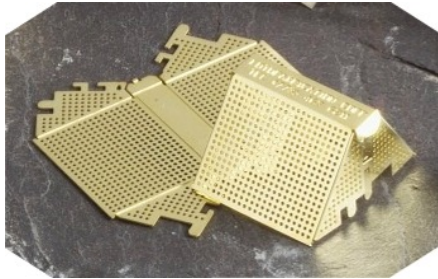


## Shielding Design

Fotofab has helped our customers manufacture custom RFI/EMI shielding enclosures for over fifteen years. If you are considering a shielding enclosure for your project, the following considerations should ensure that your design is as comprehensive and robust as possible. Don't hesitate to reach our Technical Sales staff for advice beyond the scope of this list.



Fotofab will meet your shielding needs from the first prototype quantity to the largest production quantities. If your shielding enclosure may eventually be used in quantities of several thousand or more, please consult our Technical Sales staff as soon as possible, since our progressive die stamping may be the most economical way to produce it. In this case, our Technical Sales staff will want to explain the few differences in design that you will want to take into consideration during the prototyping phase.

## Metal

Fotofab manufactures RFI/EMI shielding enclosures for attenuating components ranging in operating (and harmonic) frequencies ranging from a few hertz to over 50 GHz.

The type of metal that you specify may have an impact on a shield's performance. In general, shielding against frequencies of 15 MHz or lower is a bulk material effect, and can best be served by employing a ferromagnetic metal such as steel. For greater attenuation at these lower frequencies, metals with high permeabilities and low core losses such as Permalloy 80® or MuMetal® are good candidates.

If the frequencies you are shielding against are greater than 15 MHz, shielding becomes less of a bulk material effect and more of a skin (conductivity) affect. At frequencies (and harmonics) of 900 MHz and above, almost any metal, including brass, nickel silver, copper and steel, shields similarly assuming a thickness of .002" (.05mm) or greater.

Consider specifying a metal alloy called nickel silver (55% copper; 27% zinc; 18% nickel; and not a speck of silver) for shields that will be hand soldered or re-flow soldered with flux. In these two soldering environments, nickel silver is inherently solderable without any tin or tin/lead post plating. Going less the post solder plating will shave a few days and a few dollars from your shielding order. Note that you should consider post-solder plating like bright tin or tin/lead with any soldering processes which do not utilize an active solder fluxing agent.

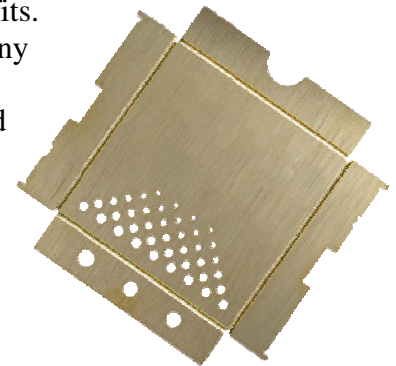


While Fotofab is capable of making your shield in metal thickness from .001" (.025mm) to .060" (1.5mm), the most common metal thickness that we stock and which offer good shielding and adequate mechanical strength are: .006" (.15mm); .008" (.2mm); .010" (.25mm); .012" (.3mm); .015" (.38mm) and .020" (.5mm). *Review the Material, Finishes and Forming Specs at the end of this guide.*

### Bend Channels

Hand-foldable, etched bend channels are one of the unique features that Fotofab can incorporate into your RFI/EMI shielding enclosure. In the common metal thickness listed above, our etched bend channels allow anyone to bend the sidewalls of a shield from a 2D blank to a 3D finished shield easily, quickly and precisely.

Incorporating our etched bend channel feature can offer you several benefits. First, since your shielding enclosure can be formed without the need for any traditional forming tooling, you can typically save hundreds of dollars in NRE tooling and several days of delivery lead time for your prototype and production needs. Second, because the etched bend channels exhibit a zero inside radii when formed, you can save space on your board by reducing the clearance necessary between the shield and the components within it. Third, although the etched bend channels are typically intended to create 90° right angle bends, they can also be used to create acute angle bends between 0° and 90°.



Fotofab does not recommend the use of etched bend channels for applications that are load bearing or encounter extended periods of vibration, since the etched bend channels are created by removing anywhere from 50% to 75% of the original metal thickness, and thus affect the strength of the metal along these bend channels proportionally. For shields which are subjected to loads or extreme vibration, we recommend forming the shield blanks with our traditional forming tools, which will create inside bend radii equal to the metal thickness, at minimum.

### Part Geometry

The economics of Fotofab's parts are similar to purchasing PCB's, in that you are purchasing the real estate of the part rather than the feature internal to the part. Therefore, features internal to the part, such as mouse-holes for traces, holes for tuning or heat dissipation, identification for your shield or shielded components and even your company's logo, are effectively "free". And similar to any other custom part from Fotofab, there is no limit to the complexity of your shield's



configuration as long as the dimensions and tolerances are within our capability, as under our *Design Guide to Photochemical Machining* located on our website [www.fotofab.com](http://www.fotofab.com).

Since higher RF frequencies radiate through smaller openings than do lower frequency waves, take advantage of our fabrication process to minimize the size of hole features and slots in your shield design. Because there isn't any difference in tooling or part cost for features interior to your part, consider making any mouse-holes for traces and any holes for tuning, cleaning or heat dissipation as small as possible. We can make slots as narrow and hole diameters as small as 120% of the metal thickness you select, and we can space them as close together as one times the metal thickness.

If your design would benefit from being identified with its part number or the component's part number, or you want your customer to see your logo "engraved" into your product, specify in your print where you would like us to incorporate these features for no additional tooling or part cost, and provide us with a CAD file (.dwg or .dxf format) of your company's logo.

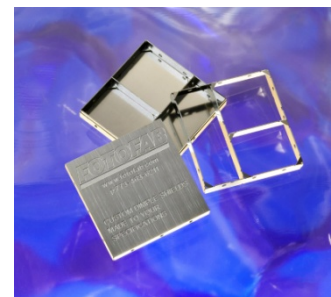
### Removable / Replaceable Covers

Your shielding design may require that the cover or lid (i.e. the top portion of the enclosure) can be removed, so that the components underneath can be tweaked or replaced, and the cover or lid can be resealed. We refer to this design as "removable lid" shield or a "two piece" shield. We are familiar with and capable of making removable lid shields with several different mechanical locking or mating methods. The methods that we are most familiar with include: 1) mating dimples, 2) mating tabs and slots and 3) locking spring fingers. Each of these methods is best suited to different shield designs. Please contact our Technical Sales staff to discuss which method(s) best pertains to what you are trying to achieve.



### Internal Walls

We are very accustomed to making RFI shielding enclosures whose components need to be isolated from one another under a common cover or lid. Similar to the removable/replaceable cover shields, there are several methods for fabricating and assembling internal walls or fences that prevent cross talk among different regions or components under a larger, universal shield. We would be glad to discuss the



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trade-offs of using one universal cover with one or more internal walls versus designing several individual, stand-alone shielding enclosures.

### Raised or Rounded Features

While it's not as common to see, your shielding design may require a part to have a unique feature such as a stepped or domed region, or a shield with rounded, rather than squared, edges or corners. With 15 years of shield fabricating experience, Fotofab has the confidence and know-how to help you with all of your metal shielding needs.

### Forming Options

Finally, you will want to let us know how you want to receive your custom shielding enclosures, since we offer you a few options. We can ship your parts:

- with etched bend channels, tabbed into the metal sheet for your company or designated contract manufacturer to easily detach and form by hand (refer to *Bend Channels* above),
- with etched bend channels, detached from the metal sheet and formed by Fotofab, ready for final board assembly, or
- without etched bend channels, detached and formed at full metal thickness to the finished part, ready for board attachment.

This shielding design guide is intended to assist you with the most common design issues that we encounter with our customers' shielding requirements. If you run into issues that are not addressed here, contact one of our Technical Sales staff to discuss and resolve your specific needs.



## Material, Finishes and Forming Specs

### Material Options

#### **Nickel Silver**

Nickel Silver (55% Cu, 27% Zn, 18% Ni) is less conductive than copper and brass but it's stronger than copper or brass. It's more corrosion resistant than copper or un-plated brass, and can be soldered without plating if you use a fully-activated flux. Despite the name, there is no silver in nickel silver. Notate Nickel Silver on your drawing, or CDA C77000.

#### **Brass:**

Brass (70% Cu, 30% Zn) is about 30% as conductive as copper and easily formed. Brass is a good general purpose metal used to manufacture parts from housings to shims. For RF shielding applications, tin plating is recommended to enhance its solderability and corrosion resistance. Notate Brass on your drawing, or CDA C26000.

#### **Copper:**

Copper (99.9% CU, 0.05% oxygen max) is a very conductive metal commonly used for RF shielding applications. Tin plating is recommended to enhance its solderability and corrosion resistance. Notate Copper on your drawing, or CDA C11000.

#### **1010 Steel:**

1010 steel, or any ferromagnetic metal, is ideal if you are shielding against frequencies 15 MHz or lower. Tin plating is recommended to enhance its solderability. Notate G1010 steel on your drawing, or low carbon steel.

### Finishing Options

#### **Bright:**

Bright-tin plating has excellent solderability, corrosion resistance and an attractive finish (a small amount of organic is added to provide brightness). Also a good candidate for formed applications. Designating *bright-tin* on your blueprint is sufficient, or if you require a Mil Spec, you should reference Mil-T-10727, Type I Bright. Tin is not good for low temperature applications (Changes structure and loses adhesion when exposed to temperatures below -40°C).

#### **Dull electro:**

Dull tin plating has excellent solderability, due to its low melting point. Corrosion resistance and has a dull-grey, white appearance. Can also be used in reflow soldering applications. Designating *dull-tin* on your blueprint is sufficient, or if you require a Mil Spec, you should reference Mil-T-10727, Type I Dull. Tin is not good for low temperature applications (Changes structure and loses adhesion when exposed to temperatures below -40°C).

#### **Tin/Lead 60/40:**

Tin/Lead 60/40 plating is most commonly used in satellite, spacecraft, and other vacuum-environment applications since it is resistant to "whiskering" or "tin whiskers", the flaking off of fine slivers of plating.



Offers excellent solderability. Mil-P-81728B. Tin/Lead 60/40 is not RoHS compliant.

**Tin/Lead 63/37:**

63/37 plating, also known as eutectic, will have a dull or whitish finish. Tin/Lead 63/37 is not RoHS compliant.

**Tin/Lead 90/10:**

90/10 plating will have a dull or whitish finish. Eliminates the risk of "tin whiskers" which can occur with tin plating. Tin/Lead is excellent for soldering. Specify Tin/Lead 90-10 on your drawing. Tin/Lead 90/10 is not RoHS compliant.

### Forming Options

**Leave in sheets w/bend lines:**

Parts will be supplied flat and tabbed into 12" X 18" sheets. A bend line is etched into the part and can be formed (by hand) to create a 90° bend.

**Detach and form @ Fotofab:**

Select this option and leave the detaching and forming to us. Fotofab will detach, hand form and package parts per your request.

**Soft forming tool:**

Select this option if your parts have bends or forms that *are not* 90° bends, or if your material thickness is less than .008" thick.

**Dimple Shield:**

Fotofab's Dimple-fit removable lid shield is an excellent design for medium-low production and prototype runs that need a removable lid. It can be made with multi-cavity features.



Close-up of Dimple fence & cover

