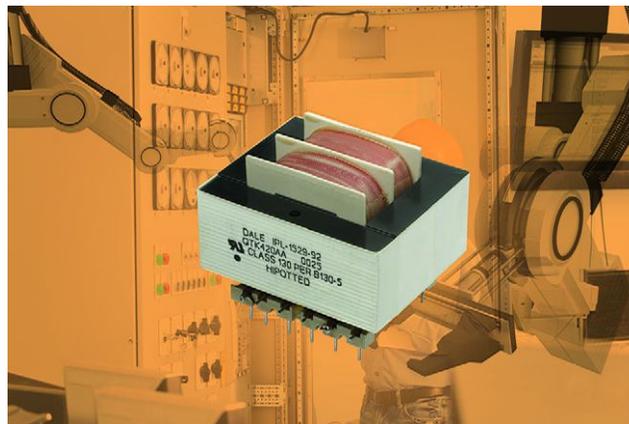




# Custom Magnetics: What Are They and When Do You Need Them?

By Tim Shafer, VP Product Marketing - Inductors

There are many manufacturers that claim they build custom magnetics. However, there is often confusion as to what constitutes custom magnetics and whether or not a designer actually needs them or can afford them. This article will clarify what custom magnetics are, help designers determine if they are needed, and explain how to engage with a custom magnetics supplier.



## WHAT IS A CUSTOM MAGNETIC DEVICE?

In the eyes of the manufacturer, custom magnetics are designed and built for one customer's specific requirements. A custom magnetic device is most often an individual transformer, inductor, or choke that is made with copper wire wound on a soft magnetic material core. The device can also be an assembly of multiple components - including inductors, capacitors, resistors, and connectors - to create a complete filter. Assemblies may include mounting features, special termination configurations, and even features to promote cooling.

Some custom magnetics do not have a magnetic core at all and are called "air core" devices. These are used in high-frequency applications in products such as flux antennae for telemetry transfer or wireless charging devices. Some custom magnetics can even be electro-mechanical and provide motion. Sizes vary from smaller than the head of a pin to the size of a large desk; the possibilities are endless.





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### WHEN DOES A DESIGNER NEED A CUSTOM MAGNETIC DEVICE?

Usually, the design engineer is tasked with designing a circuit that has the best-possible performance for the lowest possible cost. They will normally try to use “off-the-shelf” devices offered in manufacturers’ catalogs or websites that have datasheets describing electrical performance and dimensions. If the design engineer cannot find any product that fits their mechanical or electrical requirements, then they have to engage with a custom magnetics manufacturer.

### HOW MUCH WILL IT COST?

In general, custom magnetic devices will cost more than standard solutions. Unless the volume is very high, they will be built with some level of manual labor and will not be fully automated, which raises costs. Designers will often times choose to compromise size, performance, or efficiency in order to utilize a lower-cost standard solution.

### WHAT ARE NRE FEES AND WHEN ARE THEY APPLICABLE?

In order to provide a custom solution, the supplier may incur development, assembly tooling, and custom magnetic core tooling costs. These costs are typically passed on to the customer in the form of non-recurring engineering (NRE) fees, which are generally one-time fees paid up front by the customer to the supplier. However, some suppliers offer the option to amortize them into the cost of the custom magnetic device. In most cases, the design of a device remains confidential between the supplier and the end customer. It is always wise to have a signed mutual non-disclosure agreement (NDA) in place between the supplier and the customer to insure protection of the confidential information for both parties.

### WHAT KIND OF INFORMATION IS NEEDED WHEN APPROACHING A CUSTOM MAGNETICS MANUFACTURER?

There are several approaches that can be taken when contacting a custom magnetics manufacturer.

1. Build-to-print specifications: Some design engineers have experience with inductors and transformers and can provide detailed specifications that include values and tolerances for rated current, inductance, DC resistance, leakage inductance, turns ratio, primary / secondary voltage, etc. They also specify exact magnetic core shapes and materials, and can provide detailed dimension specifications. They often provide 2D or 3D drawings and test requirements. Everything is spelled out for the custom magnetics manufacturer and there are typically few questions that arise from the manufacturer to the customer.
2. “Black box” requirements: At the other end of the spectrum, the design engineer may only have “black box” requirements with input / output voltages and currents (in the case of a transformer) or just an inductance and rated current specification (in the case of an inductor).
3. Most designers provide something in between the extremes of numbers 1 and 2.

A custom magnetics manufacturer does not expect the customer to be an expert on designing or building custom magnetics, so most manufacturers can, and prefer to, provide design guidance that will help to create the best-performing and most cost-efficient solution for the customer. Good communication between the design engineer and the manufacturer’s engineer is required for the best results.

Many custom magnetics manufacturers provide a design request form that will provide the basic inputs needed to start a design. Vishay offers an online version of this form for both inductors and transformers that can be filled out by the design engineer and sent by email for review (Fig. 1 and Fig. 2). To save time, try to have as much of the requested information as possible when submitting the form.

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Magnetics  
Design Request Form

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**INDUCTORS**
VISHAY INTERTECHNOLOGY, INC.

Name: \_\_\_\_\_ Phone: \_\_\_\_\_  
 Company: \_\_\_\_\_ Email: \_\_\_\_\_  
 Industry: \_\_\_\_\_ Type of inductor: \_\_\_\_\_  
 Application: \_\_\_\_\_ Specification available:  Yes  No If yes, please attach specs to email  
 Safety agency requirements: \_\_\_\_\_  
 Check all that apply:  UL  CSA  VDE  IEC  Automotive  Medical Other: \_\_\_\_\_

**Electrical Requirements**  
 Operating frequency: \_\_\_\_\_  KHz  MHz Current (min.): \_\_\_\_\_  mAmps  Amps  
 SRF (min.): \_\_\_\_\_  KHz  MHz  GHz DCR (max.): \_\_\_\_\_  Ohms  mOhms  
 Inductance: \_\_\_\_\_   $\mu$ H  5 %  10 % Other: \_\_\_\_\_  
 Q factor (min.) at test frequency: \_\_\_\_\_  KHz  MHz

**Mechanical Requirements**  
 Mounting:  Through-hole  SMD  Flying leads Other: \_\_\_\_\_  
 Length (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_  
 Width (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_  
 Height (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_

**Environmental Requirements**  
 Dry  Varnished  Vacuum Varnished  Epoxy  Impregnated Other: \_\_\_\_\_  
 Operating temperature °C: \_\_\_\_\_

**Additional Requirements**  
 Annual quantity: \_\_\_\_\_ Start of production: \_\_\_\_\_  
 Target price: \_\_\_\_\_  Sample required  
 Prioritization (1 - Highest) \_\_\_\_\_  
 Size \_\_\_\_\_ Efficiency \_\_\_\_\_ Cost \_\_\_\_\_ Target date for sample: \_\_\_\_\_  
 Notes  
 \_\_\_\_\_

Reset Print Submit  
 605.668.4133 [custommagn@vishay.com](mailto:custommagn@vishay.com)  
 Custom Magnetics, Vishay Intertechnology  
 1505 East Highway 50, P.O. Box 180, Yorkton, SD 57078

SALES INFORMATION  
  
[www.vishay.com](http://www.vishay.com) // VMN-MS7138-1512 // 1

 Fig. 1 - Inductors: [www.vishay.com/doc?48060](http://www.vishay.com/doc?48060)

Magnetics  
Design Request Form

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**TRANSFORMERS**
VISHAY INTERTECHNOLOGY, INC.

Name: \_\_\_\_\_ Phone: \_\_\_\_\_  
 Company: \_\_\_\_\_ Email: \_\_\_\_\_  
 Industry: \_\_\_\_\_ Type of transformer: \_\_\_\_\_  
 Application: \_\_\_\_\_ Specification available:  Yes  No If yes, please attach specs to email  
 Safety agency requirements: \_\_\_\_\_  
 Check all that apply:  UL  CSA  VDE  IEC Other: \_\_\_\_\_

**Electrical Requirements**  
 Operating frequency: \_\_\_\_\_  KHz  MHz Input voltage: \_\_\_\_\_  
 Duty cycle: \_\_\_\_\_ Primary inductance: \_\_\_\_\_  mH   $\mu$ H  
 Leakage inductance: \_\_\_\_\_  mH   $\mu$ H Dielectric voltage: \_\_\_\_\_ pri to sec (volts) sec to sec (volts)  
 Output 1: \_\_\_\_\_ voltage \_\_\_\_\_ current  AC  DC  
 Output 2: \_\_\_\_\_ voltage \_\_\_\_\_ current  AC  DC  
 Output 3: \_\_\_\_\_ voltage \_\_\_\_\_ current  AC  DC

**Mechanical Requirements**  
 Mounting:  Through-hole  SMD  Flying leads Other: \_\_\_\_\_  
 Length (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_  
 Width (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_  
 Height (max.): \_\_\_\_\_  Inches  mm Other: \_\_\_\_\_

**Environmental Requirements**  
 Dry  Varnished  Vacuum Varnished  Epoxy  Impregnated Other: \_\_\_\_\_  
 Operating temperature °C: \_\_\_\_\_

**Additional Requirements**  
 Annual quantity: \_\_\_\_\_ Start of production: \_\_\_\_\_  
 Target price: \_\_\_\_\_  Sample required  
 Prioritization (1 - Highest) \_\_\_\_\_  
 Size \_\_\_\_\_ Efficiency \_\_\_\_\_ Cost \_\_\_\_\_ Target date for sample: \_\_\_\_\_  
 Notes  
 \_\_\_\_\_

Reset Print Submit  
 605.668.4133 [custommagn@vishay.com](mailto:custommagn@vishay.com)  
 Custom Magnetics, Vishay Intertechnology  
 1505 East Highway 50, P.O. Box 180, Yorkton, SD 57078

SALES INFORMATION  
  
[www.vishay.com](http://www.vishay.com) // VMN-MS7166-1512 // 1

 Fig. 2 - Transformers: [www.vishay.com/doc?48061](http://www.vishay.com/doc?48061)

### HOW DO I CHOOSE A CUSTOM MAGNETICS MANUFACTURER?

A quick internet search of the words “Custom Magnetics” will most likely include a list of permanent magnetic manufacturers at the top. This is great if you want to buy some magnets for your refrigerator, but these are clearly not what you really need. Look further and there will be a long list of custom magnetics manufacturers.

It is best to find a manufacturer that specializes in your market segment. Whether it is medical, industrial, aerospace, defense, or automotive, choosing a manufacturer that has experience in your segment will make your job easier since they are likely to have the design experience, materials, processes, and test equipment already in place to meet your needs.

Next, look at their manufacturing and quality certifications. If you are interested in automotive-grade products, then look for the TS-16949 certification and the ability to test to AEC-Q200 requirements. Several other certifications for specific industries are show in Table 1 for Vishay custom magnetics manufacturing facilities.



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## MANUFACTURING EXCELLENCE

Vishay’s custom magentics offer a global manufacturing footprint that is qualified to the highest quality and environmental standards.

| TABLE 1            |          |           |           |                |        |      |
|--------------------|----------|-----------|-----------|----------------|--------|------|
|                    | ISO 9001 | ISO 13485 | ISO 14001 | TS16949        | AS9100 | ITAR |
| <b>AMERICAS</b>    |          |           |           |                |        |      |
| Dominican Republic | X        |           | X         |                | X      | X    |
| Dover, NH          | X        |           | X         |                | X      | X    |
| Duluth, MN         | X        |           | X         |                | X      | X    |
| Marshall, MN       | X        | X         | X         |                |        |      |
| Juarez, Mexico     | X        |           | X         | X              |        | X    |
| Yankton, SD        | X        | X         | X         | X              | X      | X    |
| <b>ASIA</b>        |          |           |           |                |        |      |
| Zhuhai, China      | X        | X         | X         | Scheduled 2017 | X      |      |

Another consideration might be design and manufacturing location. Since custom magnetics often require an in-depth interchange between the designer and the manufacturer’s engineers, it is most convenient if the design center is in your same region. This will allow for conference calls and WebEx meetings to occur in the same time zone. Close proximity also enables productive in-person meetings.

In some cases, custom magnetics need to handle higher levels of power and are therefore substantial in volume and weight. Shipping costs can be a significant portion of the cost, so finding a supplier that can ship from multiple manufacturing locations within reasonably close proximity to your manufacturing site may also be a consideration.

Finally, be sure to choose a supplier that can provide the latest in technology. This will insure the most efficient and cost-effective solution for the application. For instance, new advances in power conversion include GaN and SiC devices for the switching components and diodes. These devices allow higher switching frequencies and greater power density. Be sure that your custom magnetics supplier can utilize the latest techniques for copper and magnetic loss reduction, including the mitigation of proximity losses, skin effect losses, and magnetics losses. Having the ability to simulate performance results with circuit simulation and finite element analysis software will reduce the design time to the first sample and can eliminate iterative sample build / test cycles to get the optimum performance on the first build.

## STANDARD MAGNETIC COMPONENTS ARE READILY AVAILABLE AND STOCKED BY DISTRIBUTORS AND MANUFACTURERS. HOW DOES THIS WORK WITH CUSTOM MAGNETIC PRODUCTS?

Most custom magnetics suppliers sell direct to their customers. However, a distributor may work with the supplier to support inventory and minimum shipments. Since there is usually a significant resource investment by the supplier to design, obtain material quotes, procure materials for samples, and build samples, many custom magnetic suppliers require a minimum amount of business to engage with a customer for a new design. Some suppliers specialize in small quantities and can be a good choice for applications that are relatively simple and may include quantities from tens to hundreds of pieces. However, these suppliers may not be able provide high volumes of the device or a cost-effective solution when the volumes move to thousands or hundreds of thousands of pieces per year. Be sure to ask about minimum quantities or minimum sales volume requirements during the initial discussions.

## CONCLUSION

If your application calls for a custom magnetics device, there are many factors to keep in mind when selecting a manufacturer. To meet your needs, Vishay provides unmatched design expertise across a variety of segments, proven quality and reliability, and manufacturing locations around the world for a wide variety of custom magnetic devices at a competitive price.