Packaging for RIT Microchips, MEMS and Microsystems

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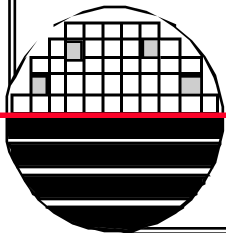

3-11-2013 RIT_Package.ppt

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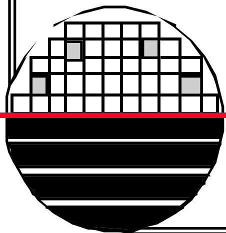
OUTLINE

Approach
Commercial Packages
Custom Packages for MEMS and Microchips
Wafer Sawing
Die Attach
Interconnect
Covers to Protect Chip and Wire Bonds
References



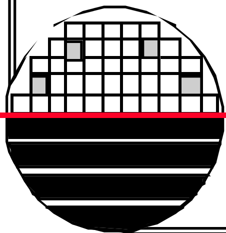
APPROACH

Package Itself:
- Purchase Commercial Packages
- Build Custom Packages

Die Attach:
- Epoxy (conductive or non conductive)

Chip to Package Interconnect
- Aluminum Ultrasonic Wire Bond
- Flip Chip with Solder Ball

Protection:
- Epoxy (Black or Clear)
- Plastic Cover
- Metal Can



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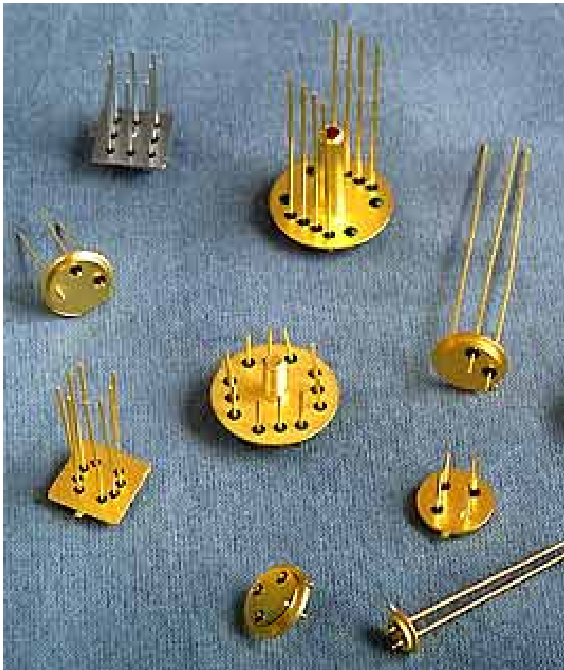
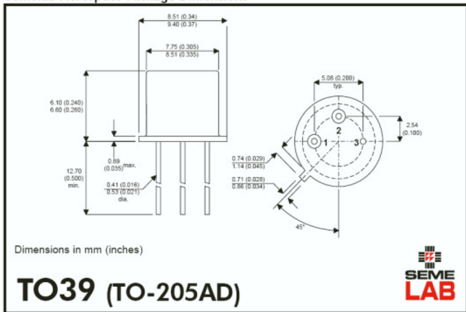
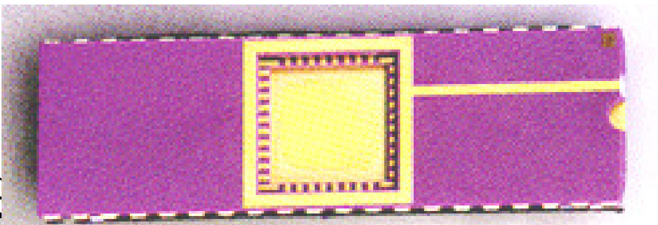
COMMERCIAL PACKAGES ARE AVAILABLE



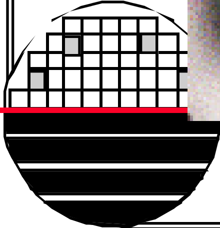
TO Packages



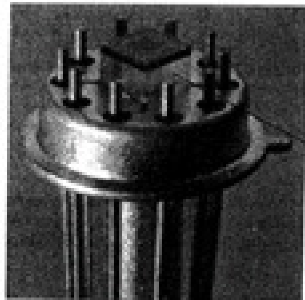


Dual-in-line, DIP

$25 to $50 each



COMMERCIAL MEMS PACKAGING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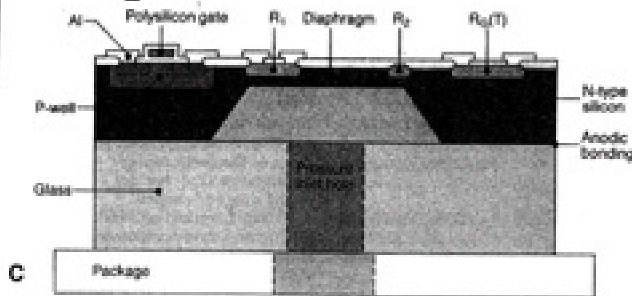

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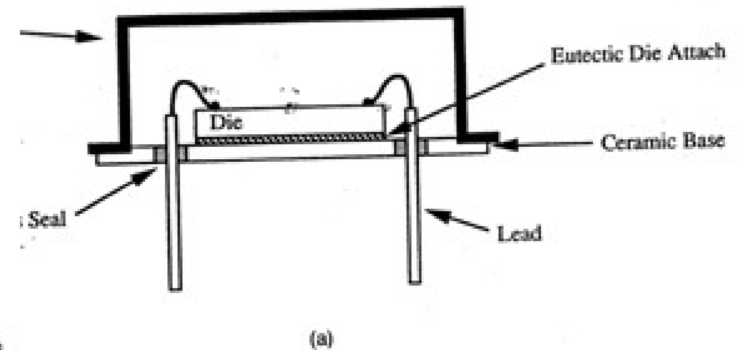
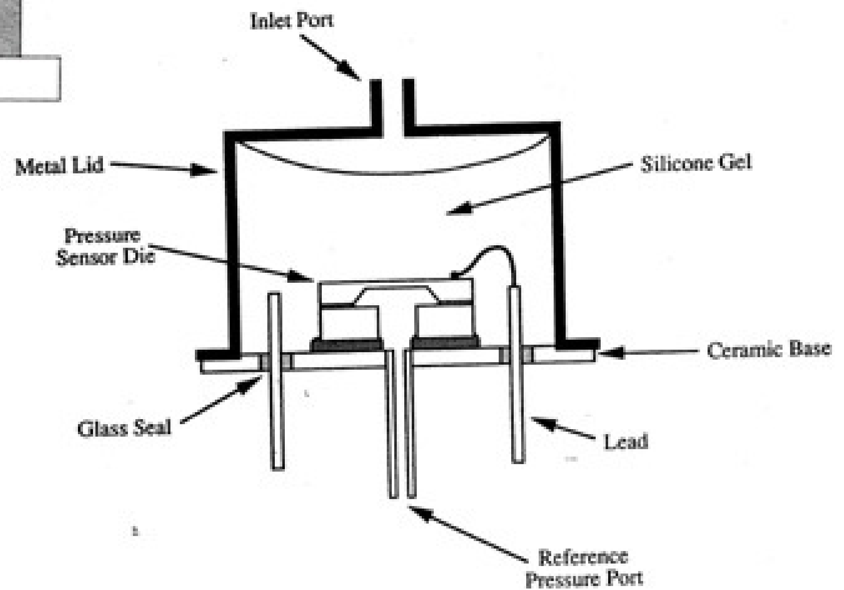
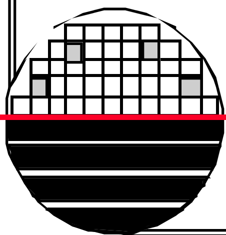


(a)



Approach

- Die Attach
- Wire Bond
- Metal Lid



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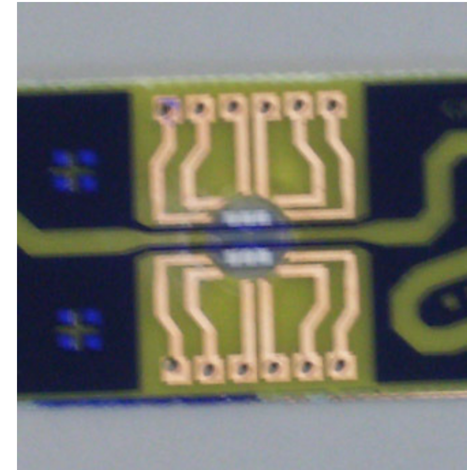
DESIGN GUIDE LINES FOR RIT CUSTOM PACKAGE



Wire bond pad (smallest…larger is okay)
- 1 mm center to center
- 600 um metal 400 um space

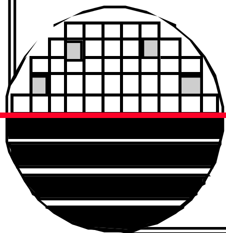
Trace (smallest… larger is okay)
- 600 um width
- 400 um space

Connector (Pin Strip Header)
- 0.1 inch center to center (0.05 inch is possible)

Chip Size (typical)

10mm x 10mm	large
5 mm x 5 mm	medium
2 mm x 2 mm	small

Arbitrary dimensions set by Dr. Lynn Fuller



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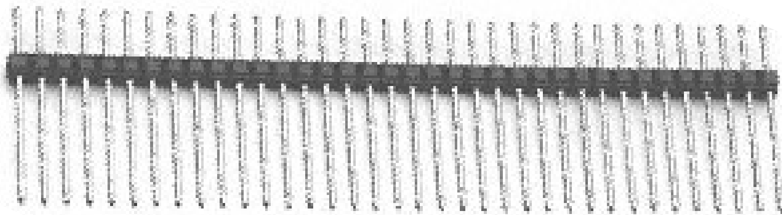
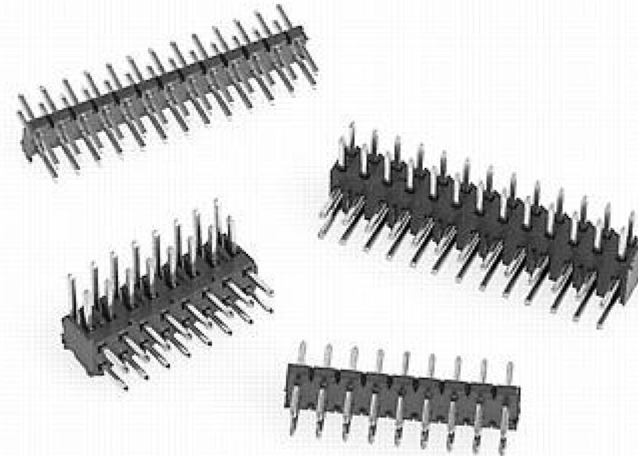
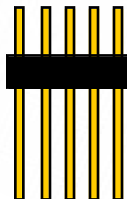
PIN STRIP HEADERS

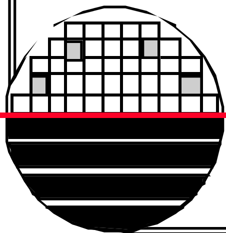
3M 929 Series Pin Strip Headers and Sockets
Dual Row and Single Row

0.1 inch center to center (2.54mm x 2.54mm)
0.05 inch center to center (1.27 mm x 1.27mm)
2mm center to center



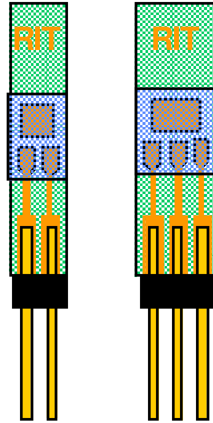


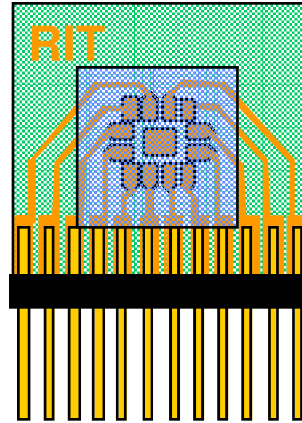


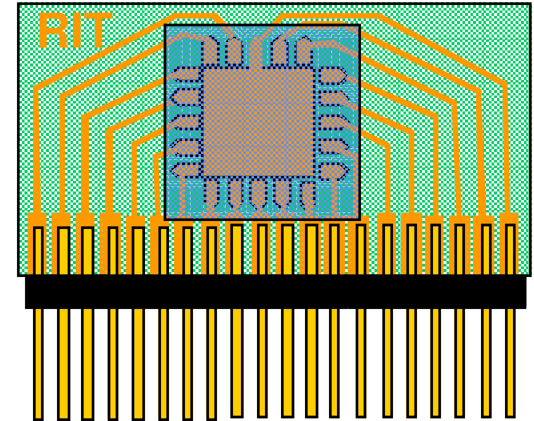


RIT CUSTOM CHIP PACKAGES WITH 0.1" PIN HEADER

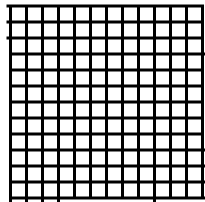
2mm x 2mm Chip
2-3 Wire Bond Pads



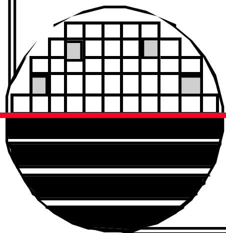




2-pin 3-pin 12-pin 20-pin



1mmx1mm Grid
Pins 0.1" Centers



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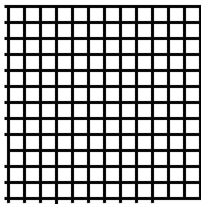
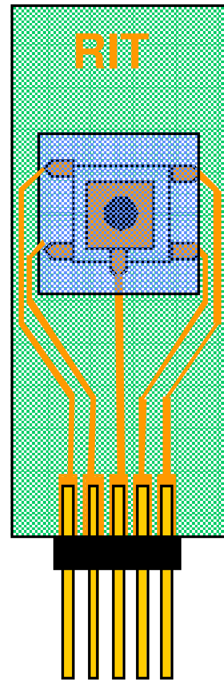
CUSTOM PRESSURE SENSOR CHIP PACKAGE

5mm x 5mm Chip
Hole for Hose Nipple
5 Wire Bond Pads

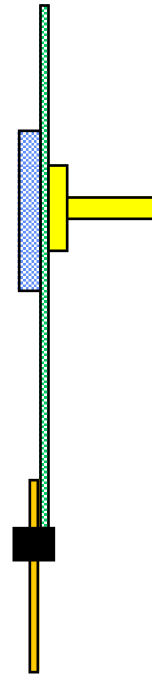


1mmx1mm Grid
Pins 0.1" Centers

Front



Side



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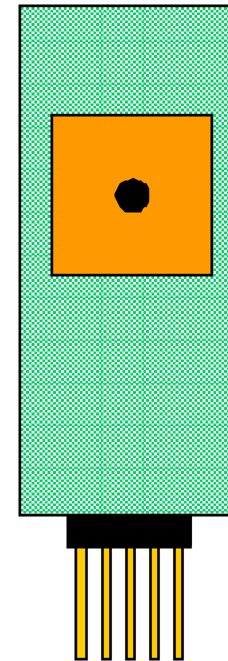

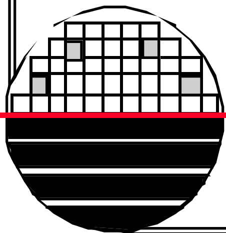

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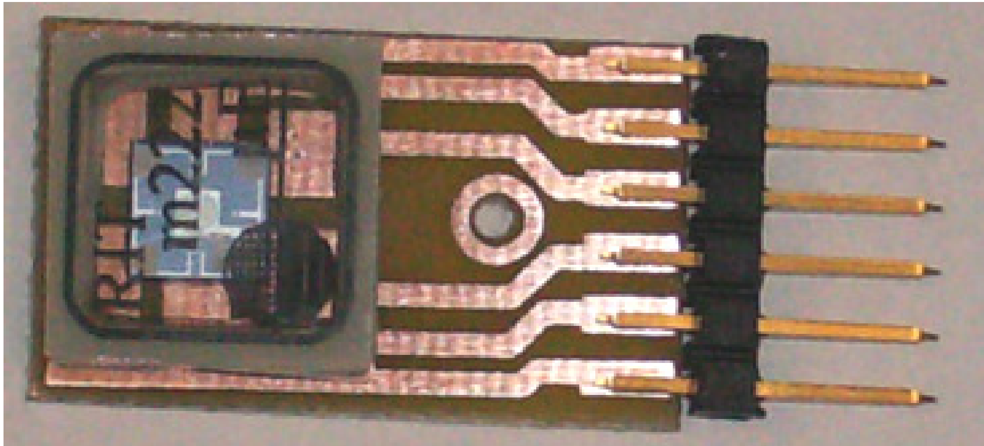
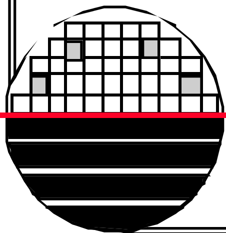
PACKAGED PRESSURE SENSOR



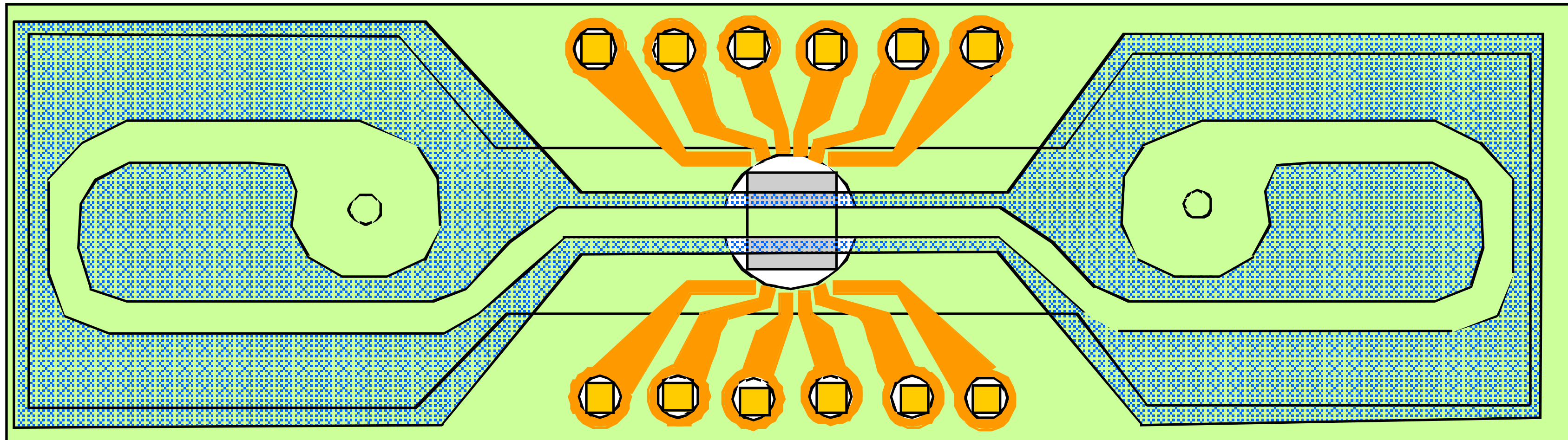
Front

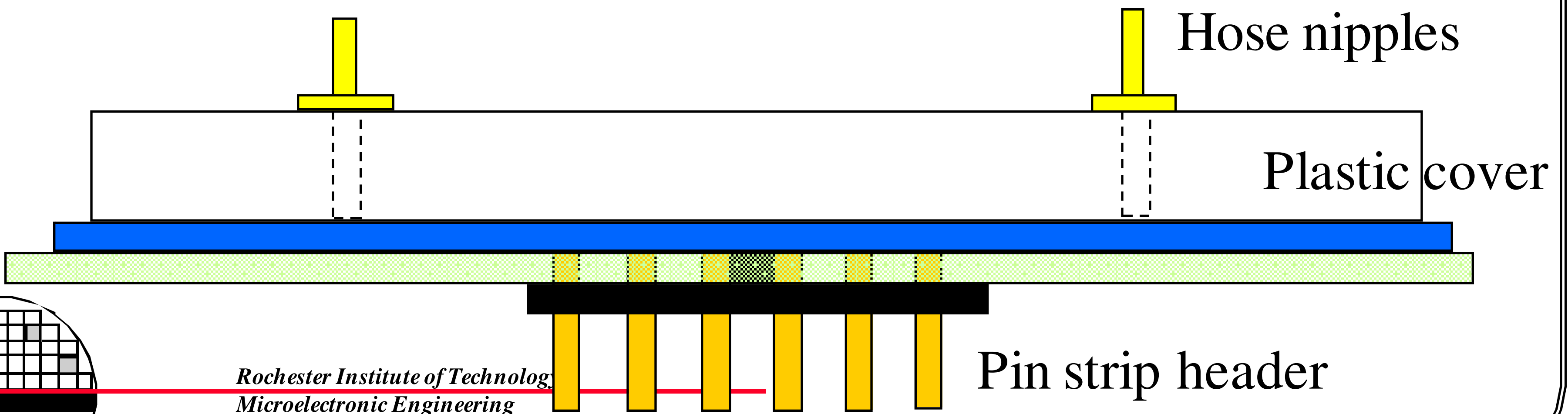
Back

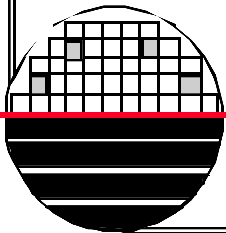


UNIVERSAL PUMP & FLOW SENSOR ASSEMBLY

1" by 3" PCB 0.0125" thick with 0.005" copper







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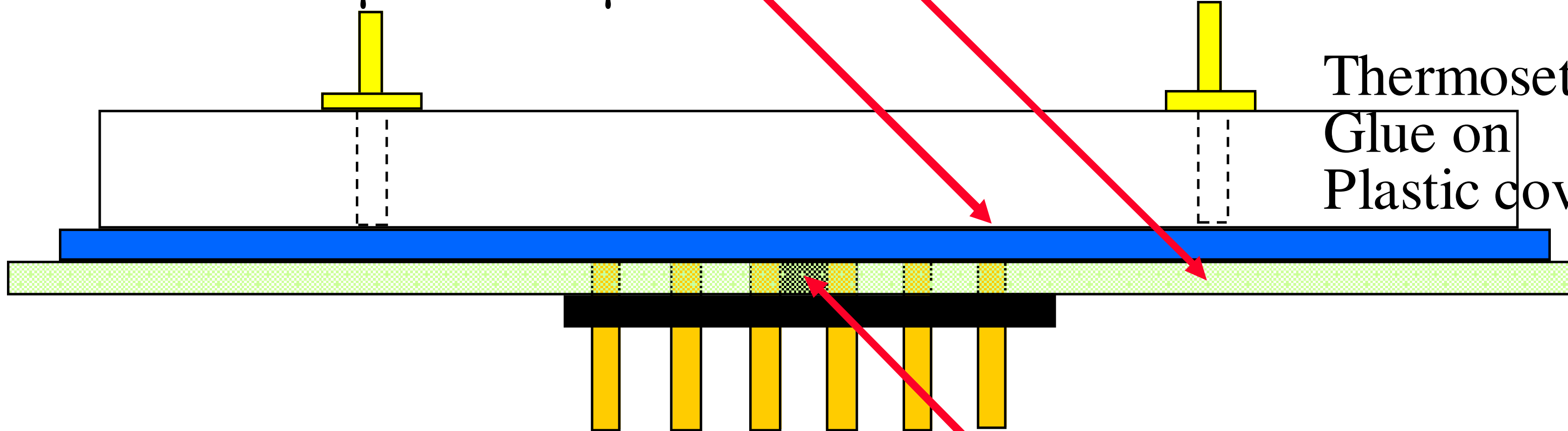
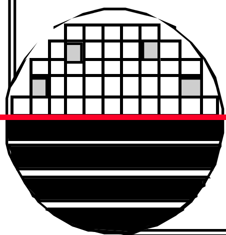
CROSSECTION





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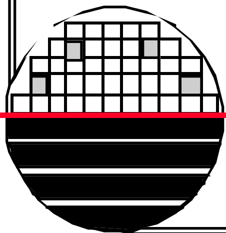
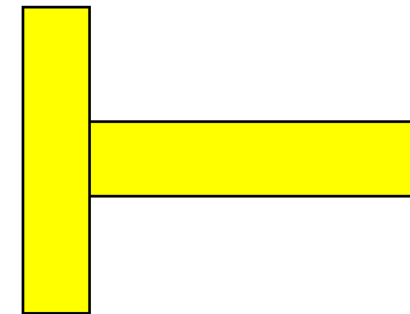
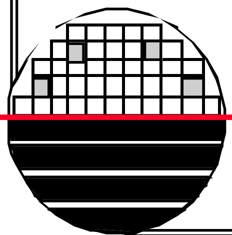
AFTER WIRE BONDS, HEADER AND NIPPLES



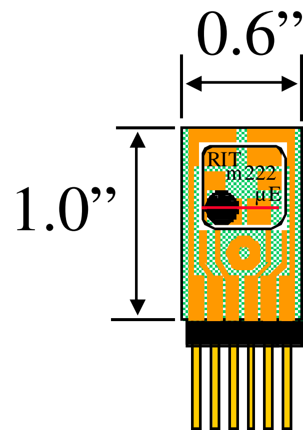
HOSE NIPPLES

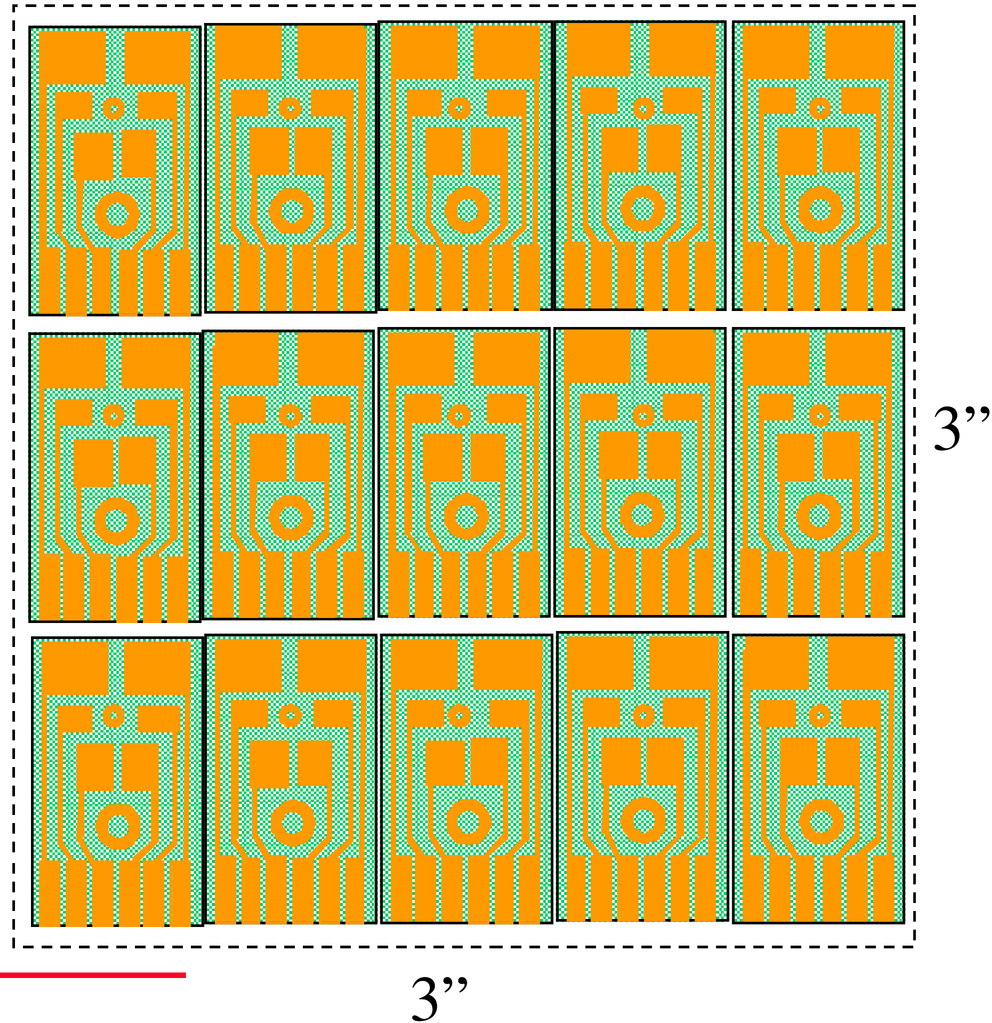


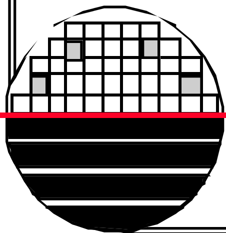
These are brass others are plastic and various sizes and shapes



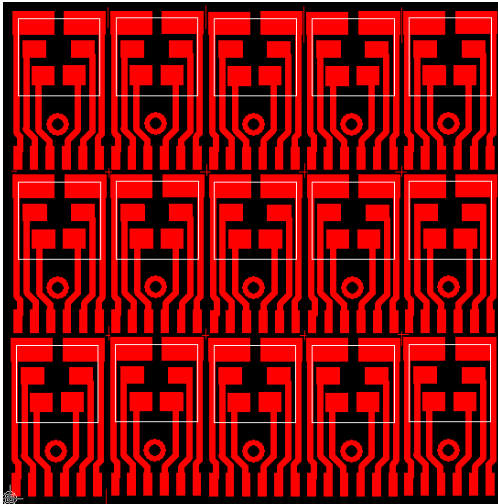
MEMS PACKAGE PCB DESIGN



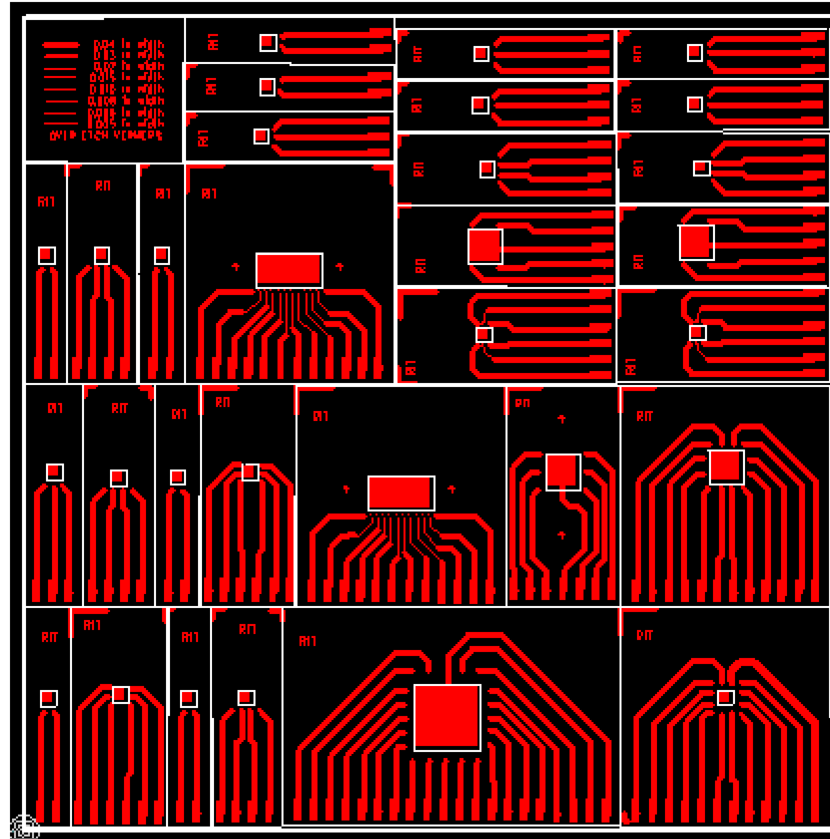




PCB LAYOUTS

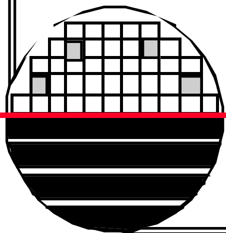


3" X 3"

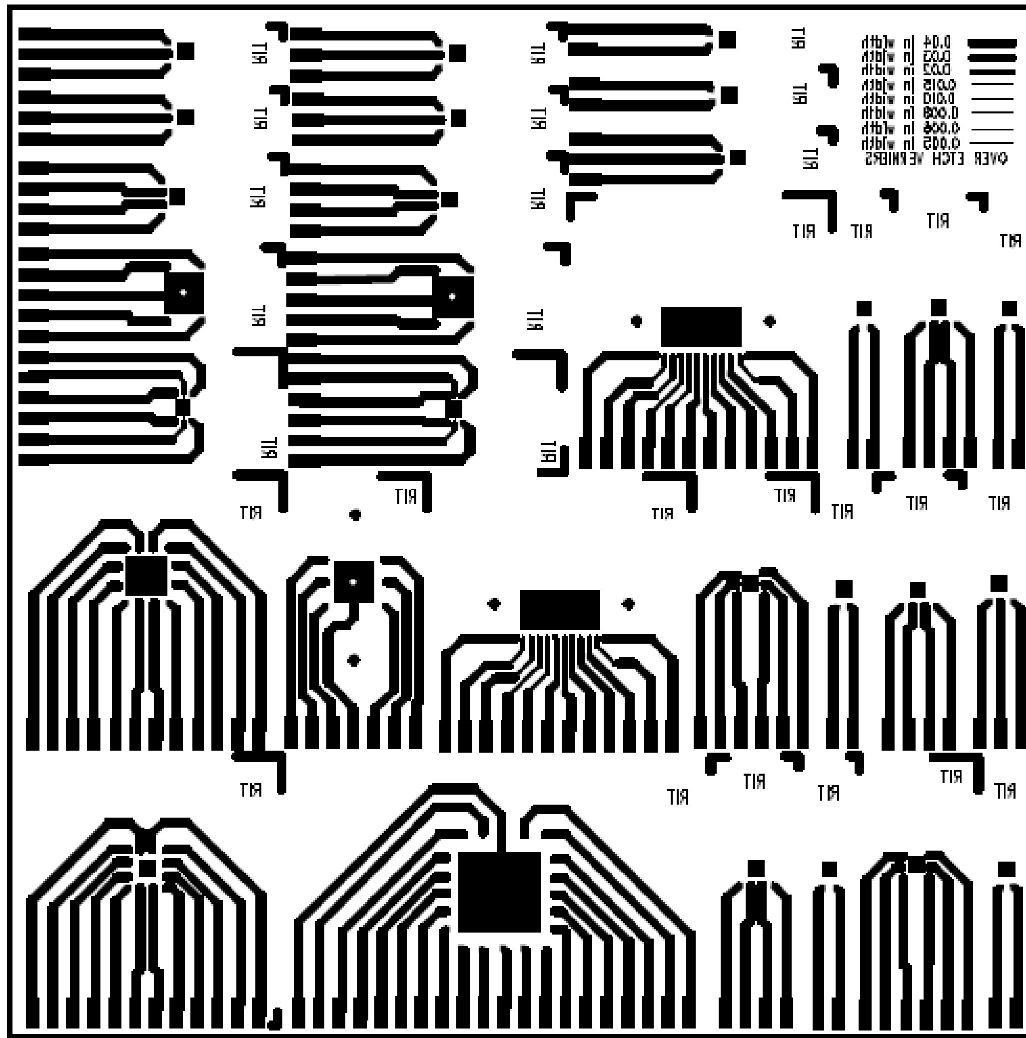


5" X 5"

Using "Express PCB" free software

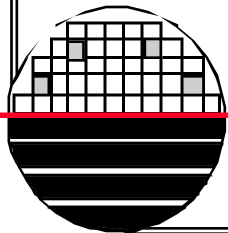


MAKE ARTWORK (TRANSPARENCY)



Select
Layer
Scale=1
Black/White

Then print on a transparency



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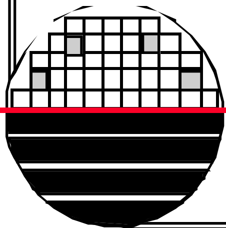
MAKE COPPER BOARD

1. Cut two sided copper board (6”x 9”) into smaller size that can be spin coated with photoresist (3”x 3”). Use shear in machine shop.
2. Clean Board with 400 grit sand paper or very fine steel wool followed by using soap, water and blow dry.
3. Spin coat with photoresist (HPR504) at 1500 rpm, 60 sec., use small 1” chuck.
4. Bake in oven 100°C, 4 min. (gray oven near ion implanter, set 5.5 on the dial to the 150 setting)
5. Place transparency on board and flatten with glass plate
6. Flood expose, (20 sec = ~ 100mj/cm2) on Karl Suss MA150
7. Develop in CD-26 developer (~1 min), inspect
8. Optional test with drop of etch mixture on bare copper area, rinse, dry
9. Hard bake in oven 140°C 15 min
10. Repeat 3 to 9 for other side of two sided board
11. Etch in mixture of Water, H_2O_2, HCl (3:2:1)
12. Strip resist in acetone, rinse in water. Blow dry.
13. Drill holes.
14. Cut board into individual PCB’s using shear in machine shop.



MAKE COPPER PCB BOARD

2-sided copper PCB
1/32" x 6"x9"
473-1011-ND $8.82

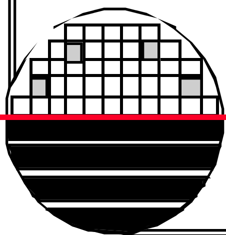
Shear
Cut into 3"x 3"

Small Shear

MAKE COPPER PCB BOARD

SCS Spin Coater

Oven

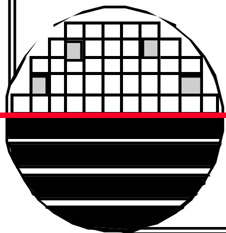


MAKE COPPER PCB BOARD

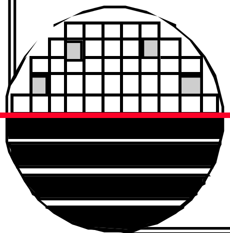
Etching of PCB

Dr. Lynn Fuller

Flood Expose
(10 sec = ~ 100mj/cm2)
Karl Suss MA150

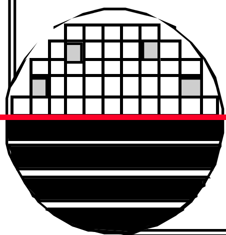


PICTURE OF INDIVIDUAL PCB AFTER SHEARING



PCB WITH COMPONENTS ADDED

ADI accelerometers
ADXL202
ADXL311
ADXL78



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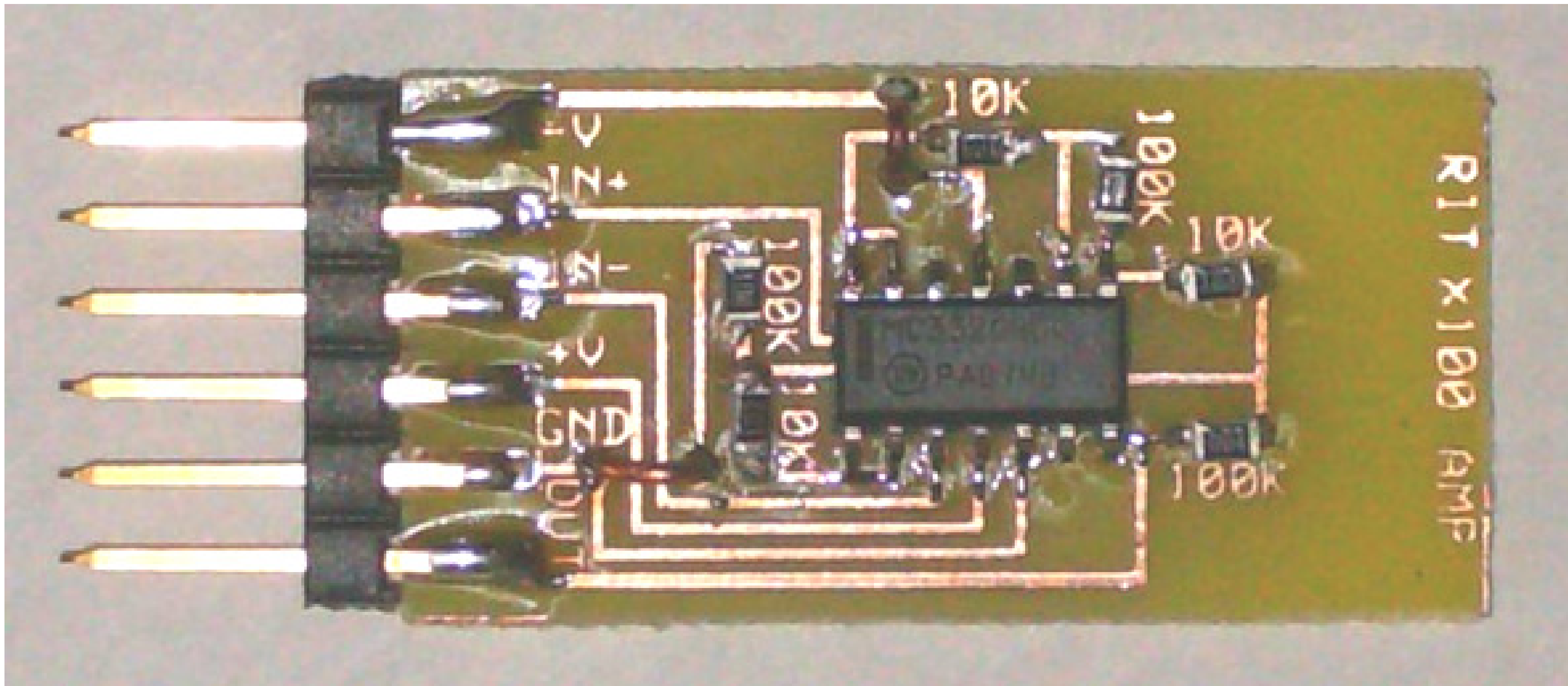
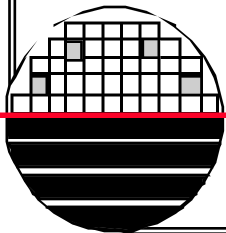
RIT 100X DIFFERENTIAL VOLTAGE AMPLIFIER



1” X 1.5”



PICK, PLACE AND SOLDER TOOL

CEMA – Center for Electronics Manufacturing and Assembly

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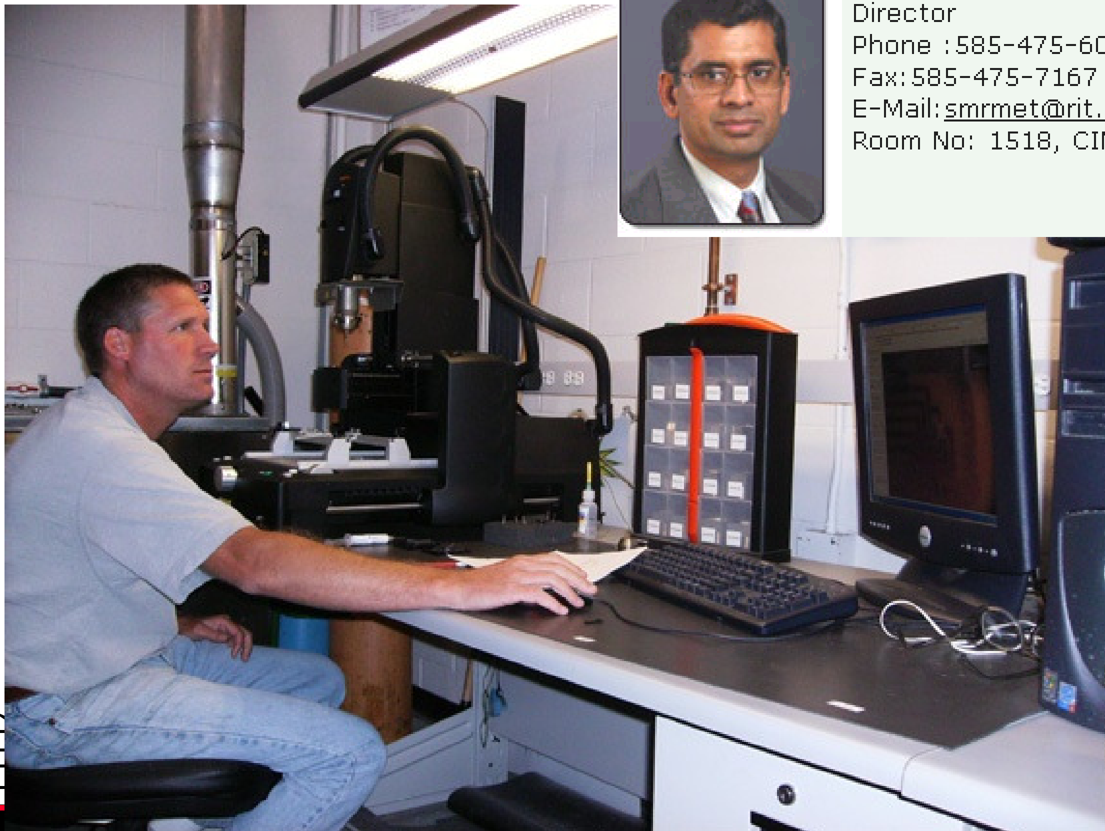
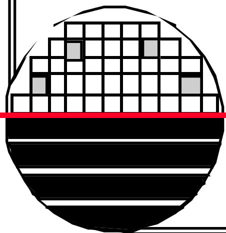


Jeff Lonneville
jglasp@rit.edu
78-1552

SURFACE MOUNT VIDEO

Surface Mount PCB Assembly

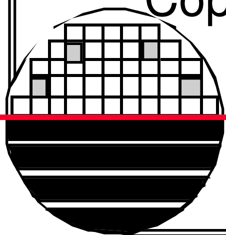
Dr. Lynn Fuller
Dr. Ivan Puchades
Nicholas Liotta
Dan Smith



ADXL325 ALIGNMENT IMAGES

Copper Traces with Solder Paste

Image of bottom of ADXL325
Superimposed on Copper Traces



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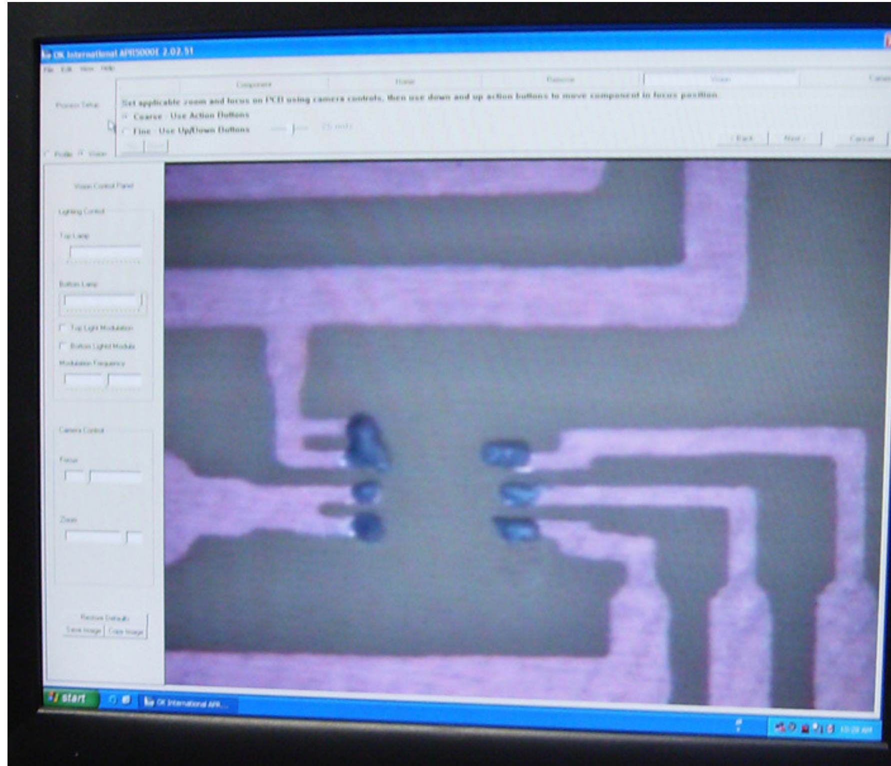
BMA140 ALIGNMENT IMAGES



Copper Traces with Solder Paste

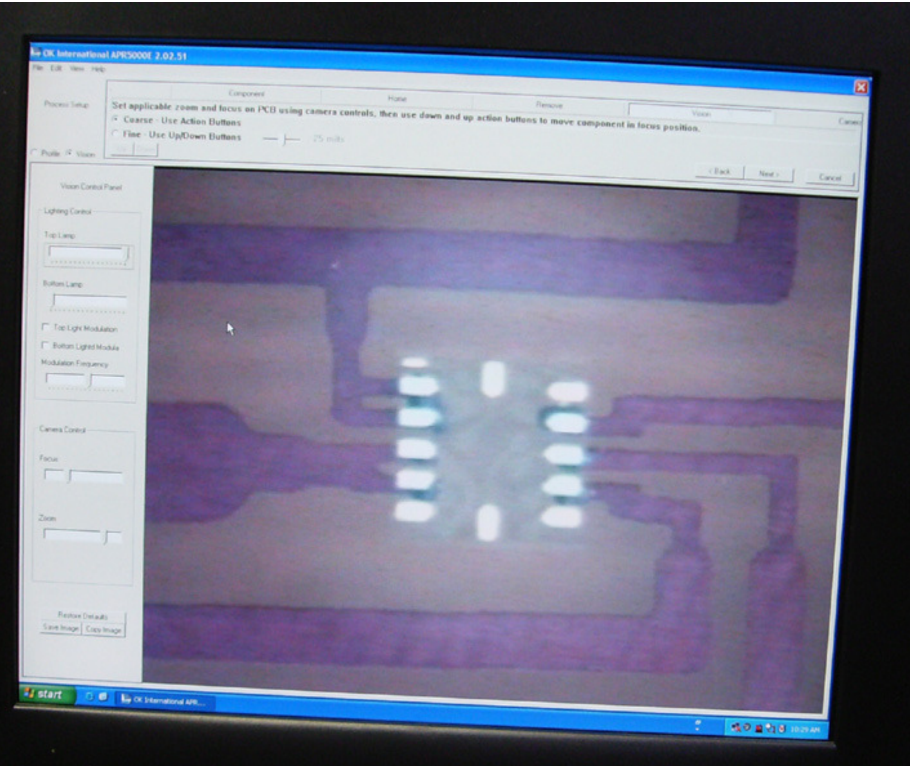
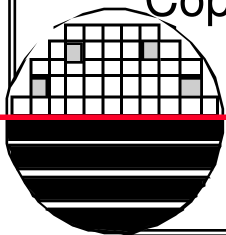


Image of bottom of BMA140
Superimposed on Copper Traces



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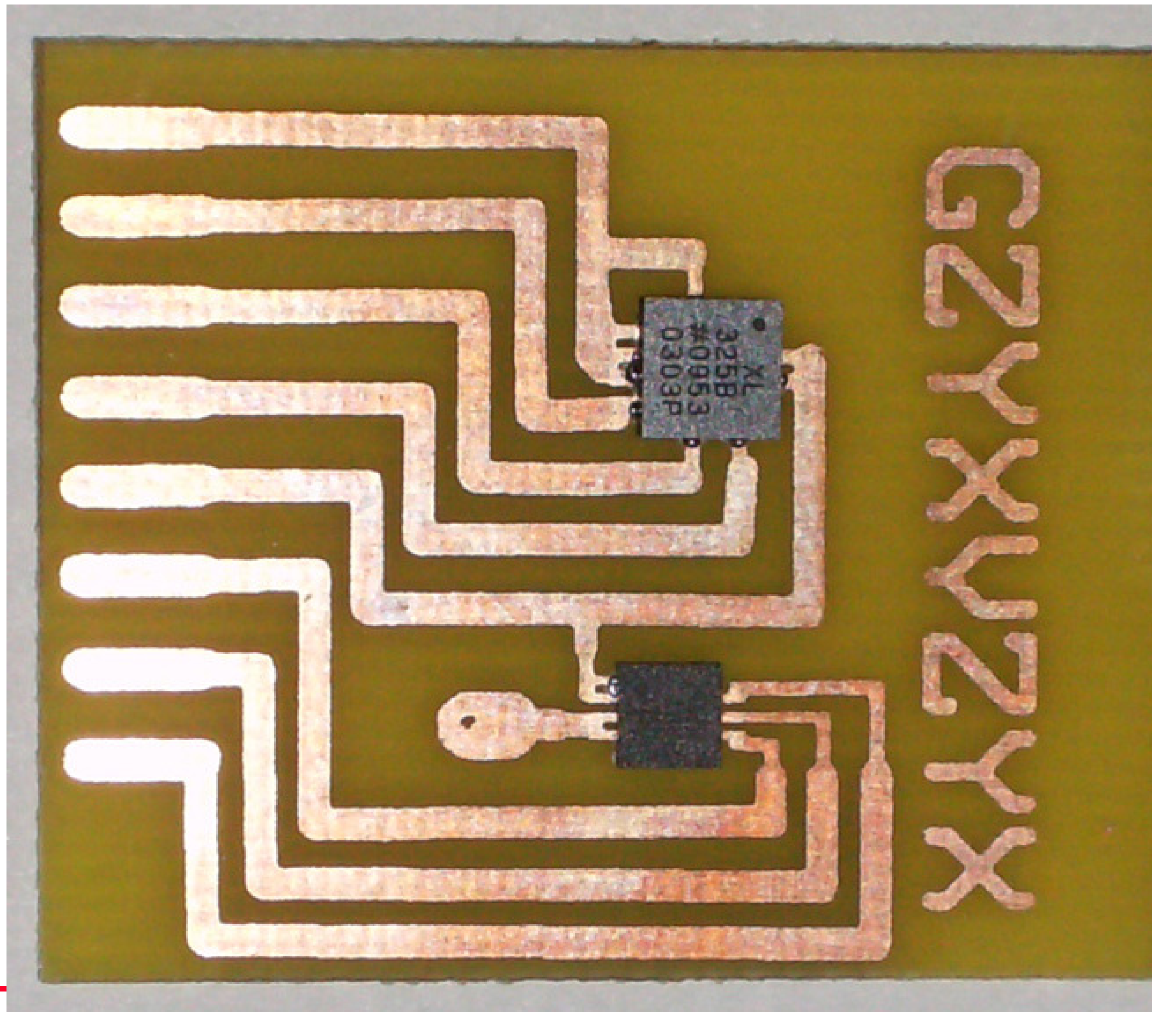
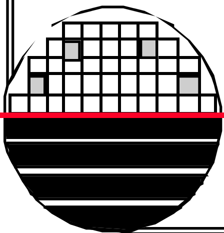
TEMPERATURE RAMP DURING SOLDERING

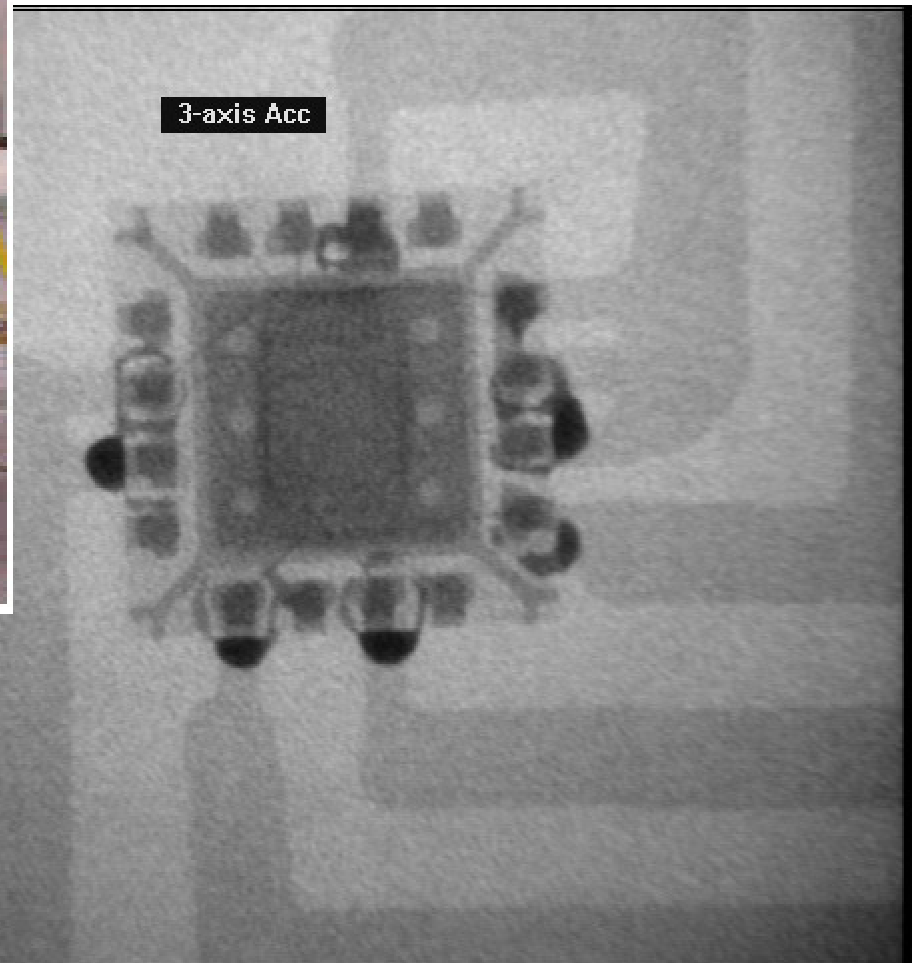
COMPLETED BOARD WITH SOLDERED COMPONENTS

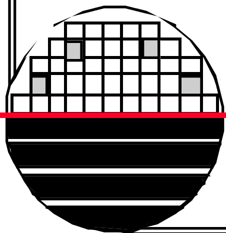




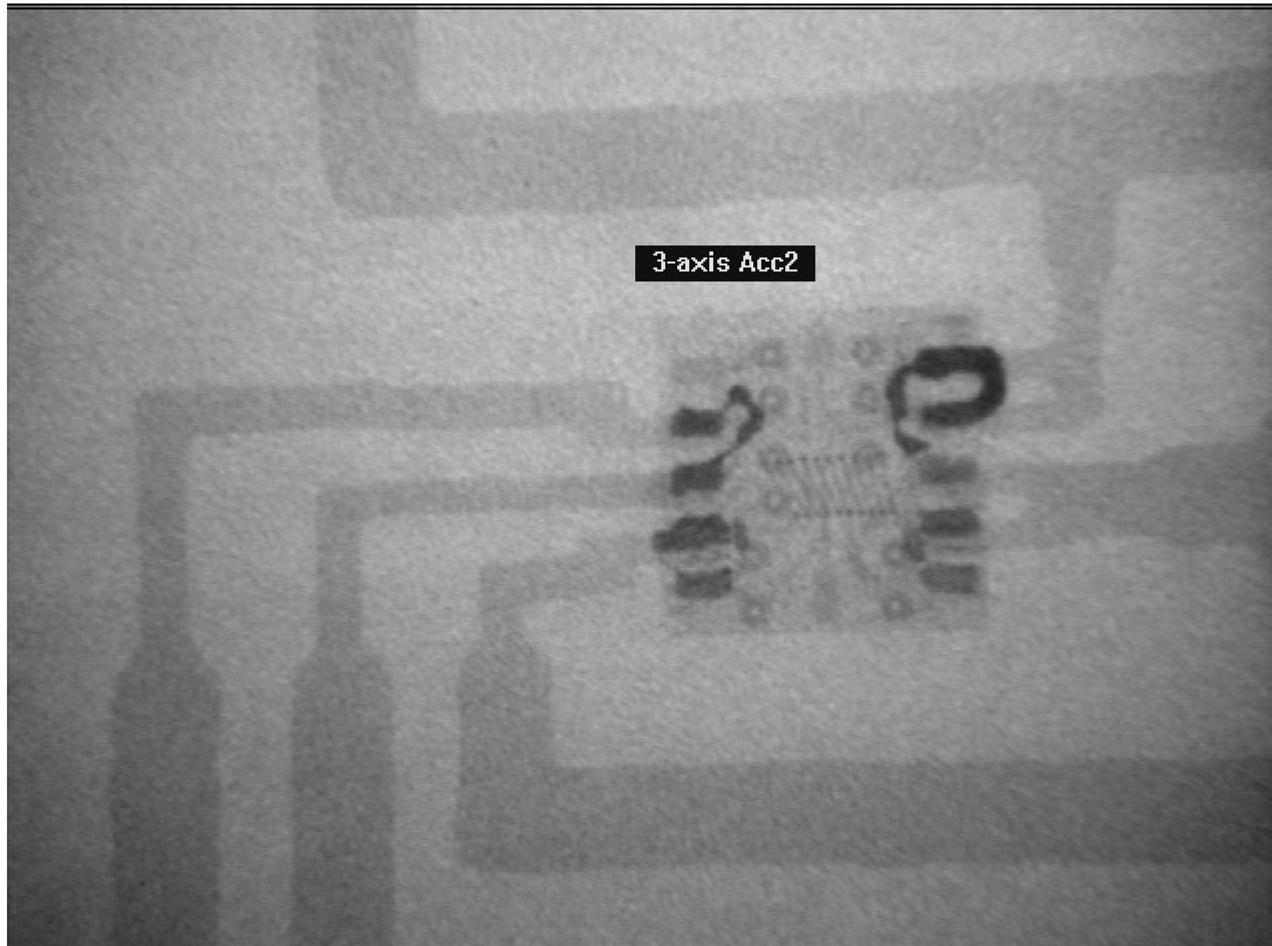
XRAY IMAGE OF ADXL325 SOLDER JOINTS

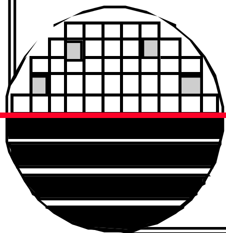
Glenbrook X-Ray Inspection





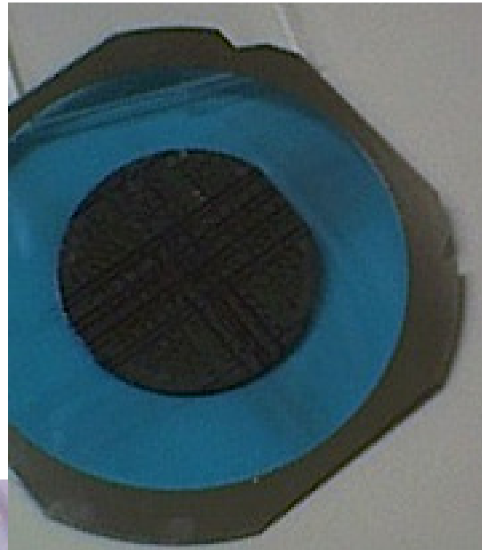
XRAY IMAGE OF BMA140 SOLDER JOINTS

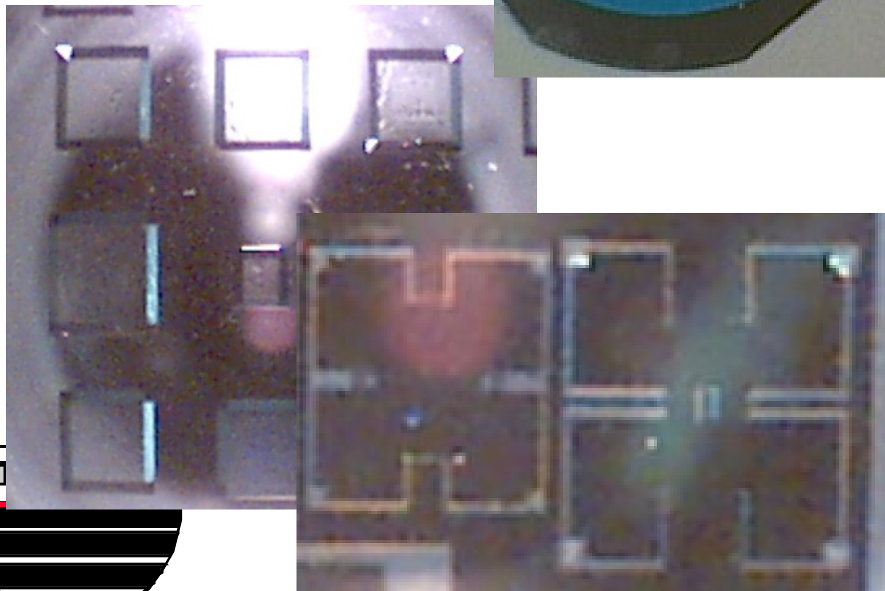




Shows Possible Problem with Y and Z outputs shorted together

K&S 780 WAFER SAW





DICING SAW BLADES FOR WAFERS, GLASS AND CERAMIC

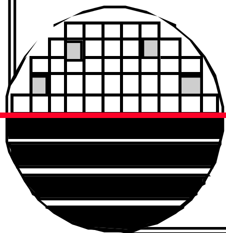
Resin-bonded dicing blades are made of epoxy with diamond grit for cutting glass, ceramic, pzt, sapphire, etc. Thermocarbon Inc., 391 Melody Lane, P.O. Box 181220, Casselberry, Florida 32718-1220, Tel (407) 834-7800 supply a variety of metal and resin bonded blades. We have 2.25M-15B-46Ru7-3 hubless blades and hubs to hold them. The blades are $25.50 each in Qty of 10. The 2.25 is 2 1/4 inch diameter, the 15 is 0.015 in thick, the 46 is the diamond grit size in µm. Mike Reeves (800) 523-1946 said that this blade should be good for 1 mm thick glass.

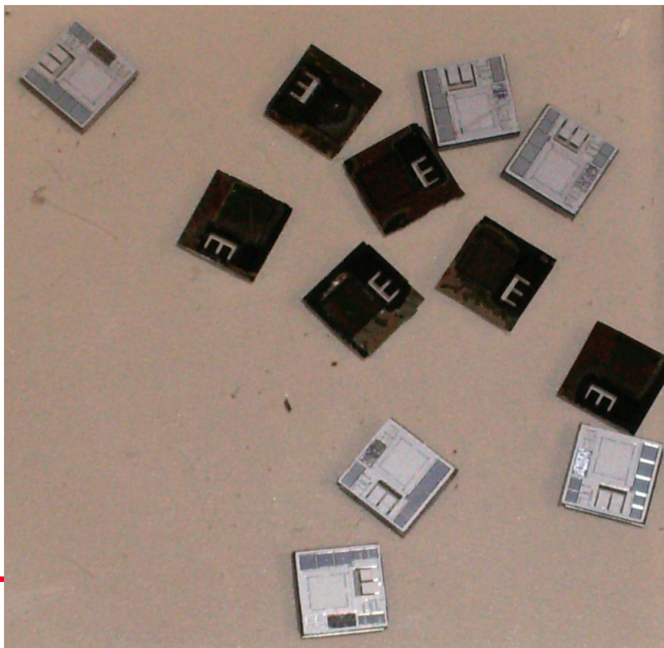
Kulicke and Soffa Industries Inc., Micro-Swiss Division, 2101 Blair Mill Road, Willow Grove, PA 19090 Tel(215)784-6975 make metal bonded and resin bonded dicing blades. Their Resinoid Blades with and without hubs are for cutting glass, ceramics, pzt, sapphire, etc. They also have a wide range of nickel hubless and hub-type blades for silicon and GaAs wafers.

TAPES FOR DICING

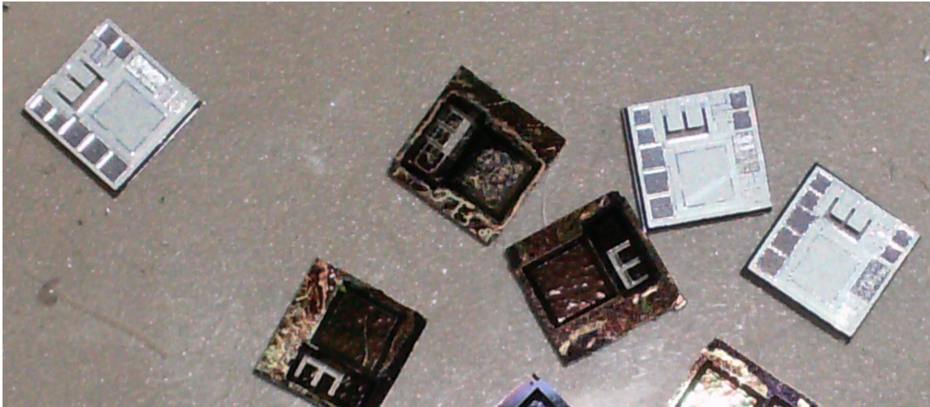
Nitto Denko Corporation (http://www.nitto.com)
Lintec Corp., Tokyo, Japan

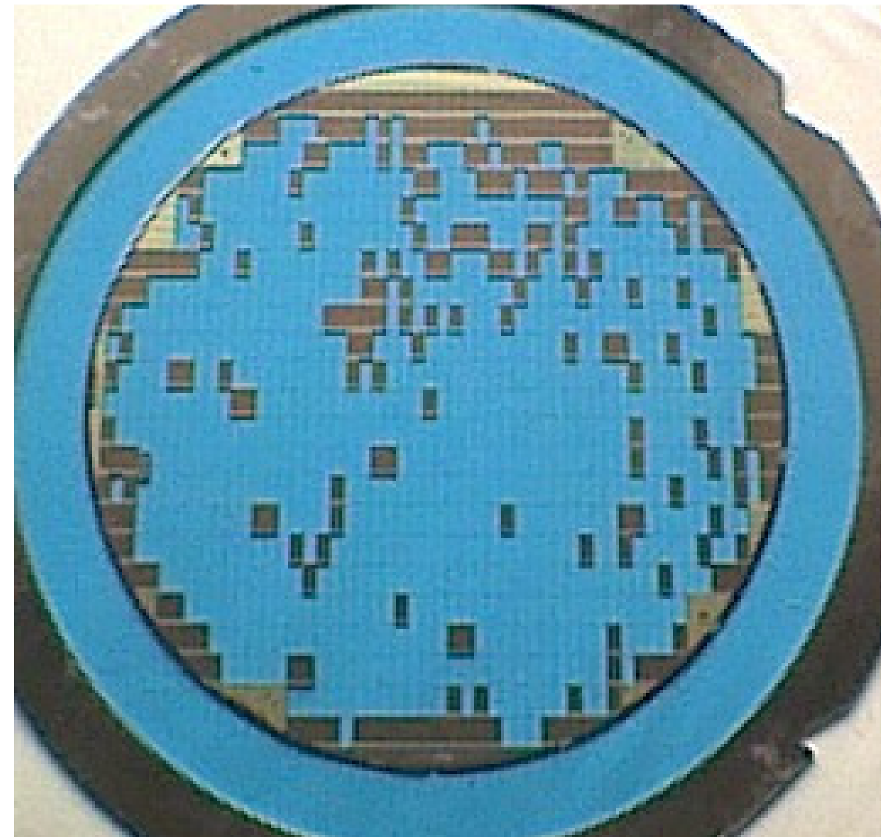
UV Light Release ADWILL T-5782, 200 mm x 10 m roll
Extra Sticky, ADWILL G-19, 200 mm x 10 m roll

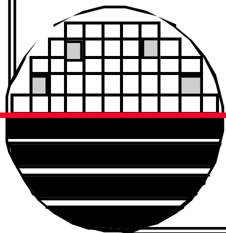




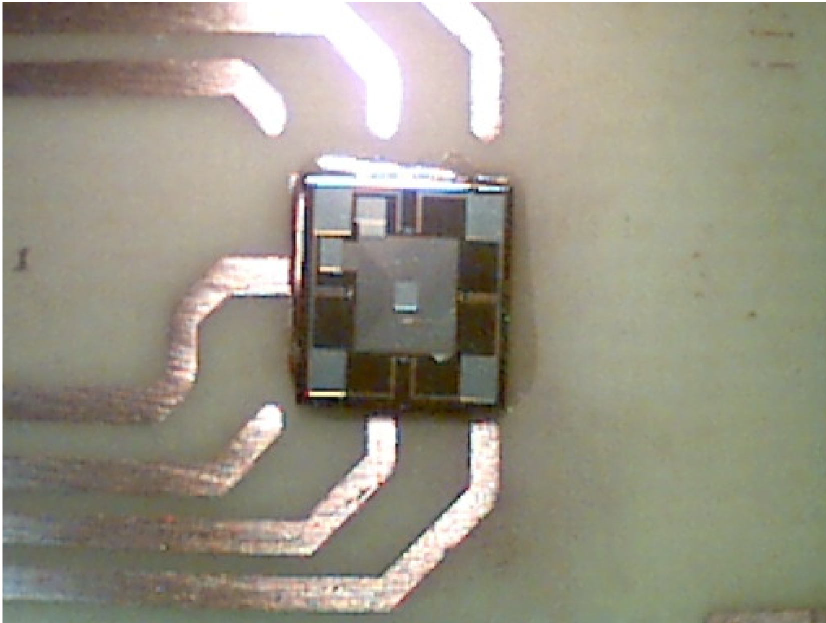
AFTER SAWING AND REMOVAL OF GOOD CHIPS





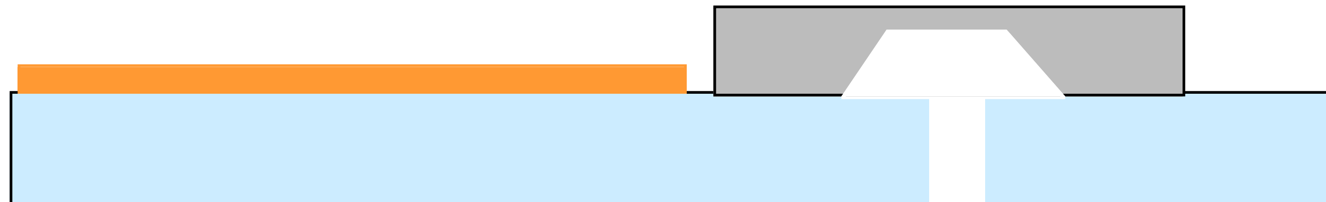


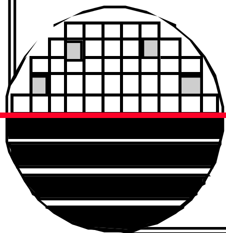
MEMS SENSOR CHIP ATTACHED TO PACKAGE



Standard 2 Part Epoxy Glue Hardens in 4 min., full cure in 24 hours.

High Temperature Epoxy Available





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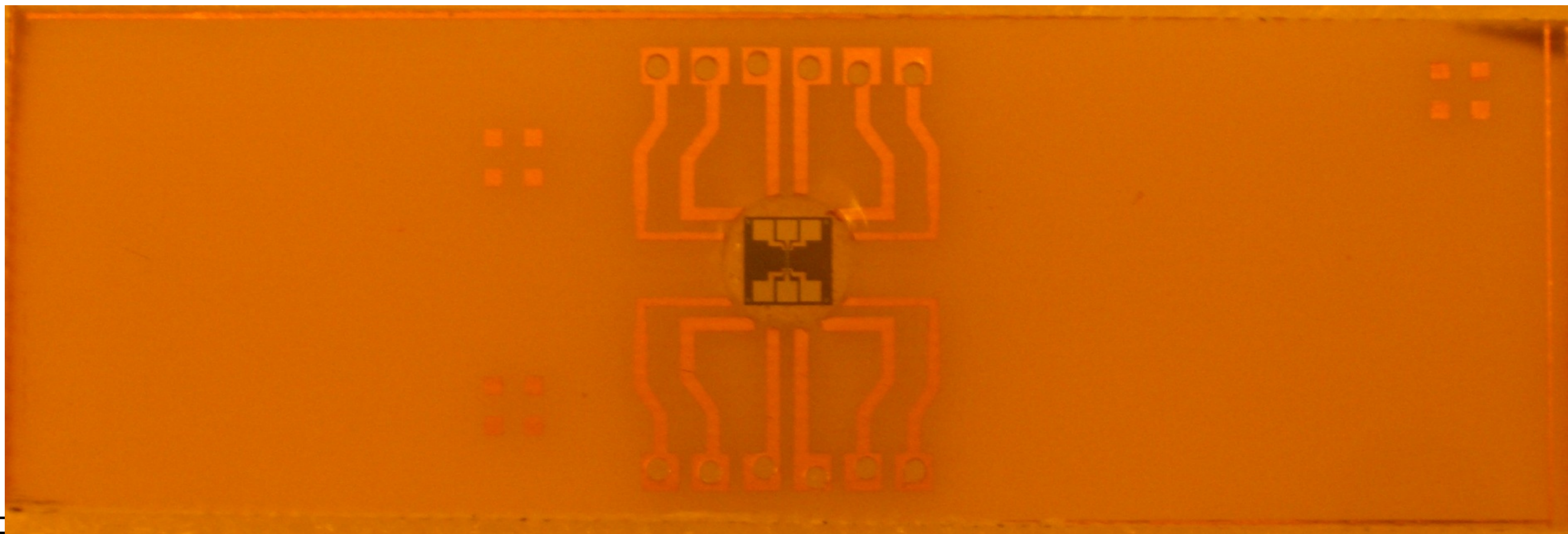
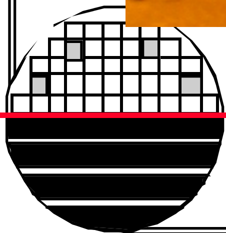
FLUID CHANNEL ASSEMBLY FABRICATION

1. Make printed circuit board (See another page)
2. Drill holes for pins and big hole (holes) for microchips
3. Mount chip or chips using blue dicing tape to temporarily hold chip
4. Epoxy chips in place (thermally conductive epoxy?)
5. Remove blue dicing tape
6. Apply sheet photoresist
7. Align and expose photoresist
8. Develop photoresist
9. Hard bake photoresist
10. Cut and laminate plastic channel cover
11. Wire bond MEMS chip to copper traces
12. Drill holes for fluid input and output in cover
13. Epoxy hose nipples
14. Fill with fluid using syringe and test pumping action
15. Gas flow sensors may need heat sink on back of assembly

AFTER MOUNTING CHIP

Drill holes.
Mount chip or chips using blue dicing tape.
Epoxy chips in place.
Remove blue dicing tape.



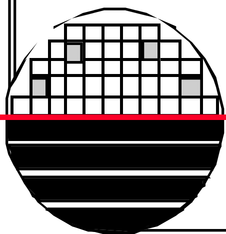


PHOTOSENSITIVE FILMS

http://www.rayzist.com/

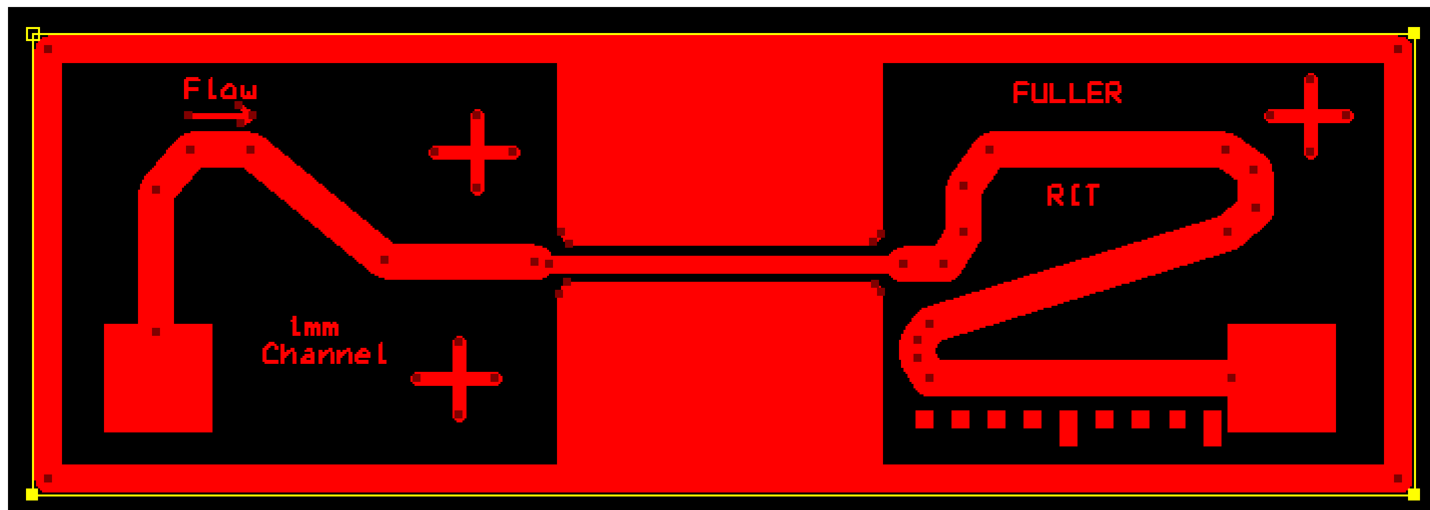
SR3000™ Self-Stick Resist - Sheets						"SELF-ADHESIVE REDEFINED"
Thickness	595 sq in	5 Sheets 8.5" x 14"	1190 sq in	10 Sheets 8.5" x 14"	2975 sq in	25 Sheets 8.5" x 14"
3 mil	$.063	$37.49	$.058	$69.02	$.053	$157.68
4 mil	$.068	$40.46	$.063	$74.97	$.058	$172.55
5 mil	$.073	$43.44	$.068	$80.92	$.063	$187.43

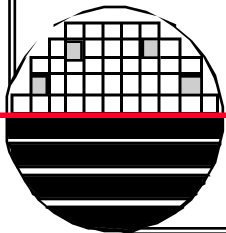
Also ImageOn from
RIT Bookstore 12”x10’x0.002” thick
for $18



CHANNEL ARTWORK

Fluid
Alignment keys to match PCB





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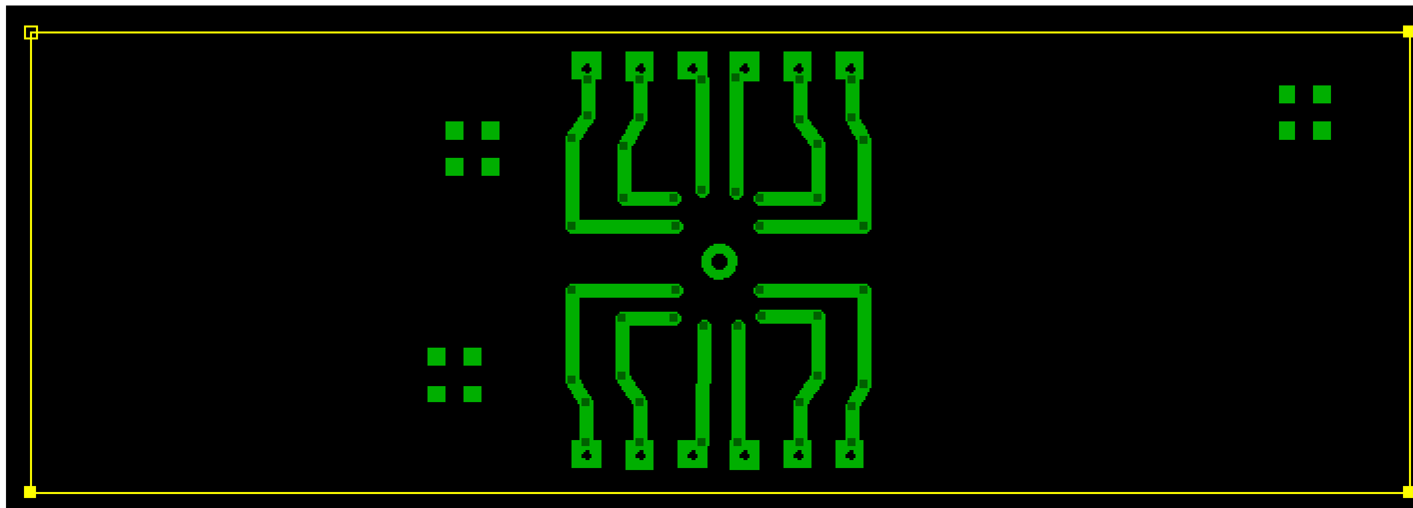
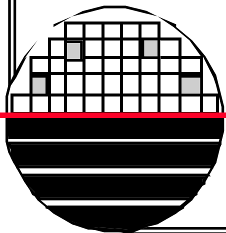
PCB ARTWORK

PCB

Donuts for drill hole alignment

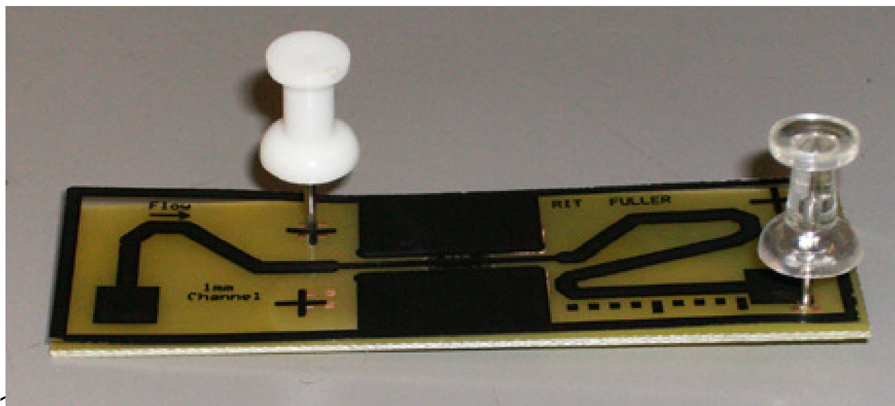
Alignment Keys to match channel

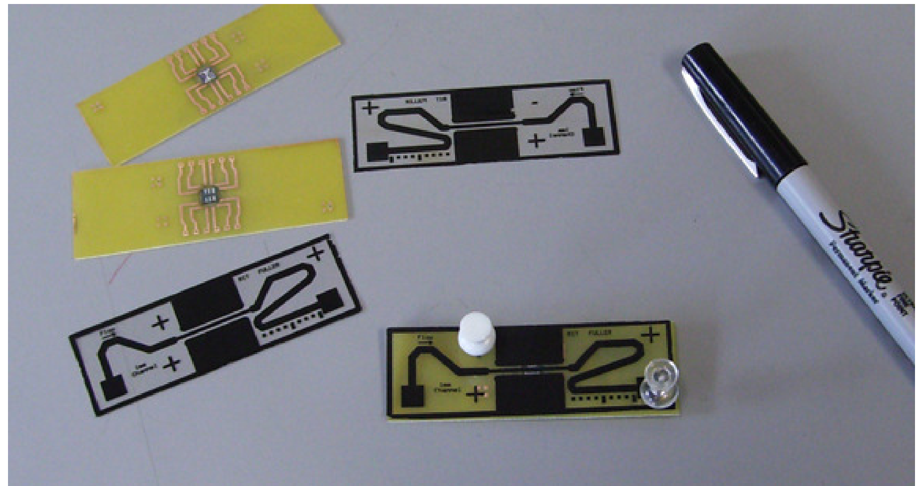




ALIGNMENT OF MASK TO CHIP

Since the ImageOn resist is opaque. It is difficult to align the channel perfectly across the chip as needed. If holes are drilled in two locations (opposite corners) on the PCB the mask can be aligned perfectly prior to applying any ImageOn. Then push pins can be used to make holes in the plastic mask. After the multiple layers of ImageOn are laminated to the board push pins thru the hole will allow the mask to be aligned. Once aligned it is held in place with tape until after exposure.





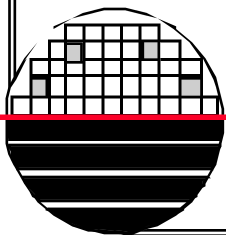
IMAGEON ULTRA RAPID DRY FILM RESIST

ImageOn Processing –negative working resist, 50µm Thick

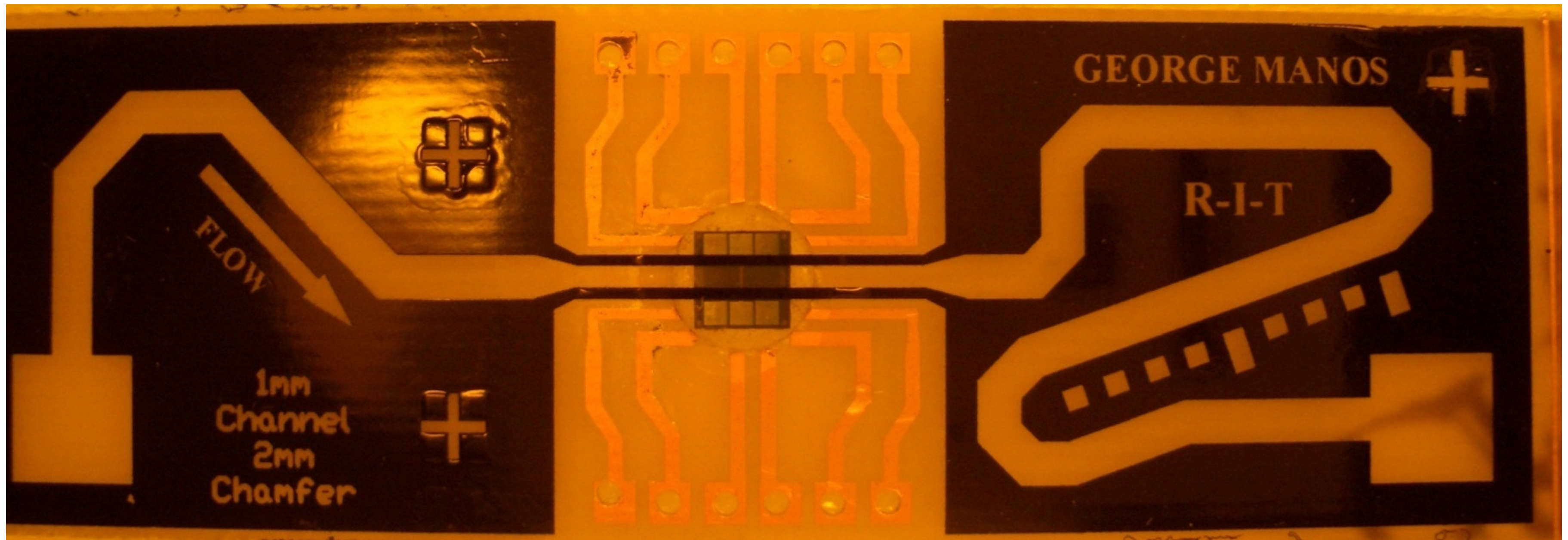
Clean and dry substrate
Remove mylar film from the non-shiny side of the resist
Place resist on the substrate (one try, no air bubbles, etc)
Press down from center to edge,
    Laminate or heat on hot 50°C plate with pressure
    Remove top mylar film
    Repeat to get 100, 150, 200 µm total thickness
Expose: Dose = ~50, 100, 150 or 200 mj/cm2
    Irradiance = 3.5mW/cm2 x 15 sec
        30s for 100µm, 45s for 150µm, etc.
Remove top mylar film
Develop in CD26 (develop 15 sec, spray DI water,
    repeat every 15 sec until clear)
Rinse with water and dry
Hard bake or expose to UV light for 2 min.

150µm DEEP CHANNELS

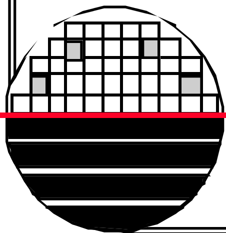
150µm ImagOn Channels on Glass Substrate



AFTER CHANNEL (NO TOP COVER) DEFINED



PCB with MEMS Chip and Channel Walls

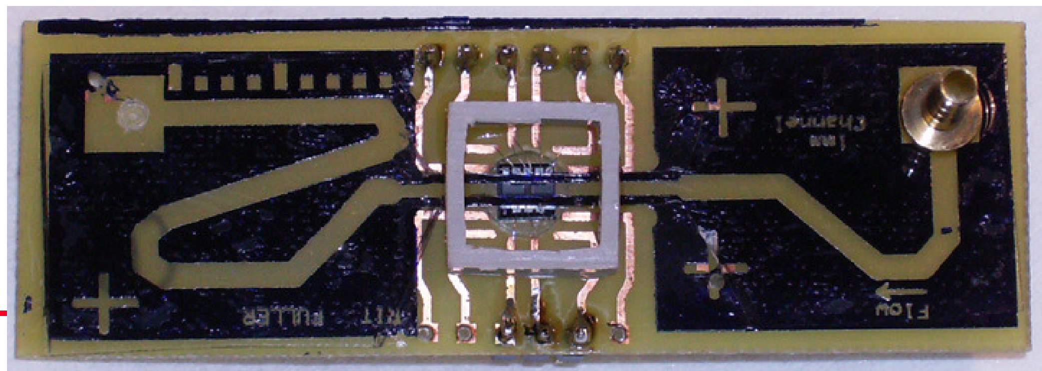


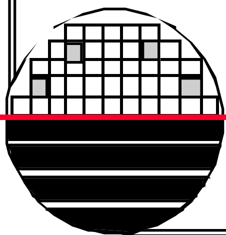
THERMOSETTING GLUE ON PLASTIC COVERS

Plastic used for lamination of nametags, signs, etc. is plastic with a coating of thermosetting glue on one side. This plastic makes a good cover for the fluid channels.

Cut a piece of plastic the right size. Use exacto knife and trace the outline of the channel. Lay it over the channels. Lay a microscope slide or piece of glass to weigh down the plastic. Set it on a hot plate set to 150C. Watch the glue change from frosty to clear. Remove from the hot plate and allow to cool.

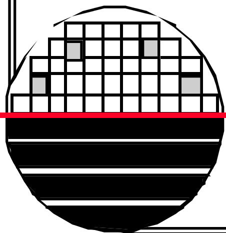
Drill a hole in the plastic for inlet and outlet port.





CHIP TO PACKAGE CONNECTION

Wire Bonds
Solder Bumps
Lead Frames
Connectors
- Press-fit
- Zero Insertion Force



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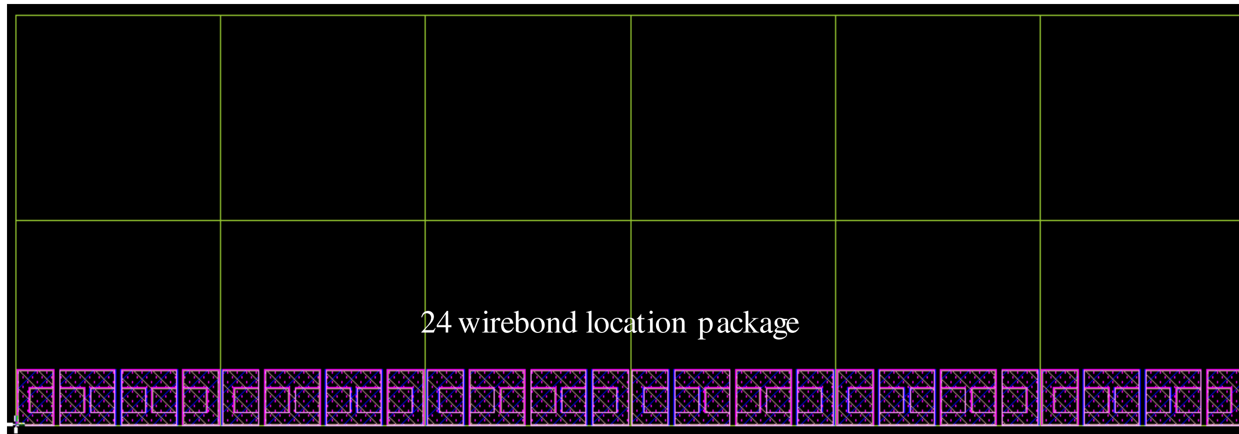
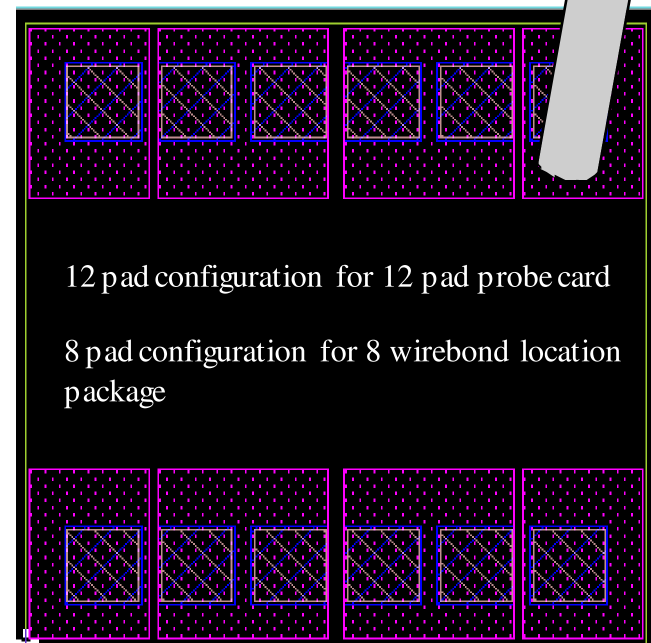
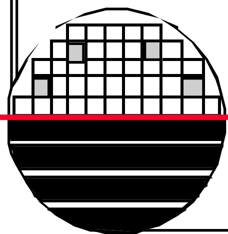
WIREBOND PADS FOR PACKAGING



Pads ~0.22mm x 0.22mm
With ~ 0.030mm space
Wire is ~75µm diameter
Bond is ~150 µm diameter





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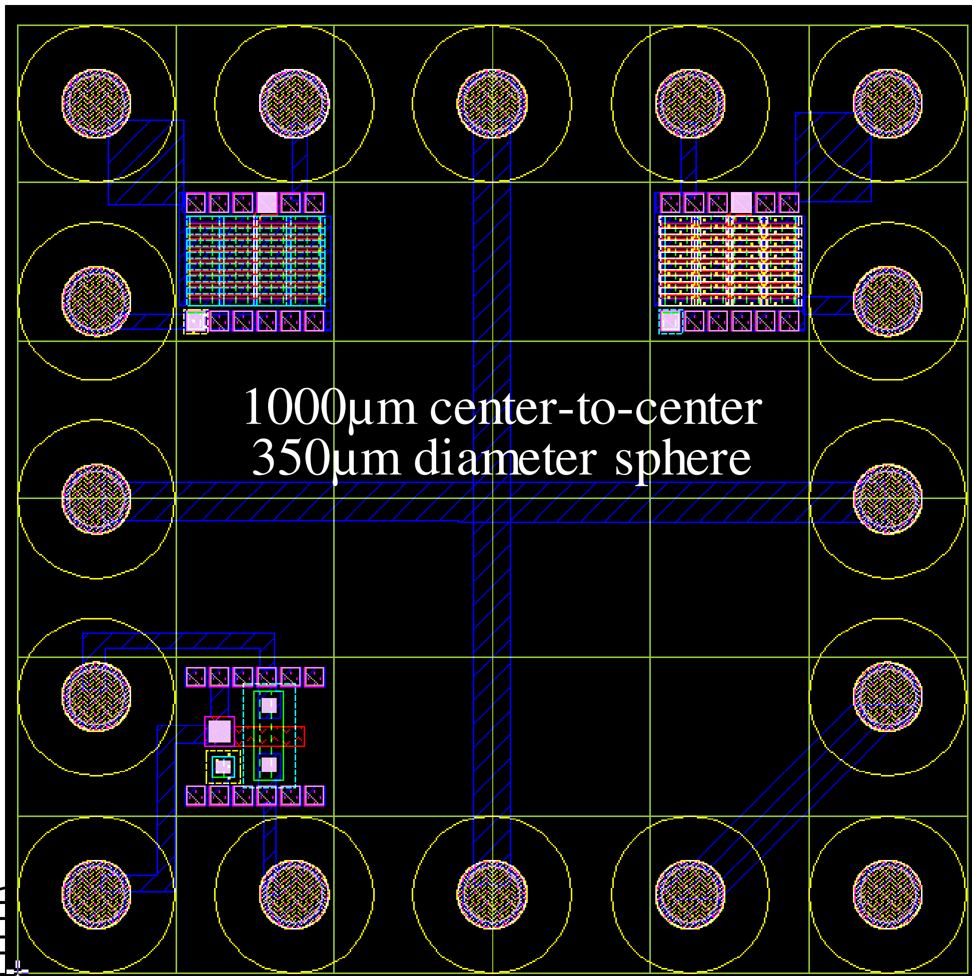
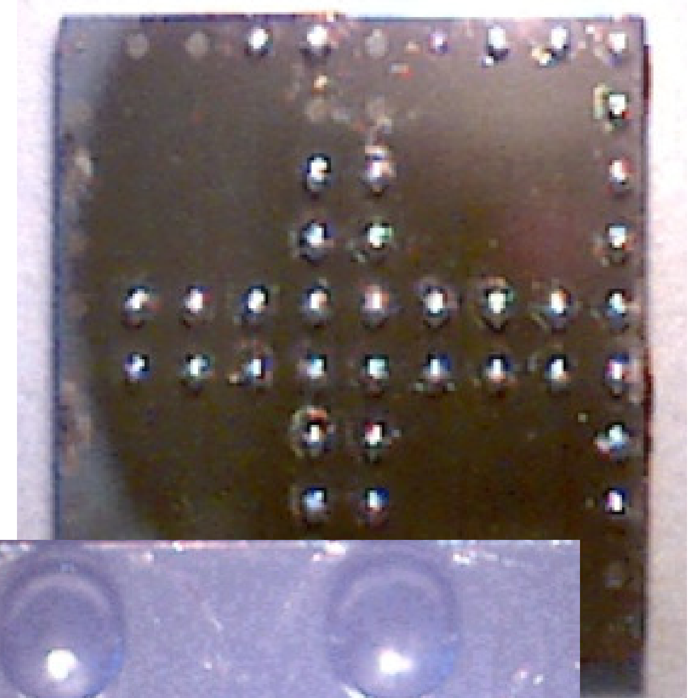
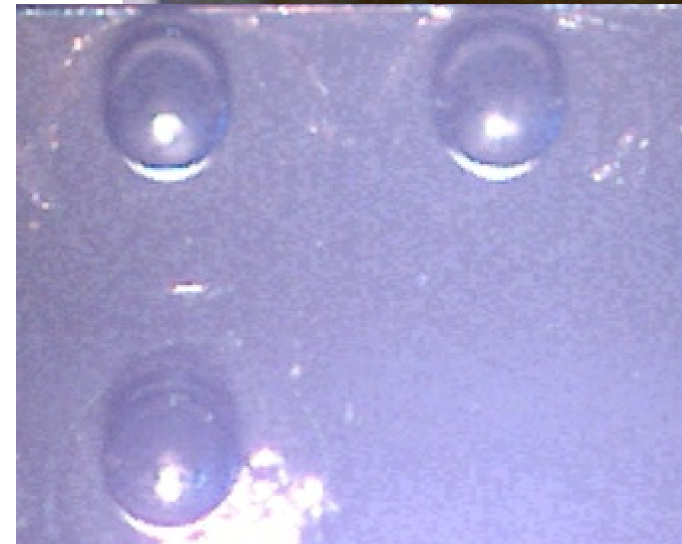
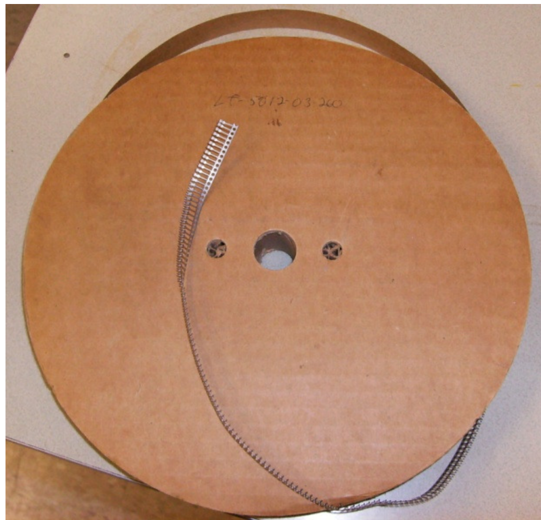
SOLDER BUMP TEST CHIP





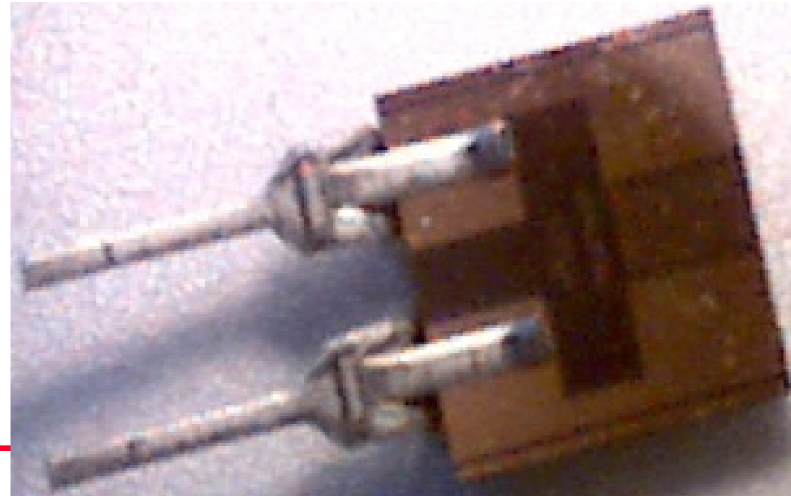


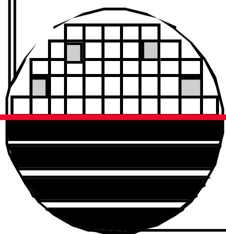
LEAD FRAMES



2.54mm (0.1")Center to Center
Pad ~ 2mm x 2mm with 1mm space
Epoxy on back holds pins in place
Pressure makes contact, Silver epoxy on front can make more reliable contact.

Lead Frame: LF – 5012-03-260



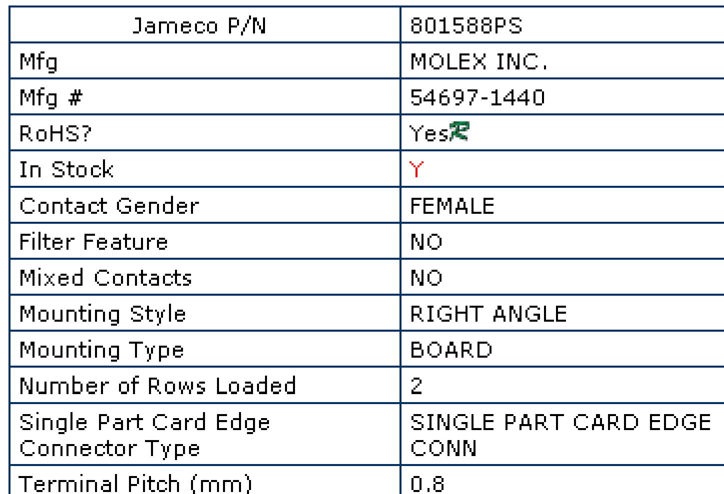


CONNECTORS

144 CONTACT(S), FEMALE, RIGHT ANGLE SINGLE PART CARD EDGE CONN, SURFACE MOUNT, SOCKET

0.8 S.O.DIMM HSG ASSY 144CKT

This product ships from a Jameco satellite warehouse, usually within 2 to 3 the next business day when received by 5:00PM EST. Please choose *expedited processing* at checkout if you prefer to have the other products on your order ship immediately. Separate shipping charges would then apply.

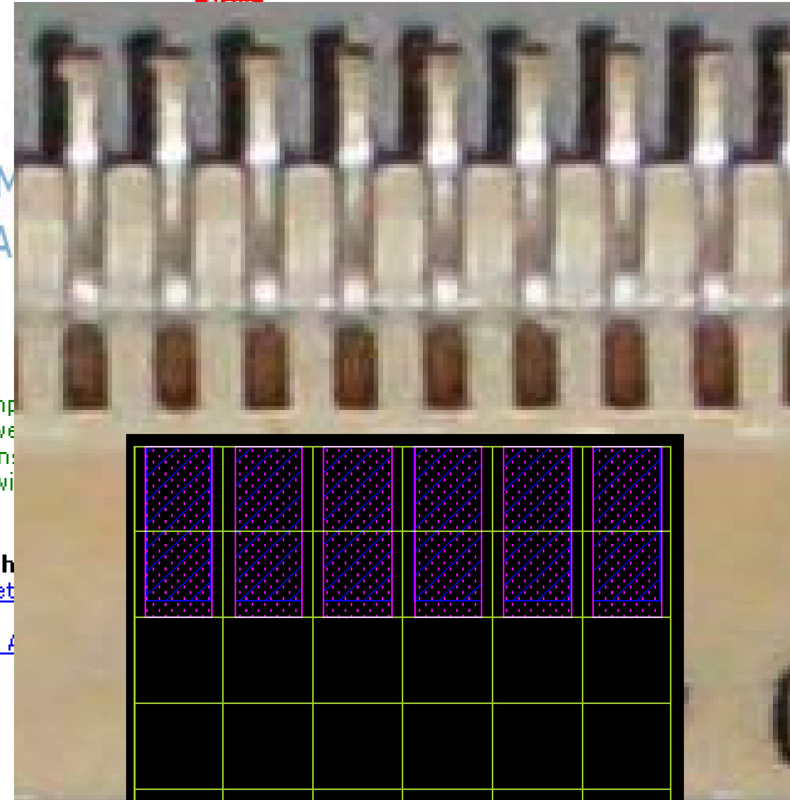


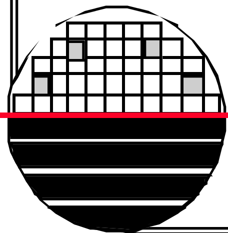
Jameco P/N	801588PS
Mfg	MOLEX INC.
Mfg #	54697-1440
RoHS?	Yes
In Stock	Y
Contact Gender	FEMALE
Filter Feature	NO
Mixed Contacts	NO
Mounting Style	RIGHT ANGLE
Mounting Type	BOARD
Number of Rows Loaded	2
Single Part Card Edge Connector Type	SINGLE PART CARD EDGE CONN
Terminal Pitch (mm)	0.8

**We temp at this lowe supply run quantity wi

View Tech Data Sheet

Download Font Pack





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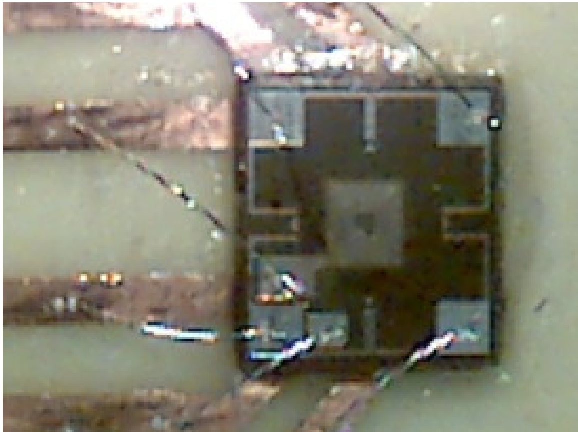
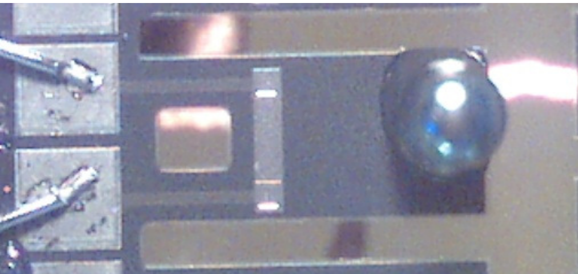
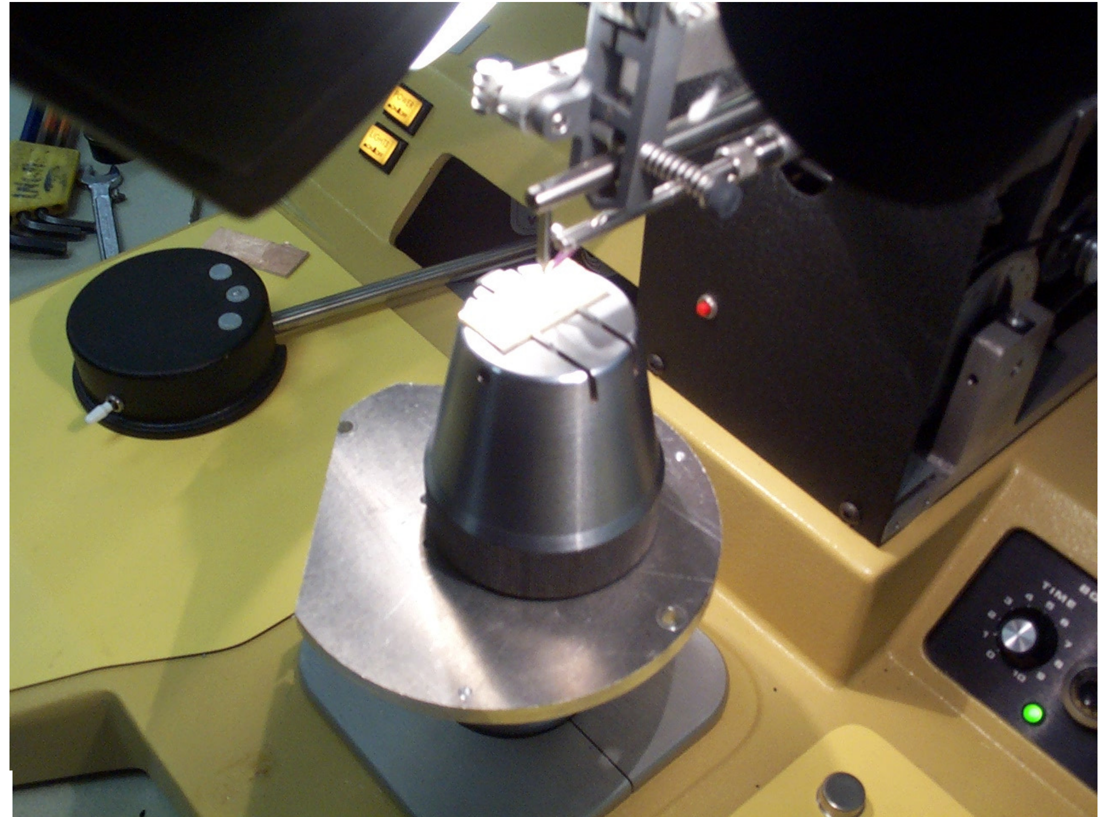
ULTRASONIC ALUMINUM WIREBOND



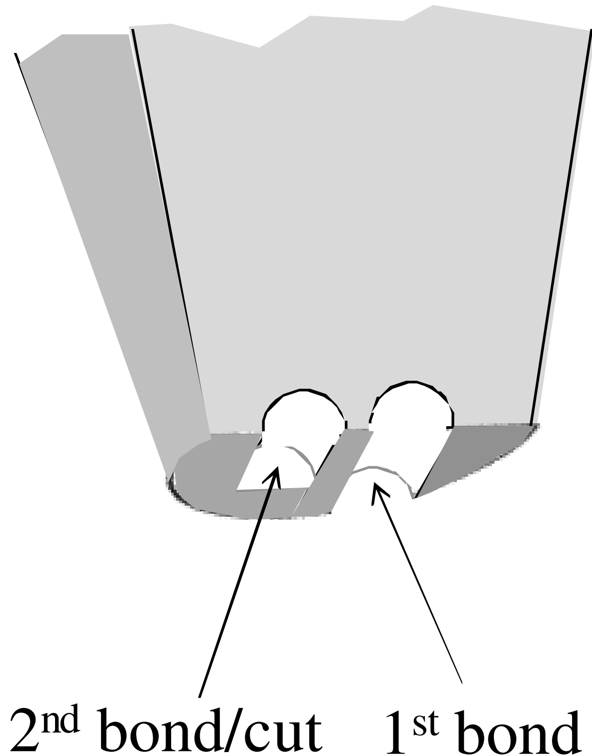


Bond 1, time=1, power=250
Bond 2, time=2, power=320



Orthodyne Electronics Model 20
Ultrasonic Wire Bonder

WIRE, BONDING TOOLS AND CAPILLARY



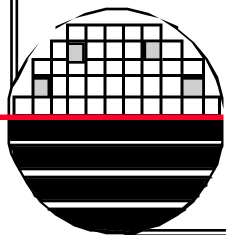
Orthodyne Electronics
16700 red Hill Ave
Irvine, CA 92606-4802
(949)660-0440

6/9/2006

Bonding Wedge 0.003 V GRV Twin 1CR4-B
Capillary 0.004 Violet narrow guide 1CR4-J

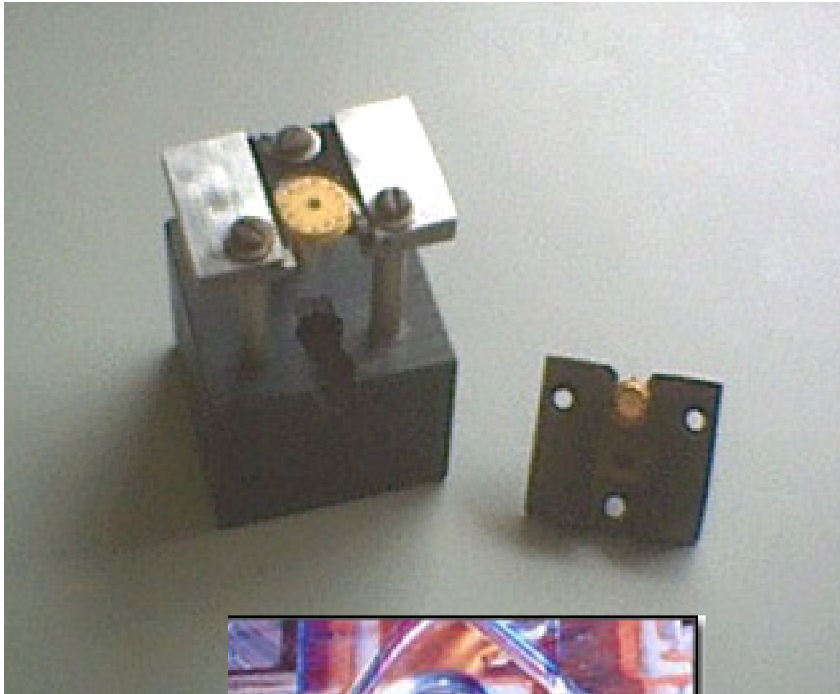
Semiconductor Packaging Materials, Inc.
1 Labriola Court
Armonk, NY 10504
www.sempck.com
(914) 273-5500

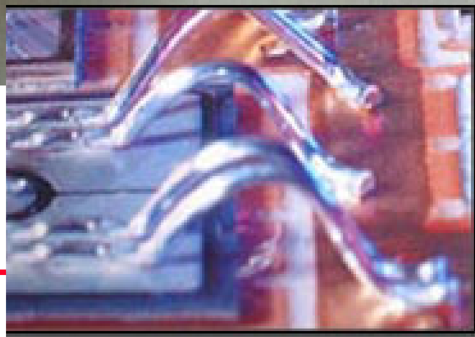
1%SiAl wire, 0.003 inches diameter

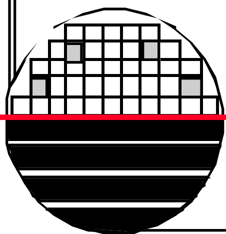


WIRE BONDING

Fixture to hold TO-8 and TO-39 packages for wire bonding.
Ultrasonic Aluminum Wire bonder.

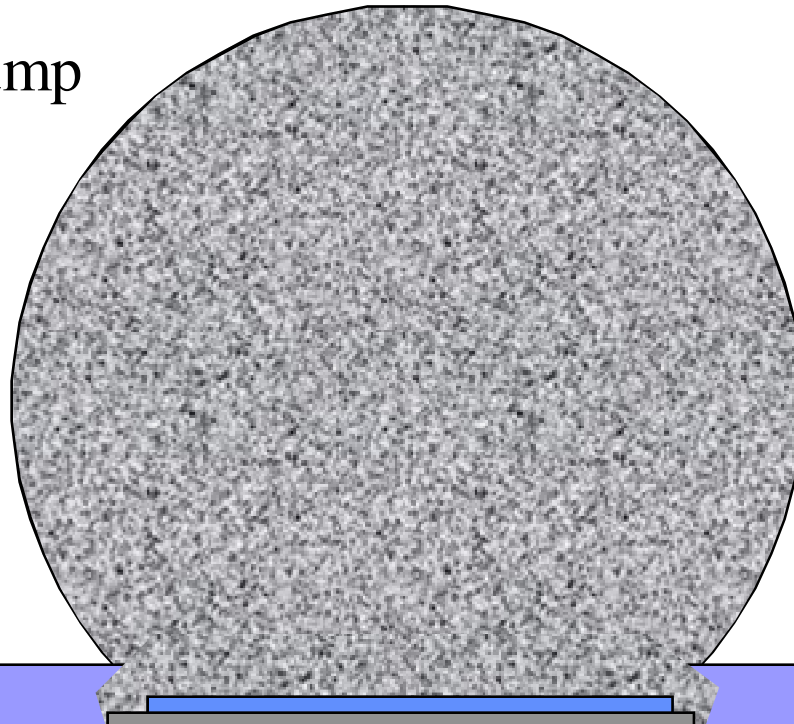


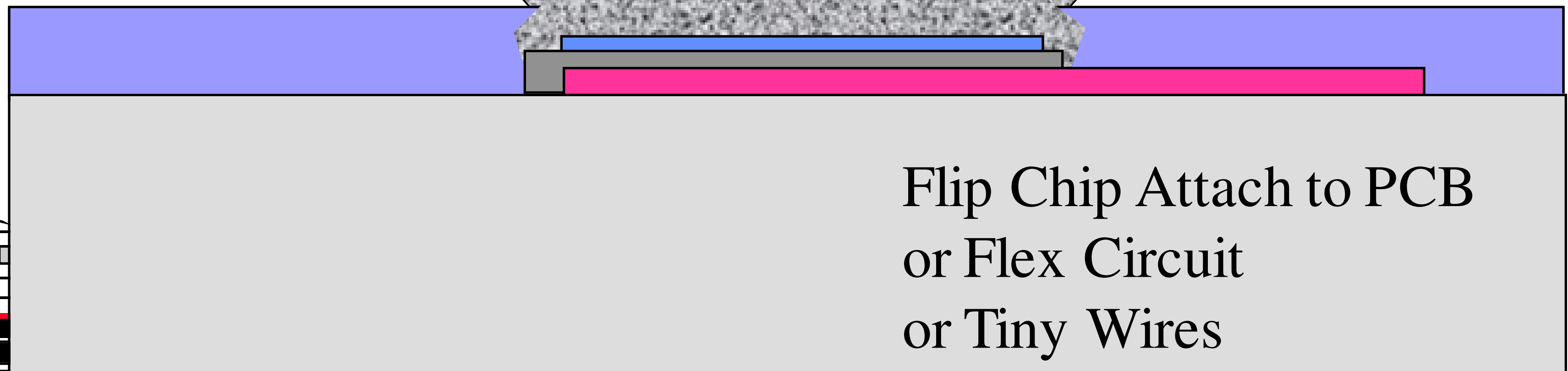




SOLDER BUMPS ON CHIP

- 350 um Solder Bump
- 0.5 um Ni
- 0.1 um Cr
- 1um Al/1%Si





Flip Chip Attach to PCB
or Flex Circuit
or Tiny Wires

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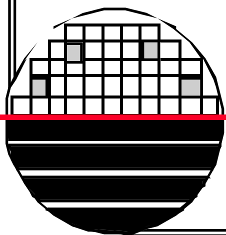
RIT SOLDER BUMP PROCESS

1. Aluminum already on microchip
2. Deposit 1µm of TEOS
3. Photo for etching vias in TEOS (normal positive resist)
4. Etch vias (over etch a little to get undercut for lift-off)
5. Sputter Cr (1000Å), Ni (5000Å) single pump down
6. Sputter Cu (5,000Å) (optional)
7. Lift-Off in acetone using ultrasonic agitation
8. Put down 150µm of the Blue photoresist (negative)
9. Expose and develop openings over the under bump metal
10. Squeege solder paste filling the openings
11. Heat on hot plate to melt solder and form bumps
12. Solvent strip blue resist off and clean solder flux off



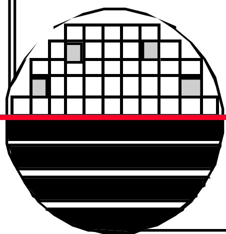
PHOTOSENSITIVE FILMS

http://www.rayzist.com/

Blue Negative Resist

SR3000™ Self-Stick Resist - Sheets "SELF-ADHESIVE REDEFINED"						
Thickness	595 sq in	5 Sheets 8.5" x 14"	1190 sq in	10 Sheets 8.5" x 14"	2975 sq in	25 Sheets 8.5" x 14"
3 mil	$.063	$37.49	$.058	$69.02	$.053	$157.68
4 mil	$.068	$40.46	$.063	$74.97	$.058	$172.55
5 mil	$.073	$43.44	$.068	$80.92	$.063	$187.43

Also ImageOn from
RIT Bookstore 12”x10’x0.002” thick
for $18



IMAGEON ULTRA RAPID DRY FILM RESIST

ImageOn Processing –negative working resist, 50µm Thick

Wet Substrate
Remove mylar film from the non-shiny side of the resist
Place resist on the wet substrate
Remove water from center to edge,
    Laminate or heat on hot plate with pressure
    Remove top mylar film
    Repeat to get 100, 150, 200 µm total thickness
Expose: Dose = ~50 mj/cm2,
    Irradiance = 3.5mW/cm2 x 15 sec
        30s for 100µm, 45s for 150µm, etc.
Remove top mylar film
Develop in CD26 (develop 15 sec, spray DI water,
    repeat every 15 sec until clear)
Rinse with water and dry
Hard bake or expose to UV light for 2 min.

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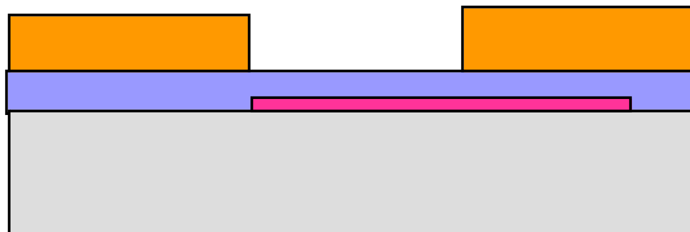
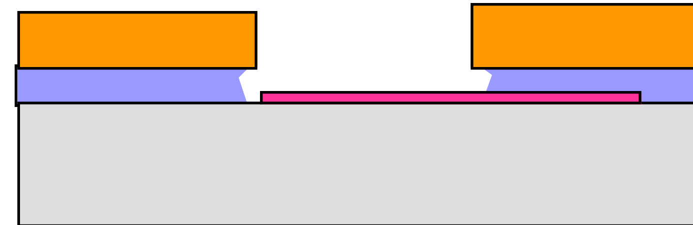
PROCESS DETAILS

Completed CMOS wafer with Al Metal

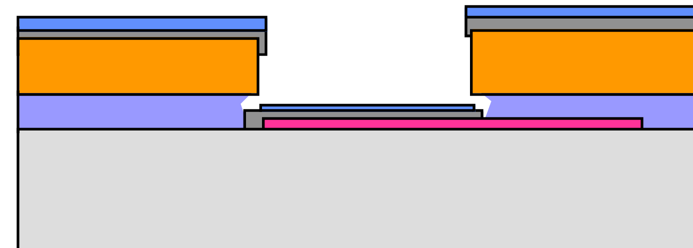
Deposit 1µm TEOS or LTO



Normal Positive Photoresist Via

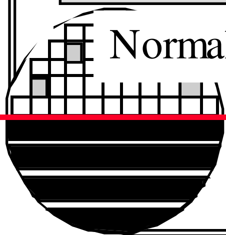


Over etch to create undercut



Deposit Cr and Ni

Lift-Off in Acetone and ultrasonic



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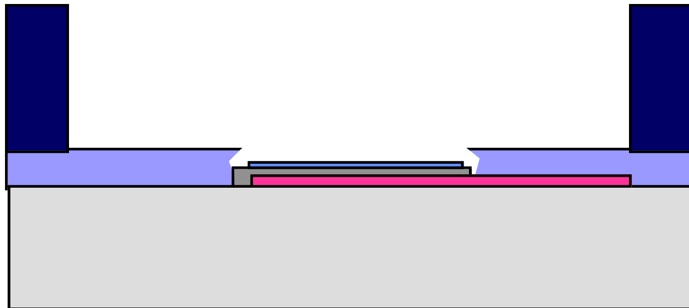
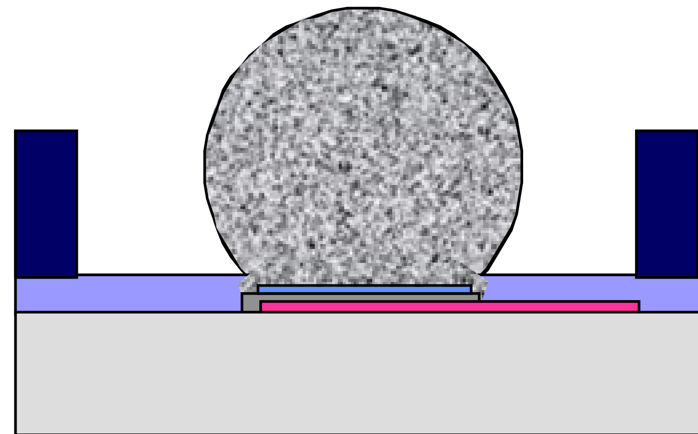
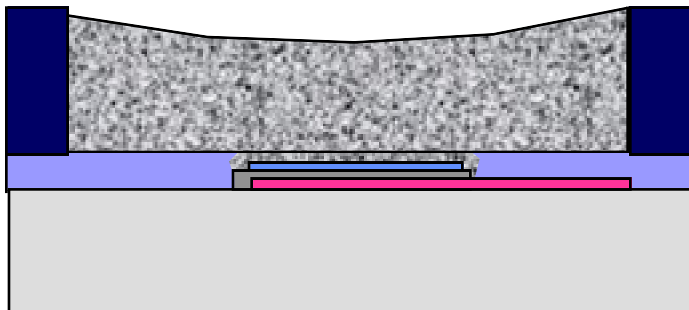
PROCESS DETAILS



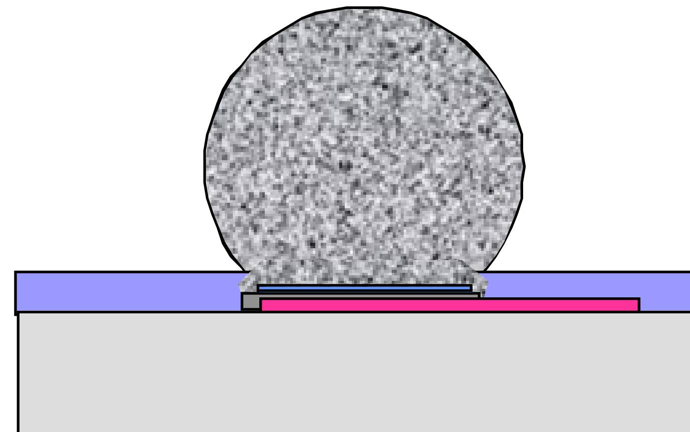
Apply and Image 150µm Thick Neg. Photoresist



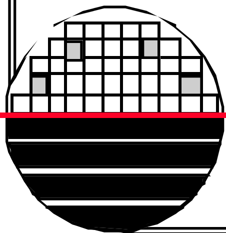
Hot Plate Heat to form Bumps



Squeege Fill with Solder Paste



Solvent Strip 150µm Photoresist



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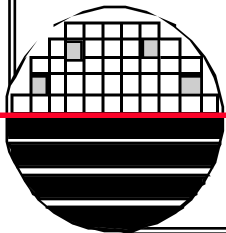
MASK LAYOUT FOR TRIAL SOLDER BUMPS



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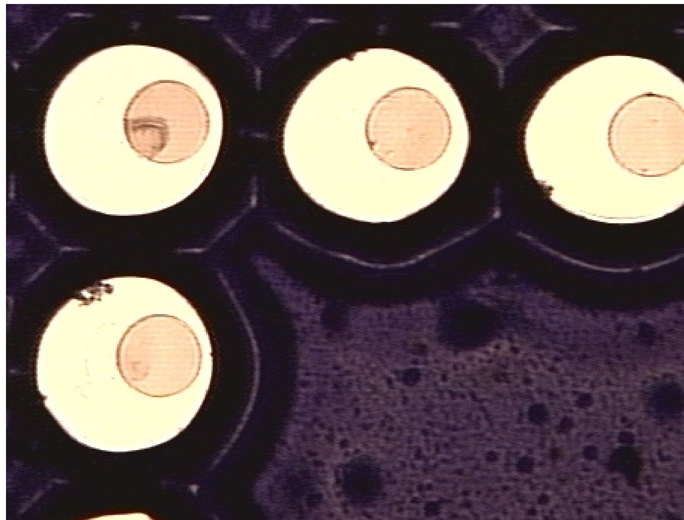
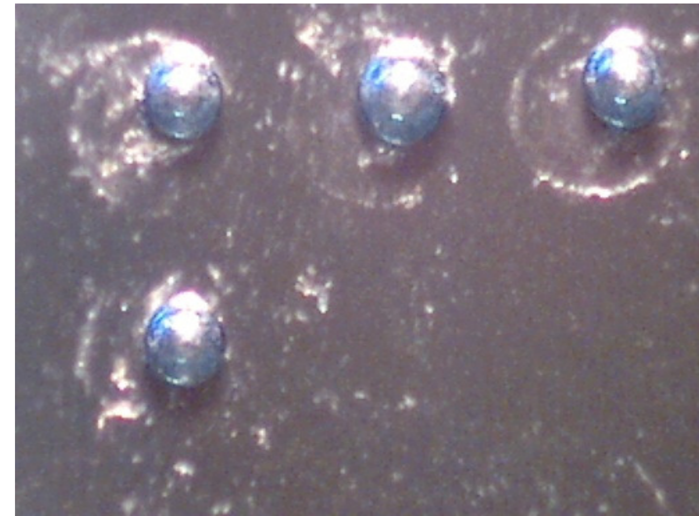
PICTURES DURING PROCESS



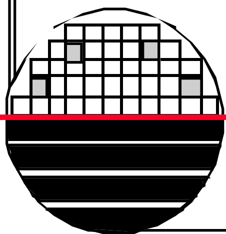
After Imaging 150µm Resist
Over Under Bump (Cr/Ni) Metal

After Stripping Resist in Solvent Strip



1mm space, 350 µm
Diameter Bump

After Spreading Solder
Paste into holes and heating
to form Solder Balls



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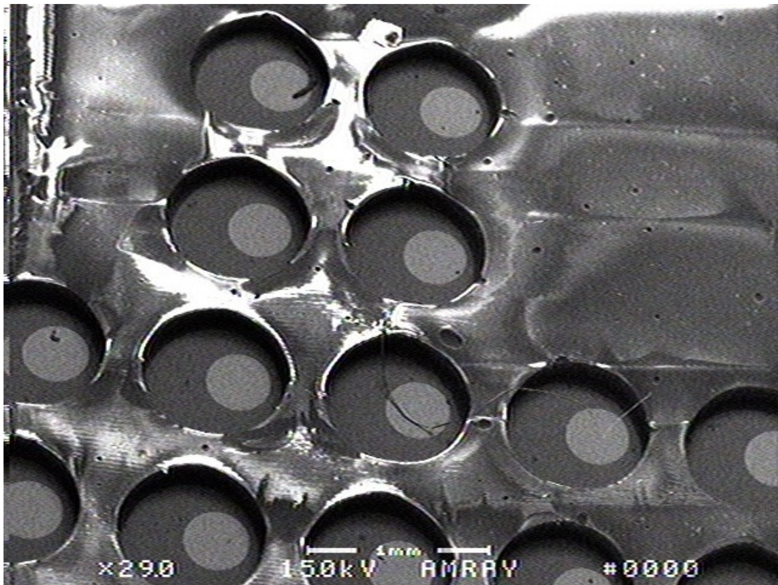
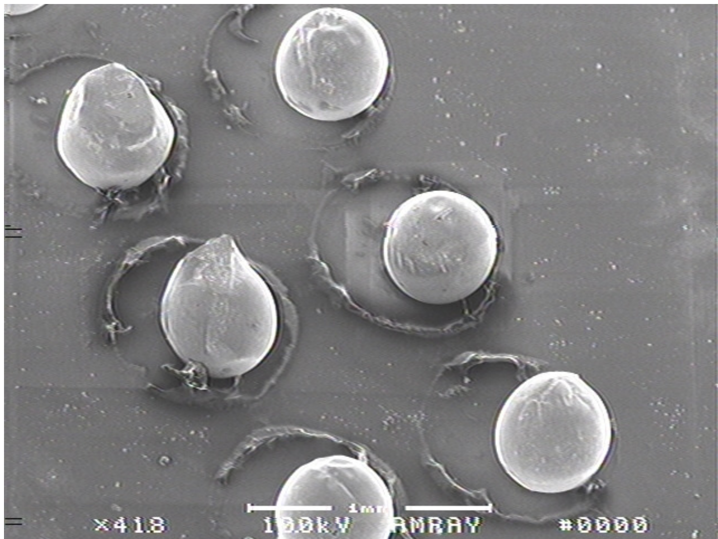
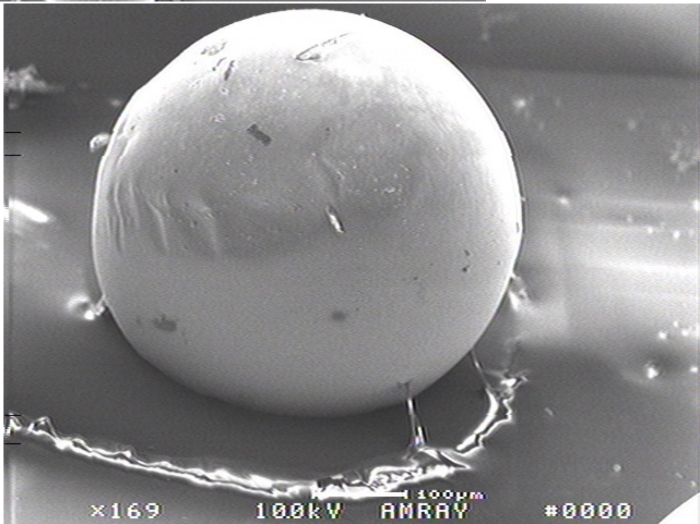
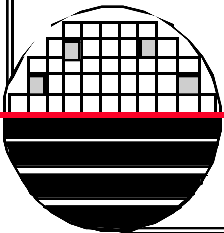
SOLDER PASTE

SEM PICTURES

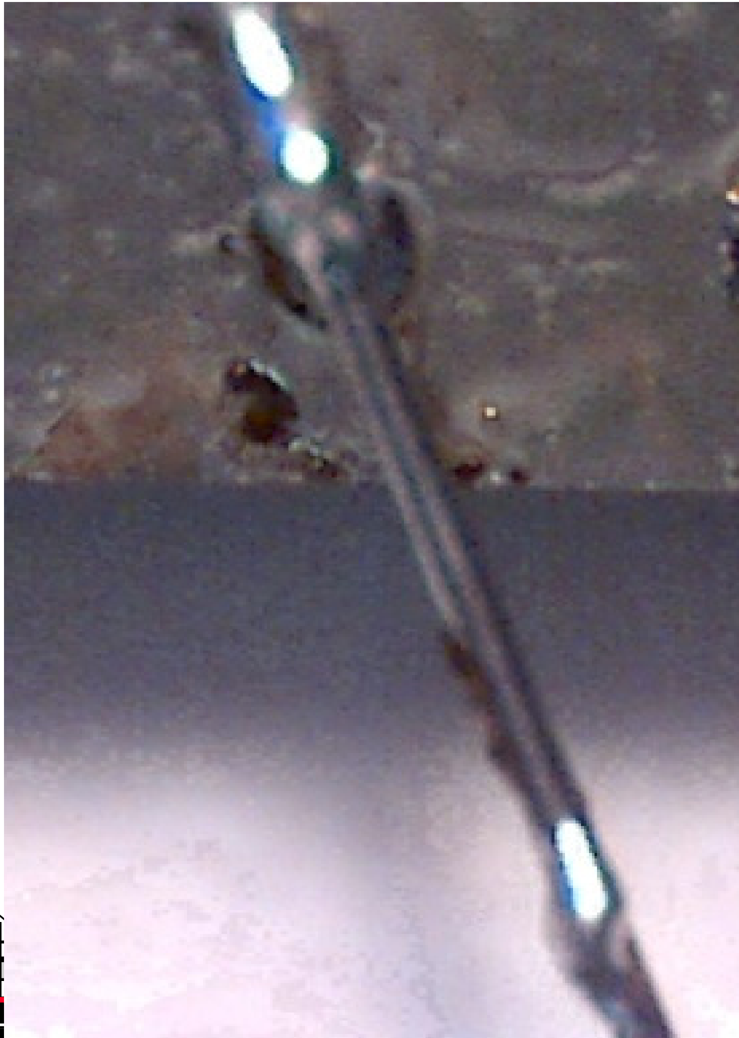


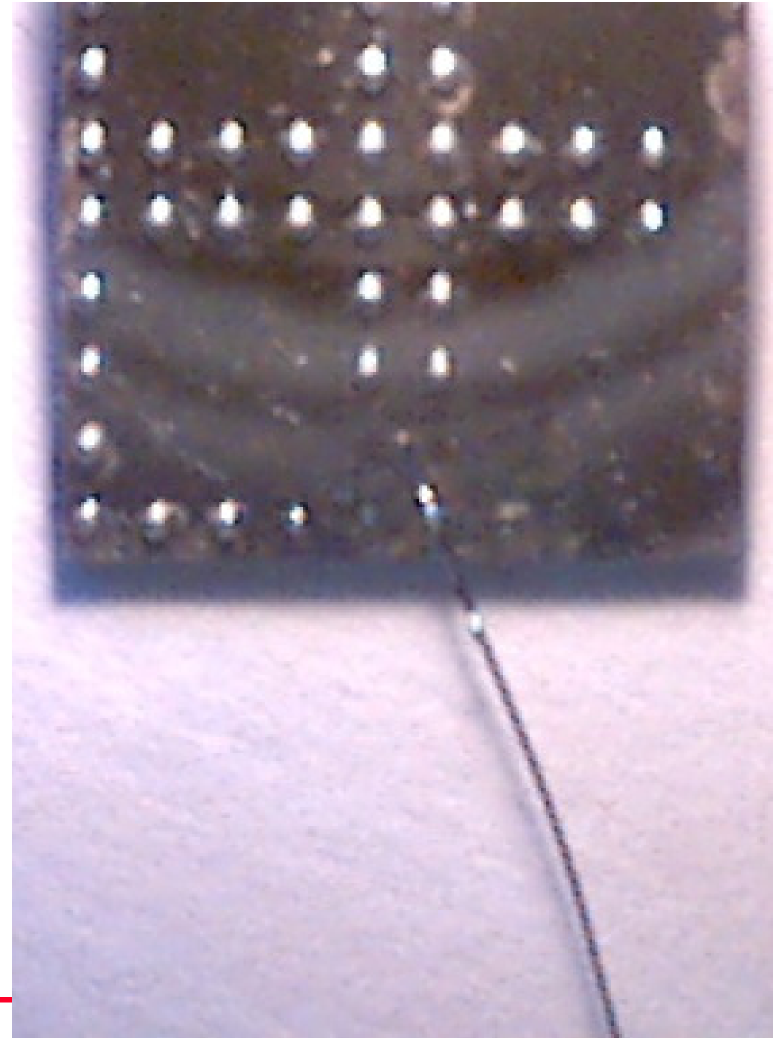


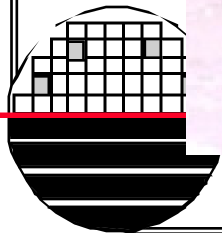




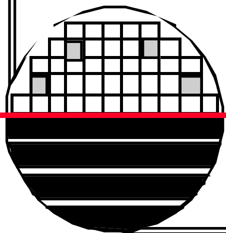
TINY WIRE SOLDERED TO ONE BUMP







INTERCONNECT TO PCB



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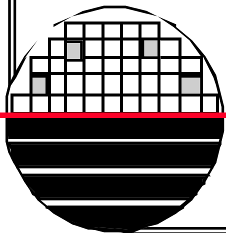
PROTECTION

Epoxy
Metal Covers
Plastic Covers



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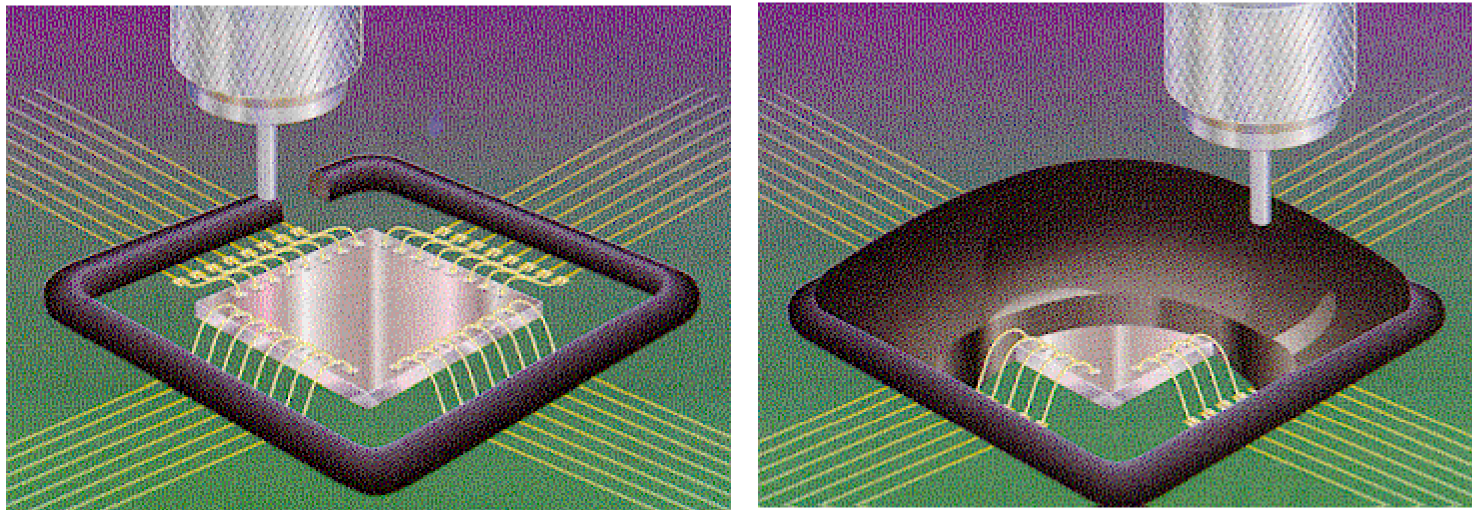
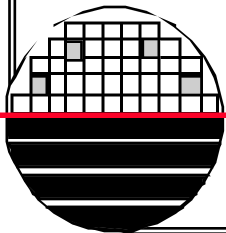
EPOXY FOR CHIP PROTECTION

Conductive epoxy is printed, chips are placed on board (tacky epoxy holds them in place), oven cure of epoxy. Conductive epoxy is used under the chip where electrical or thermal conductivity is needed.



Non conductive epoxy used to cover the chip. Epoxy forms a dam and a different type of epoxy fills and protects.



EPOXY MATERIALS

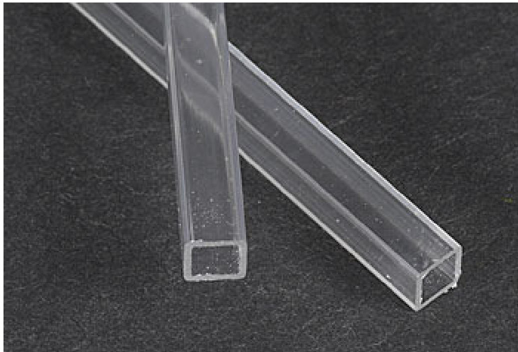
Master Bond Inc
154 Hobart St.
Hackensack, NJ 07601

(201) 343-8983
Offers over 100 different epoxy products, adhesives, sealants and coating.

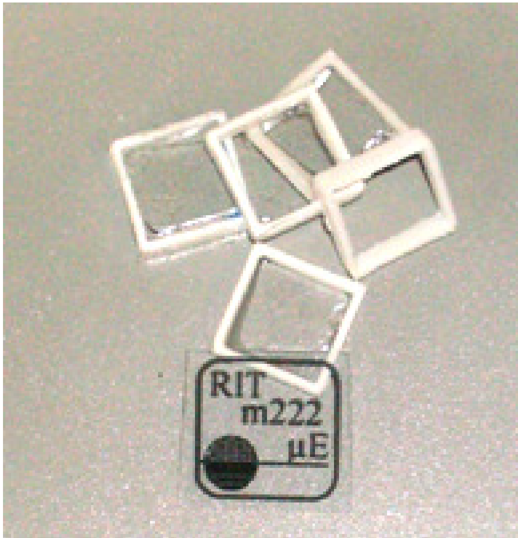
Product Name	Mix Ratio	Viscosity RT, cps	Set-up time, RT	Cure Schedule	Applications
EP21TDCS					Silver Epoxy 20 grams min. sample $230
EP21TPND	100/100	thixotropic	30min	48hrs@RT+2hrs@200F	Polysulfide modified, Fuel and oil resistant sealant
EP30LTE	100/10	17,000	30min	24hrs@RT+3hrs@200F	Exceptionalyy low coefficient of expansion, low shrinkage
EP30	100/10	2000	25min	24hrs@RT+2hrs@200F	Clear system for optical and fiber optic bonding
EP77M-F	100/100	paste	8min	1hr@150F+8hr@300F	Electrically conductive silver filled epoxy
EP121AO	100/80	50,000	15hrs	3hrs@200F+9hrs@200F	Thermally conductive potting and encapsulation
SuperGel#7	100/100	500	3hrs	60hrs@RT+3hrs@200C	Soft resilient, transparent epoxy gel
SteelMaster 43HT	100/20	Thixotropic	25 min	24hr@RT+2hr@200C	Machinable, stainless steel filled

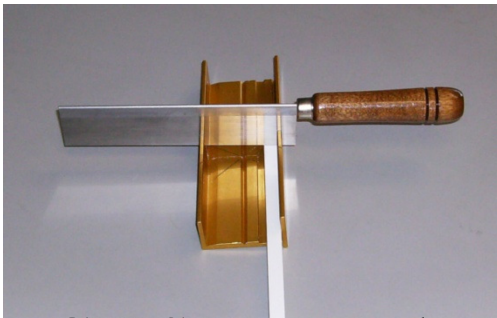
http://www.masterbond.com

PLASTIC COVERS FROM SQUARE PLASTIC TUBE



http://www.hobbylinc.com

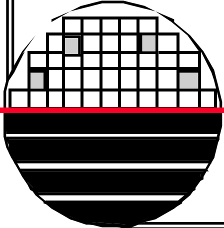




Cut Square Tube

μE RIT	μE RIT	μE RIT
μE RIT	μE RIT	μE RIT
μE RIT	μE RIT	μE RIT
μE RIT	μE RIT	μE RIT
RIT μE	RIT μE	RIT μE
RIT m222 μE	RIT m222 μE	RIT m222 μE
μE m222 RIT	μE m222 RIT	μE m222 RIT
μE m222 RIT	μE m222 RIT	μE m222 RIT

Print covers on transparency sheets, cut and glue



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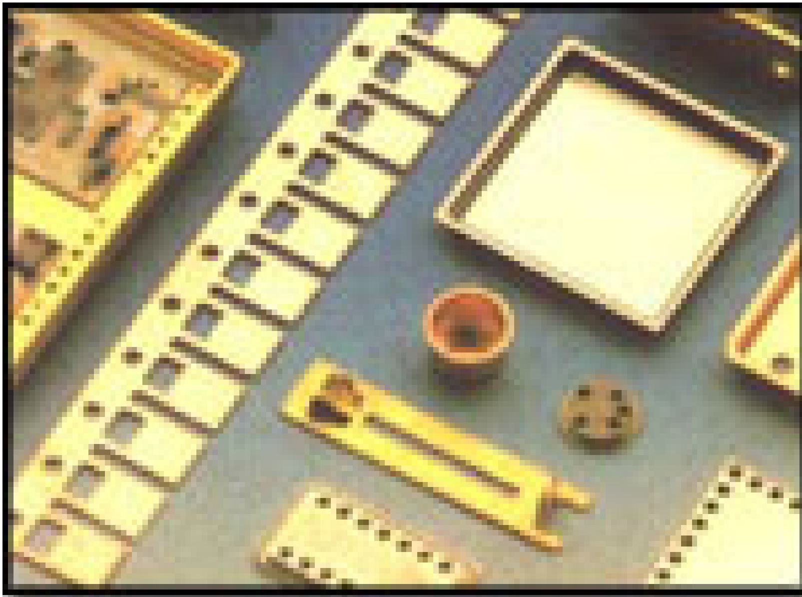
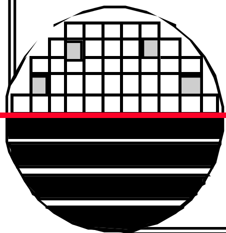
PURCHASED METAL COVERS



TO-8



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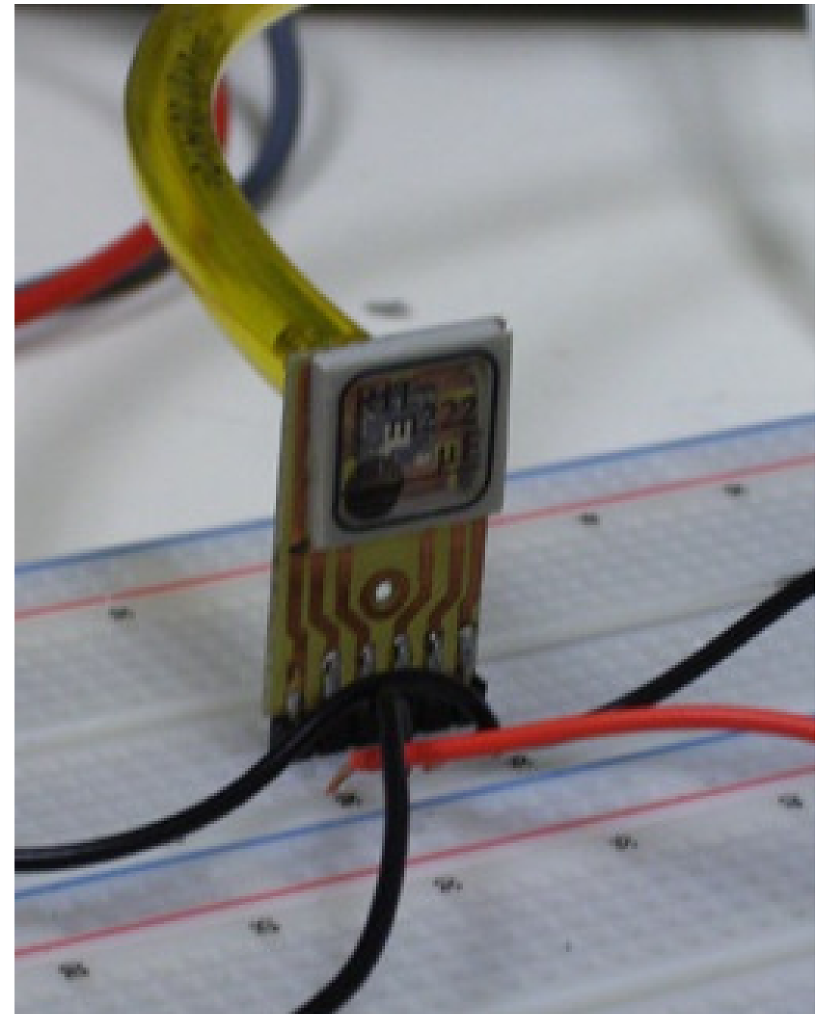
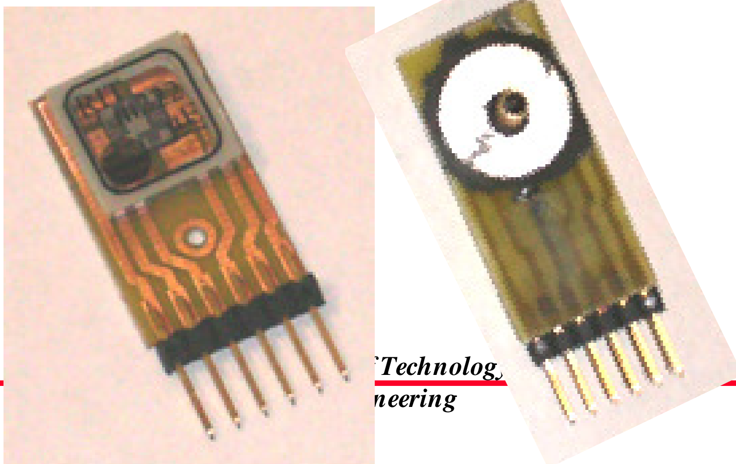
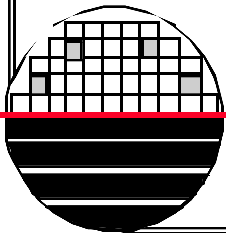
RIT PACKAGED PRESSURE SENSOR







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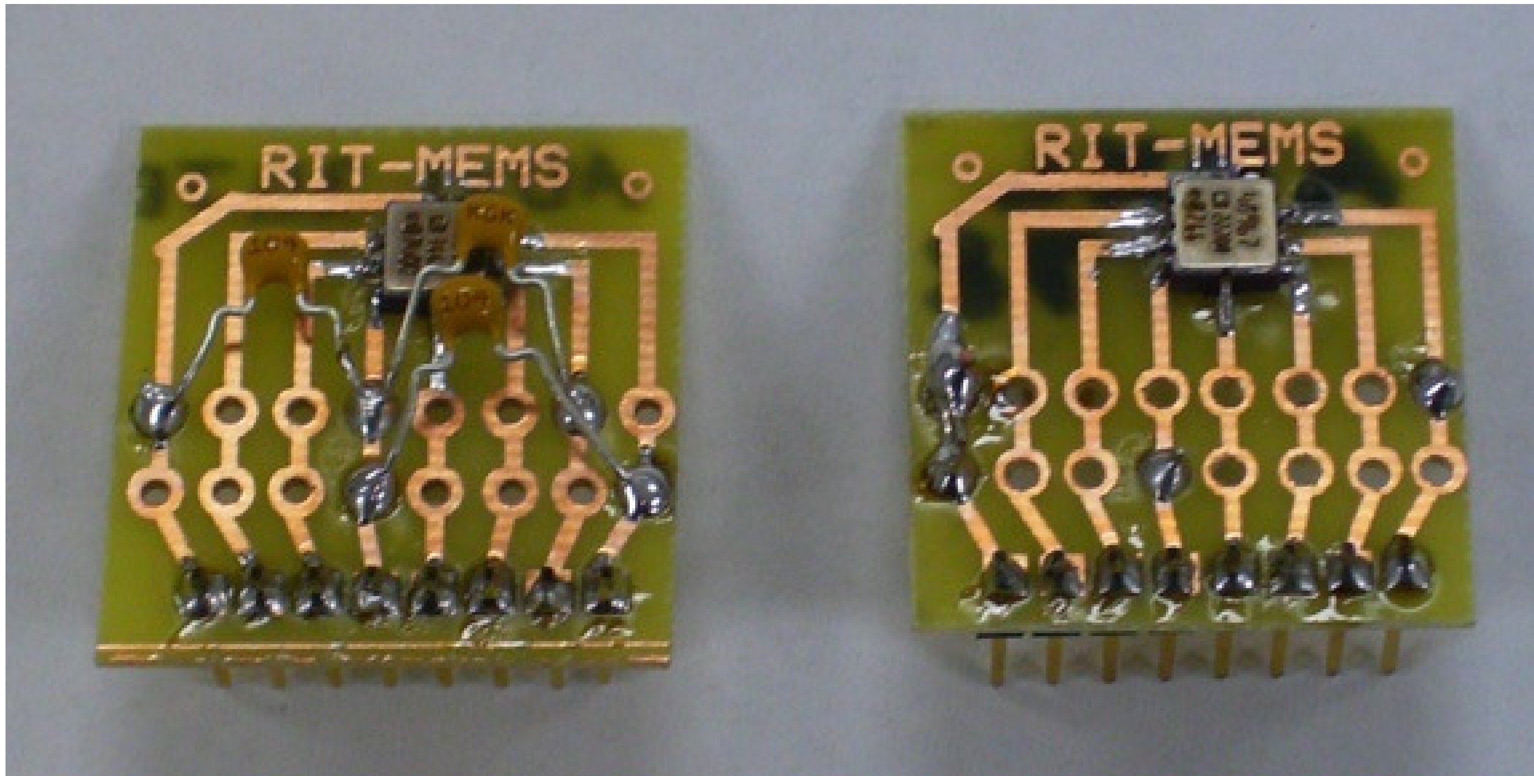
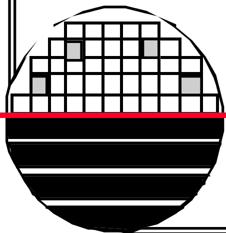
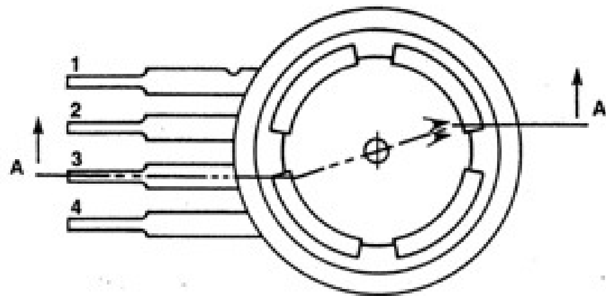
neering

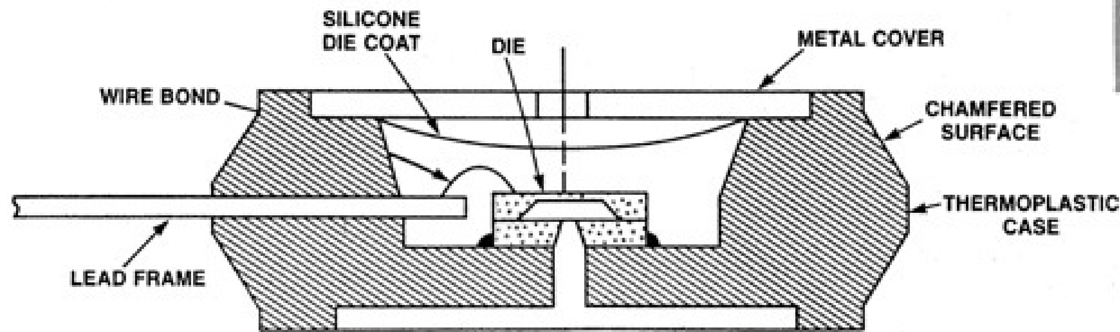
ADI ACCELEROMETERS

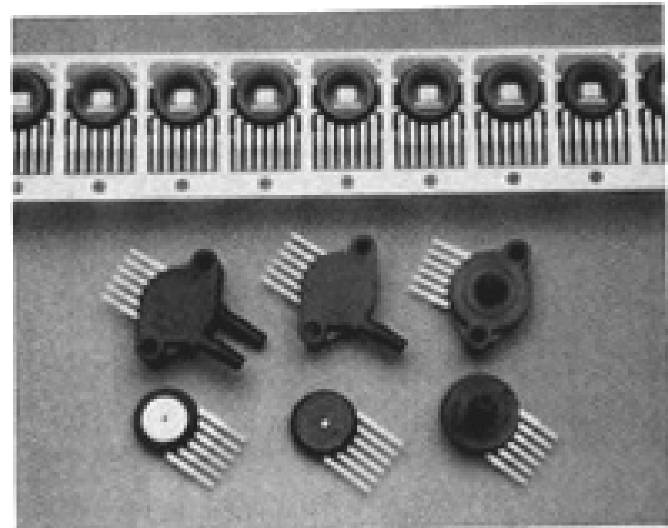


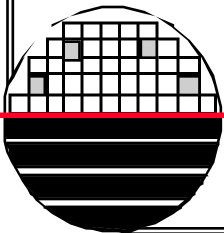


FREESCALE'S PRESSURE SENSOR PACKAGES









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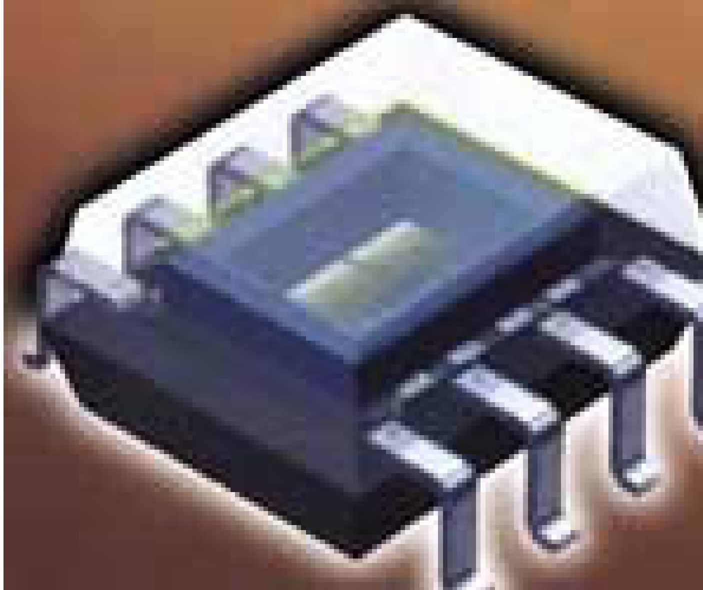
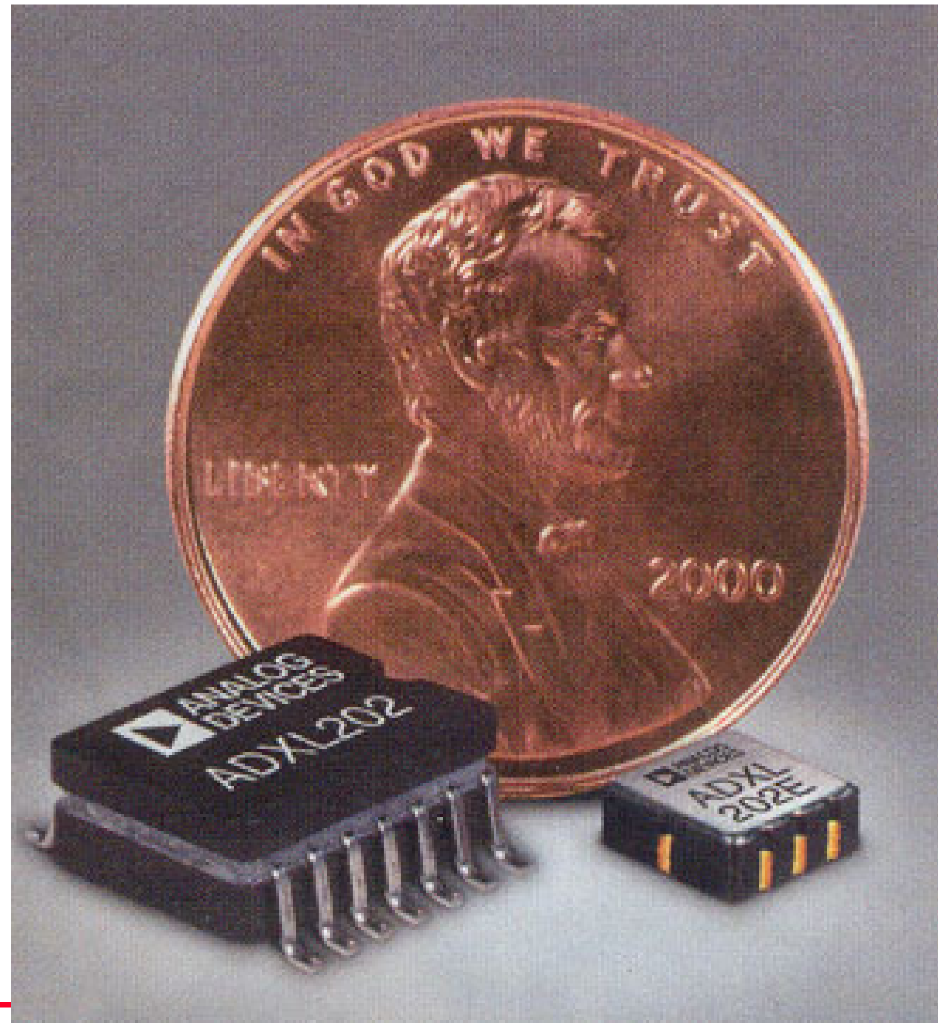
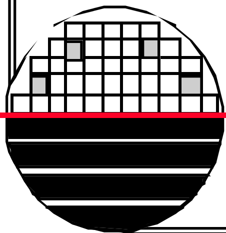
PACKAGED ANALOG DEVICES ACCELEROMETER

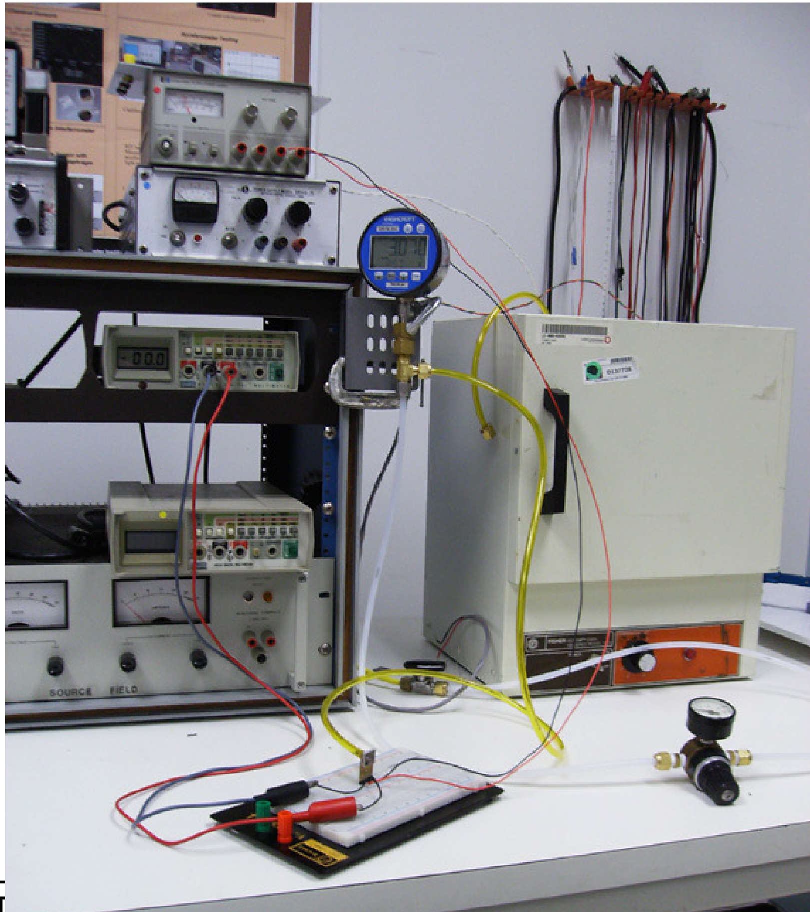


Siemens microrelay in SO-8 package

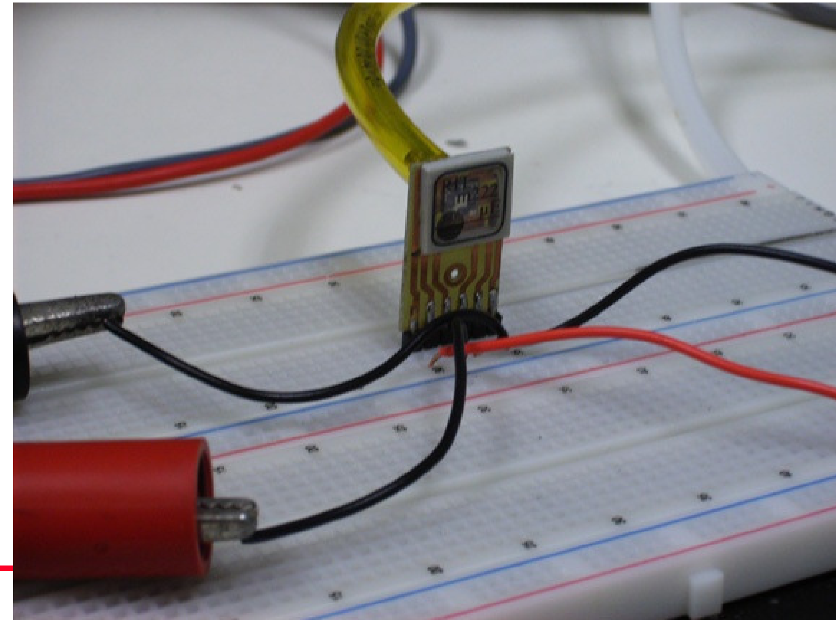




USING PACKAGED RIT PRESSURE SENSOR



Apply pressure, measure and compare with other pressure gages. Collect data.



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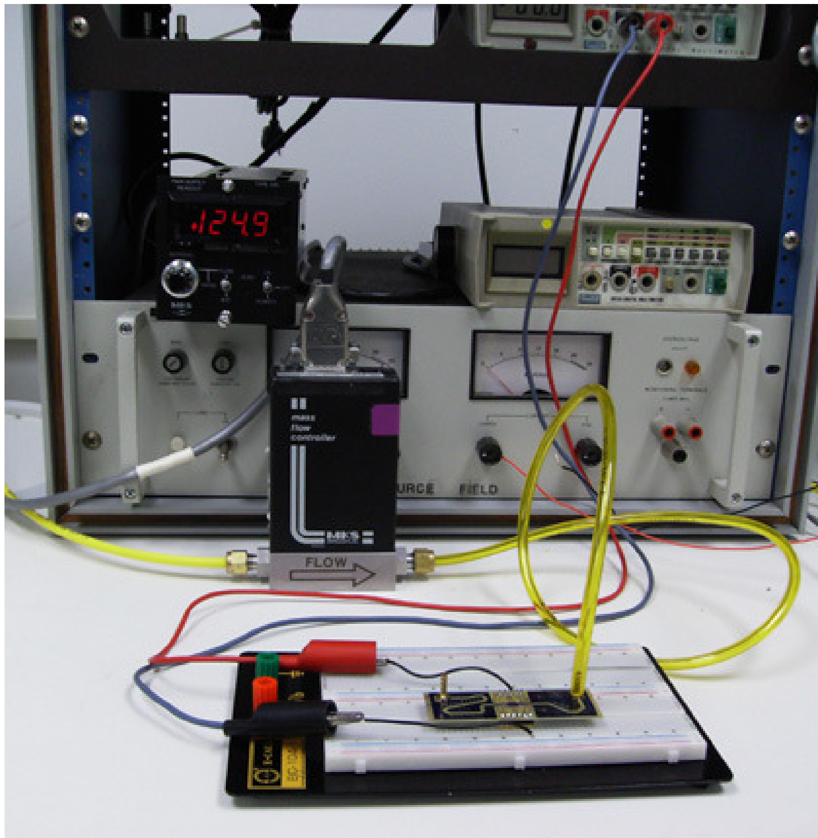
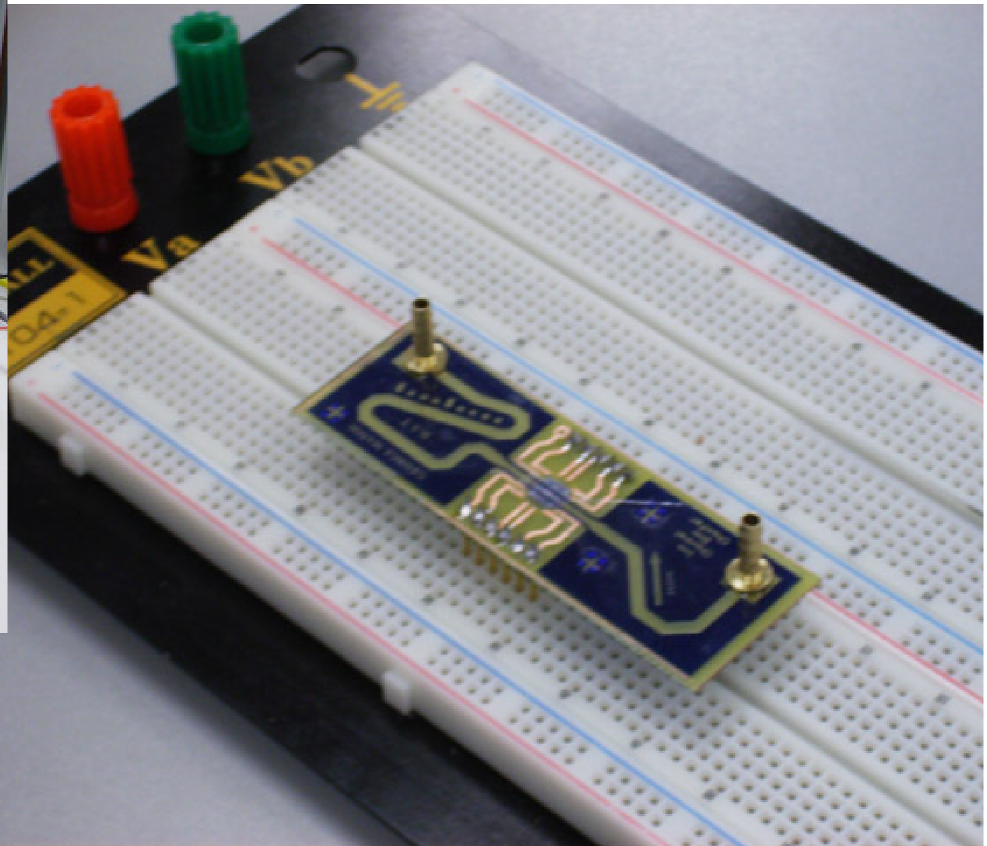
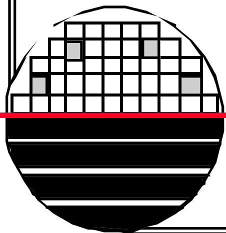
PACKAGED AIR FLOW SENSOR







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1. Electronic Packaging & Interconnection Handbook, 2nd Edition, Charles A. Harper, McGraw Hill, 1997.
2. "Advanced Packaging", HIS Publishing Group, monthly magazine.
3. Flip Chip Technologies, 3701 East University Drive, Phoenix, AZ 85034, (602) 431-6020, Fax (602) 431-6021, www.Flipchip.com
4. SPECTRUM, Semiconductor Materials, Inc. 2027 O'Tool Ave, San Jose, CA 95131, (408)435-5555, (408) 435-8226, www.bizcom.com/spectrumsemi
5. Indium Corporation of America, 1676 Lincoln Ave., Utica, NY 13502, Tel (315) 768-6400
6. Heraus Solder Paste, F367 Series, www.4smt.com
7. Alpha Metals, Ultraprint 78 solder paste, www.alphametals.com
8. Orthodyne Electronics, www.orthodyne.com
9. Small Precision Tools, www.smallprecisiontools.com
10. Universal Laser Inc. www.ulsinc.com

REFERENCES (Cont)

11. Dans Crafts and Things, 352 Empire Blvd, Rochester, NY, for hobby tools, plastic, styrene tube, www.danscraftsandthings.com
12. http://www.oakridgehobbies.com , for ABS square tube ½" square, PLA-ST-16.
13. Hobby shops for glue, etc. such as kitkraft.inc www.kitkraft.biz for ½" square plastic tubing, 15"long $2.20 each SKU ST-16