assembly

1. SMD Tape Splicer
2. Grounding Wrist Bands
3. Heel Grounders
4. Workstation Mats
5. Microcare Anti-Static Freeze

TopLine will add more ESD Safe products in the future.

RESISTIVITY

Electrons flow faster through metallic conductive surfaces but slower through insulative materials.

Resistivity is measured in Ohms.

Metals, such as copper and aluminum, have near zero Ohm of resistivity, so electrons flow very quickly.

Certain conductive materials such as carbonized plastics have $100\text{K}\Omega$ to $1\text{M}\Omega$ resistivity.

Antistatic plastic materials have $1,000\text{M}\Omega$ resistivity.

UNITS OF RESISTIVITY

Resistivity is measured in Ohms.

As the number of zeros increase, it is more convenient to express ohms in scientific notation.

ESD NOMENCLATURE	OHMS	OHMS	SCIENTIFIC NOTATION	MATERIALS
↑ conductive ↓	10	10Ω	10 ¹	↑ metals ↓
	100	100Ω	10 ²	
	1,000	1KΩ	10 ³	
↑ dissipative ↓	10,000	10KΩ	10 ⁴	↑ water ↓
	100,000	100KΩ	10 ⁵	
	1,000,000	1MΩ	10 ⁶	
↑ anti static ↓	10,000,000	10MΩ	10 ⁷	↑ plastics ↓
	100,000,000	100MΩ	10 ⁸	
	1,000,000,000	1,000MΩ	10 ⁹	
↑ insulative ↓	10,000,000,000	10,000MΩ	10 ¹⁰	↑ ceramics ↓
	100,000,000,000	100,000MΩ	10 ¹¹	
	1,000,000,000,000	1,000,000MΩ	10 ¹²	
	10,000,000,000,000	10,000,000MΩ	10 ¹³	
	100,000,000,000,000	100,000,000MΩ	10 ¹⁴	

Note: K = 1000 and M = 1,000,000

Dummy Class 101

Pop Quiz #5 for pages 74-80

Your Name _____

Date _____

Answer True or False:

- _____1. TopLine's catalog may be downloaded from the web.
- _____2. InstaCredit, up to \$500, is available to USA companies who complete and sign the InstaCredit form.
- _____3. Metals such as copper are high in resistivity.
- _____4. Antistatic materials must have near zero ohms of resistivity.
- _____5. Static electricity will destroy live semiconductors.

Circle the one that doesn't belong:

- | | | | |
|-----|--------------------------|---------------|-------------|
| 6. | Wrist Strap | Heel Grounder | Safety Net |
| 7. | Copper | Ceramic | Carbon |
| 8. | Diode | Transistor | Rectifier |
| 9. | Tube | Drawer | Tray |
| 10. | Conductive | Dissipative | Insulative |
| 11. | 1000 Ω | 1M Ω | 1K Ω |
| 12. | 10 ⁶ Ω | 1K Ω | 1M Ω |

PART NUMBERING SYSTEM

TOPLINE DEVICE	WEBSITE PRICE LIST PRODUCT CODE	TYPE	FUNCTION	LEAD STYLE	SMD THRUHOLE
BGA	XJ1	BGA	IC	Ball	SMD
BGATRAY	XZ1	Tray		-	SMD
BQFP	XQ1	QFP	IC	Gull	SMD
CBGA	XJ1	BGA	IC	Ball	SMD
CCBGA	XJ1	BGA	IC	Ball	SMD
CERDIP	XN1	Ceramic DIP	IC	Lead	Thru
CERQUAD	XC1	Ceramic QFP	IC	Gull and J	SMD
CF	XA1		Resistor	Axial Lead	Thru
CK	XR1		Ceramic Capacitor	Radial Lead	Thru
CKR	XR1		Ceramic Capacitor	Radial Lead	Thru
CQFP	XC1	QFP	IC	Gull/J	SMD
CS	XR1		Tantalum Capacitor	Axial Lead	Thru
CSP	XJ1	Chip Scale Package	IC	Ball	SMD
CTREEL	XM1	Reel	Reel	-	SMD
D2PAK	XD1	Discrete	Power Transistor	Gull	SMD
D3PAK	XD1	Discrete	Power Transistor	Gull	SMD
DIP	XN1	DIP	IC	Dual Inline Lead	Thru
DO	XA1		Diode/Rectifier	Axial Lead	Thru
DPAK	XD1		Transistor	Gull	SMD
FC	XJ1	Flip Chip	IC	Bump	SMD
FCPBGA	XJ1	BGA	IC	Ball	SMD
FM1	XD1	Discrete	Diode/Rectifier	C-Bend	SMD
FP	XF1	FP	IC	Flat Lead	Thru
LCC	XL1	LCC	IC	Castellation	SMD
LCN	XD1	LCC	Crystal	Castellation	SMD
LQFP	XQ1	QFP	IC	Gull	SMD
LQTRAY	XZ1	Tray	IC	-	SMD

PART NUMBERING SYSTEM

TOPLINE	WEBSITE PRICE LIST				
DEVICE	PRODUCT CODE	TYPE	FUNCTION	LEAD STYLE	SMD THRUHOLE
LX0	XR1		Oscillator	PIN	Thru
LX0SMD	XD1		Oscillator	Gull	SMD
LX1/2	XR1		Oscillator	PIN	Thru
LX1/2SMD	XD1		Oscillator	Gull	SMD
MCR	XQ1	QFP	IC	Flat	SMD
MQUAD	XQ1	QFP	IC	Gull	SMD
PLCC	XP1	PLCC	IC	J	SMD
QFP	XS1	QFP	IC	Gull	SMD
QSOP	XS1	SOIC	IC	Gull	SMD
QTRAY	XZ1	Tray		-	SMD
RC	XA1		Resistor	Axial Lead	Thru
RCR	XA1		Resistor	Axial Lead	Thru
RL	XA1		Resistor	Axial Lead	Thru
RLR	XA1		Resistor	Axial Lead	Thru
RN	XA1		Resistor	Axial Lead	Thru
RNR	XA1		Resistor	Axial Lead	Thru
RS	XA1		Resistor Network	SIP Lead	Thru
RSM	XA1		Resistor Network	SIP Lead	Thru
RSMH	XA1		Resistor Network	SIP Lead	Thru
RSMP	XA1		Resistor Network	SIP Lead	Thru
SB	XD1		Ferrite Bead	Chip Metalized	SMD
SC	XD1		Ceramic CAP	Chip Metalized	SMD
SD	XD1		Tantalum CAP	C-Bend	SMD
SE	XD1		Aluminum CAP	Gull	SMD
SI	XD1		Inductor	C-Bend	SMD
SM1	XD1	Discrete	Diode/Rectifier	MELF	SMD
SM49	XD1		Crystal	J	SMD

PART NUMBERING SYSTEM

TOPLINE	WEBSITE PRICE LIST			LEAD	SMD
DEVICE	PRODUCT CODE	TYPE	FUNCTION	STYLE	THRUHOLE
SMAG	XD1	Discrete	Diode/Rectifier	Gull	SMD
SMAJ	XD1	Discrete	Diode/Rectifier	C-Bend	SMD
SMBG	XD1	Discrete	Diode/Rectifier	Gull	SMD
SMBJ	XD1	Discrete	Diode/Rectifier	C-Bend	SMD
SMCG	XD1	Discrete	Diode/Rectifier	Gull	SMD
SMCJ	XD1	Discrete	Diode/Rectifier	C-Bend	SMD
SO	XS1	SOIC	IC	Gull	SMD
SOCKET PLCC	XP1	Socket		J	SMD
SOCKET SOJ	XS1	Socket		J	SMD
SOD	XD1	Discrete	Diode/Rectifier	Gull	SMD
SOL	XS1	SOIC	IC	Gull	SMD
SOLJ	XS1	SOJ	IC	J	SMD
SOLX	XS1	SOJ	IC	J	SMD
SOM	XS1	SOIC	R-Network	Gull	SMD
SOP	XS1	SOIC	IC	Gull	SMD
SOT	XD1	Discrete	Diode/Transistor	Gull	SMD
SOW	XS1	SOIC	IC	Gull	SMD
SOX	XS1	SOIC	IC	Gull	SMD
SOY	XS1	SOIC	IC	Gull	SMD
SP	XD1	POT	Trimmer	Gull/J	SMD
SR	XD1		Resistor	Chip Metalized	SMD
SRA	XD1		Resistor Array	Chip Metalized	SMD
SCM	XD1		Capacitor	MELF	SMD
SRM	XD1		Resistor	MELF	SMD
SSOP	XS1	SOIC	IC	Gull	SMD
SV	XD1		Variable CAP	J/Gull	SMD
SX	XD1	Crystal		J	SMD

PART NUMBERING SYSTEM

TOPLINE	WEBSITE					
DEVICE	PRICE LIST	PRODUCT CODE	TYPE	FUNCTION	LEAD STYLE	SMD THRUHOLE
SXE		XD1	Crystal		J	SMD
T2TRAY		XZ1	Tray		-	SMD
TAPEPAK		XQ1	QFP	IC	Flat	SMD
TBGA		XJ1	BGA	IC	Ball	SMD
TO		XR1	Discrete	Transistor	Radial Lead	Thru
TQFP		XQ1	QFP	IC	Gull	SMD
TQTRAY		XZ1	Tray		-	SMD
TSOP		XO1	TSOP	IC	Gull	SMD
TSSOP		XS1	SOIC	IC	Gull	SMD
TTRAY		XZ1	Tray			SMD
μBGA		XJ1	BGA	IC	Ball	SMD
VSPA		XQ1	QFP	IC	Special	SMD



PART NUMBER SYSTEM

PASSIVE & DISCRETES

<u>SC</u>	<u>0805</u>	<u>P</u>	<u>7</u>	<u>A</u>
<u>PASSIVES</u>	<u>SIZE CODE</u>		<u>REEL SIZE</u>	
SB = Ferrite Bead	<u>INCH DIMENSIONS</u>		4 = 4" (100mm)	
SC = Ceramic Capacitor	Example: 0805 = .08" x .05"		7 = 7" (180mm)	
SD = Tantalum	(Tantalum SD Code is metric)		11 = 11" (300mm)	
SE = Aluminum Cap	Example: 3216 = 3.2mm x 1.6mm		13 = 13" (330mm)	
SI = Inductor				<u>REEL MATERIAL</u>
SP = Potentiometer				A = Plastic
SR = Resistor				P = Paper
SRM = Melf Resistor		<u>PACKAGING</u>		
SV = Trimmer Cap		P = Paper Tape		
SX = Crystal/Oscillator		E = Plastic Tape		
		F = Bulk Cassette		
		B = Bulk		
		X = Small Qty. Bag		
<u>DISCRETE DEVICE</u>				
SOD = Diode				
SOT = Transistor				
DPAK = Power Device				



PART NUMBER SYSTEM

QUAD FLAT PACK

QFP

100

T

25

-

3.9

-

Options

DEVICE

QFP = Quad Flat Pack
 BQFP = Bumpered
 LQFP = Low (1.4mm Thick)
 TQFP = Thin (1.0mm Thick)
 CERQUAD = Ceramic
 CQFP = Ceramic (multilayer)
 TAPEPAK = Molded Carrier Ring

NUMBER LEADS

PACKAGING

T = Tray
 C = Coin Stack (TAPEPAK Only)
 M = Tube (BQFP Only)
 E7A = 7" Tape & Reel
 E13A = 13" Tape & Reel
 X = Single Pack

LEAD PITCH (MIL)

<u>MIL</u>	<u>MM</u>
50	1.27
40	1.0
30	0.8
25	0.65
19.7	0.5
15.7	0.4
11.8	0.3

FOOTPRINT

Add to body for total tip to tip dimensions.

2.0
 2.6
 3.2
 3.9

OPTIONS

Blank = Unspecified
 ISO = Isolated
 DE = Daisy Chain Even
 DO = Daisy Chain Odd
 BUS = All leads shorted

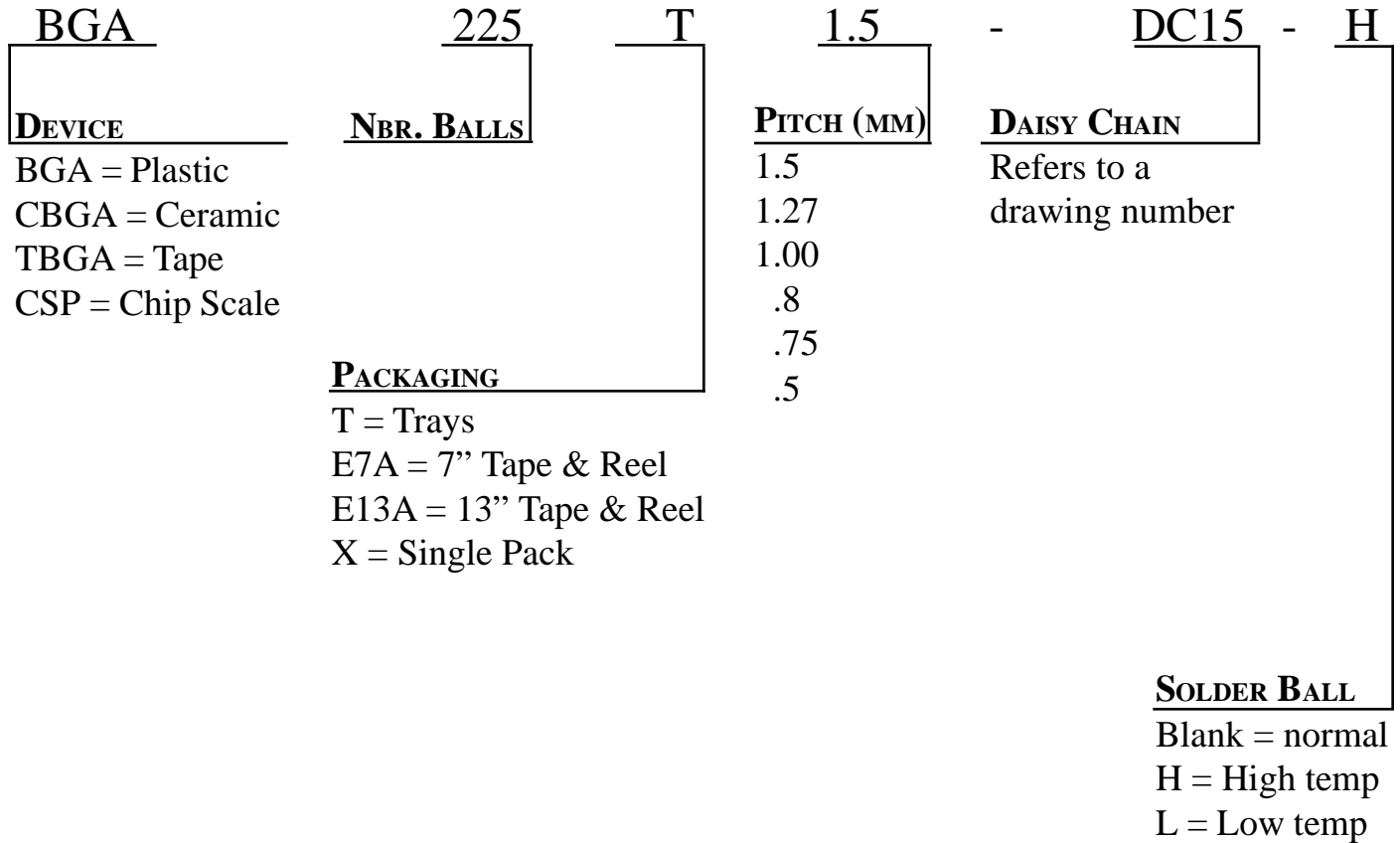


PART NUMBER SYSTEM

TSOP

TSOP	32	T	19.7	T1	Option
DEVICE TSOP		PACKAGING T = Tray E4A = 4" Tape & Reel E7A = 7" Tape & Reel E13A = 13" Tape & Reel X = Single Pack		TYPE T1 = Leads on ends T2 = Leads on wide side	
NBR. LEADS 32 = 32 leads 28/32 = 28 leads on 32 lead body (4 leads missing)			PITCH (MILS) 19.7 = 0.5mm 21.6 = 0.55mm 30 = 0.8mm 50 = 1.27mm	OPTION Blank = unspecified DE = Daisy Chain Even DO = Daisy Chain Odd	

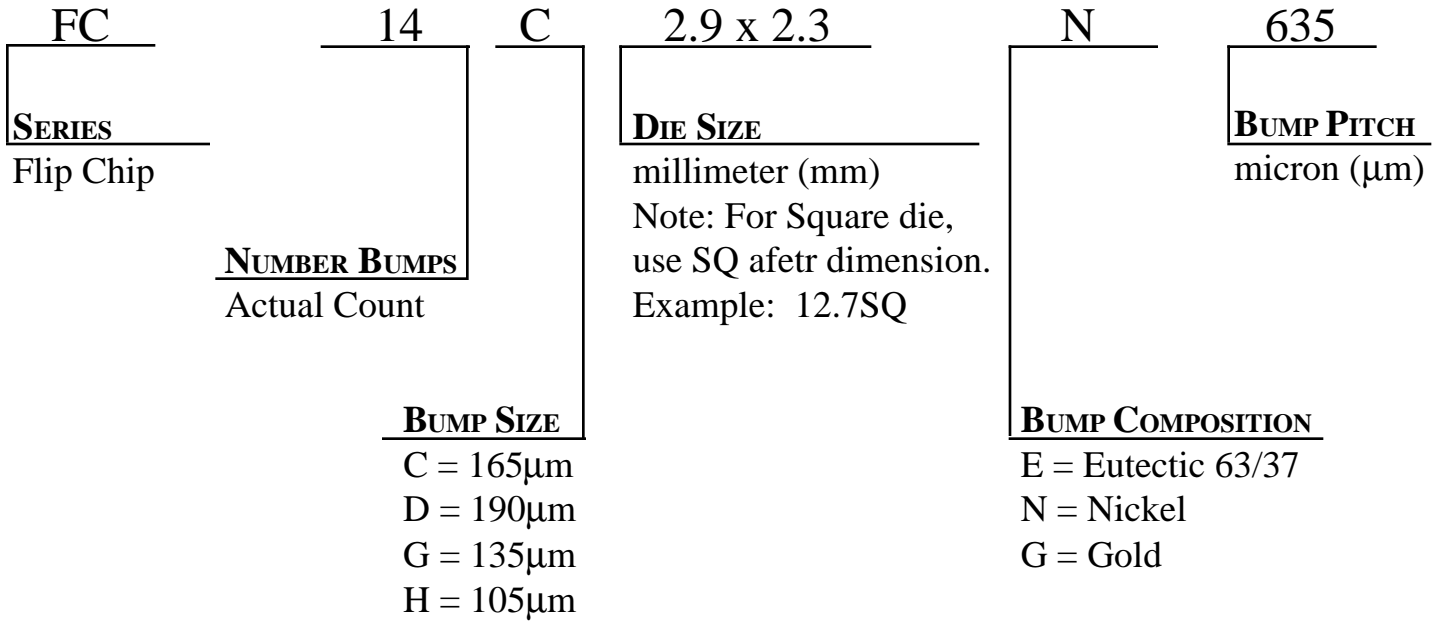
PART NUMBER SYSTEM
BALL GRID ARRAY



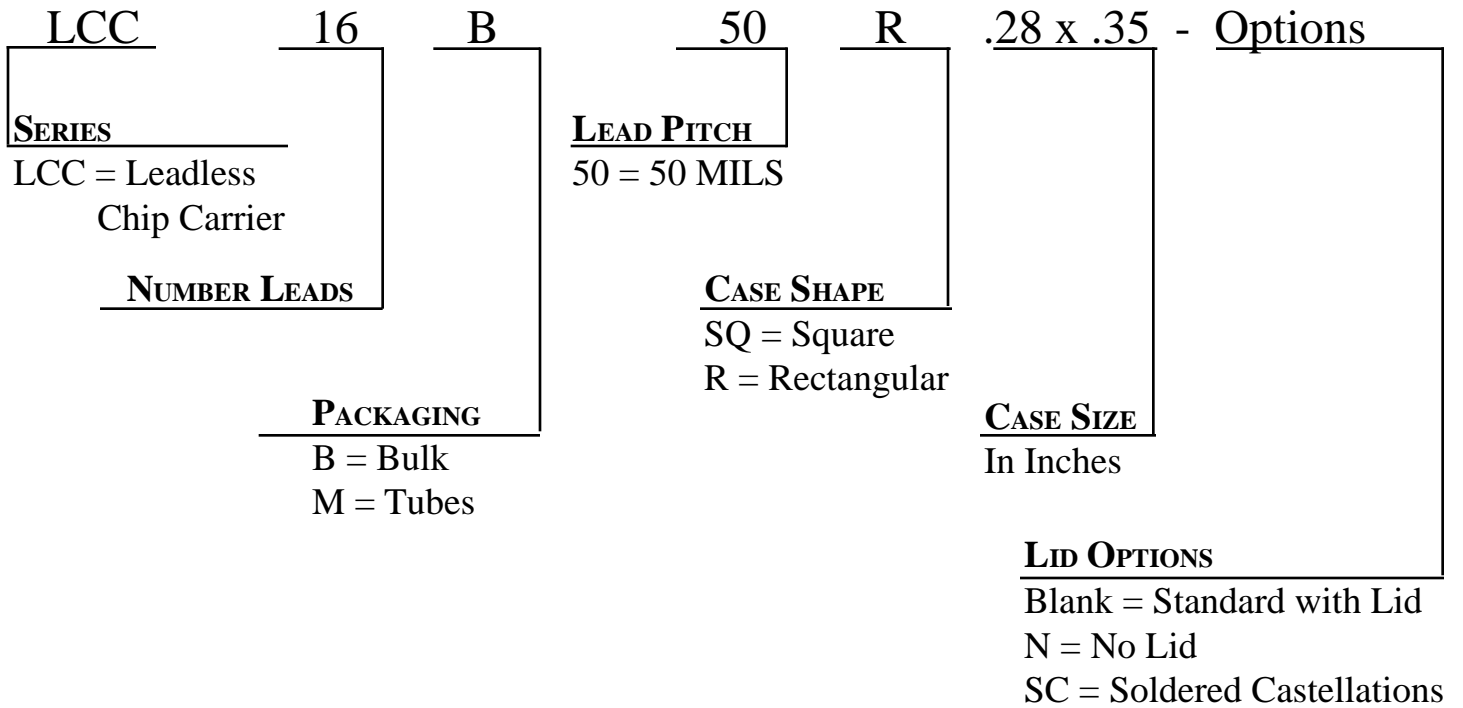


PART NUMBER SYSTEM

FLIP CHIP



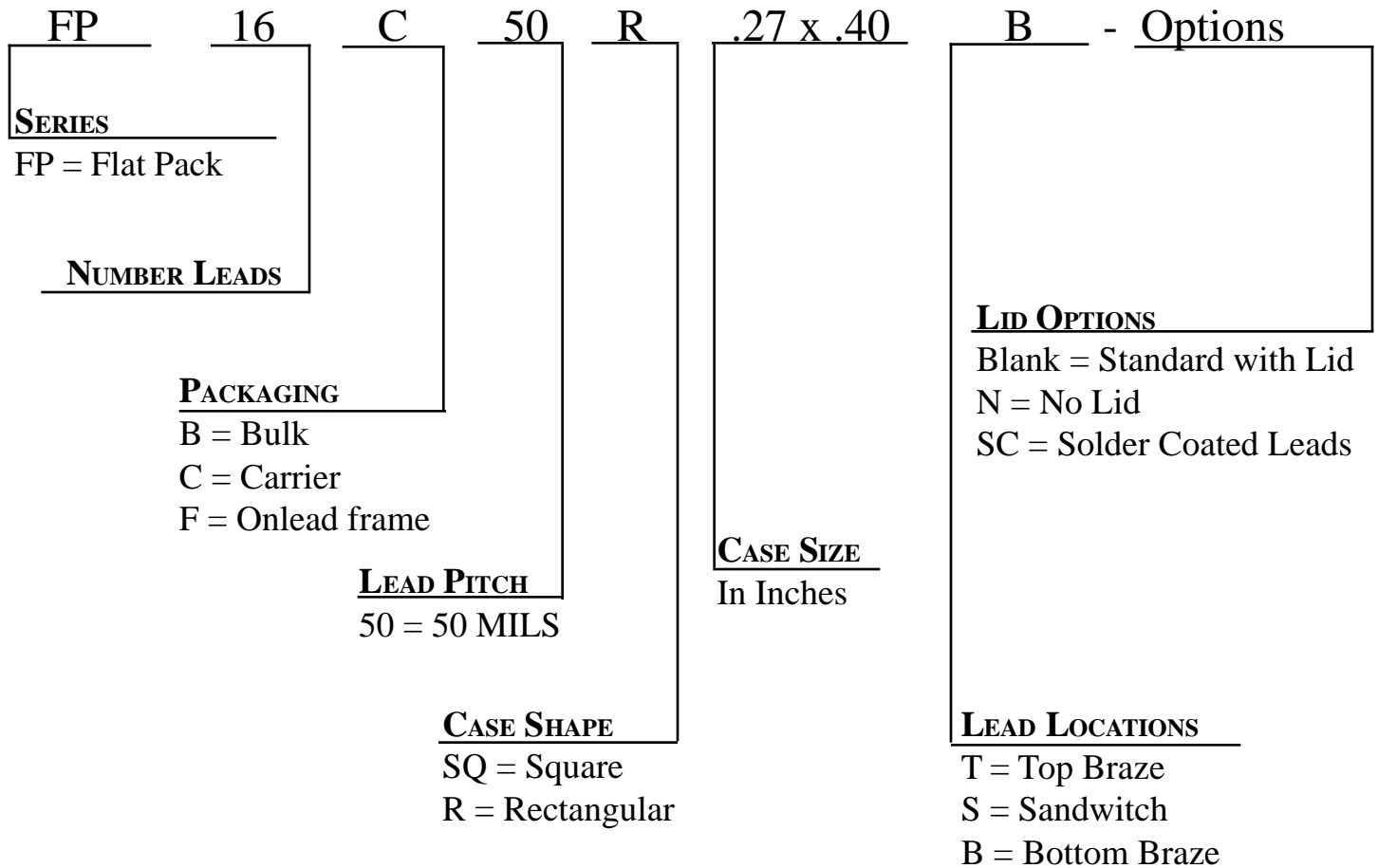
PART NUMBER SYSTEM LCC





PART NUMBER SYSTEM

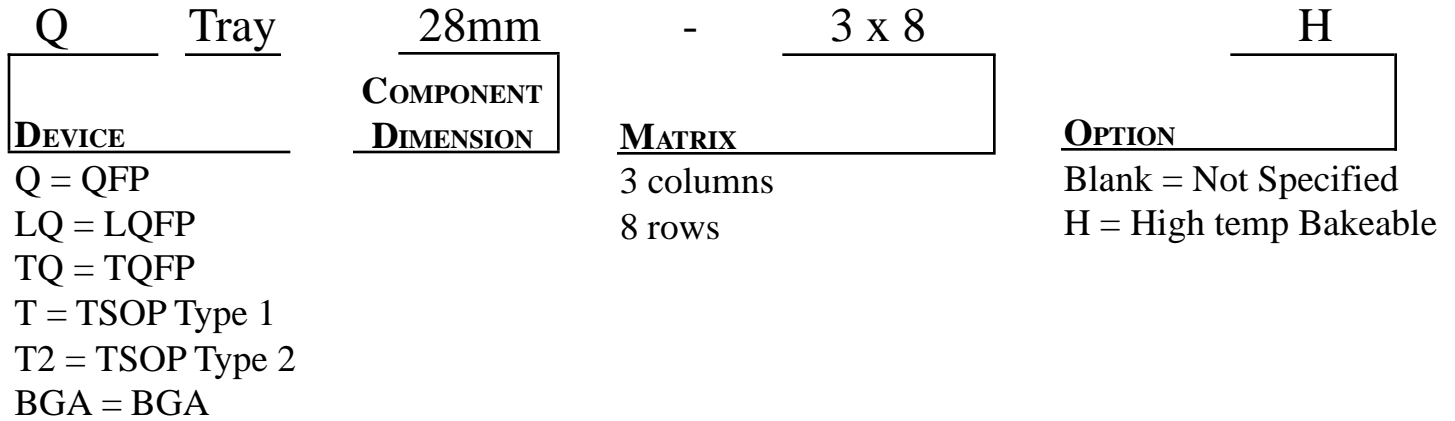
FLAT PACK





PART NUMBER SYSTEM

TRAYS





PART NUMBER SYSTEM

SIP DEVICES

<u>RS</u>			<u>8</u>	<u>M</u>
<u>DEVICE</u>				<u>PACKAGING</u>
<u>SERIES</u>	<u>CASE</u>	<u>HEIGHT</u>		M = Tubes Blank = Bulk
RS	Conformal	.2"		
RSM	Molded	.2"		
RSMP	Molded	.25"		
RSMH	Molded	.35"		
			<u>NUMBER LEADS</u>	
			4 to 14	

PART NUMBER SYSTEM

DIP DEVICES

<u>DIP</u>	<u>14</u>	<u>M</u>	<u>3</u>
DEVICE	NBR LEADS	PACKAGING	BODY WIDTH
DIP = Plastic CERDIP = Ceramic	8 ~ 64	M = Tubes	3 = 300mil 4 = 400mil 6 = 600mil



PART NUMBER SYSTEM PRACTICE KITS

920		025	
SERIES		SPECIFICATIONS	
906 =	FC96 Ceramic	947 =	Unassigned
907 =	FC96 Laminated	948 =	Unassigned
908 =	FC48 Ceramic	949 =	Unassigned
909 =	FC48 Laminate	950 =	SMTA Saber
910 =	Beginner Throughhole	951 =	CBGA
911 =	Beginner Answer Key	952 =	TBGA
912 =	Citizen FC-PBGA80	953 =	Visual BGA
913 =	300 mil DIP	954 =	Custom
914 =	Mixed Technology 2	955 =	Custom
915 =	Multipurpose Throughhole	956 =	Custom
916 =	Multipurpose Throughhole	957 =	Custom
918 =	Dima Machine	958 =	Unassigned
919 =	Phillips Machine	959 =	Custom
920 =	Challenger 1 (obsolete)	960 =	Machine Diagnostic
921 =	µBGA TV46	961 =	Fiducial Comparator
922 =	Custom	962 =	28mm QFP Assortment
923 =	µBGA TV-188M	963 =	TQFP160 (obsolete)
924 =	Beginners SMD	964 =	0402/0603 Chip
925 =	SMD Introductory	965 =	Advanced Rework Practice
926 =	Practical Hand	966 =	Custom
927 =	Custom	967 =	BGA169/225
928 =	Challenger 2	968 =	0805/1206 Chip
929 =	Jumbo Chip Set	969 =	Mixed Technology 1
930 =	Advanced w/o QFP256	970 =	Display Boards
931 =	Advanced w/QFP256	971 =	Display Labels
932 =	TQFP Assortment	972 =	~
933 =	Custom	976 =	Unassigned
934 =	Edsyn Rework	977 =	Metcal
935 =	Stencil Eval. w/LQFP168	978 =	~
936 =	Stencil Eval. w/o LQFP168	979 =	Unassigned
937 =	Econo Kit 1	980 =	PC Board Album
938 =	Econo Kit 2	981 =	~
939 =	Econo Kit 3	999 =	Special/Custom
940 =	Monster	9603 =	TSOP32
941 =	Mydata	9613 =	BQFP132
942 =	VSPA264/3	9616 =	QFP160
943 =	TQFP168	9618 =	Rotational Test
944 =	Rework Practice II	9621 =	QFP208
945 =	PCMCIA	9625 =	QFP256
946 =	Universal BGA		

Dummy Class 101

Pop Quiz #6 for pages 82-97

Your Name _____

Date _____

Answer True or False:

- _____ 1. SOJ has Gull leads.
- _____ 2. E7A is TopLine's packaging code for trays.
- _____ 3. The DE suffix at the end of a TopLine part number means Daisy Chain Even.
- _____ 4. PLCC components have 25 mil pitch J -leads.
- _____ 5. The tape and reel version of SOL20M is SOL20E13A.
- _____ 6. QFP components come with different footprints.
- _____ 7. The footprint 3.2 means add 1.6mm to each side of the component.
- _____ 8. TSOP28/32 means choice of 28 leads or 32 leads.
- _____ 9. QFP comes standard packed in coin stack tubes.
- _____ 10. Add suffix DC to TopLine SOIC part number for Daisy Chain connections.

Fill in the blank

TopLine Part Number	LEAD Pitch	REEL Size	CHECK OFF		Tape & Reel
			Tube	Tray	
11. SR1206P7A	---	_____	_____	_____	_____
12. SOL20E13A	_____mil	_____	_____	_____	_____
13. TQFP100T19.7-20	_____mm	_____	_____	_____	_____
14. PLCC20M	_____mil	_____	_____	_____	_____
15. TSOP32T19.7-T1	_____mm	_____	_____	_____	_____
16. SD7343E13A	---	_____	_____	_____	_____
17. QFP100E13A25-3.2-DE	_____mm	_____	_____	_____	_____
18. LCC20M50SQ.35	_____mil	_____	_____	_____	_____
19. BGA169T1.5-DC10	_____mm	_____	_____	_____	_____
20. SOT23E7A	---	_____	_____	_____	_____

Circle the part number which doesn't belong:

- 21. SR0805B SR1206X SOT23E7A
- 22. QFP100T25-3.2 QFP100E13A25-3.2 QFP100T25
- 23. SC0805P7A SC1210E7A SC1206P7A
- 24. BGA169E13A1.5-DC10 BGA225T1.5-DC15 BGA169M1.5
- 25. LQFP100T LQFP100T19.7-2.0 LQFP100E19.7A-2.0

Fill in the blanks:

<u>PART NUMBER</u>	<u>TOPLINE'S PRODUCT CODE</u>
26. SC0402P7A	_____
27. BGA420T1.27-DC85	_____
28. QFP100T25-3.2	_____
29. CERQUAD68J50	_____
30. SOT23E7A	_____
31. SOLJ16M	_____
32. DPAK-E13A	_____
33. TSOP32T19.7-T1	_____
34. LQFP100T19.7-2.0	_____
35. DIP8M	_____
36. LCC68B50SQ.95	_____
37. SSOP24M25	_____
38. PLCC44E13A	_____
39. SOD323E7A	_____
40. SOM16E13A	_____

Dummy Class 101

Answer Keys for Quizzes #1 - 3

Quiz #1 pages 1-20

1. E
2. I
3. G
4. B
5. H
6. J
7. D
8. A
9. C
10. F
11. 5.08mm or 5mm
12. 0.65mm
13. 0.5mm
14. 2.54mm or 2.5mm
15. .0393 inch
16. 3.2 x 1.6mm
17. B
18. .08" x .05"
19. D
20. 1005
21. 6032
22. 1206
23. 1206
24. False
25. True
26. True
27. False
28. True
29. False
30. False
31. True
32. True
33. True
34. False
35. True
36. Tray
37. Diode
38. J-lead
39. SMD
40. DPAK

Quiz #2 pages 24-36

1. False
2. True
3. False
4. True
5. True
6. False
7. True
8. False
9. False
10. True
11. 50
12. 300
13. J
14. 1.0
15. 1.3
16. H
17. E
18. J
19. K
20. I
21. B
22. A
23. F
24. G
25. D
26. C
27. 50
28. .3
29. .65
30. 1.25
31. 19.7
32. 15.7
33. SOM
34. SOXJ
35. QFP
36. SOL20M
37. Bumpers
38. SOL
39. BQFP
40. DIP

Quiz #2 pages 24-36

1. G
2. I
3. H
4. J
5. C
6. K
7. B
8. E
9. L
10. D
11. A
12. F
13. False
14. False
15. True
16. True
17. False
18. True
19. True
20. False
21. False
22. False
23. Daisy Chain
24. 4
25. ammo/tape & reel
26. 24
27. .1
28. DIP
29. axial
30. LCC
31. BGA
32. axial
33. 0.5 inch
34. 1000 mils
35. TBGA
36. QFP
37. Pitch
38. Tape & Reel
39. Daisy Chain
40. TO92

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Answer Keys for Quizzes #4 - 6

Quiz #4 pages 59-71

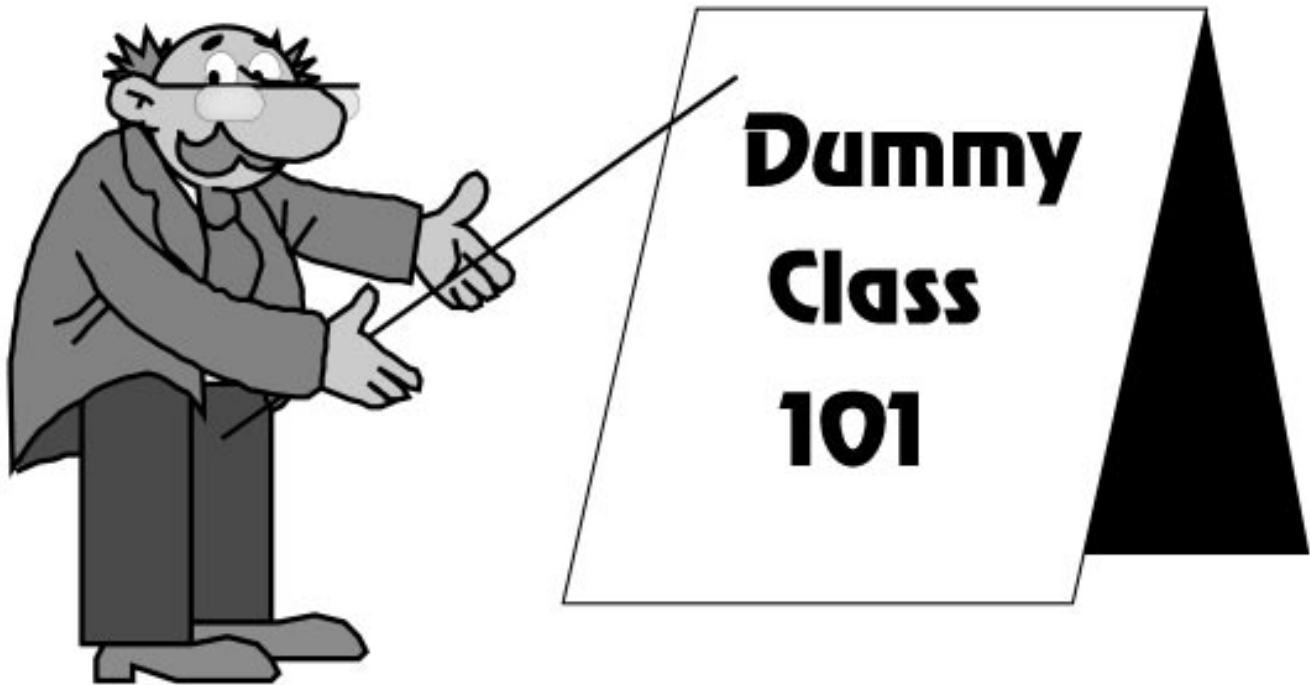
1. True
2. False
3. True
4. True
5. False
6. False
7. True
8. False
9. False
10. True
11. Drilling
12. Copper
13. Throughhole
14. OSP
15. Fiducials
16. SMEMA
17. Parts Placement
18. M
19. D
20. L
21. K
22. B
23. I
24. J
25. K
26. H
27. A
28. G
29. C
30. E

Quiz #5 pages 74-80

1. True
2. True
3. False
4. False
5. True
6. Safety Net
7. Ceramic
8. Transistor
9. Drawer
10. Insulative
11. 1M Ω
12. 1K Ω

Quiz #6 pages 82-97

1. False
2. False
3. True
4. False
5. True
6. True
7. True
8. False
9. False
10. False
11. Reel-7", Tape & Reel
12. Pitch-50mil, Reel-13", Tube + Tape & Reel
13. Pitch-.5mm, Tray
14. Pitch-50mil, Tube
15. Pitch-.5mm, Tray
16. Reel-13", Tape & Reel
17. Pitch-.65mm, Reel-13", Tape & Reel
18. Pitch-50mil, Tray
20. Reel-7", Tape & Reel
21. SOT23E7A
22. QFP100T25
23. SC1210E7A
24. BGA169M1.5
25. LQFP100T
26. XD1
27. XJ1
28. XQ1
29. XC1
30. XD1
31. XS1
32. XD1
33. XO1
34. XQ1
35. XN1
36. XL1
37. XS1
38. XP1
39. XD1
40. XS1



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