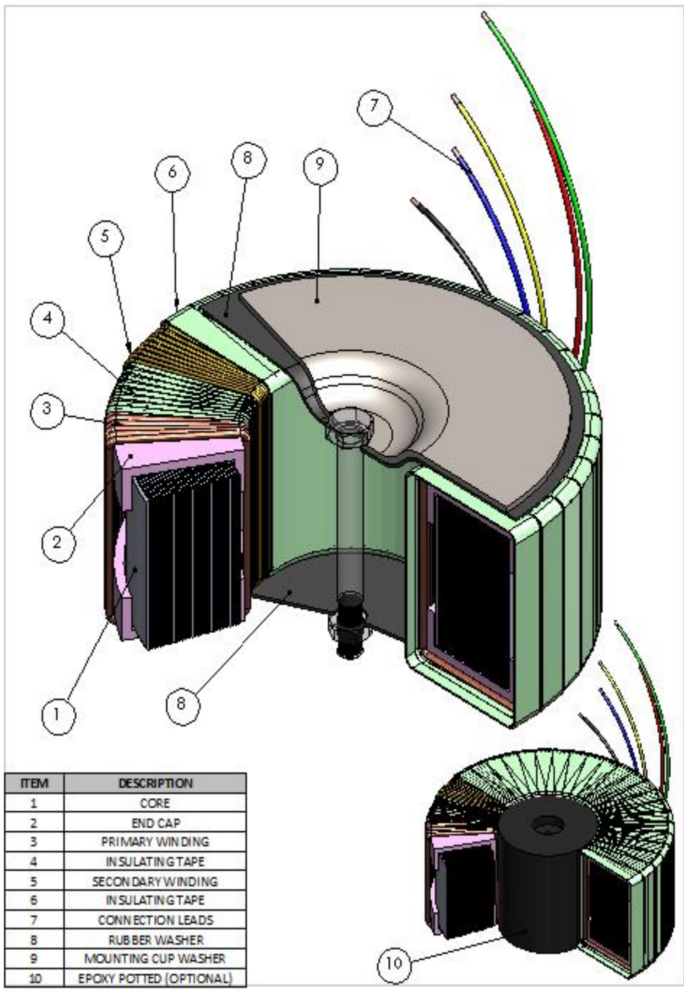
Bridgeport Magnetics Design Guide

Our design guide takes you step by step through the process of designing a toroidal transformer.

- No engineering design charges for all standard designs.
- State of the art computer-aided design tools for quick turnaround of prototypes.
- Certified to UL, Canadian, EN and IEC safety standards

For most custom transformer designs, there's no need for special costly tools, such as stamping dies required for custom lamination forms. Unlike E-I cores which require special tooling.

If you have any questions about your design, our engineering and design team is available at 800-836-5920 to help you



ITEM	DESCRIPTION
1	CORE
2	END CAP
3	PRIMARY WINDING
4	INSULATING TAPE
5	SECONDARY WINDING
6	INSULATING TAPE
7	CONNECTION LEADS
8	RUBBER WASHER
9	MOUNTING CUP WASHER
10	EPOXY POTTED (OPTIONAL)

Step 1- Choose your Primary Windings

- Choose the line voltage: 100V, 120V, 208V, 220V, 230V, 240V, 277V or other
- Specify the Total Power Rating (VA)
- Specify the % Duty Cycle on all secondary windings.

Step 2- Choose your Operating Frequency

The standard line operating frequency in North America is 60 Hz. The rest of the world operates at 50 Hz.
A transformer designed for 50 Hz will also work at 60 Hz but a transformer designed for 60 Hz will not work at 50 Hz.
A 50 Hz transformer is 20% larger than a 60 Hz design so allow space for a 50 Hz design if you plan to export your product at a future date.

400 Hz is used for weight sensitive airborne and seaborne applications as it allows the transformer to be about 1/3 smaller.

Step 3- Specify your Power Requirements

Our toroidal power transformers are available from 7 VA to 30,000 VA (Single Phase) or 90,000 VA (Three-Phase).
You can specify the output load in one of two ways:

Method 1: Specify the AC (RMS) voltage and current or power (VA) and duty cycle for each secondary output. Please specify whether the secondary voltage is open or under load.

Method 2: Specify the DC load parameters. Please tell us the: DC voltage, current, rectifier type (full wave, full wave bridge, etc.) and specify the capacitor type and value, regulator type and specifications, any special load characteristics, including duty cycle.

If possible, please supply a schematic so that we can determine the optimum secondary DC specifications for each output.

Because of the way primaries and secondary's are wound uniformly around the core, and the fact that toroids have no air gaps, there is very low emission of stray magnetic fields or EMR (Electro-Magnetic Radiation).

If the transformer is not operating continuously under full load, please specify the duty cycle so that we can calculate a smaller power rating which will save you space and cost.

Step 4- Specify the Insulation Class

The standard insulation is Class A (105ºC).
Class B (130ºC) or Class F (155ºC) are available as options.

Step 5- Specify the Primary Windings (Input Voltages)

For 60 Hz single phase applications: 117V, 208V 220V or 277V. For three-phase configurations: 380V.
For 50 Hz single phase applications: 230/240V and for three-phase configurations: 440V.
For 50-60 Hz worldwide single phase applications: 100V, 117/120V, 220V and 234/240V voltages. You need 100V/50Hz for the Japanese market.
If your overseas market is very small, you can save money by having a dedicated 50Hz design.

Specify the Secondary Windings (Output Voltages)

You can specify the output loading in one of two ways:

Method 1: Specify the AC (RMS) voltage and current or power (VA) and duty cycle for each secondary output. Please specify whether the secondary voltage is open or under load.

Method 2: Specify the DC load parameters. Please tell us the: DC voltage, current, rectifier type (full wave, full wave bridge, etc.) Specify the capacitor type and value; regulator type and specifications, any special load characteristics, including duty cycle.

If possible, please supply a schematic so that we can determine the optimum secondary DC specifications for each output.

Step 6- Choose the Mounting Method

A metal washer and rubber pads provide the most economical way of mounting the transformer horizontally and is adequate for transformers under 600 VA, provided the transformer is not installed in a product that receives rough handling. Above 600 VA, epoxy potted center is the standard mounting method. Prices include mounting hardware, either a steel washer with two rubber pads or as shown for larger sizes, an epoxy potted center with one or two drilled mounting holes.

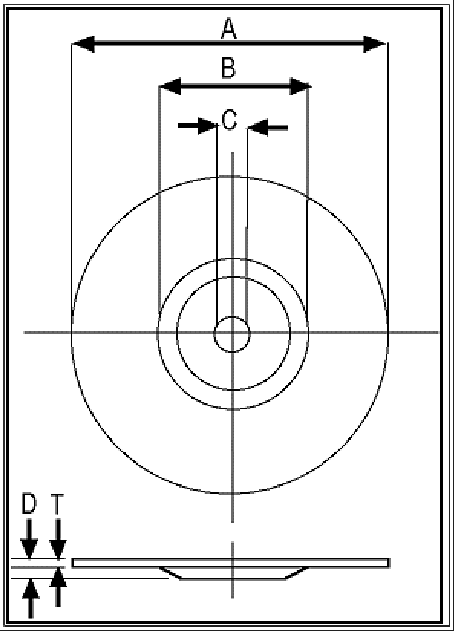
Optional Potted Center - For a nominal cost you can order smaller transformers with epoxy potting, either with drilled hole or threaded inserts. The potting has a recessed top to accommodate screw head. Flat bottom is a standard feature.

The L-Bracket - An L-shaped steel bracket is an economical solution for vertical mounting. A metal washer and two rubber pads are furnished with each L-bracket. Larger transformers will have an epoxy potted center.

Standard Sizes of Steel Washers

Dimensions in Inches

Size	A	B	C	T	D
1	2.00	.75	.188	.04	.18
2	2.38	.88	.188	.05	.22
3	2.75	1.13	.25	.06	.26
4	3.50	1.25	.25	.06	.28
5	4.38	1.38	.31	.08	.33
6	5.70	1.75	.31	.08	.50



Step 7-Choose the Connections and Leads

Our standard design is to provide toroidal transformers with multi-stranded leads. Self leads and connector assembly are also available as an option.

Step 8- Choose the Thermal Protection

When a fuse or thermal cut-out is desirable, we use a cut-out that opens at 110C unless otherwise specified. You can choose between auto-resettable or non-resettable thermal fuse. 95% of our designs have the thermal fuse installed in-line on the primary leads.

Step 9- Choose the Electrostatic Shielding

An Electrostatic shielding (a.k.a. Faraday shield) may be needed to minimize capacitive coupling between primary and secondary windings if transformer operates in an extremely noisy environment.

Step 10- Is your design sensitive to electromagnetic stray-fields?

Our standard design greatly reduces stray fields compared to a laminated transformer. For sensitive electronic applications, our optional Ultra-Low Stray Field Design achieved through a proprietary process further reduces the emissions. In applications such as audio equipment, high-resolution CRT displays, a magnetic shield around the circumference of the transformer achieves even lower stray field levels.

Step 11-Factors that influence Physical Size and Weight

Experience has shown that for the conventional transformer using stacked lamination cores with air gaps, the working flux densities of 12 to 14 kilogauss are the practical limits, i.e. before the transformer goes into saturation. Toroidal transformers can be designed with flux density of up to 16 kilogauss. With this higher working flux density our toroidal transformers require fewer turns and/or a smaller cross sectional core area. We can significantly reduce transformer size and weight where the transformer is loaded intermittently. In such cases, the load is energized for a short time duration, which is much shorter than the overall thermal time constant of the transformer. The same is true for transformers mostly running at half the load. To know the actual duty cycle will therefore be very helpful in designing the adequate power rating.

Step 12- Power Ratings / Size and Weight information

Typical sizes and weights listed in the chart below serve as a basic guideline to determine size and weight based on power (VA) rating. Height and diameter can be varied, as long as the core cross section holds constant. The most economical height to diameter ratio is approx. 1:2. You may specify the diameter and height you would like or simply tell us the maximum physical envelope available.

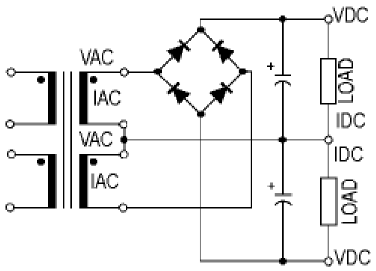
Quick Reference Table for Approximate Physical Sizes

Rating	Dimensions OD x HT		Weight	
VA	inches	mm	lbs	kg
25	2.6 x 1.4	66 x 36	1.1	0.5
50	3.2 x 1.5	81 x 38	1.7	0.8
100	3.9 x 1.6	99 x 41	2.4	1.1
150	4.3 x 1.7	109 x 43	3.4	1.6
200	4.5 x 1.9	114 x 48	4.4	2.0
250	4.7 x 2.1	119 x 53	5.4	2.5
300	5.0 x 2.3	127 x 59	6.2	2.8
400	5.2 x 2.5	132 x 64	7.4	3.4
500	5.4 x 2.8	137 x 71	8.8	4.0
600	5.7 x 2.9	145 x 74	10.3	4.7
750	6.3 x 2.9	160 x 74	12.7	5.8
1000	6.6 x 3.0	168 x 76	15.4	7.0
1500	7.8 x 3.5	198 x 89	26.0	11.8
2000	8.4 x 3.9	213 x 99	34.0	15.5

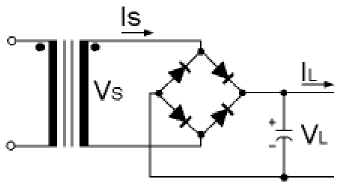
Power rating (VA) is determined by secondary RMS data. Physical size may vary from above data depending on number of primary and secondary windings and whether duty cycle is 100%.

Step 13- Choose the Best Rectifier Circuit for your application

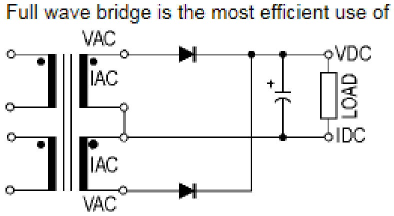
When using a toroidal power transformer, some rectifier circuit designs are more efficient than others. Four typical circuits are illustrated here with our recommendations. Consult us for further information and assistance.



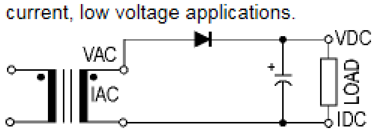
Dual Center Tap Rectifier
This is a very efficient use of toroidal transformers, and the best choice for two balanced outputs with a common return. The output windings are wound for precisely matched series resistance, coupling and capacitance



Full Wave Bridge
Full wave bridge is the most efficient use of toroid technology and secondaries; best for high voltage outputs.



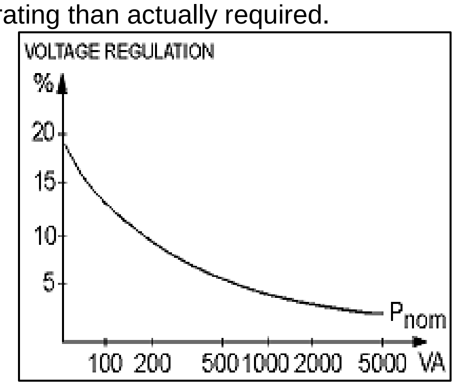
Full Wave Center Tap
The full wave does not make full use of secondaries. However, it is more efficient than the half wave. It is good for high current, low voltage applications.



Half Wave Rectifier
Avoid half wave rectifier circuits, as they are an inefficient use of toroidal transformers. They cause the core to become polarized and saturate in one direction.

Step 14- Aspects of Voltage Regulation

Output voltage regulation varies with the size of the toroidal electrical transformer. Regulation can be improved by selecting a transformer with a higher VA rating than actually required.



Step 15- Avoiding Shorted Turn Condition

A completed path by any conductor passing through the center hole of the toroid constitutes a shorted turn. A through-the-center screw making contact to the chassis at both ends can inadvertently establish a shorted turn. As with any short circuit, this condition will result in high circulating currents and high local heat. Such mounting must be avoided.

Step 16- Avoiding the Nuisance Inrush Current Phenomenon

Because toroidal electrical transformers have excellent magnetic properties and no air gaps, the inrush current when power is turned on is sometimes higher than with stacked transformers. Inrush current can be as high as 15 times the peak steady state rated current. It typically lasts less than 10ms and rarely lasts over a half cycle.
We suggest using a delayed action fuse or circuit breaker protection to avoid nuisance tripping of circuit breakers or blown fuses

Transformer Rating	Suggested Protection
Up to 300VA	None
300VA to 1,000VA	Use slow-blow fuse in primary circuit
1,000VA to 2,000VA	Add a small value resistor in series with primary circuit.
2,000VA and up	Add a by-pass relay that will momentarily short out the resistor after 100-200 milliseconds. An NTC thermistor may be sufficient for some applications.

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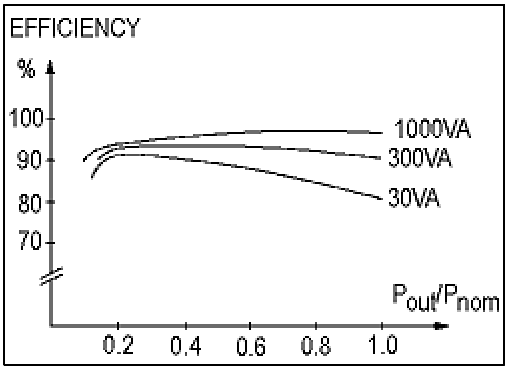
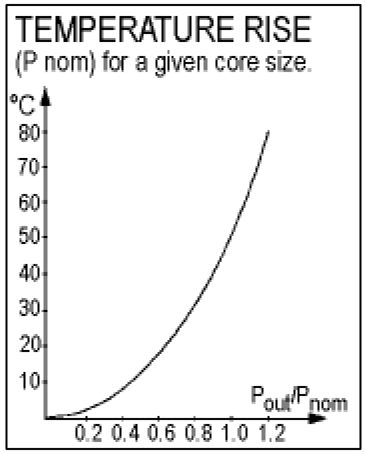
Step 17- Aspects of Efficiency

The graph illustrates the effect of increasing load on the efficiency for various nominal ratings. Using an oversized core will increase the efficiency.



Step 18- Temperature Rise

Temperature rise varies with the actual output power (P-out) in relation to nominal power (P-nom) for a given core size. Our basic design guideline is not to exceed 55 ºC to comply with Class A (105 C) and Class B (130C) requirements for room temperature applications with a comfortable safety margin. . Actual temperature increase will depend on how and where the transformer is mounted and how well it is cooled. When higher temperature ratings are needed, we offer transformers built to Class F (155C). Please specify the temperature rise or tell us the operating ambient temperature.



Using a larger core size will reduce the temperature rise. The small core losses will cause the temperature rise to drop drastically when reducing the output power. At half the load, the temperature rise will only be about 25% of the rise at full load.

Total losses for the transformer, including winding loss and core loss per pound of silicon steel at a given flux level, may be calculated from design data and data furnished by steel suppliers. The graph illustrates the rise in transformer temperature as the actual power approaches the toroidal transformer's nominal power rating.

Safety Standard Agency Approvals

Our standard and custom designed transformers are certified to the following standards**:**

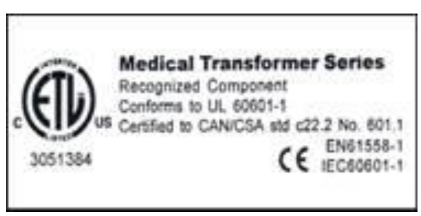
General Purpose Transformers

Safety standards: UL506, CSA C22.2 No.66-1988, EN 61558-1, IEC61558-1, IEC742

Intertek File: 3051384

Medical Application Transformers

Safety standards: UL60601-1, CSA std. c22.2, No.601.1, EN61558-1, IEC60601-1 **3rd Edition**



Intertek File: 3051384

CB Report# 100891440BOX-002

Our transformers are also designed to the applicable sections of other standards, such as UL950, IEC950, UL813, UL1236, EN742, VDE0750, VDE0551, CSA C22.2#125, and many more.