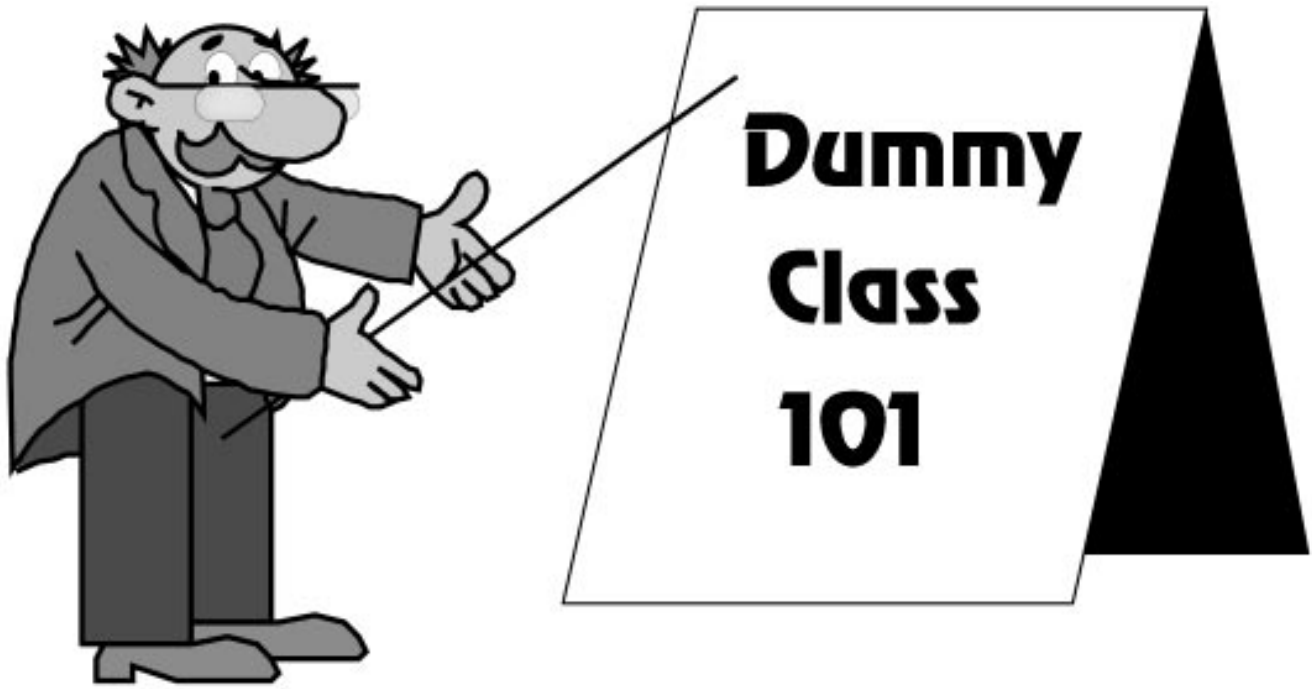


TopLine®
7331A Garden Grove Blvd, Garden Grove, CA 92841
Tel. 1-800-776-9888 Fax 1-714-891-0321
e-mail info@topline.tv
www.TopLine.tv

Table of Contents

DEFINITION OF DUMMY

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

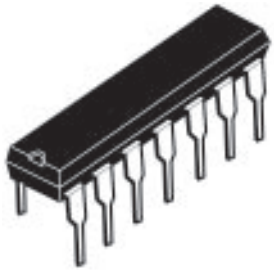
APPLICATIONS USING DUMMY COMPONENTS:

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

THROUGHHOLE LEAD STYLES

TYPE	DRAWING	COMPONENTS
Axial		capacitors resistors inductors diodes
Radial		capacitors crystals inductors transistors
DIP		Integrated Circuits

Measurements

Mils and millimeters are often used interchangeably.

1 mil = 1/1000 inch (.001”)
1 mm = .0393 inch
1 inch = 25.4 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

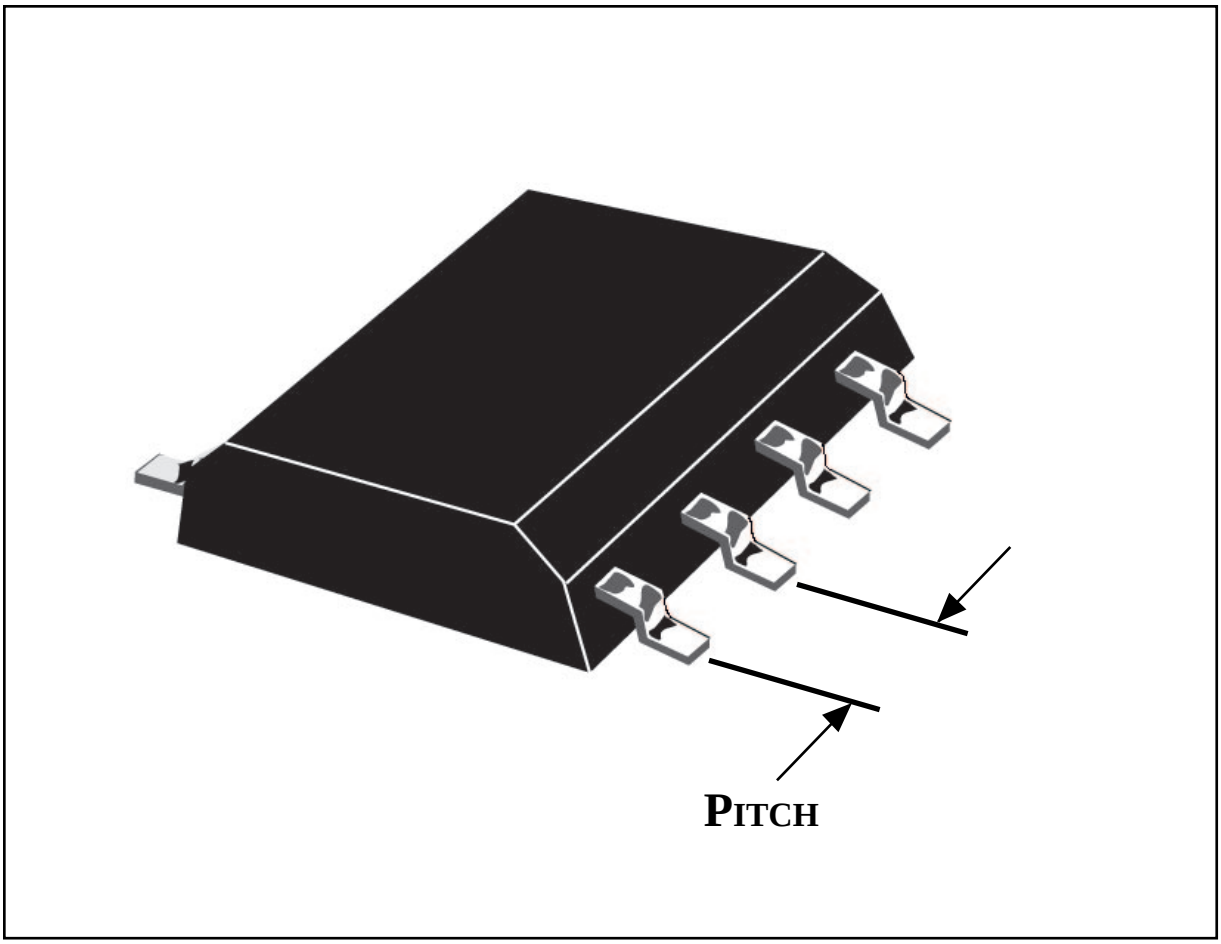
Exact Measurement			MILS* Rounded	Component Type
Inches	mils	millimeter		
.2”	200mils	5.08mm	200mils	Throughhole
.1”	100mils	2.54mm	100mils	DIP & Throughhole
.05”	50mils	1.27mm	50mils	SOIC, PLCC
	39.3mils	1.00mm	40mils	
	31.5mils	0.8mm	30mils	
	25.6mils	0.65mm	25mils	QFP
	25.0mils	0.636mm	25mils	TSOP
	19.7mils	0.5mm	20mils	SSOP
	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

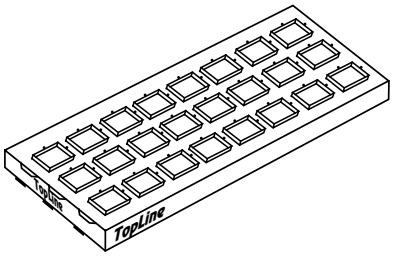
Lead pitch is always measured from center to center of the leads.

Pitch is never considered the air gap between the leads.

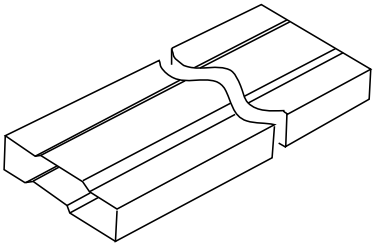


Component Packaging

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

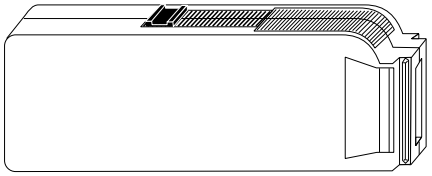


Trays



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*

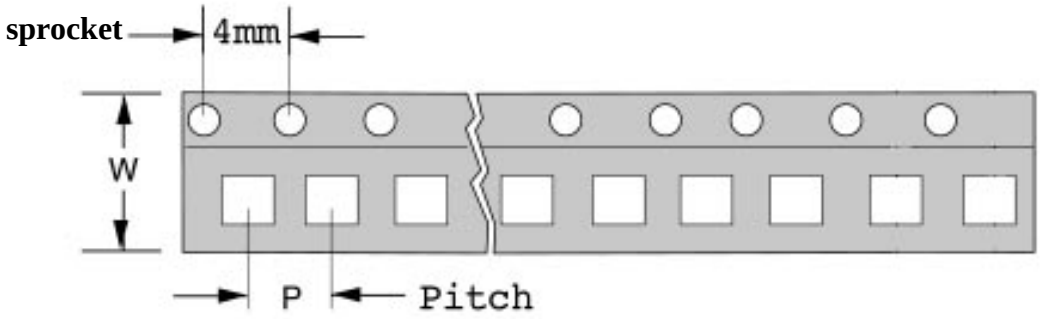
4”
Patented
miniReel

7” (180mm)

13” (330mm)

*Note spindle hole is same for each reel size.

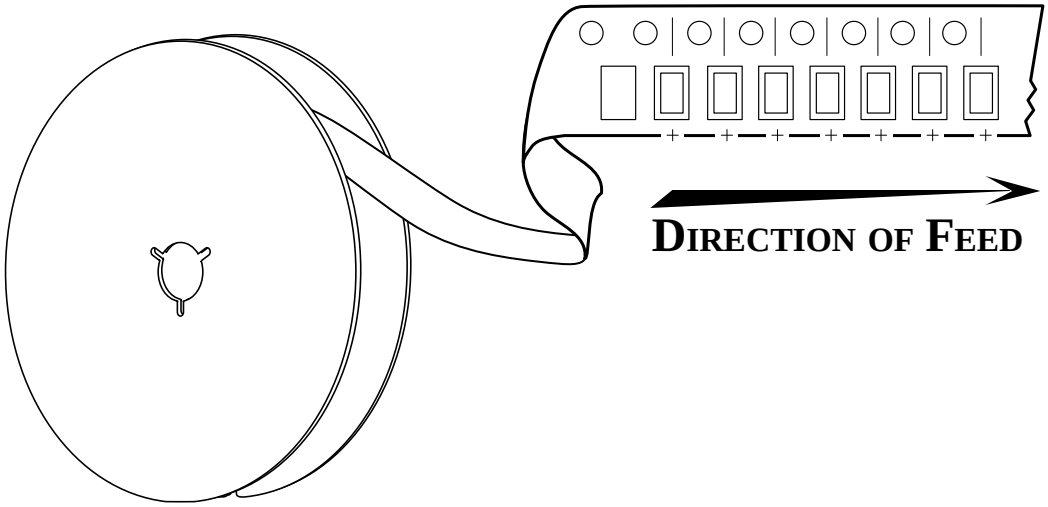
TAPE DIMENSIONS



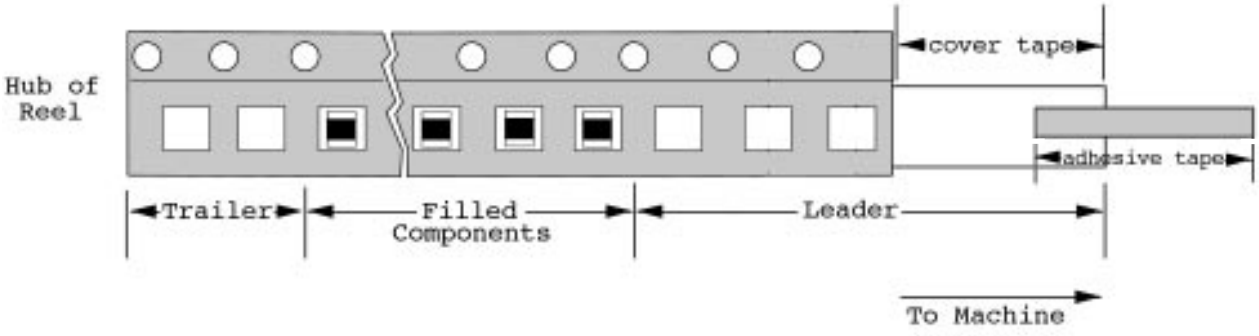
STANDARD (W) TAPE WIDTHS	POPULAR PITCH (P) *
8mm	2mm (for 0402 components)
8mm	4mm (for 0603~1210 components)
12mm	4mm or 8mm
16mm	8mm or 12mm
24mm	12mm, 16mm or 24mm
32mm	12mm, 16mm or 24mm
44mm	24mm, 32mm or 40mm

***other pitches available depending on component dimensions.

TAPE DIRECTION

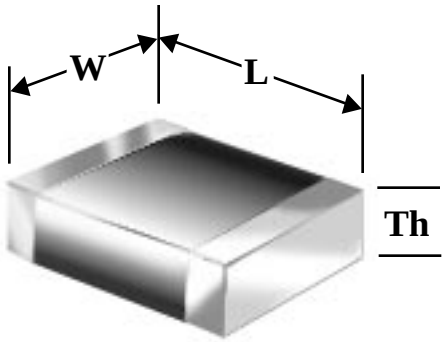


LEADER & TRAILER



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
LENGTH	WIDTH
.12”	.06”

EXAMPLE:
(METRIC)

32	16
LENGTH	WIDTH
3.2MM	1.6MM

Inch vs. Metric Codes

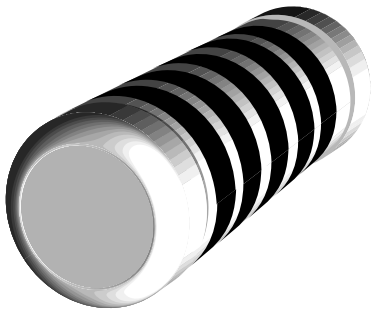
In the USA and most parts of Europe, chip size codes are defined in Inches.
In Japan, and some places in the orient, chip size codes are defined in millimeters.

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

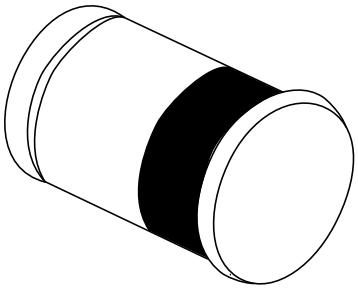
MELF (CYLINDRICAL)

Melf components are cylindrical.

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



MELF RESISTOR



MELF DIODE

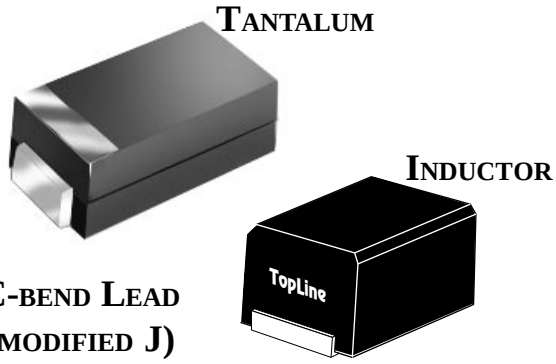
SIZE DEFINITIONS		
NAME	**INCH CODE**	**APPROXIMATE METRIC (D X L)**
MELF	-	2.5 x 5.0mm
mini-MELF	1206	1.6 x 3.2mm
micro-MELF	0805	1.1 x 2.2mm

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

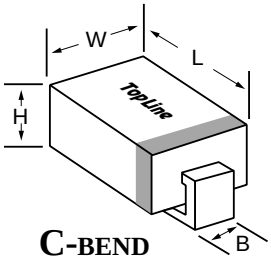


Tantalum

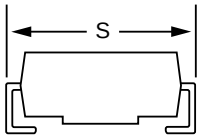
Inductor

C-bend Lead
(modified J)

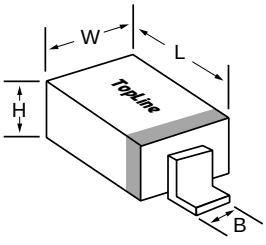
Rectifiers



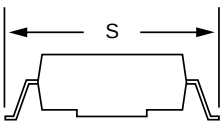
C-bend
(modified J)



Side View
C-bend

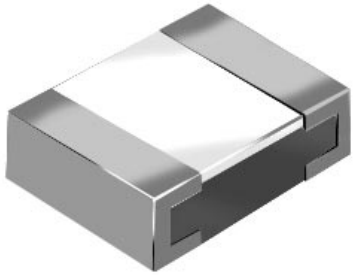


Gull wing lead



Side View
Gull Wing

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).

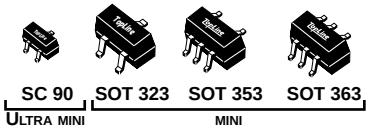
Chip Capacitors

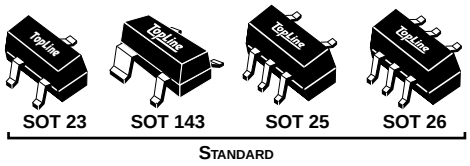
Ceramic chip capacitors are relatively low cost. Sizes are similar to chip resistors. Available on both plastic and paper carrier tape.

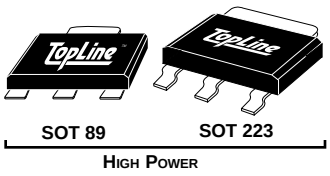
Size Code* Inch	Size Code* Metric	Standard 7" Reel Qty.	Tape Material
0402	1005	10,000	paper
0603	1608	4,000	paper
0805	2012	3,000~5,000	paper or plastic
1206	3216	3,000~4,000	paper or plastic

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.

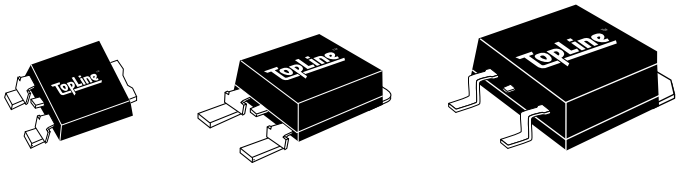






DPAK

DPAK is a used for high power applications.



DPAK **D2PAK** **D3PAK**

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.

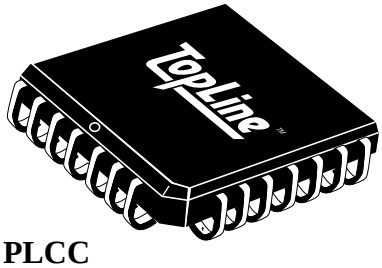
____ 34. Reels are standard in 5 inch and 12 inch diameters.

____ 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

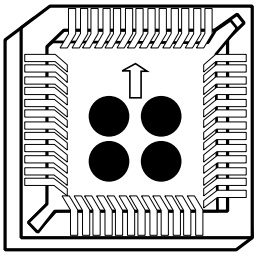


PLCC

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

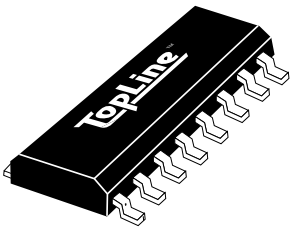
The pitch is 50mils (1.27mm). PLCC devices are usually soldered directly to the PC board; however, they can also be mounted in a socket for replacement in the field.

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.

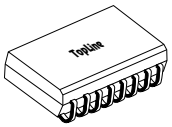
Standard packaging is tube or tape and reel.

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

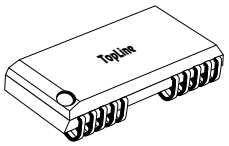
	Body Width		
Part Series	Mils	Metric	Notes
SO	150	4.0mm	Standard for 8-16 lead
*SOP	208	5.3mm	Popular in Japan only
SOM	220	5.6mm	Standard for resistor network
SOL	300	7.6mm	Popular for 20-28 leads
SOW	330	8.4mm	
SOX	400	10.0mm	
SOY	450	11.1mm	

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

SOJ



SOLJ16



SOLJ20/26

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.

	Body Width	
Part Series	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.

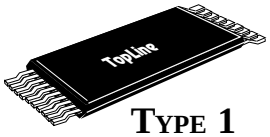
The body length of the SSOP “shrink” version is approximately half the size of the standard 50mil pitch SOIC.

Standard packaging is Tube or Tape and Reel.

TopLine assigns different part numbers to distinguish the various body.

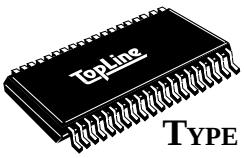
	Body Width			
Part Series	Mils	Metric	Lead Counts	Notes
SSOP	208	5.3mm	8-30	1.75mm height
TSSOP	173	4.4mm	8-28	1.0mm height
*QSOP	150	3.8mm	16-28	1.6mm height

*****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).

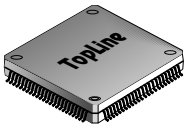
Maximum seated height of Type 1 is 1.0mm and Type 2 is 1.2mm.

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.

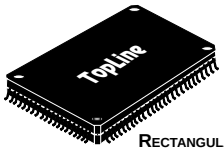
TSOP Type	Popular Lead Pitch		
	.5mm	.8mm	1.27mm
Type 1	X		
Type 2		X	X



SQUARE BODY

QFP

QUAD FLAT PACK



RECTANGULAR BODY

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.

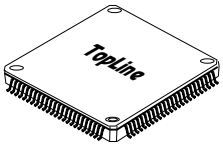
The same body size and lead count is usually available with 2 or 3 different lead length footprint adders.

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

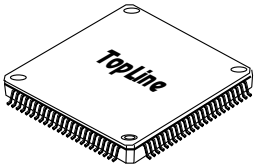
For example, a 28mm square body with a 3.9mm adder actually measures 31.9mm from lead tip-to-tip.

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

	POPULAR LEAD PITCH					LEAD COUNT
STANDARD BODY	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.

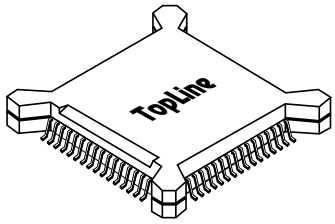
TQFP and LQFP are available in a wide range of body sizes and lead pitch.

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.

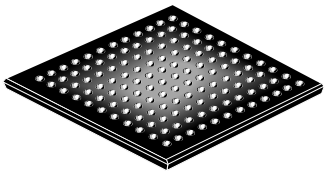
The BQFP is no longer popular.

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.

SERIES	TYPE	POPULARITY
*BGA	Plastic	Most popular, common usage
CBGA	Ceramic	High temperature applications
TBGA	Tape	High power dissipation

*Sometimes called PBGA

BGA (CONT'D)

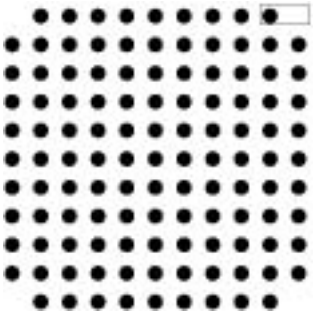
The material of the solder ball is usually eutectic 63/37 SnPb for assembly onto normal epoxy FR4 laminate PC Boards.

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

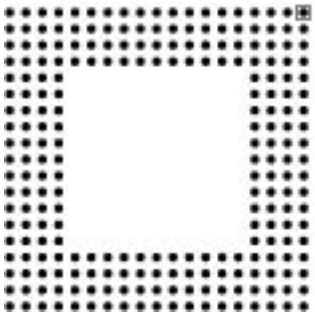
TopLine supplies a wide assortment mechanical dummy BGA with Daisy Chain Patterns for continuity testing after assembly.

BGAs are packaged in trays and tape and reel.

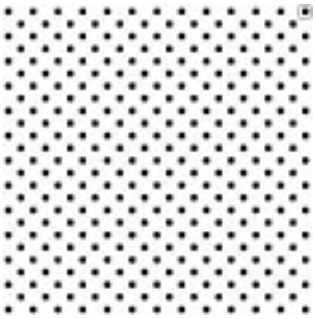
BGA ball patterns come in a variety of configurations.



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.

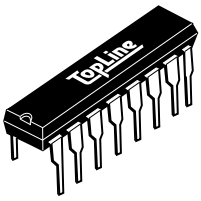
Different kinds of Chip Scale Packages are being developed.

The most popular (at the time of this writing) is the Tessera µBGA® 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, refered 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.	450µm	H. DIP
_____24.	Self aligning	I. Trays
_____25.	True 25 mil pitch	J. TQFP
_____26.	CSP	K. 10/90 SnPb

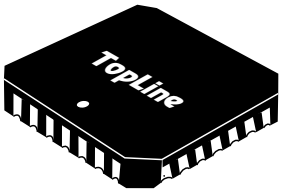
Convert the following dimensions:

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.

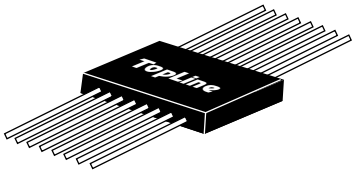
The pitch of LCC is either 40mils (1.0mm) or 50 mils (1.27mm).

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

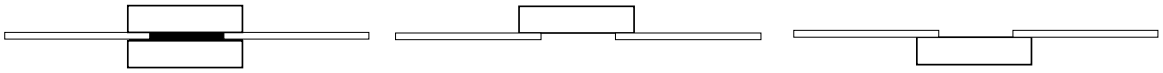


Flat Packs were developed in the late ‘60’s and still enjoy limited usage today, mainly in military and aerospace applications.

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.



SIDE/SANDWICH
CODE S

BOTTOM BRAZED
CODE B

TOP BRAZED
CODE T

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 that 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)

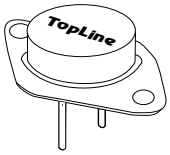
Most TO92 on tape and reel have the leads formed (prior to taping) with .1" (2.54mm) pitch between the leads.

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

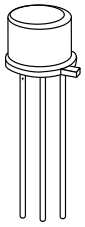
The standard TO220 has 3 leads, however a 4-lead and 5-lead version is available.

METAL CASE

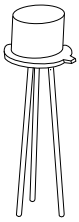
TO3



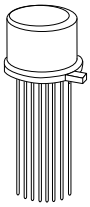
TO5 (1.25" LEAD LENGTH)
TO39 (.75" LEAD LENGTH)



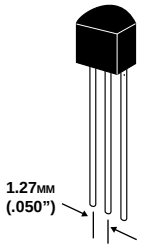
TO18



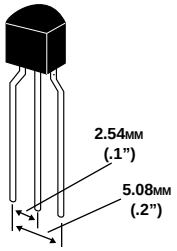
TO75 6 LEAD
TO99 8 LEAD
TO100 10 LEAD



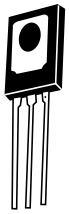
PLASTIC CASE



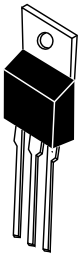
TO92
.05" LEAD SPACE
STANDARD



TO92T-.2
SPECIAL ORDER



TO126



TO220

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

Throughhole 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.

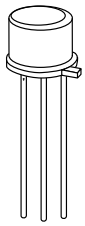
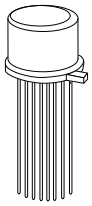
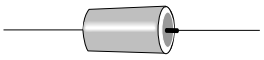
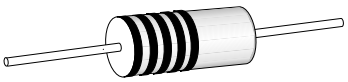
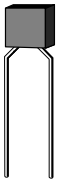
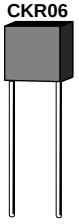
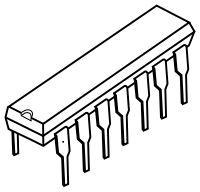
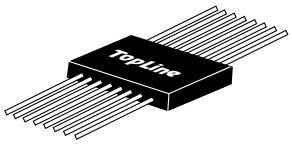
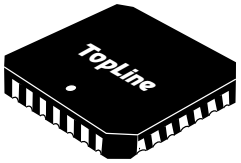
Popular Throughhole
for Military

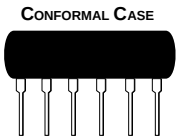
The military and aerospace industries still use component packages which were designed 20 or even 30 years ago.

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

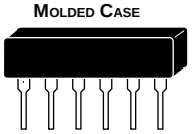
Listed below are popular throughhole component packages which are still used by the military for solder practice and certification of technicians.

Popular Mil Spec Components

TopLine Part #	Description	Drawing
TO5 TO39	**Transistor**	TO5 (1.25" lead length) TO39 (.75" lead length) 
TO99	**Integrated Circuit**	
CS2	**Tantalum Capacitor** **CS13/CSR13**	
RC07 RCR07	**Resistor**	
CK05 CKR05 CK06 CKR06	**Ceramic Capacitor**	CK05 CKR05  CK06 CKR06 
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).

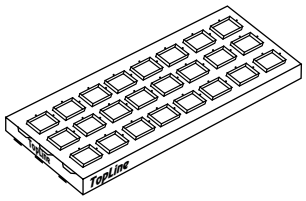
The conformally coated case offers the lowest cost and is the most popular for commercial use.

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

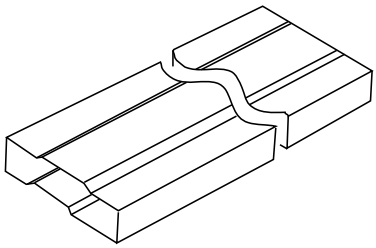
TopLine's tray part numbering system includes the size of the component and the cavity matrix.

Example:

QTRAY	**28**	**-**	**3 x 8**	**H**
TRAY TYPE	SIZE		CAVITIES	TEMP RATING
QFP	28MM SQUARE		3 COLUMNS X 8 ROWS	H = BAKEABLE BLANK = UNSPECIFIED

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.

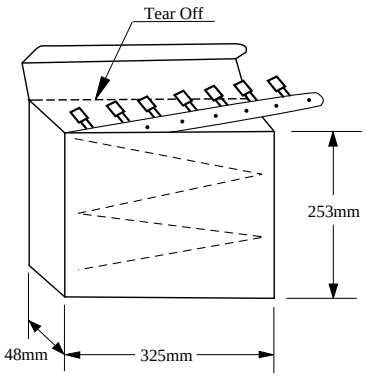
CT reels are a low cost solution to perform “dry” machine runs without the need to pick up and remove components from the carrier tape.

Dummy Component Ordering Information

Tape Info Width	Tape Info Pitch	Tape Material	Typical Cavity Size	Part Number	Nbr Cavities
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

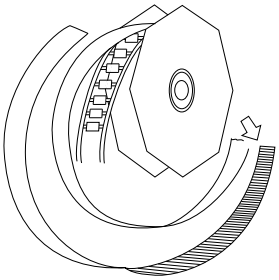
THROUGHHOLE COMPONENTS



FAN FOLD IN BOX

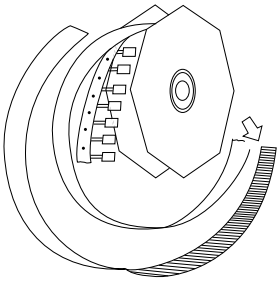
Ammo is quite popular in Asia and in very similar to tape and reel, except the tape is fan folded in a box instead of rolled onto a reel.

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.

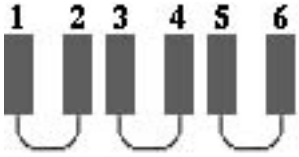
COPLANARITY

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.

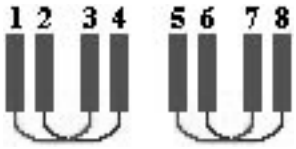
Technical definition: a setting plane formed by the first 3-leads touching the surface. All other leads are measured from this plane.

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



DAISY CHAIN EVEN



DAISY CHAIN ODD

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-bounding 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. Castellation
_____ 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

Dummy Class 101

Answer Keys
for Quizes #1 - 3

Quiz #1 pages 1-20

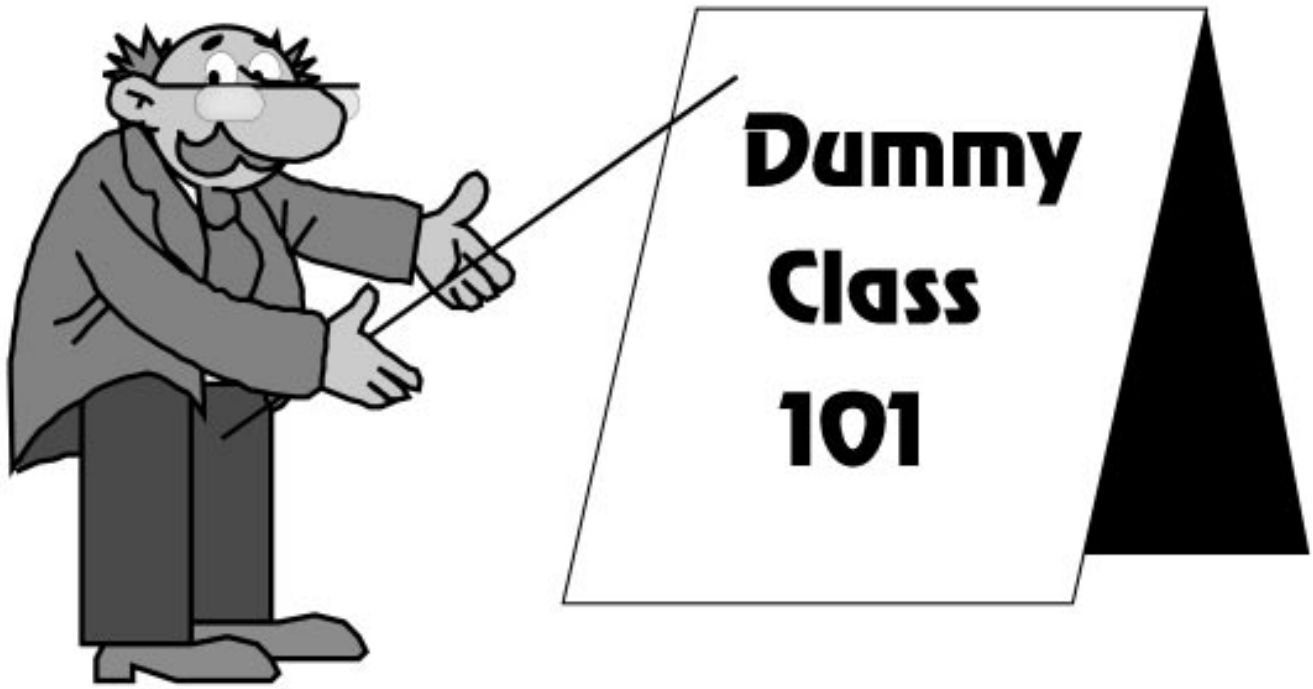
1. E
2. I
3. G
4. B
5. H
6. J
7. D
8. A
9. C
10. F
11. 5.08mm or 5mm
12. 0.65mm
13. 0.5mm
14. 2.54mm or 2.5mm
15. .0393 inch
16. 3.2 x 1.6mm
17. B
18. .08” x .05”
19. D
20. 1005
21. 6032
22. 1206
23. 1206
24. False
25. True
26. True
27. False
28. True
29. False
30. False
31. True
32. True
33. True
34.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



TopLine®
7331A Garden Grove Blvd, Garden Grove, CA 92841
Tel. 1-800-776-9888 Fax 1-714-891-0321
e-mail info@topline.tv
www.TopLine.tv