

AMETEK
Electronic
Components and
Packaging

AMETEK[®]
ELECTRONIC COMPONENTS
AND PACKAGING

Hermetic Packaging
Design Guide

PACKAGE TYPE

Flatpacks

A flatpack is a type of package in which the leads are in a plane which is parallel to the substrate mounting surface. AMETEK's flatpacks range from as narrow as .250" wide up to more than 2" long. Flatpacks have been made in sizes up to 4" square with over 350 leads. Flatpacks usually have a wall thickness of .040" or thicker, and are usually rectangular or square. Flatpacks are grouped into one of three general categories: One-piece, Multi-piece, or Special.

One-piece

A one-piece flatpack is a type of flatpack in which the body is formed from one piece of metal in a process called deep drawing. The result is a body with no braze joints or seams. The bottom thickness originally matches the thickness of the walls but may be reduced by grinding after the body is formed.



Multi-piece

A multi-piece flatpack is a type of flatpack in which the ring frame (four walls) is formed by deep drawing. The bottom is separately stamped from flat stock. The ring frame and bottom will be produced from the same type of metal. The bottom and the ring frame are joined together using a brazing process during assembly.



Special

A special flatpack may be either a one-piece or multi-piece flatpack that also includes one or more special characteristics such as:

- | | |
|----------------------|---|
| Extended bottom | No bottom |
| Special connector | Fiber optic ports (tubes) |
| Unusual lead forming | Dissimilar material for ring frame & bottom |



Flatpack Design Rules

While AMETEK prides itself on providing highly customized hermetic packages, there are some design rules that will help ensure timely, economical, and repeatable production of a robust hermetic package.

1.1.1.1 Glass seal diameter = (wall thickness x 0.7) + lead width or diameter

1.1.1.2 Minimum distance from top edge of glass seal to seal ring $\geq .050$ "

1.1.1.3 Lead pitch = either .050" or .100"

1.1.1.4 Max leads/side = integer[(length of side - (2 x wall thickness) - .040")/lead pitch]

Plug-ins

A plug-in is a type of package in which the leads are perpendicular to the substrate mounting surface. The all-metal plug-in is available as small as .390" wide and as large as nearly 3" long. Plug-ins usually have a wall thickness of .040" or thicker, and are usually rectangular or square

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although round styles are available as well. Plug-ins are grouped into one of three general categories: Standard, Flat, or Special.

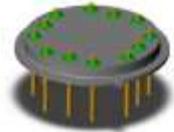
Standard

A one-piece flatpack is a type of flatpack in which the body is formed from one piece of metal in a process called deep drawing. The result is a body with no braze joints or seams. The bottom thickness must match the wall thickness.



Flat

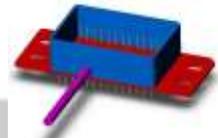
A flat plug-in is a type of package in which the body is formed using a process called coining. The coining process is capable of producing a thin flange for seam welding around a raised “pedestal” area. The pedestal area is used to substrate attach. The thin welding flange is used for final sealing with a domed cover. Flat plug-in are usually .060” thick.



Special

A special plug-in may be either a standard or flat type that also includes one or more special characteristics such as:

Extended bottom	Fiber optic ports (tubes)
Special connector	Unusual lead forming



Machined Housings

Machined housings may take nearly any shape from a simple rectangle similar to a flatpack or a plug-in to octagonal or even irregular shaped packages. The leads on machined housings may pass through the sidewalls or the bottom of the package or both. Machined housings have been produced with every type of lead and/or connector available, dissimilar materials, and even post-plating machining.

Machined packages are used primarily when the required shape of the housing prohibits the use of traditional tooled components. Machined housings are also used for small order quantities that would make the production of a new flatpack or plug-in tool economically unjustified.



MATERIALS

Common materials

ASTM F-15 alloy is an iron-nickel-cobalt, controlled expansion alloy whose chemical composition is controlled to assure uniform thermal expansion properties. It is the most common material used in “matched” seals for both the eyelet and leads. There are a number of other alloys such as Alloy #48 with slightly different characteristics but with the similar thermal expansion properties.

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Alloy #52 is a 50/50 nickel-iron alloy developed for glass-to-metal seals. The alloy's rate of thermal expansion is virtually constant to a temperature of about 1050°F (565°C) and is often used as a pin material in “compression” seals.

Plain carbon steel is the most common non alloy used in hermetic applications. It has the advantage of a low cost material however it has poor corrosion resistance qualities. It is often used in low cost “compression” seal applications as an eyelet material.

Copper, copper based and molybdenum alloys provide very good heat dissipating and current capacity properties. They are not suitable for direct sealing however provides a suitable base material.

Aluminum Silicon Carbide (AlSiC) composite materials are designed to have a high thermal conductivity with the added benefit of low density.

There are numerous specialty materials available for unique applications. Please contact Design Engineering for more information.

Table 1 - Selected Material Data

Material	Density (g/cc)	CTE (ppm/°C)	TC (W/m/K)	Electrical Resistance (μΩ-mm)
ASTM F-15 (Kovar®)	8.36	10.4 (@800°C)	17	489
Alloy #48	8.25	12.1 (@800°C)	13	482
Alloy #52	8.30	12.5 (@800°C)	14	429
CRS	7.87	13.8 (@400°C)	52	143
Copper	8.96	17.7 (@300°C)	391	171
Tungsten-Copper	14.87-16.98*	6.7-9.6* (@400°C)	175-205*	
Molybdenum-Copper	9.90-10.01*	7.0-8.0* (@400°C)	165-185*	
Molybdenum	10.22	6.0 (@400°C)	138	
AlSiC	2.89-3.01*	7.4-8.0* (@300°C)	160-180*	207

* - actual value depends on specific composition

Table 2 - Common Material Combinations

Frame	Base	Leads/ pins	Seal type
ASTM F-15	ASTM F-15	ASTM F-15	Matched
ASTM F-15	Tungsten-Copper	ASTM F-15	Matched
ASTM F-15	Molybdenum	ASTM F-15	Matched
Alloy 48	AlSiC	ASTM F-15	Matched
CRS	CRS	Alloy #52	Compression
CRS	Copper	Alloy #52	Compression

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LEADS (I/O)

Standard leadframes

Standard leadframes are used primarily for flatpacks although some machined housings utilize leadframes as well. The standard leadframe consists of coplanar parallel leads connected to a common tie bar which is used for electroplating contact. The lead portion of the leadframe is .010" thick and .015" wide and has an overall length of either .743" or 1.000" which includes the .125" wide tie bar. The leads are spaced either .050" or .100" center-to-center.



Special leadframes

Special leadframes may be obtained that may have thinner cross sections, longer overall length, non-standard lead spacing, etc. Consult engineering for details.

Round pins

Round pins (sometimes called straight pins) are used for all package styles but are most commonly used in plug-in type packages. Round pins are typically .018" in diameter but many other sizes are available upon request. Pin length can range from .100" to as long as 1.000". When round pins are used in flatpacks, they usually will have one end flattened to create a small area for wirebonding (see "Flattened Pins").

Nailhead pins

Nailhead leads are used almost exclusively for plug-in type packages. Nailhead leads have a larger diameter wire bond surface formed at one end which makes them look like a nail. Nailhead leads are typically .018" in diameter but the length can range from .250" to as long as 1.000". The nailhead end of the lead is usually .035" in diameter and .008" thick. As with round leads, nailhead leads are available in sizes other than those mentioned here. Consult engineering for details.



High Power Leads

Often there is a need to transmit high current signals through sealed conductors. There are many materials that are able to conduct high current but many are not suitable for glass sealing. See Table 3 - Suggested Conductivity of Various Lead Materials for a list of some of the most common lead materials and their current carrying capabilities. AMETEK utilizes the properties of copper and ASTM F-15 alloy together in a "Butt-brazed" lead. These leads are formed by brazing a length of copper lead to a section of ASTM F-15 which is much shorter in length but larger in diameter than the copper. The ASTM F-15 portion of the lead is used to provide the glass seal while the highly conductive copper forms the external portion of the lead. One design rule to consider when considering the use of these Butt-brazed leads is:



$$\text{ASTM F-15 section Diameter} = \text{Copper section Diameter} + .020''$$

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Table 3 - Suggested Conductivity of Various Lead Materials

	Conductor Diameter							
	.090"	.080"	.060"	.050"	.040"	.030"	.025"	.020"
52 ALLOY	22	16	11	8	5.5	3.5		1.5
ASTM F-15	20	15	10	7	5	3.2	2.25	1.3
Cu CORED 52 ALLOY	31	22	16	11.2	8.2	4.5		2.5
Cu CORED ASTM F-15	28	20	15	10.3	7.5	4.1	3.1	2.1
Cu	65	51	29	20	12.5	7.2		3.2

Values given are in AMPS

These values will produce conductor temp rise < 40°C at continuous duty

Special Connectors

AMETEK can create custom connectors or integrate many existing hermetic connectors. In either case most connectors can be classified into one of two categories:

Coaxial

IMPEDANCE FORMULA SINGLE COAX LINE 50 OHMS

$$Z = \left(\frac{138}{\sqrt{E}} \right) (\log 10) \left(\frac{D}{d} \right)$$

Z = IMPEDANCE

E = DIELECTRIC CONSTANT

D = HOLE DIAMETER

d = LEAD DIAMETER

Dielectric Constants of some commonly used glasses

7052 - 4.9 7070 - 4.1 9010 - 6.3 AIR = 1 (used as reference)

Table 4 - Pin & Hole Diameter Combinations for 50 Ohm Impedance

PIN DIAMETER	7052 GLASS GLASS DIA.	7070 GLASS GLASS DIA.	AIR	9010 GLASS GLASS DIA.
.010/.011	0.063	0.054	0.023	0.081
0.012	0.076	0.065	0.027	0.097
0.015	0.095	0.081	0.034	0.122
0.018	0.114	0.097	0.041	0.146
0.020	0.127	0.108	0.046	0.162

All dimensions are in inches

GPO & GPPO

AMETEK has the RF expertise for design and manufacture connectors for microwave and other applications. AMETEK does manufacture our own replacement "GPO" connectors in accordance with DESC 94007 (see AMETEK connector evaluation report). A GPO connector can withstand anywhere from 100 to 1000 interconnect cycles, depending upon the type of detent used (smooth bore, limited detent, full detent or catcher's mitt). GPO connectors are rated to 40 GHz. GPPO's are smaller versions of GPO connector, normally 30% smaller, and are rated to 65 GHz.

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K100 & V100

The K connector is trademarked by Anritsu Corporation. K connectors can be directly mated to an SMA. K connectors are designed to operate to at least 20 GHz, however a mated pair of K connectors can perform at up to 46 GHz. K connectors have been tested to withstand at least 10,000 interconnect cycles without an effect on performance. The V connector is also a trademark of Anritsu Corporation. V connectors are rated to 65 GHz.

SMA

The SMA (Subminiature A) is one of the most commonly used RF/Microwave connectors. It is intended to be used with infrequently connected components and semi-rigid cables. A standard SMA connector is rated to 12.4 GHz although high quality versions rated to 26.5 GHz are also available.

Multi-pin

Multi-pin connectors are another interconnect option that is available. Micro-D receptacles per MIL-PRF-83513 may be incorporated into hermetic housings. Custom bulkhead type multi-pin connectors are also able to be integrated into your housing. Consult Design Engineering for details.



Special pins

Spherical ended pins

Spherical ended pins can be used for all package styles, but are most commonly used in conjunction with screw-on field-replaceable connectors. These pins may be spherical (radiused) at either one end of the pin or at both ends. Some commonly used pin diameters are .012", .015", and .018".

Stepped pins

Stepped pins are pins that have a thicker diameter and then "step down" to a narrower diameter. These pins can be used on all types of packages, including flatpacks, plug-ins and machined housings, where a thicker diameter may be required inside the package but is not necessary externally. The narrower diameter of these types of pins is typically .018" or .020" and can range in length up to .750". The thicker portion of the pin can range up to .035" diameter and is fairly shorter in length, typically under .100".

Flattened pins

Flattened pins are used in flatpacks and machined packages where the leads exit through the sidewall of the housing. There are many sizes of flattened pins that can be made but there are a couple of rules that will ensure proper performance.

Pin flat thickness must be .010" or greater.

Pin flat length \leq (pin flat thickness X 3)

There are three dimensions that govern the size of a flattened end of a pin:

Pin flat thickness Pin flat width Pin flat length



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The most common way to dimension a pin flat is to specify the minimum pin flat length and minimum width which will be used as the area used for wirebonding. Table 5 - Available Pin Flat Configurations shows pin flat dimensions that are available for use on your package.

Table 5 - Available Pin Flat Configurations

PIN DIAMETER	FLAT THICKNESS	FLAT WIDTH	FLAT LENGTH
.015	.010 REF	.016 MIN.	.015±.005
.018	.010 REF	.018 MIN.	.020±.005
.018	.012 REF	.015 MIN.	.020±.005
.018	.013 REF	.013 MIN.	.010±.005
.020	.010 REF	.025 MIN.	.025±.005
.020	.011 REF	.020 MIN.	.030±.005
.020	.012 REF	.018 MIN.	.020±.005
.025	.012 REF	.020 MIN.	.025±.005
.025	.015 REF	.015 MIN.	.030±.005
.025	.020 REF	.010 MIN.	.025±.005
.030	.015 REF	.030 MIN.	.035±.005
.030	.018 REF	.025 MIN.	.035±.005
.030	.020 REF	.020 MIN.	.035±.005
.030	.022 REF	.018 MIN.	.035±.005
.030	.025 REF	.015 MIN.	.035±.005
.040	.010 REF	.075 MIN.	.035±.005
.040	.015 REF	.055 MIN.	.035±.005
.040	.020 REF	.040 MIN.	.035±.005
.040	.025 REF	.030 MIN.	.035±.005
.050	.025 REF	.050 MIN.	.060±.005
.050	.030 REF	.045 MIN.	.060±.005
.050	.035 REF	.035 MIN.	.060±.005
.060	.025 REF	.080 MIN.	.060±.005
.060	.035 REF	.055 MIN.	.050±.005
.060	.040 REF	.030 MIN.	.055±.005
.060	.045 REF	.020 MIN.	.060±.005
.070	.030 REF	.080 MIN.	.070±.005
.070	.040 REF	.070 MIN.	.070±.005
.070	.050 REF	.060 MIN.	.075±.005

All dimensions are in inches

Upset pins

Another pin option that is available is an upset pin. This pin style is similar to the nailhead style. However, upset pins have an addition straight section of the pin on each side of the larger diameter section. Upset pins are commonly used to provide a standoff for a substrate in a plug-in style package.



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SEALS

Glass

Matched

Matched seals rely on glass and metal combinations with similar coefficients of thermal expansion to form an oxide bond that results in a hermetic seal. This design produces a stress free robust seal well suited to many applications.

Compression

Compression seals rely on glass and metal combinations that due to the greater coefficient of thermal expansion of the metallic case will create a mechanical bond that provides the hermetic seal. This design is well suited when the design parameters of the final package fall outside of the matched seal glass and metal combinations.

Ceramic

AMETEK does have HTCC capability in-house with relocation of General Ceramics to New Bedford. We have assembled tens of thousands of hermetic packages that included ceramic terminals and/or ceramic feedthrus. Refer to our High Temperature Cofired Ceramic Design [®] Guide.

Ceramic Terminals

AMETEK offers 94% min. Al₂O₃ ceramic seals as an alternative to glass. Some considerations to keep in mind during design stages are:

Ceramic OD \geq lead diameter

Pin-to-pin spacing – Ceramic OD \geq .020"

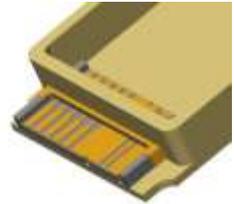
Distance from top of ceramic seal to seal ring \geq .020"

Ceramic seals can be brazed into ASTM F-15 Alloy, Copper, CRS or Stainless Steel frames.

Copper Cored 52 Alloy or GlidCop can be used for the pin material.

Ceramic Feedthrus

AMETEK can also integrate ceramic feedthrus which are sometimes referred to as strip-line connectors. These feedthrus can contain conductors designed for RF, DC and/or ground signals. Also these components can be provided either with a leadframe attached to the external traces or without leads (see illustration at right). Due to the unique nature of each customer's design, AMETEK prefers to have the ceramic supplied by the buyer of the packages. If this is impractical, then AMETEK can procure and integrate the ceramic.



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TOLERANCES

Body

Standard tolerances on tooled bodies are as follows:

Length = $\pm .005$ "

Width = $\pm .005$ "

Wall thickness = $\pm .005$ "

Bottom thickness = $\pm .002$ "

See Standard Tolerance sheet for additional information.

Leads

Standard tolerance on leads dimensions are as follows:

Flatpack external lead length = MIN (from ext wall of case to near edge of tie bar)

Flatpack internal lead length = $+.010$ "/ $-.005$ " or $\pm .007$ "

Plug-in external lead length ("chop") = $\pm .010$ "

Plug-in internal lead length ("post height") = $\pm .005$ "

Rectangular lead width = $\pm .003$ "

Rectangular lead thickness = $\pm .002$ ".

Round pin diameter = $\pm .002$ ".

See Standard Tolerance sheet for additional information.

Seals

Standard glass meniscus is .010 max.

FINISHES

Considerations

AMETEK is fully capable of plating our own packages. Our abilities extend to plating various types of materials and alloys using rack plating and barrel plating processes for both 'all over' plating and 'selective' plating (leads only). We can also have areas free of gold plating by performing masking operations when required. We carefully monitor compliance to customer requirements by the use of X-Ray Florescence for plating thickness measurement.

"Standard" Plating

The standard plating for packages is as follows:

- Electrolytic Ni: $50-200\mu$ ". Note: the maximum must be equal to or greater than 4x the minimum.
- Electroless Ni: $100-200\mu$ ". Note: the maximum must be equal to or greater than 2x the minimum. (may not be used on flexible leads)
- Gold: 50μ " MIN. Note: prefer a minimum (or the maximum must be equal to or greater than 3 times the minimum).

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- For example: if you require a minimum of 50μ” of electrolytic nickel and 100μ” min. gold, you would specify a requirement of 50-200μ” Ni under 100μ” min. Au (or 50-200μ” Ni under 100-300μ” Au)
- Note: Plating thicknesses can be held to a tighter spec. if a specific part of the package is indicated (i.e. “Plating thickness to be measured on seal ring only”)

Special plating

AMETEK has the ability to plate Aluminum Silicon Carbide. We also offer Lead Tinning for customers who require a hot solder dip on a portion of their leads. Tin plating and Silver plating are also available if required in application.

Military standards –

Electrolytic Sulfamate Nickel per ASTM B689-97 (MIL-QQ-N-290)

Electroless High-and Mid Phosporate Nickel per ASTM B733-47 (MIL-C-26074)

Gold - Type III Class A per ASTM B488-95 (MIL-G-45204)

Hot Solder Dip per Mil-PRF-38534 (SN60 or SN63)

BRAZE & SOLDER

Braze

Brazing is the process of joining two or more materials using a metal alloy with a lower melting point than that of the materials being joined. This is done through a heating process that can vary greatly in temperature, depending upon the materials and alloys involved. Our proprietary furnace profiles and furnace controls differentiate AMETEK from our competition.

For more information refer to “[BRAZE PROPERTIES](#)”

Copper

Copper is commonly used to join a frame to a base (such as in a multi-piece package) and also to join a fiber optic tube to a housing. It is most commonly used to braze materials with very similar CTE due to the temperature at which the operation is performed. Copper (99.99%) has a melting temperature of 1083° C.

Gold/Copper

Gold/Copper is most commonly used to ground leads/pins to a package, although it can also be used to braze a tube to a housing. It is most commonly used in the form of washer preform. AMETEK performs gold/copper brazing at temperatures above 905°C.

BT (CuSil)

BT (CuSil) braze is another alloy that is available as a brazing option. It can be used to join dissimilar metals, such as a Kovar (ASTM F-15 Alloy) frame to a Molybdenum base. The composition of BT (CuSil) is 72% Silver / 28% Copper and its melting temperature is 780° C.

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Solder

Soldering is defined as the joining of two or more metallic components through the use of any fusible alloy. AMETEK distinguishes soldering from brazing by the lower temperatures (less than 450°C for soldering) than those used during brazing. Most soldering operations are performed after all plating operations have been completed. In this way, soldering can be used to produce parts which would be difficult or impossible to plate after assembly. There are many soldering alloys used at AMETEK. The most common alloys are described below:

Gold/Germanium

Gold/Germanium solder alloy is used by AMETEK to produce solder joints that will not reflow when the customer performs subsequent operations at elevated temperatures (up to 330°C) such as Gold/Tin soldering of the substrate to the package floor. The composition of the alloy used is 88% Gold / 12% Germanium which is a eutectic alloy and has a melting point of 356°C. This type of solder operation is performed in a controlled atmosphere belt furnace which eliminates the need for solder flux.

Gold/Tin

Gold/Tin alloy is used for soldering where the amount of braze runout needs to be controlled more closely than is possible with Gold/Germanium. AMETEK may also use Gold/Tin solder following a Gold/Germanium solder operation. The composition of the alloy used is 80% Gold / 20% Tin which is a eutectic alloy and has a melting point of 280°C. This type of solder operation is performed in a controlled atmosphere belt furnace which eliminates the need for solder flux.

Others

Other solder types used by AMETEK include but are not limited to: Lead/Tin, Tin/Silver, and Lead/Silver. All of these solders require the use of flux. Consult Design Engineering for details.