Design Guidelines for
Nippon Graphite Industries
Heat Seal Connectors

In addition to the dimensional information listed in our product catalogs, we have put together the following list of design guidelines to help you design the connector which best suits your needs, budget, and production capabilities. Should you have any further questions, suggestions, or comments, please feel free to contact us.

Nippon Graphite Industries
Ito America Corporation

1. Overview:

Each heat seal connector, as with all components, will only perform correctly if it has been designed correctly. In addition to the connector itself, the bonding areas on your substrates must also be designed properly. Finally, your bonding equipment will also play a vital role in determining the efficiency and reliability of your bonding process.

2. Printed Construction Guidelines

2.1 Explaining the Dimensions

A section labeled Design and Physical Parameters appears on the back page of all NGI heatseal connector catalogs. This will provide an addendum to that section and will hopefully more clearly explain some of the dimensions. The critical dimensions for any connector are listed below:

1. W,Width
2. L,Length
3. B,Active Area
4. A,Inactive Area
5. G,Bonding Area Delimiter

Width is the dimension across your traces and Length is the dimension running with your traces. The Active Area (B) dimensions simply defines the distance between the leftmost and rightmost trace (center to center) of your connector. The other dimensions, however, need to be further explained.

The 'A' dimension, or the Inactive Area, is important because it is what primarily defines the connector's ability to withstand delamination at the edges. The purpose of this inactive area is to provide an area of pure adhesive to give the connector some additional strength at the edges. It is particularly important on Planar and Monosotropic constructions because of those constructions' limited adhesive strength over each trace when compared to the Anisotropic construction.. We recommend a minimum of 2.0mm for this dimension for all types of heat seal connectors.

The 'G' dimension defines the bonding area. It also, therefore, defines the non-bonded or insulated areas of the connector if insulation is requested. The important points to remember when designing this dimension are as follows:

1. To a great extent, the length (the dimension running parallel to the traces on the connector) of your bonding area will determine the strength of your mechanical bond and the contact resistance of your electrical bond. We recommend a minimum of 2.0mm for the length of your bond.
2. If, as we recommend, you are using a Sarcon® type bonding pad between your bonding head and the connector, you must remember to factor in the thickness of the pad when considering how much space you need to bond. Not doing so can cause the rubber pad (usually 0.3-0.45mm thick) to become pinched or cut on the inner piece of glass as the head bonds.
3. Do not design your connector so that the bonding head extends past the 'G' dimension and into the insulated area. The height difference between the insulated and non-insulated areas will skew, shift,

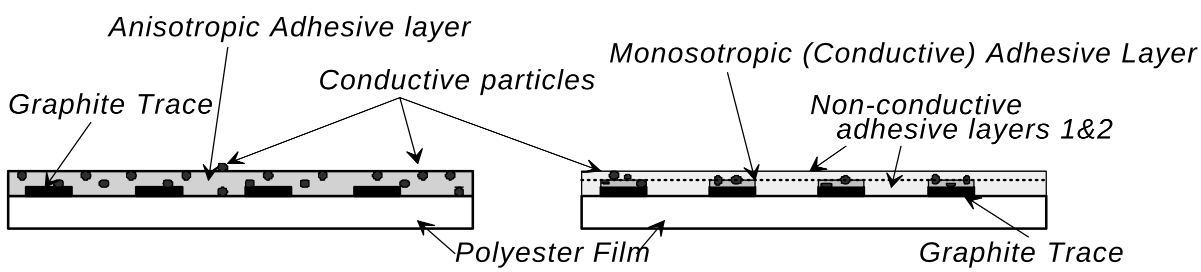
destabilize, and otherwise affect your ability to reliably bond the connector. If there is no insulation, you may extend the head as far as you wish, but it is usually neither necessary nor desirable.

4. Never allow any type of component to be mounted on the rear side of the substrate's bonding area. This will cause heat sinks and limit your ability to support the substrate correctly to maintain coplanarity during the bond. This is the most common design failure we see.

2.2 Choosing a Construction

There are three basic construction options for heatseal connectors. A breakdown of current production would show that approximately 50% of all production uses an Anisotropic construction, 45% uses Monosotropic construction, and the remaining uses Planar construction. The ratio of Anisotropic and Monosotropic connectors has been growing and that of Planar connectors has been shrinking in recent years. Planar connectors are still produced for some customers because Planar connectors have the largest "usability" window -- you can get further away from ideal bonding parameters with them and get away with it than you can with the other constructions. Planar, however, suffers from two large liabilities: it cannot be used for pitches smaller than about 0.6mm, and it is substantially more expensive than either of the other connectors. Planar heatseal connectors, however, are the only heatseal connectors recommended at the present time for flexible plastic LCDs. For more information on bonding to plastic LCDs, please contact us.

That said, this document will concentrate on Anisotropic and Monosotropic constructions. Of the two, Anisotropic is substantially cheaper and is used whenever possible. A look below at a cutaway view of each construction will give you a good indication of why this is happening.



Basic Graphite-Anisotropic Connector　*Basic Graphite-Monosotropic Connector*

This drawing illustrates the number of steps required in the printing of the trace and adhesive systems for an Anisotropic and a Monosotropic connector. Each system utilizes conductive particles within the adhesive system to conduct electricity in the Z-axis after being bonded. In an Anisotropic construction, however, the particles are carefully distributed and suspended in the adhesive so that while there are not enough particles to conduct electricity in the X and Y axis, there are enough to insure that after compression each trace will have a number of particles compressed between it and the bonded substrate. The Monosotropic construction differs in that it places conductive particles only on the traces themselves. This allows us to pack the conductive particles within the adhesive much more densely because we don't have to worry about shorting out the traces. It does, however, mean that we have an extra printing process to worry about, as well as increased registration liability during the manufacturing of the connector.

The following list shows the printing steps necessary for the parts shown above:

Anisotropic Monosotropic

1. Print Graphite Traces 1. Print Graphite Traces

2. Print Anisotropic Adhesive 2. Print Monosotropic Adhesive

3. Print Adhesive Layer 1

4. Print Adhesive Layer 2

Note: Two adhesive layers are necessary for the Monosotropic connector in order to maintain the proper final thickness. We would like to print it all in one step as much as you would, but we can't. Sorry.

Obviously, with two less printing processes (and thus two less drying/curing processes) the Anisotropic construction is more efficient to manufacture. So why use Monosotropic at all?

The main, but not only, reason that a Monosotropic connector would be chosen is that until very recently, printed Anisotropic connectors were limited to connectors with a minimum pitch of 0.5mm while Monosotropic connectors can be used down to pitches of 0.20mm. Now, however, our ability to control the size and distribution of the particles used in Anisotropic conductors has been refined to the point where we can now manufacture Anisotropic connectors with pitches approaching those of Monosotropic construction.

Monosotropic connectors still have some advantages, the main one being that because there are conductive particles only on the traces themselves, we can pack the particles in much more densely. This translates into a somewhat reduced contact resistance. Another advantage in some situations is that while our fine pitch (<0.4mm) Anisotropic connectors use gold-plated plastic spheres as their conductive particles, Monosotropic connectors use gold-plated nickel particles. The extra hardness of the nickel allows it to impinge into the receiving substrate, which can sometimes help to generate and maintain a stronger electrical contact than when using softer particles.

2.3 Traces: Lines and Gaps

Lines and gaps are respectively defined in our catalog with the notations T_1 and T_2. T_1 and T_2 are often the same value but do not have to be. In some instances, increasing the T_1 value (line) to increase the amount of trace that will contact the receiving substrate in the bonding area results in a more robust design. T_1 must be at least 0.12mm and T_2 must be at least 0.1mm. Outside of those limitations you are free to design as you wish. Please note, however, that narrowing either T_1 or T_2 may increase costs if it affects our yields.

2.4 Trace Angles

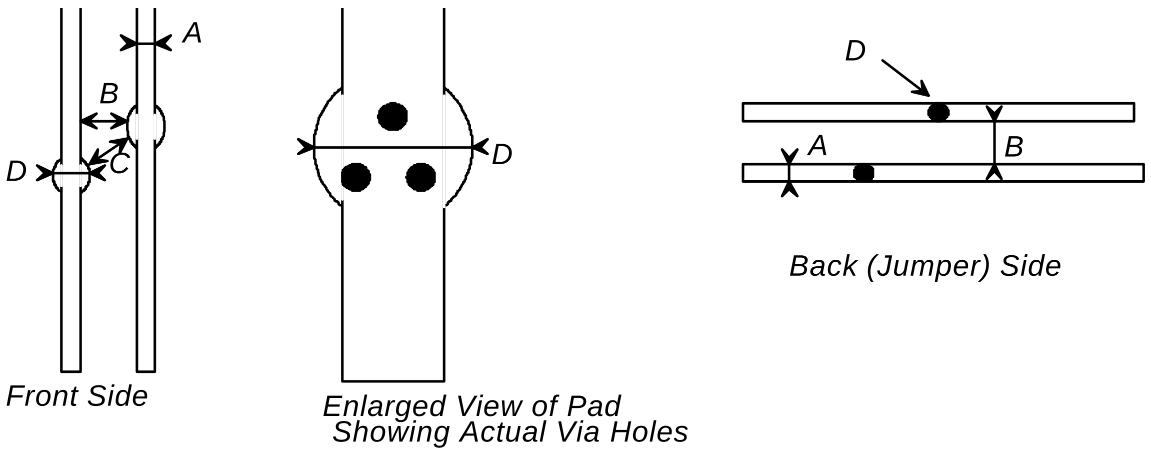
The finest pitch possible with printed connectors at this time is 0.20mm. This assumes that all traces at this pitch are traveling in a straight line. Curves or angles will increase this minimum pitch to varying amounts. While each connector is different, the following may be used as a general guideline.

All angles are calculated from the direction the squeegee travels when printing the parts.

1. Traces parallel to the direction of squeegee travel may have pitches as fine as 0.20mm.
2. Traces up to 60 off of the direction of squeegee travel may have pitches as fine as 0.4mm.
3. Traces more than 60 off of the direction of squeegee travel may have pitches as fine as 0.6mm.

As with many things in this world, your mileage may vary. Please contact us if your connector is one of those that is close to the guidelines above but does not meet them exactly.

2.5 Via Holes



NGI is proud to be the only heatseal manufacturer to reliably produce double-sided connectors. The following diagram shows design limitations when incorporating via holes into a connector.

	A	B	C	D
Front Side	MIN 0.25mm	MIN 0.25mm	MIN 0.5mm	MIN 1.0mm
Back Side	MIN 0.5mm	MIN 0.5mm	MIN 0.5mm	MIN 1.0mm

2.6 Alignment Targets

Alignment targets are often used to align the connector to the substrate. Targets are easily designed, with the most common being an open cross as shown in figure 2.6.   If an "open-cross" connector is used, we recommend that the internal dimensions on the connector be slightly smaller than the corresponding mark on the receiving substrate. If a window of no adhesive is desired around the alignment target to facilitate viewing, please be aware that it may increase your initial NRE as custom screens may need to be created for the adhesive layer. This is especially true of anisotropic connectors.

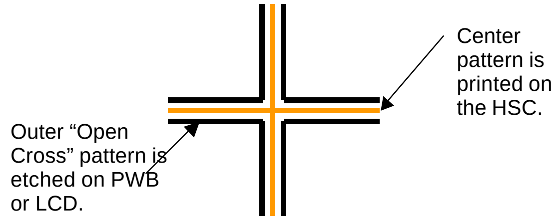


Fig 2.6

2.7 Inks

Graphite inks are used in all of the examples in this document, but Silver and Silver-Graphite Mix inks are also available, as are etched copper ***FlexEC*** heatseal connectors. All inks are interchangeable, but when designing your connector keep in mind that Silver is a highly reactive element and will oxidize over time, possibly causing component failure. Typically, failure occurs when the silver in a trace pulls moisture out of the air and grows silver oxide crystals. The crystals take the form of fern-like structures which over time can grow across traces and short them out. The problem is one which needs serious consideration, but it is also one which has been overcome by hundreds of companies using thousands of different designs. A film laminated insulation is necessary, as is a modified bonding area. Please consult with us for more information. The following shows the electrical resistance in Ohms per square for each ink.

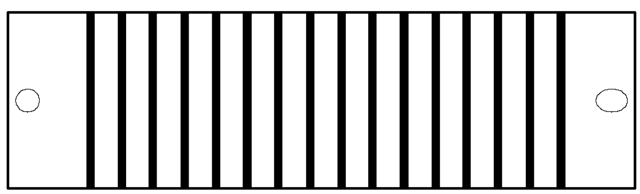
1. Graphite: 35.0 Ohms/sq.
2. Silver-Graphite Mix: 0.5 Ohms/sq.
3. Silver: 0.05 Ohms/sq.

3. Physical Outline Guidelines

All NGI connectors are punched out with Thompson Steel Rule Die, Hardened Machined Punch Die, or a combination of the two. The following is a list of guidelines to help you create the connector you need without incurring extra costs.

3.1 Alignment Holes

Alignment holes are used for aligning the connector on pins before bonding. If the pins and pitch are large, holes slightly larger than the pins themselves may be used, but for fine pitch designs, we recommend a combination of a round hole on one side and a slotted or oblong hole on the other. This arrangement allows the connector to first be anchored using the round hole, while allowing for some movement in the second as it is applied and aligned. Slot holes are slightly more expensive that round holes. A typical arrangement is shown below.



Punched holes should have a diameter of 1.5mm or larger if possible. Diameters lower than this will require special, (read "more expensive") tooling. Diameters from 1.5mm on up, increasing in 0.1mm increments, are standardized and will result in the lowest NRE. We suggest that even if you design the rest of your connector in inches, design the holes in metric. Values not on the 1.5mm, 1.6mm, 1.7mm ..... scale will be non-standard and more expensive.

3.2 Punched Shape

As it is in so much of life, the rule here is KISS (Keep It Simple, Stupid). The more corners, bends, sweeps, or angles you have in your part, the higher your NRE for tooling will be. Guaranteed. Other than that, remember that radiused corners are usually cheaper than hard (right angle) corners. The minimum radius is 0.7mm. If you do not specify a corner angle on the drawing, we will radius it 0.7mm or make it a right angle, depending on which is less expensive for that part. If unspecified, we will always radius an inner corner to provide strain relief.

4. Insulation

NGI offers either printed or laminated film insulations. Film lamination will increase your tooling NRE slightly, while printed insulation will increase you artwork/screens NRE slightly. Either will increase your piece-part price. The total costs of printed and film insulations are basically the same, so unless you need more flexibility or a higher tolerance on the 'G' dimensions, we recommend using film lamination.

Film lamination is available in 23µm and 12µm thicknesses. Standard film color is clear, but translucent green and opaque white are also available.

Print insulations come in either urethane-base or epoxy-base formulas. The epoxy insulation is slightly more insulative, but it is stiffer than the urethane insulation. Urethane-based insulation is white or blue, Epoxy-based insulation is green.

5. Base Films and Stiffeners

NGI offers base films in 23µm, 50µm, and 100µm thicknesses. For heat seal applications, we recommend the 25µm thickness only, but keyswitch designs may use any thickness. Polyester and polyimide films are available.

Some applications require a heatseal application at one end and a different attach method at the other end. For a standard printed heatseal connector, NGI offers stiffeners which will allow the connector to work with a ZIF (Zero Insertion Force) connector such as those manufactured by Molex, Dupont, or AMP. Alternately, the connector may be processed to allow soldering. Soldering applications require that Polyimide be used for the base film and will require a ***FlexEC*** etched copper construction.

6. Flexible Etched Copper *(FlexEC)* Connectors

NGI now has a complete line of Flexible Etched Copper Connectors available in addition to the ink-based Heatseal Connectors we have traditionally sold.. These connectors are available only in the anisotropic heatseal construction and feature pitches down to 0.1mm. In addition to the finer pitches available, the photoetched copper connectors remove the limitations on angles and curves that are present with printed connectors (See section 2.4).

In general, design guidelines for NGI ***FlexEC*** Connectors are similar to those for the printed connectors outlined above. ***FlexEC*** connectors are available with the same base films as heatseal connectors and with standard copper thicknesses of 18µ and 35µ using either galvanic or rolled annealed copper.

In addition to the copper base metal, different plating options exist. Gold, Tin, and Solder are all offered as standard, and other metalizations are available upon request.

7. Conclusion

The guidelines in this document were created to help you design your product. They cannot cover every instance and every possible configuration we make. Use these to start, but finish by asking us to look at the drawing -- a picture is certainly worth a thousand words and may be worth thousands of dollars in savings. We strongly believe in early supplier involvement, so contact us at any time in your design cycle. Above all, ask questions. We can always be reached at the following locations:

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