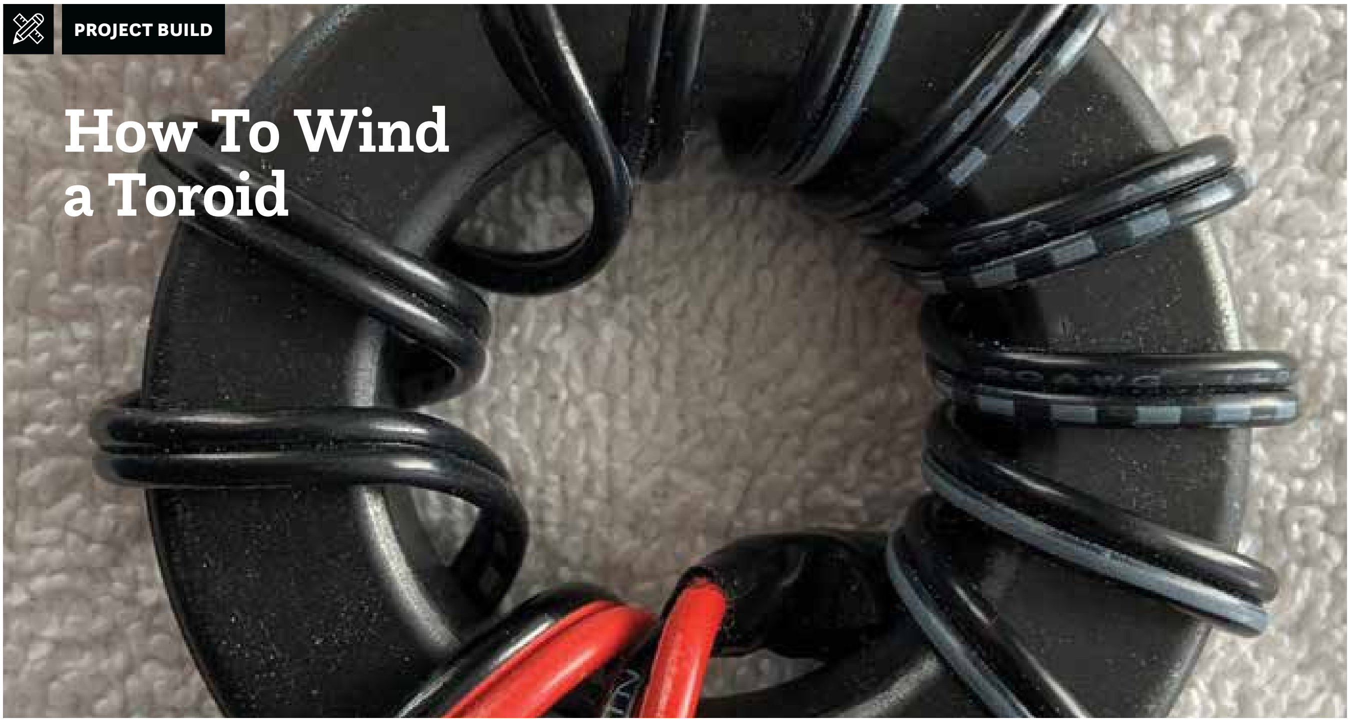
PROJECT BUILD

How To Wind a Toroid



When you think of a coil of wire, better known in electronics as an *inductor*, you probably imagine something similar to the coil shown in Figure 1. Inductors store energy in magnetic fields when electric current flows through them. They are used in radio circuits to reduce or block signals at certain frequencies. When combined with capacitors, inductors can be used to create so-called *tuned circuits*.

Inductors come in many forms, but among the most common are those that use wires wound around a donut-shaped form called a *core*, which is made of powdered iron or other materials. When you wrap wires around a core, the result is a *toroidal inductor*, or what most hams simply call a *toroid*.

Toroids have certain advantages over traditional coils:

- Toroids are compact. They usually take up less room than an air-wound coil and offer the same amount of inductance.
- Toroids offer superior electrical performance. The advantage of a toroid's shape is that, due to its symmetry, the magnetic fields are confined mostly to the core. This means a toroid doesn't interfere with surrounding circuitry.

Core Types

When you're using a toroid inductor in a radio frequency (RF) circuit, not any old core will do. Cores are sold in a variety of sizes, but they are also classified according to their *type*. Loosely defined, a core's type (sometimes called a *mix*) dictates how the inductor will behave in a circuit in a given range of frequencies. The types you're most likely to encounter are 43, 52, 61, 67, 68, 75, and 76. It is important to know which type you are using, which we'll explain later.

Why You Should Care About Toroids

You'll find toroid inductors frequently in amateur radio equipment, so it helps to know a little about what they are and how they work. Some toroids are simply inductors made with a core and a single strand of wire (see Figure 2). Other toroids use multiple wires and can be somewhat complex, such as the transformer shown in Figure 3.

If you want to try your hand at building a receiver or transmitter kit, chances are the kit will require you to assemble one or more toroids. The instructions will include steps such as, "Take the yellow Type 67 core and wind 20 turns of number 18 wire."

Also, if you're running into interference problems, such as when your radio signal is getting into your stereo speakers, you can use a toroid core to create a *choke* that will block the energy from entering the speaker. Chokes like these can also be used to suppress RF energy that may be traveling down your antenna system cables and causing problems in your station.

Figure 1: When you think of a coil, an image like this probably comes to mind. You'll see coils like these in ham equipment such as power supplies, manual antenna tuners, transceivers, and more. Regardless of how they may look, the function of a coil is always the same: to oppose changes in the current flowing through it.

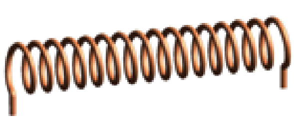


Figure 2: A simple toroid is little more than a length of wire that has been wound around a core of powdered iron or other materials. Some hams refer to cores as *ferrite donuts*.

Creating a Toroid Inductor

Some hams find toroids intimidating because they don't know how to wind them properly. Yes, toroids with multiple wires can be a bit tricky if you don't follow the instructions carefully. However, simple toroids wound with single wires or cables are extremely easy to build, and these are the ones you're most likely to use.

Step 1:

If you're building a kit, the instructions will tell you which core to use and how many turns of wire you need to apply. When winding a toroid, the first time the wire passes through the center of the core counts as the *first* turn — even though you haven't actually turned or bent the wire yet. This is a fact that confuses some hams (see 1).

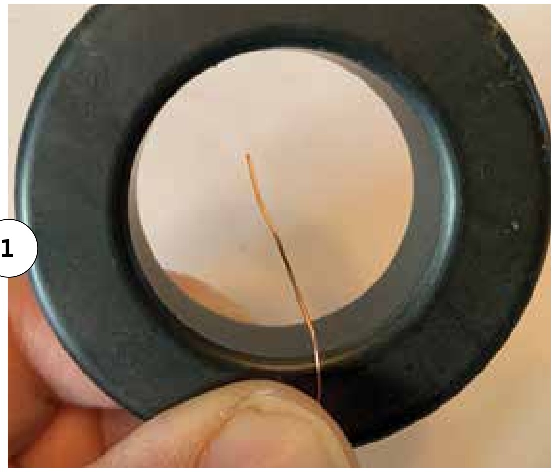
Step 2:

Once you've passed the wire through the center of the core (turn number 1, as described in Step 1), bring the wire up and over the outside edge of the core's "ring," and then send it back through the center again and pull it tight. This will be turn number *two* (see 2).

Step 3:

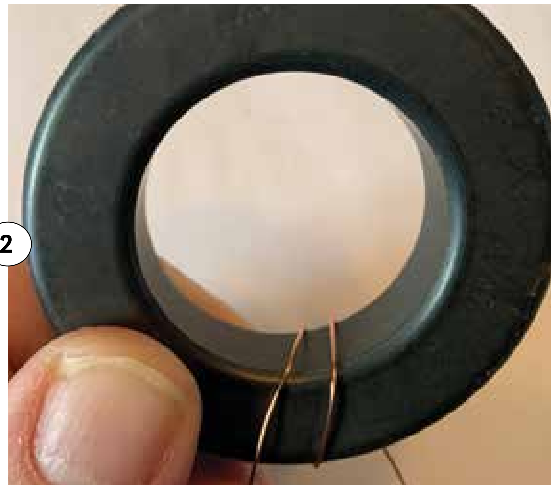
Repeat Step 2 over and over, spacing the turns of wire evenly around the core as you go. Each time you thread the wire through the center counts as another turn. Keep wrapping until you reach the required number of turns. Be careful not to overlap turns (see 3) and make sure they are evenly spaced. You can adjust the spacing after you wrap the last turn.

1



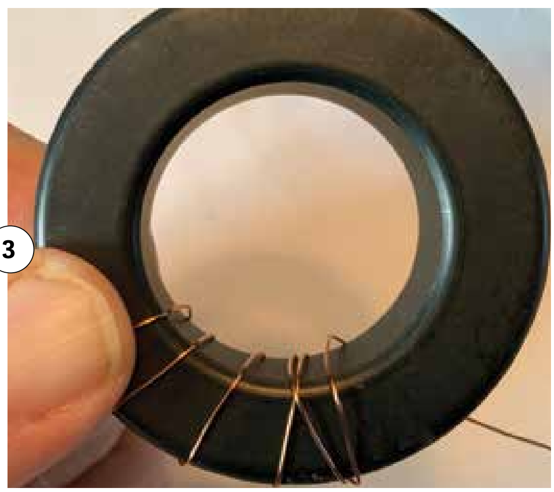
We count turns beginning with the first time the wire passes through the center of the core. This photo shows turn number 1.

2



Once the wire has passed through the center of the core, bring it back around, pass it over the edge of the core, and then send it back through the center once again. This will be the *second* turn.

3



Beware of overlapping turns when winding wire around a toroid core. This photo shows an example of what *not* to do!

Figure 3: Some toroids can be complicated, such as this toroid transformer that has several different windings. In a transformer application, one winding is often larger or smaller than the other. The fields around the windings interact, allowing the transformer to boost an ac voltage (including a signal) to a higher value, or vice versa.

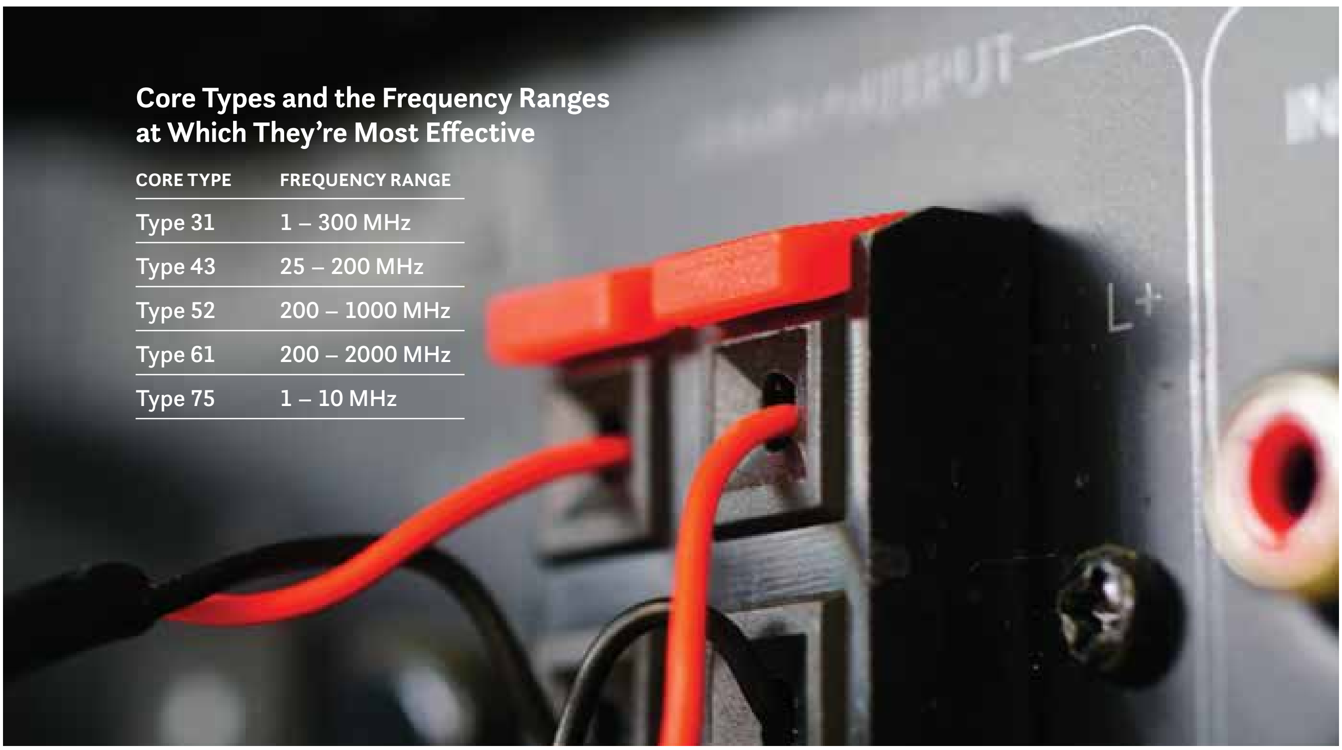
Making an RF Choke from Coaxial Cable

The toroid shown in (4) is made by using coaxial cable rather than wire. This is a type of choke that we discussed earlier, and it is used to reduce any RF energy on the antenna feed line

For applications such as blocking RF signals from entering audio amplifiers through various wires (such as speakers or ac power lines), you can create a choke by wrapping 7 or 8 turns of the trouble-some wire through a toroid core (see the facing page). This is where the core type becomes important. See the table of "Core Types and the Frequency Ranges at Which They're Most Effective." As you might guess, Type 31 is popular for ham applications because it can be used to create effective chokes at frequencies amateurs use most often.

4

You can make an effective RF choke for an antenna system by wrapping coaxial cable through a sizable core.



Core Types and the Frequency Ranges at Which They're Most Effective

CORE TYPE	FREQUENCY RANGE
Type 31	1 – 300 MHz
Type 43	25 – 200 MHz
Type 52	200 – 1000 MHz
Type 61	200 – 2000 MHz
Type 75	1 – 10 MHz

A toroid core can be used as a choke to block RF signals from entering other devices. In this example, a dc power cable is wound through a core to prevent interference to a powered device. Unlike toroids used in circuitry, there is no hard-and-fast rule for the number of turns used to create a choke. Generally, the more the better. More turns means more inductance and a greater ability to "choke off" RF energy that might be traveling on the line and causing problems. In this example, 12 turns were wrapped around the core. We've numbered the turns to show the correct way to count them.