



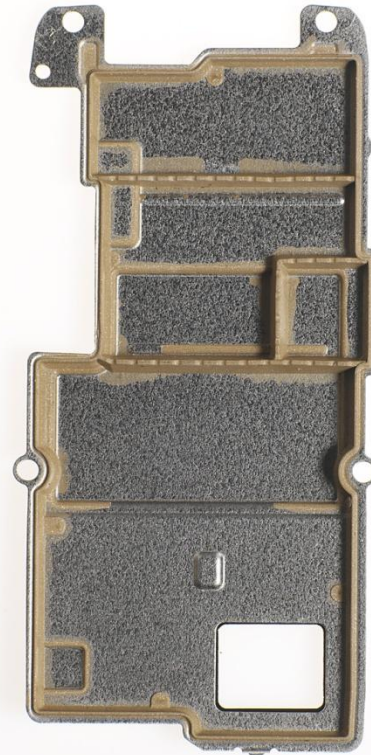
Email: jeff@tennmaxusa.com

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PCB and System Shielding

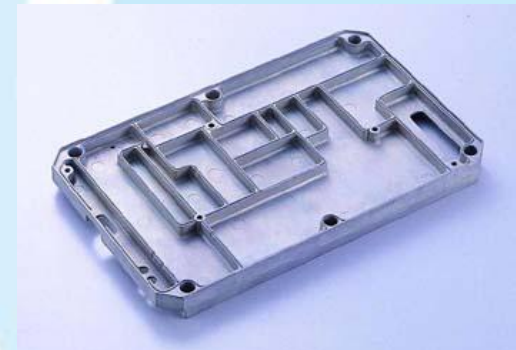
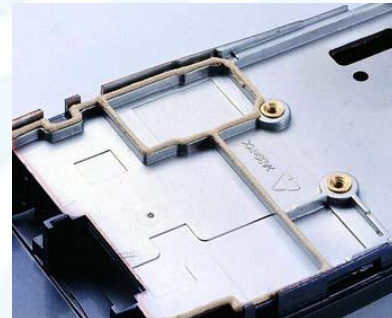
Considerations

- **Shielding requirements**
 - Frequency / Power / System performance
- **Mechanical constraints**
 - Size / Weight / PCB
- **Manufacturability**
 - Rework / Screws
- **Cost vs. Performance**
- **Other**
 - Thermal / Environmental

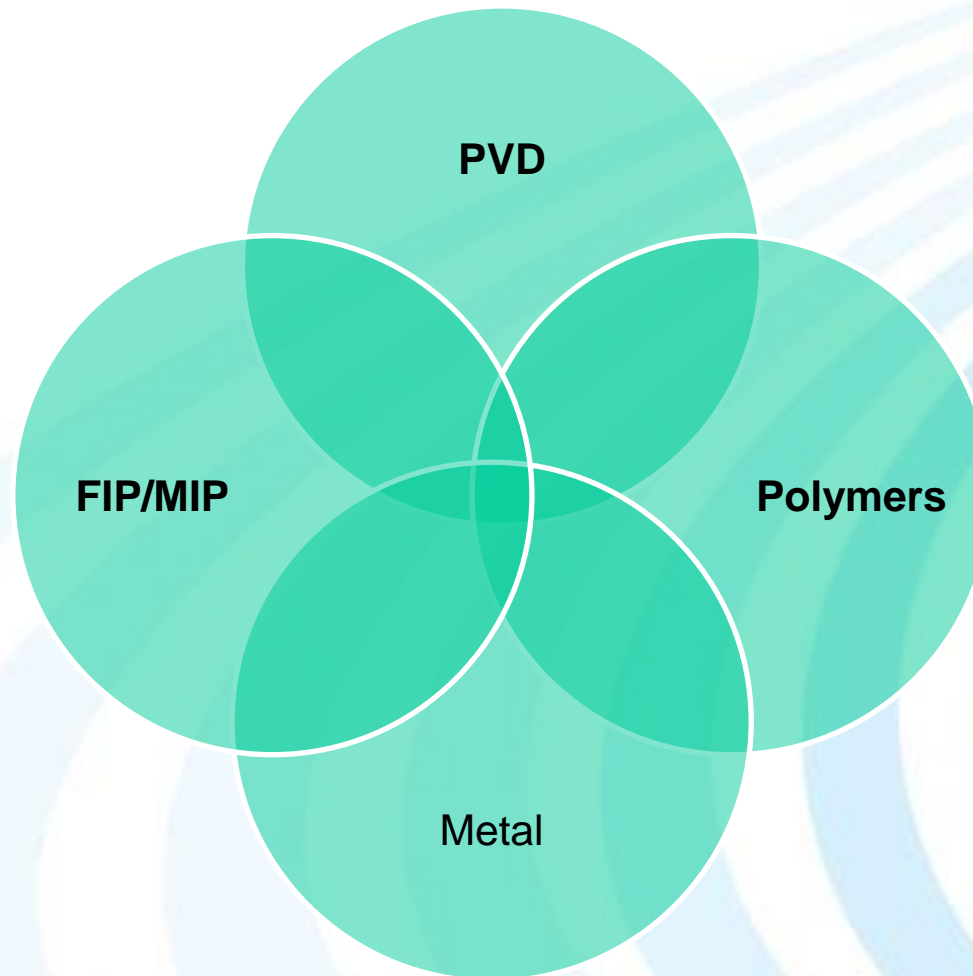


Common Components

- ❑ **Conductive Silicone**
- ❑ **Conductive Adhesive**
- ❑ **Metallized Plastic**
- ❑ **Cast Metal**
- ❑ **Formed Metal**



Key Technologies



Form In Place

- **Gasket height should be enough to fill gap between housing and PCB.**
- **Min compression 5 % for electrical contact.**
- **Recommended compression 25-30%.**
- **Normal gasket height between 0.3 and 2 mm.**
- **The gasket width should be as narrow as possible but it is set by the gasket height.**
- **PCB traces and walls can be sub 1mm**

Trishield Process



Material Selection

Silver plated Copper (AgCu) filled Form-In-Place silicone gasket

Our AgCu FIP silicone designed for high shielding requirement Form-In-Place application, it is 2 components, heat curable Ag/Cu filled silicone compound. It has excellent shielding performance combined with low compression forces and good mechanical properties with outstanding compression set.

Silicone rubber can easily stand heat, cold, moisture, UV, ozone and pressure over long times. Operating temperatures are between -55 C and $+125\text{ C}$

Material Selection

Silver plated Nickel (AgNi) filled Form-In-Place silicone gasket

Our AgNi material used to produce EMI shielding gaskets in triangular profile by dispensing and post treatment. The material is characterized by excellent shielding properties combined with low hardness and good mechanical properties. In environmental tests this material has proved none or only slight deterioration of conductivity and shielding effect. Silicone rubber can easily stand heat, cold, moisture, UV, ozone and pressure over long times. Operating temperatures are between -55 C and $+125\text{ C}$.

Material Selection

Nickel Graphite (NiGr) filled Form-In-Place silicone gasket

Our NiGr FIP silicone designed to replace high cost Ag plated particles at a fraction of the cost. The nature of the Ni plated Graphite particles not only provides reasonable Electrical conductivity but also Absorption property. The system offers enhanced galvanic corrosion resistance and stability in severe environments.

Material Selection

Environmental sealing Form-In-Place silicone gasket – It is designed as a water and environmental sealed Form-In-Place gasket, It is not electrical conductive but provides extremely resilient elastic gasket with good adhesion on general plastics and metals. It is a two component, heat curable Silicone system, optimized for Form-In-Place process. Short cycle due to its less than 1 hour head curing process which meet high production rate products. No leaking of silicone oil under high temperature and pressure. Very elastic rubber property, low compression force

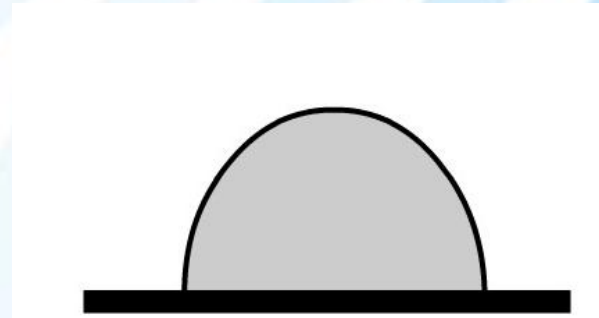
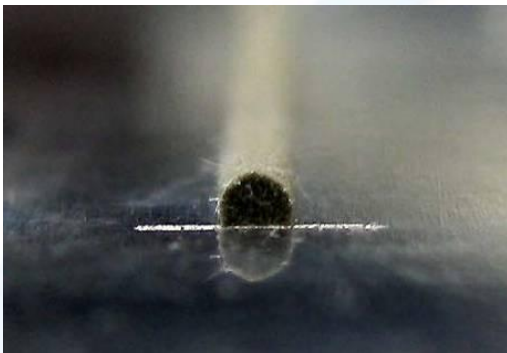
Curing Dispensed Gaskets

- **Curing can be done over a longer period at room temp or shorter period by heat treating.**
- **We recommend heat cured.**
- **Heat curing advantages.**
 - **Short lead time**
 - **Quick feed-back and quality control**
 - **Better compression set**
 - **No risk for silicone bleeding**

Gasket profile selection - Dispensing technology



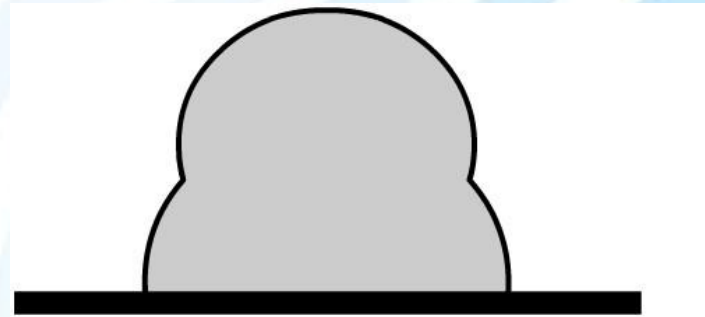
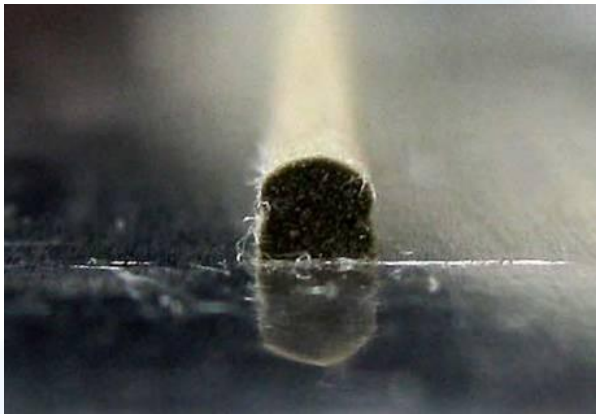
Single bead D-shape gasket - provides a lowest total cost of small cross section and complex pattern applications. Eliminate gasket packaging, handling and assembly to reduce the final housing assembly time.



Gasket profile selection - Dispensing technology



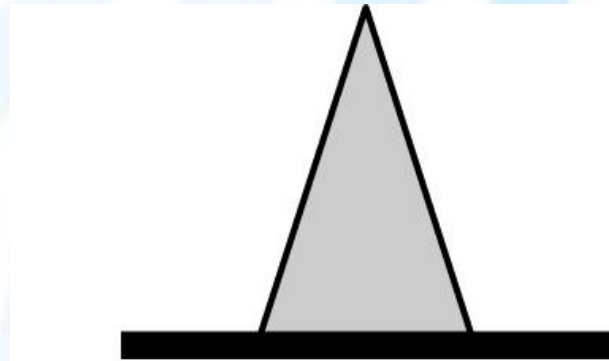
Double bead gasket – dispensing a high profile bead by running one bead path on top of the other to form a double bead. No equipment or material needs to be modified and it is a simple and easy for high profile applications.



Gasket profile selection - Dispensing technology

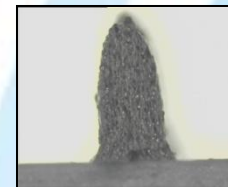


Triangular shape gasket – Tri-shape gives more 30% lower compression force than the traditional materials. This is because of its geometry and the fact that it contains less material than the traditional gasket. Tri-shape shortens the cycle time by producing higher profile, dispensed gaskets without the doubling the dispensing path of double bead that the traditional height gasket needs. With this method we can achieve a shorter cycle time and a higher output with existing equipment. Tri-shape technology makes better utilization of raw material, because of its thin geometry, thus the amount of material can be reduced which saves cost.



Specification on Gasket

Height of bead [mm]	0.5	0.8	1.0	1.7
Width of bead [mm]	0.3	0.7	0.8	1.3
Width of track [mm]	0.7	1.0	1.1	1.5
Compr. 0.1mm F [N/cm]	2.9	2.9	3.1	5.3
Tolerance [mm]	h+/- 0.1	h+/- 0.1	h+/- 0.1	h+/- 0.1

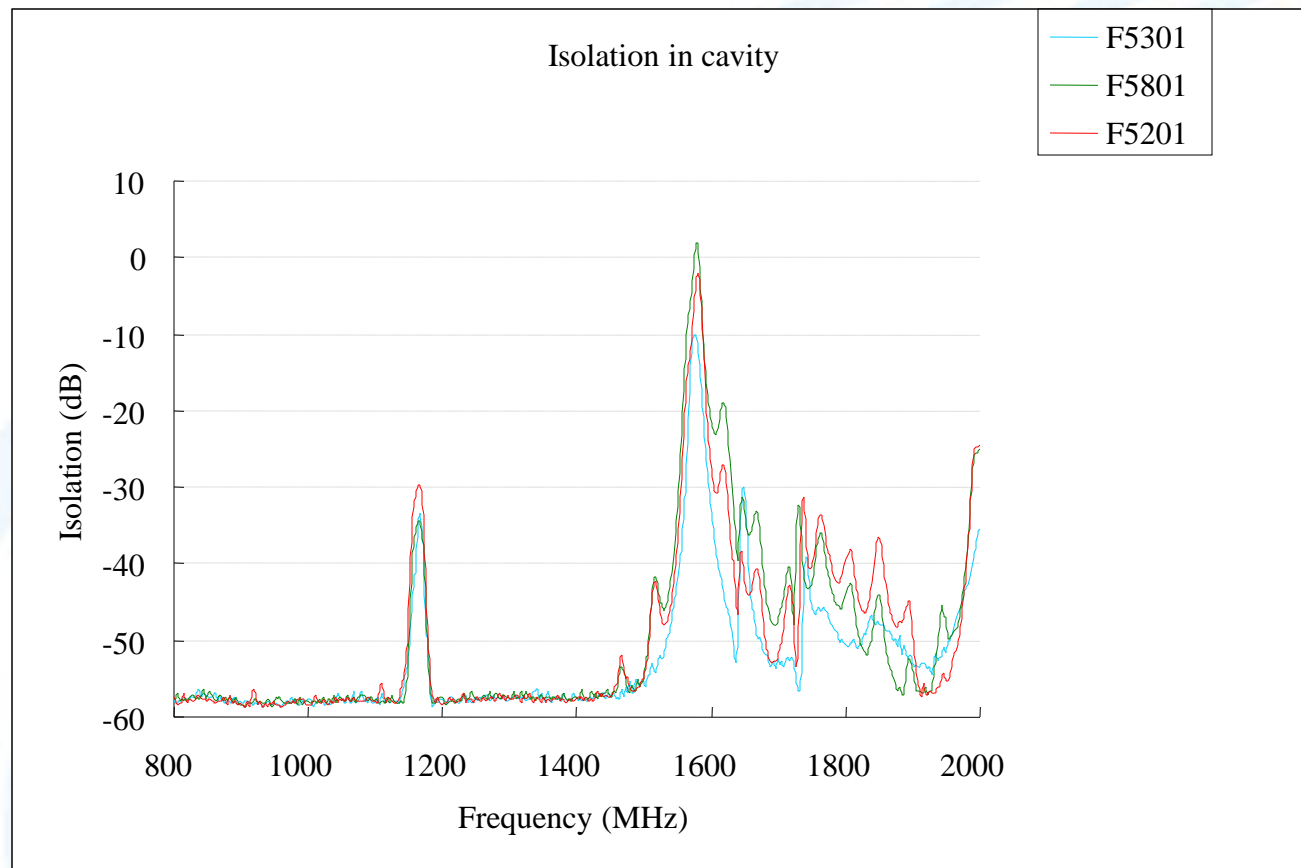


FIP Selection Guide

Form	Unit	Conductive Silicone									Environmental Silicone	
Part No		F-5301	F-5304	F-5311	F-5321	F-5801	F-5201	F-5203	F-5211	F-5222	F-6003	F-6031
Polymer		Silicone Rubber	Silicone Rubber	Silicone Foam	Silicone Rubber	Silicone Rubber	Silicone Rubber	Silicone Rubber	Silicone Foam	Silicone Rubber	Silicone Rubber	Silicone Foam
Filler		Ni/Gr	Ni/Gr	Ni/Gr	Ni/Gr	Ag/Ni	Ag/Cu	Ag/Cu	Ag/Cu	Ag/Cu	None	None
Color		Dark Grey	Dark Grey	Dark Grey	Dark Grey	Beige	Beige	Beige	Beige	Beige	Black	Dark Grey
Density	g/cc	2.0	2.0	1.8	2.0	3.1	2.9	2.8	2.6	2.9	1.05	0.46
Height	mm	0.3 ~ 2.0	0.3 ~ 2.0	0.5 ~ 2.0	0.4 ~ 2.0	0.6 ~ 3.0	0.4 ~ 2.0	0.4 ~ 2.0	0.5 ~ 2.0	0.4 ~ 2.0	0.4 ~ 2.0	0.8 ~ 2.0
Hardness	Shore A	55	35	< 25	60	55	55	35	< 25	60	45	22
Resistivity	ohm-cm	0.04	0.04	0.04	0.04	0.015	0.02	0.02	0.02	0.02	-	-
Curing Condition		Heat cure	Heat cure	Heat cure	Room Temp	Heat cure	Heat cure	Heat Cure	Heat Cure	Room Temp	Heat cure	Room Temp
Features		High Shielding Performance	Softer version of F-5301	Highly Compressible Foam	Less Silicone Oil Bleeding	Tri-shape Ultra-thin Profile	Low Resistivity	- High Shielding Performance - Softer version	Ultrasoft	Less Silicone Oil Bleeding Low Resistivity	UV Resistant	Highly Compressible Foam UV Resistant Less Silicone Oil Bleeding
Special Note					Note 1					Note 1		

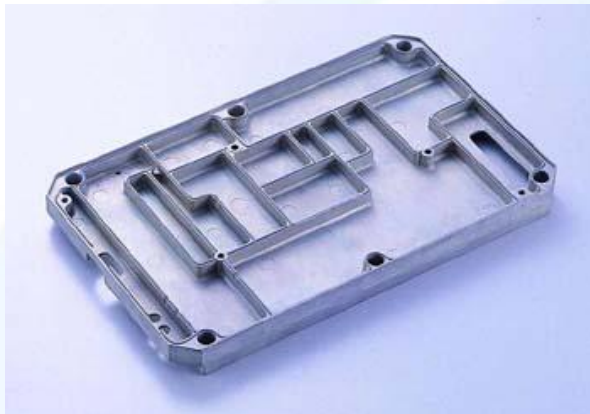
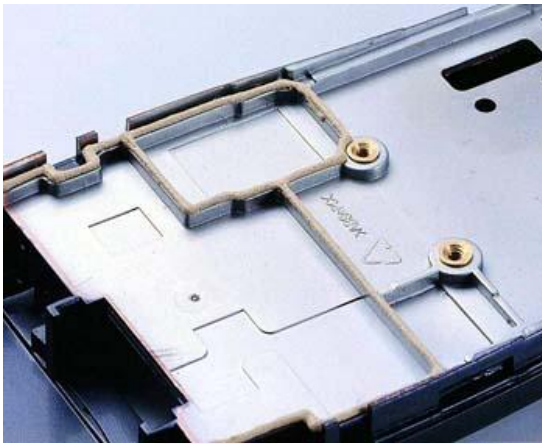
Cavity isolation of F5301, 5201 and 5801

Those dips was due to the antenna resonance, the radiation is very strong on this frequency range



Max - Shield

FIP

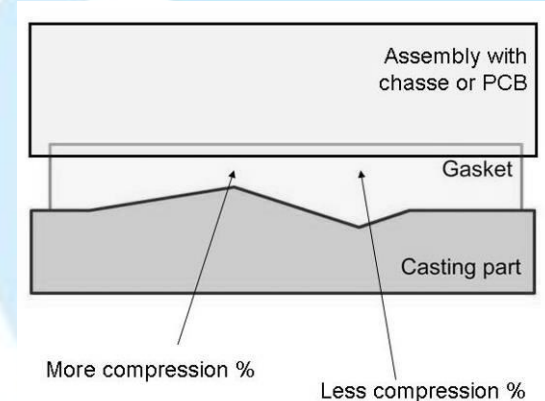
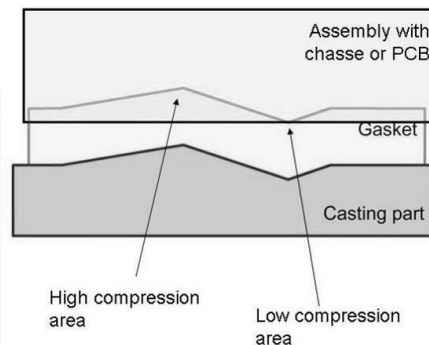
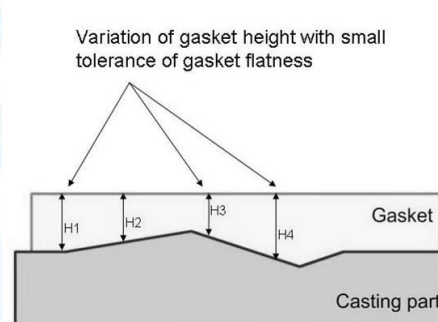
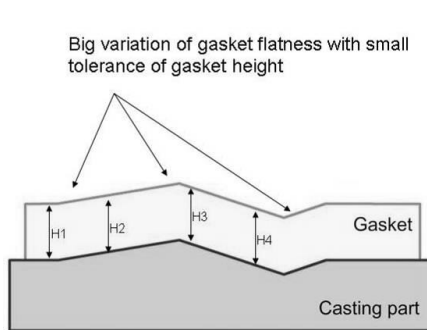


- **Conductive gasket dispensed by high precision XYZ-robots on a carrier of aluminium, magnesium or metallized plastic.**
- **Bead height from 0,3 to 2,0 mm.**
- **No assembly work.**
- **No expensive tooling required.**
- **Rapid prototyping.**
- **Cost effective even in small volumes.**

Flatness and tolerance

Warping or non-uniform housing

A reasonable degree of variation in the housing dimensions could be absorbed by the FIP silicone gasket, however, the most common avoidable problem is warped or non-uniform housing. This problem can be restrained by hold-down fixtures, and our Tri-shape gasket can also absorb the warpage and have higher degree of gasket flatness at the top.

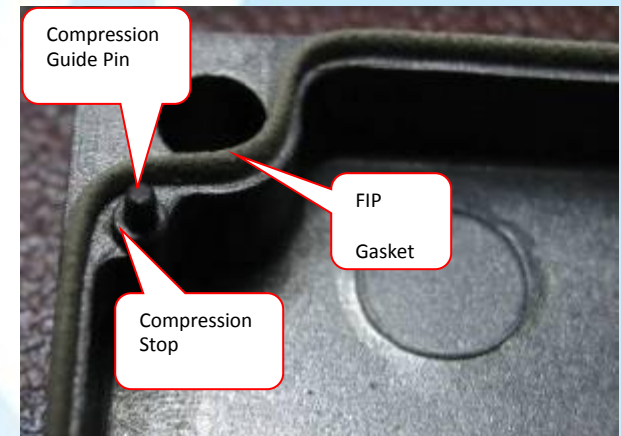
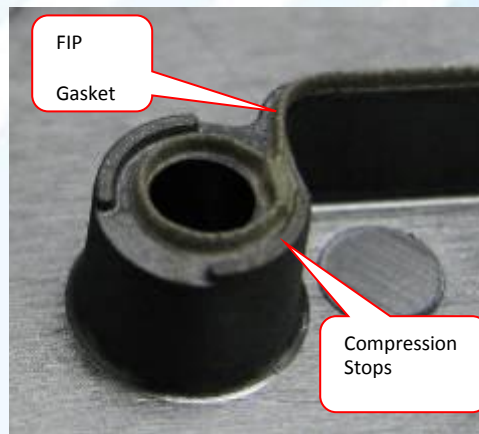
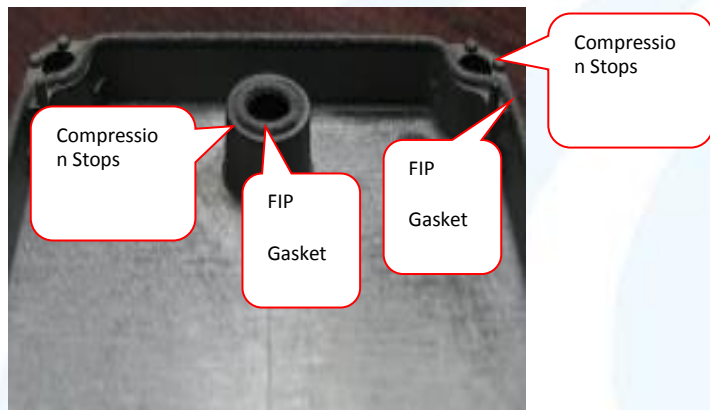
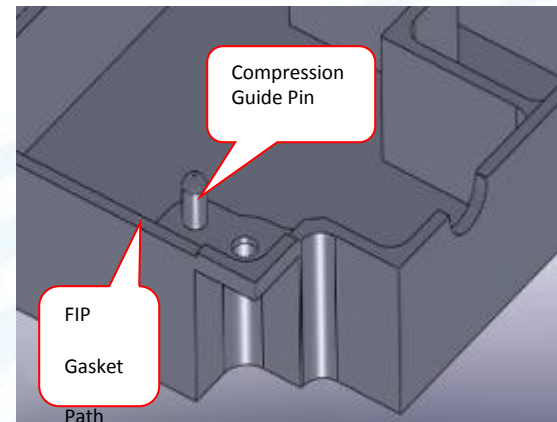
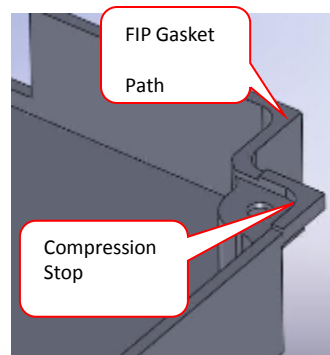
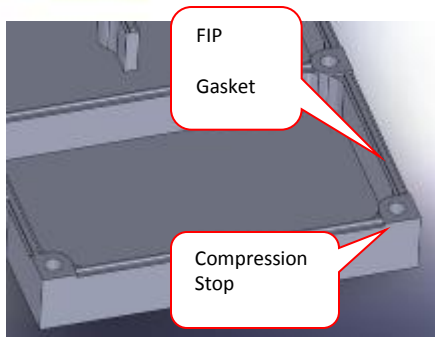


Flatness and tolerance

Flatness

It is highly recommended to maintain the flattest surface possible to optimize the FIP process, for optimum performance, it is best to maintain a flatness spec of less than 0.2mm.

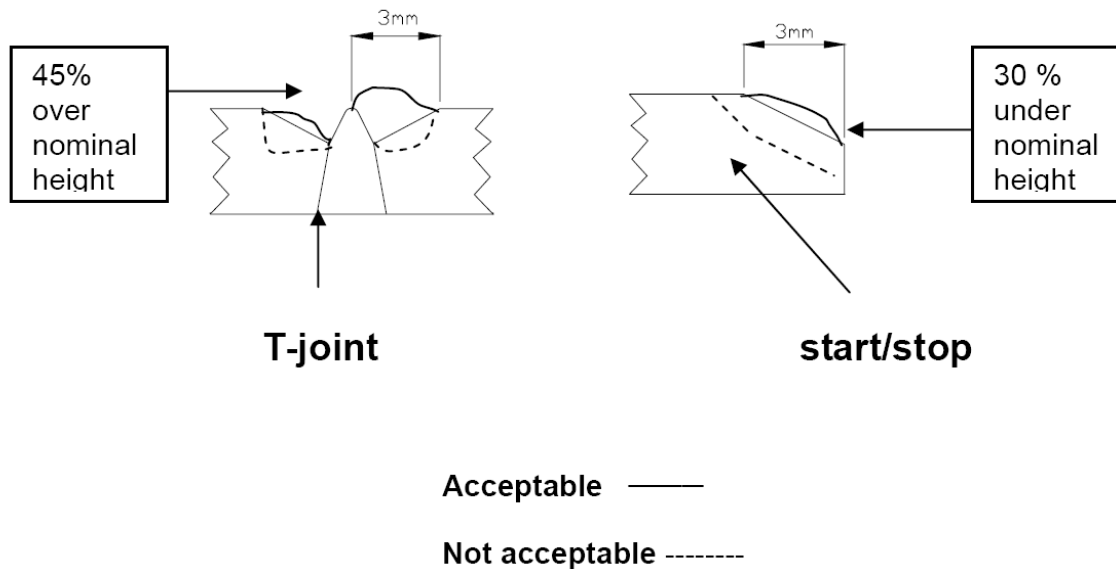
Compression stop & guide pin



Joins

Start / stop and joint tolerances

The gasket dimensions are achieved on steady state dispensing on straight runs. In the start and stop zones there will be slight differences in gasket cross section. The start/stop/T-joint is defined as an area of 3 mm in each direction around the start/stop/T-joint location. In these areas, a -30% up to $+45\%$ differ of gasket height from nominal is allowed for tri-angular shape gasket; and an additional 0.15mm (besides normal gasket height tolerance) gasket height tolerance is allowed for D-shape gasket.



F-5304 Ultrasoft FIP

F-5304 is extremely soft version of F-5301, it remains the same shielding effectiveness but much softer

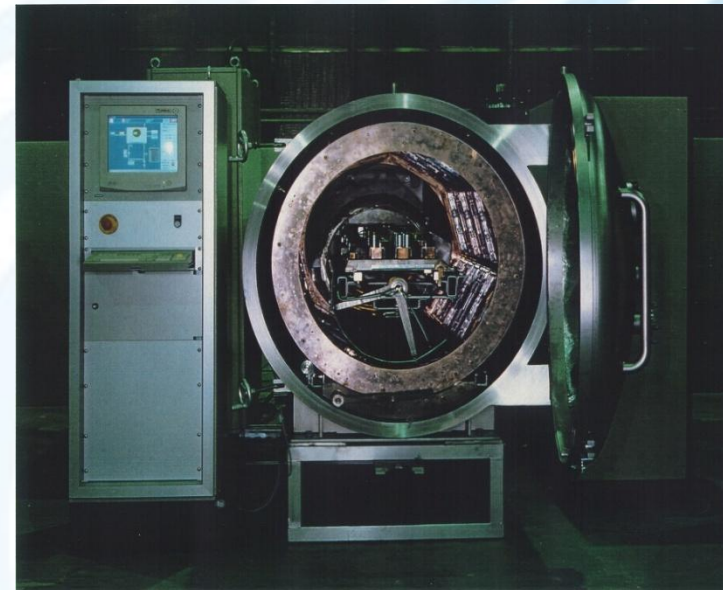
Properties	Unite	F-5304
Elastomer Binder		Silicone
Conductive Filler		Ni/Gr
Physical Properties		
Specific Gravity	g/cm	2.2
Shore A Hardness		15
	psi	80
	%	200
	lb/in	300
Compression Set	%	30
Color		Dark Grey
Temperature Range	°C	-45 ~+150
	°C	200
Electrical Properties		
Volume Resistivity	Ohm -cm	0.08

Max – Plate

Physical Vapor Deposition

PVD

EMI



Max – Plate Physical Vapor Deposition

PVD

EMI

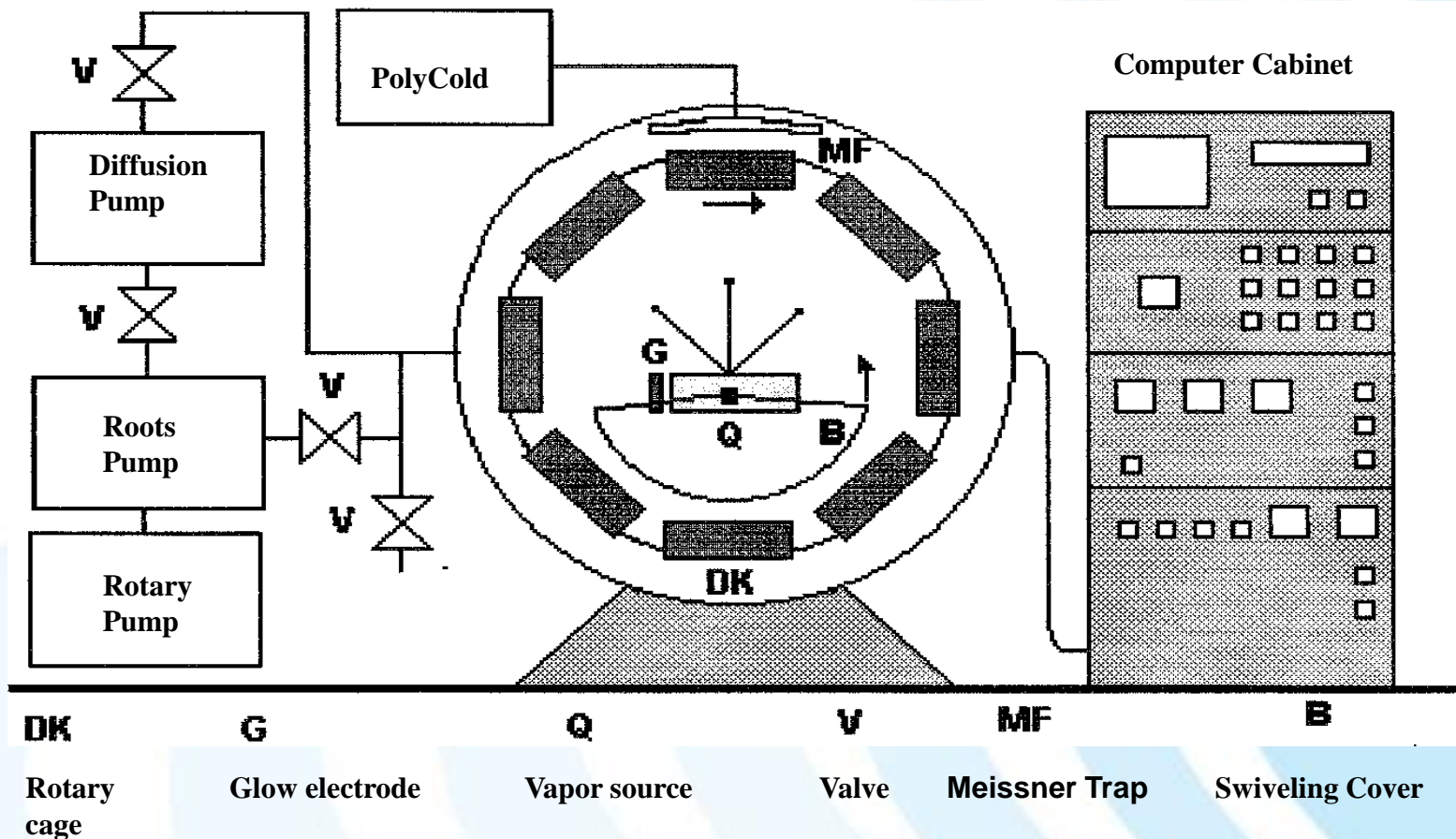


Max – Plate

PVD

Physical Vapor Deposition

How it works

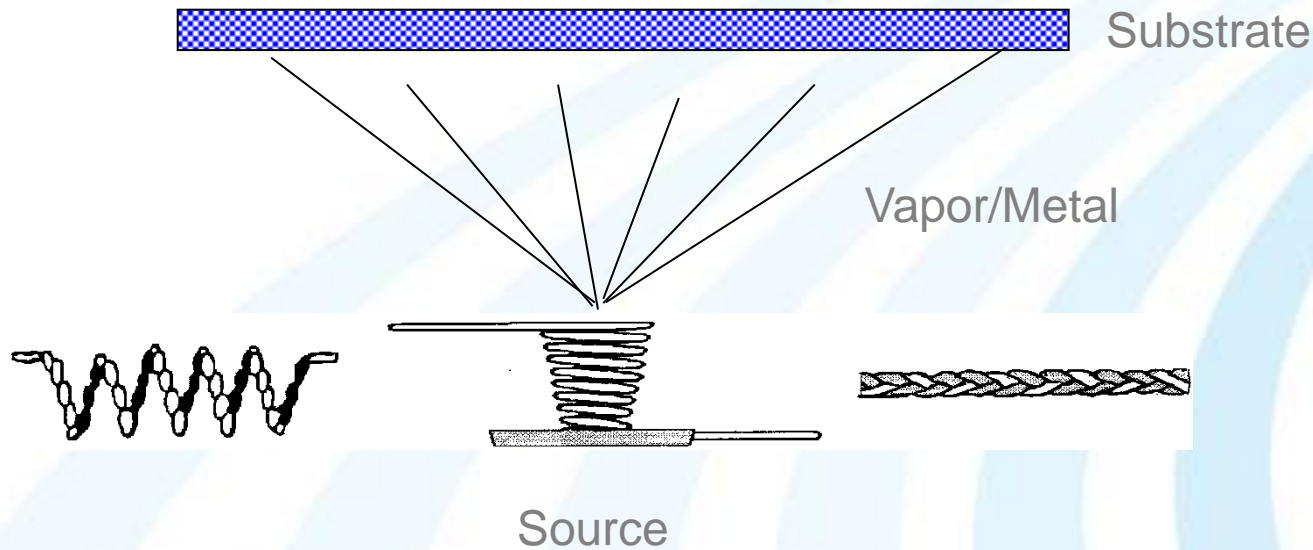


Max – Plate

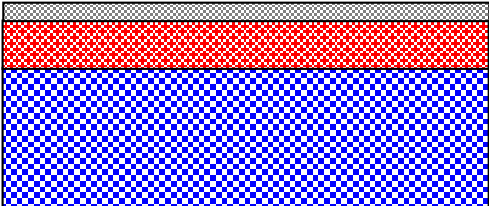
PVD

Physical Vapor Deposition

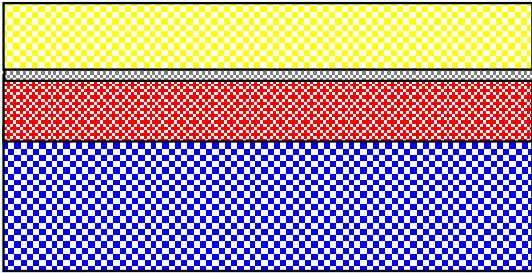
Vacuum Metallization



Standard Process

thickness	structure	layer
0.15 μm 2.0 μm		nickel chromium copper (electrical conductive layer) substrate (plastic material)

Solder Capable Application

thickness	structure	layer
1.5–3.0 μm 0.15 μm 2.0 μm		tin nickel chromium copper (electrical conductive layer) substrate (plastic material)

Max – Plate

PVD

Physical Vapor Deposition

➤ **UL 764C Certification**

➤ **No Flaking**

➤ **Adhesion Commitment**

Primer

Glow Discharge

Nickel Chromium

➤ **Groves, Corners, Edges**

Minimum 1 X 1 depth ratio

Consistent and Predictable

Physical Vapor Deposition vs. Conductive Paint

➤ **Capital cost for paint is much less**

➤ **Paint flakes PVD does not**

➤ **PVD is more repeatable**

Thickness always the same

Gets into corners without globs

Better adhesion

➤ **More metal options**

Different requirements require different metals

Mixing metals for optimal effect



Max – Plate

PVD

Physical Vapor Deposition

Common Plastics	Max. Temperature °C		Coating Behavior		
	Short	Long	Good	Moderate	Fair
ABS	95	85	X		
ABS/PC	110	95		X	
PA-66	190	120	X		
PBT	165	100	X		
PC	150	130		X	
PEEK	240	240		X	
PEI	200	180	X		
PES	190	190		X	
PET	200	100	X		
PI (Polyimide)				X	
PMMA	95	85		X	
PP	140	100		X	
PPA	185	180	X		
PTFE (Teflon)	300	250		X	
PVC	75	65	X		

Max – Plate Metal Selection

PVD

Metals	Cu/Ni-Cr	Cu/Ni-Cr/Sn	Cu/SS	Al	Al/CVD	Ni-Cr
Applications	Plastic enclosures	Antenna	Camera Lens Mount	Automotive	Stringent Applications	Heater
	Antenna		Optical Fiber			
Products	Mobile Devices, FPC, GPS	Mobile Devices	Mobile Phone, Broad Band	GPS, Display	Automotive, Samsung	Copier
Thickness	2 μ	>3.0 μ	2 μ	2 μ	2 μ	< 1 μ
Features	General	Solderable	Finger Print Resistance	General	Salt Spray Resistance	Controllable Resistivity
			Long time Color Stability	Low Galvanic Corrosion		
Cost	Low	High	Moderate	Low	Moderate	High

Max – Plate

Physical Vapor Deposition

PVD

EMI

1.GPS



2.Mobile



3.Network Device



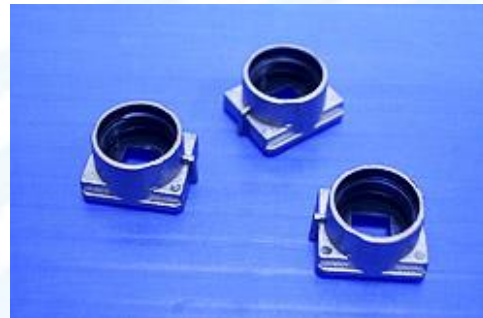
Max – Plate

PVD

Physical Vapor Deposition



1. Mobile Phone Camera Lens



2. Optical Fiber Connector

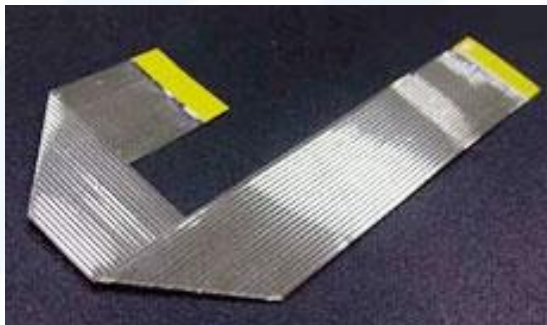
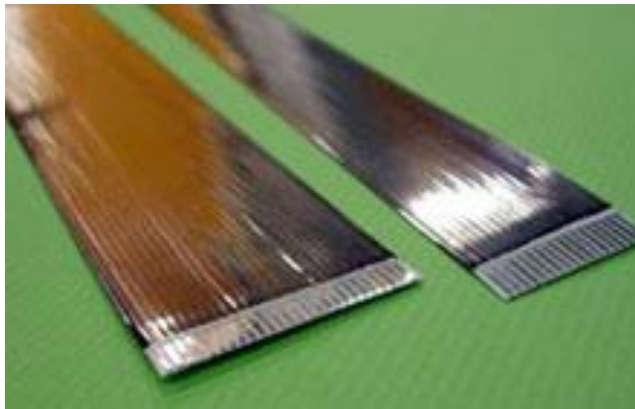


Max – Plate

PVD

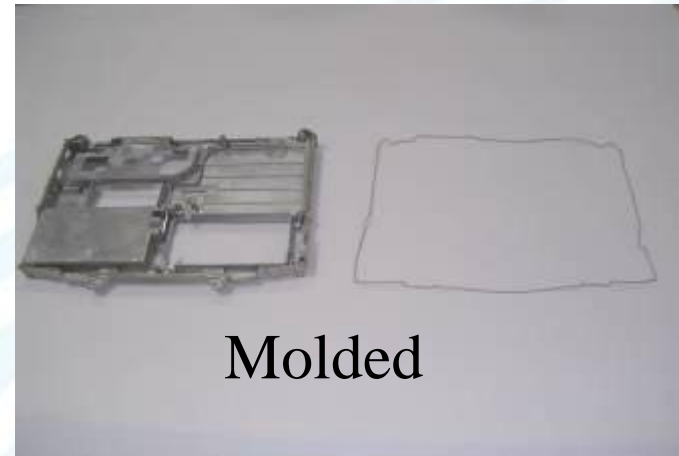
EMI

Physical Vapor Deposition



Polymers

- Ag/Glass, Ni/Gr filled silicone
- Sheet Stock
- Extrusion
- Molded



Polymers

Technology:

- Pt catalyzed, 2 comp silicone
- Heat curable: Short cycle time
- No silicone oil bleeding concern

Products:

- EMI
- Thermal
- Environmental Seal

Properties	Unite	S-3311
Elastomer Binder		Silicone Foam
Conductive Filler		Ni/Gr
Physical Properties		
Specific Gravity	g/cm	1.0
Shore A Hardness (Shore 00)		25 (00)
Tensile Strength	Kgf/cm ²	9.75
Elongation	%	70
Tear Strength	lb/in	40
Compression Set	%	20
Color		Dark Grey
Maximum Using Temperature	° C	-45 ~+150
	° C	200
Electrical Properties		
Volume Resistivity	Ohm .cm	0.03
E-Field, 100 MHz	dB	100
E-Field, 500 MHz	dB	100

Polymers

Form	Unit	Mold In Place (MIP)			Sheet Stock			Extrusion		
Material		M-1102	E-1201	M-1301	S-3101	S-3301	S-3311	E-5101	E-5201	E-5301
Polymer		Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone
Filler		Ag/Glass	Ag/Cu	Ni/Gr	Ag/Glass	Ni/Gr	Ni/Gr	Ag/Glass	Ag/Cu	Ni/Gr
Color		Beige	Beige	Dark Grey	Beige	Dark Grey	Dark Grey	Beige	Beige	Dark Grey
Density	g/cc	2.0	2.9	2.0	2.0	2.0	1.0	2.0	2.9	2.0
Thickness	mm	0.3~10	Ø1~Ø10	0.3~10	0.3~10	0.25~3.0	0.5~3.0	Ø1~Ø10	Ø1~Ø10	Ø1~Ø10
Hardness	Shore A	60	65	60	60	60	25	60	65	60
Resistivity	ohm-cm	0.03	0.02	0.04	0.03	0.04	0.04	0.03	0.02	0.04
Fabrication		Injection/Mold	Injection/Mold	Injection/Mold	Die cut	Die cut	Die cut	Extrusion	Extrusion	Extrusion
Feature		3D Profile	3D Profile	3D Profile	Rubber	Rubber	Highly Compressible Foam	Various Profiles Selection: Solid/Hollow	Various Profiles Selection: Solid/Hollow	Various Profiles Selection: Solid/Hollow

Silicone oil migration

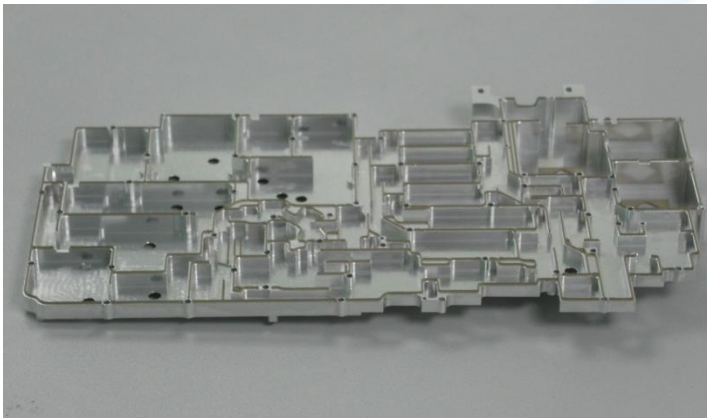
This is a phenomenon that can occur with non-heat cured materials commonly known as moisture cured or RTV. Continuous exposure to heat variations and compression can cause leakage of the silicone material; this may create an adhesive effect, or worse, the silicone oil may come into contact with other components and create long-term reliability issues.



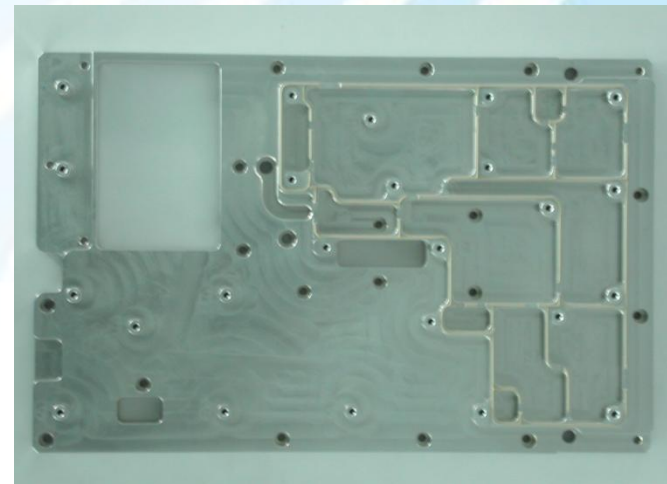
Clamshell Gasket

Traditional gasket using Aluminum and FIP. Also can be used to help remove heat from components

Cast Units for volume Production



CNC for Prototype and low volume Production



P-Can



Plastic Housing

- Max Temp 70-150 Deg C
- ABS, PCABS,PA,PPA,PPS
- Rigid

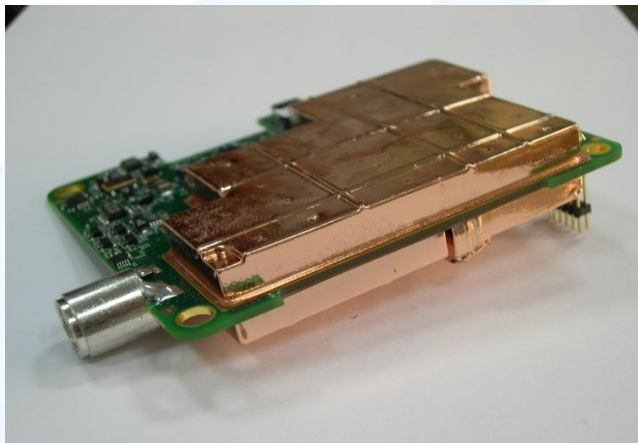
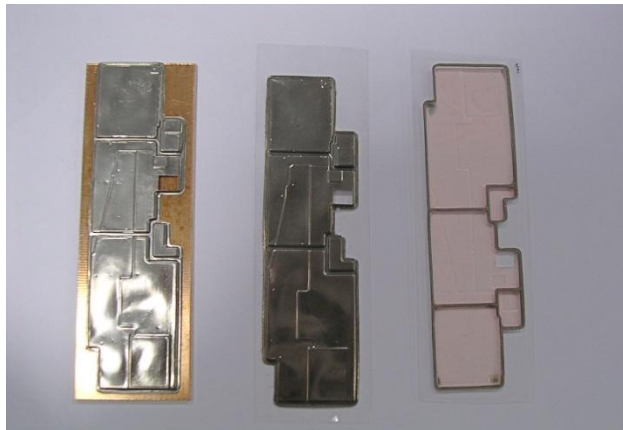
Conductive Silicon Gasket

- Robotic Placement for repeatability
- Highly conductive for superior shielding
- Minimum contact width of .3mm
- Grounds to PCB

Physical Vapor Deposition

- Copper/NiCr coating
- Excellent adhesion and conformity

Pressure Formed P-Can

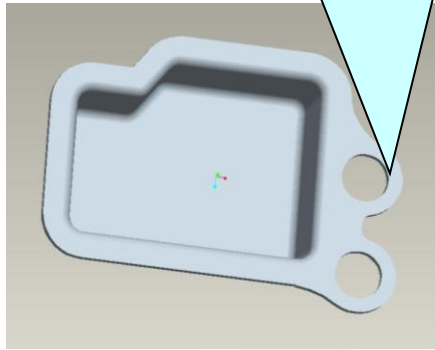


- Applications –
 - Mobiles
 - High Volume Low Cost Devices
- Metals –
 - Al
 - Cu/Ni-Cr
 - Cu/Ni-Cr/Sn
- Plastic Materials –
 - PET, ABS, PVC...etc.
- Attaching Methods –
 - Screw/Clip Mount
 - Conductive PSA Mount
- Features –
 - Light Weight, Multi-Cavities Integrated Design
 - Easy Installation, Reworkable
 - Low Cost
 - Short Design Cycle, Fast Delivery
 - Requires less PCB space
 - Low Tooling Cost

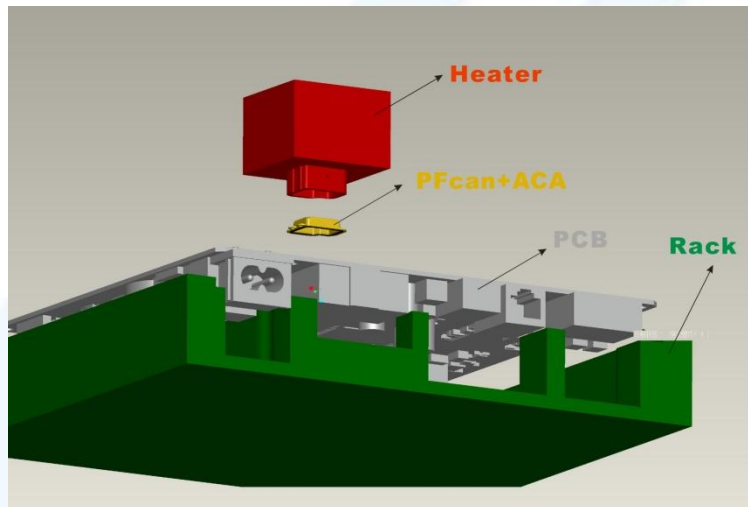
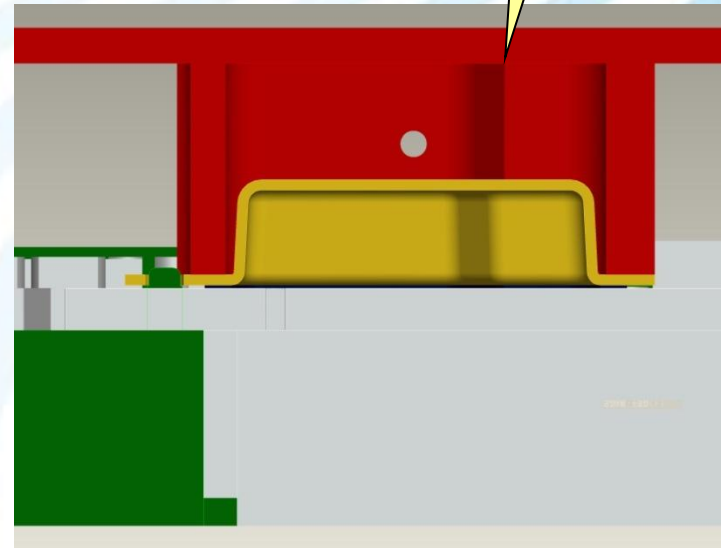


Pfcan Assembly

Locater Pin for easy alignment

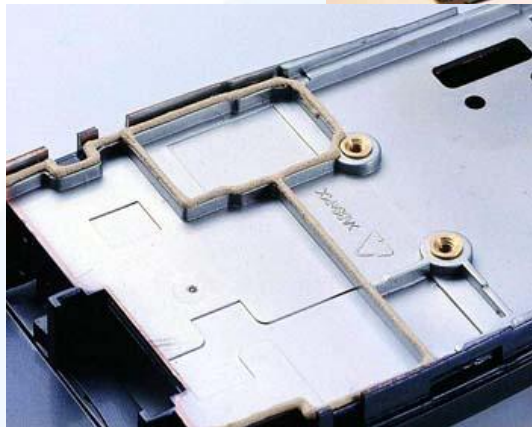
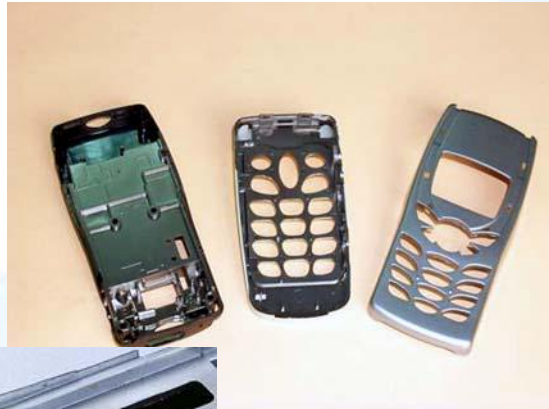


Heat Press



Shielded Housing

- Metallized Plastic Housing (PVD)
- Conductive Silicone Dispensed onto ridges



➤ Advantages

- Lower Cost
- Single Part Number
- Manufacturability
- Board Space
- Weight

Picking the correct housing

➤ **Plastic**

Light Weight

Better Cosmetics

Detailed

Tooling required

➤ **Machined Metal**

Low Volume

Highly Detailed

No Tooling

➤ **Extrusion**

Good Thermal Performance

Reduced unit cost vs. CNC

Low Tooling

➤ **Cast Metal**

Low Unit Cost

High Tooling

Low Precision

High Minimum Order

Metal Treatment

➤ **Chromate**

Cheap

Nonconductive /

Thickness needs good control

Good Adhesion

➤ **Ni Plating**

Good conductivity

Poor Adhesion

Higher Cost

➤ **Ag Plating**

Great Conductivity

Oxidation

Terrible Adhesion

Expensive

Nickel Plating

HARDNESS

The as-plated film has a hardness of 500-600 Vickers (45 – 54 Rockwell C Equivalence). This can be increased by heat treatment up to, for suitable substrates, around 1000 Vickers.

CORROSION RESISTANCE

Similar to high grade stainless steel

ABRASION/WEAR RESISTANCE

The Electroless Nickel Plating surface has a natural lubricity which, in combination with the hardness, makes it ideal for applications where wear and abrasion resistance are essential.

It is best used in combination with dissimilar surfaces e.g. chromium or stainless steel. Sliding contact between ENP surfaces should be avoided.

SOLDERABILITY

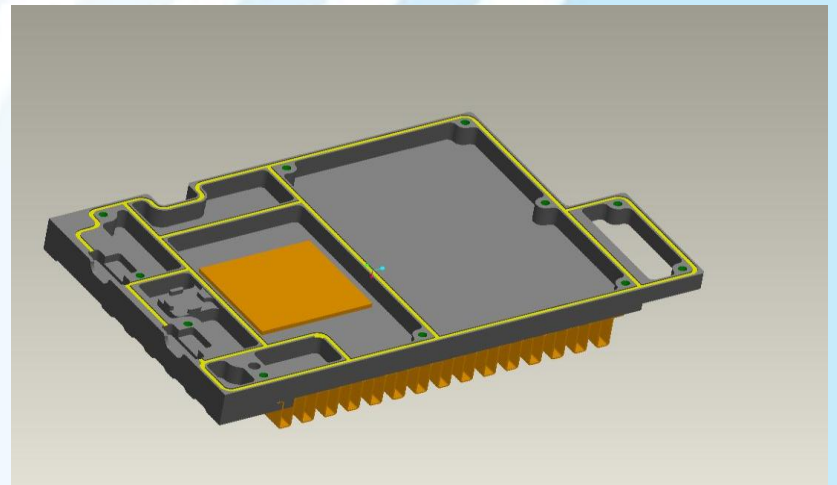
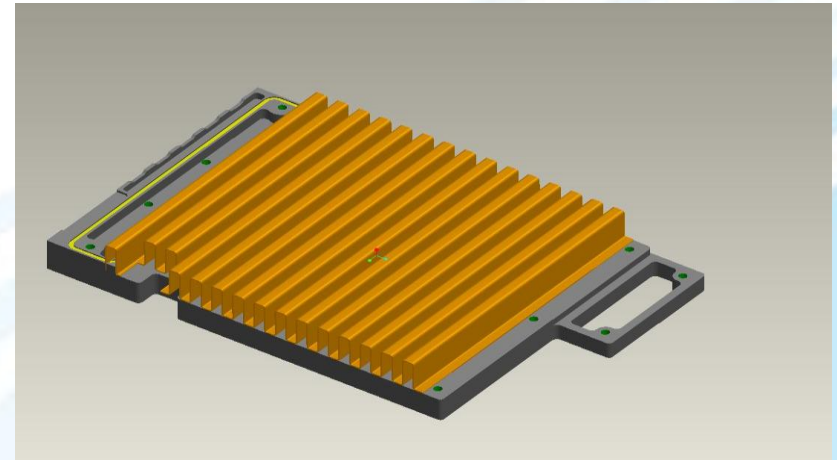
Electroless Nickel Plating has excellent solderability and is used to confer this property on other metals. For the best results the film should be relatively fresh and an appropriate flux should be used.

BRAZING AND WELDING

Numerous substrates can be brazed if they are given an Electroless Nickel Plating surface. Welding is not recommended, as the phosphorous tends to migrate toward grain boundaries, causing cracking.

Thermal Shield

- Thermal simulation module is similar to real structure .
- Ambient temp=25C.
- CPU module is made per 3D drawing .
- Power dissipation =25W.
- Wind flow=120ft/min.
- Add a Copper spreader in the heat sink base.
- Add 2Pcs heat pipes in the heat sink base
- Welding a folded fin onto the heat sink base.
- Reduce Tim's thickness to 0.25MM, which would be 0.1MM after compressed.



Max-Therm Thermal Interface Material Selection Guide

Thermal Pad GP Series

Specially treated high performance ceramic particles impregnated into silicone rubber creates a highly conformal and thermally conductive Thermal pad.

Insulation Pad IP Series

A fiberglass-reinforced material, combined with functional ceramic particles placed in silicone rubber. This provides a high performance interface pad with 3.8W thermal.

Putty Pad PP Series

Designed for applications that have variable system height requirements and an interface material that can compress beyond 50% of its original thickness.

Typical Properties:

	GP2000	GP3000	GP5000	GP7000	GP8000	IP1000	PP5000	CP3800
Form	Gap filler	Gap filler	Gap filler	Gap filler	Gap filler	Insulator Pad	Putty Pad	Conductive Pad
Polymer	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic particles	Silicone / ceramic AgCu particles
Color	Blue	Grey	Light Blue	Green	Grey	Magenta	Green	Gray
Thickness	0.13 - 5 mm	0.13 - 5 mm	0.13 - 5 mm	0.25 - 5 mm	0.25 - 5 mm	0.13 - 0.5 mm	0.5 - 6.0 mm	0.2 - 3.0 mm
Density	2.60 g/cc	2.80 g/cc	3.26 g/cc	2.70 g/cc	2.55 g/cc	2.85 g/cc	2.96 g/cc	2.00 g/cc
Thermal Conductivity	1.2 W/mK	2.0 W/mK	3.0 W/mK	5.0 W/mK	7.8 W/mK	3.8 W/mK	3.2 W/mK	4.0 W/mK
Sheet Stock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fabrication	Die cut	Die cut	Die cut	Die cut	Die cut	Die cut	Die cut	Die cut
Multilayer Capable	0.5mm up	0.5mm up	0.5mm up	0.5mm up	0.5mm up	NA	NA	NA
Ultra Soft Min. Thickness	0.5mm up	0.5mm up	0.5mm up	0.5mm up	0.5mm up	NA	NA	NA
Electric Insulation	Yes	Yes	Yes	Yes	Yes	Superior	Yes	Conductive, <0.5ohm

Polymers

Multi-layer Thermal Pads



● Design Flow Chart:

