BRIEF NOTES ON TOROID CHARACTERISTICS

by R. Jayaraman, VU2JN

The following notes are not meant to represent a comprehensive article on toroids.

1. Toroids are circular rings made of Powdered-iron or Ferrite, for use as the 'former' for winding inductors and transformers that do not interact with nearby metal objects, and do not radiate an electromagnetic field. The core cross-section may be square or circular.

2. Both Powdered-iron toroids and Ferrite toroids are passively magnetic. Powdered-iron toroids conduct electricity, so are painted for insulation. Ferrite toroids do not conduct electricity, and are not painted. This difference helps in identifying them.

3. Both types are available in various diameters, typically:

P-iron toroids:	0.25", 0.37", 0.50", 0.68", 1.06", 1.57", 2.00"
Ferrite toroids:	0.23", 0.37", 0.50", 0.68", 0.82", 1.14", 2.40"

Ferrite toroids are usually thinner than powdered-iron toroids of similar diameter.

4. Ferrite toroids have very high permeability, but saturate easily, so cannot transmit power. They are preferred for low-level tuned or broadband circuits. Powdered-iron toroids have lower permeability, but can carry larger currents without saturation. They are preferred for tuned or broadband circuits in RF power amplifiers, filters, antenna tuners, baluns, etc. Powdered-iron toroids are painted and colour-coded.

5. Both types are available in various 'mixes' having different permeability (μ) and recommended upper frequency (f). The types that are of interest to hams are:

P-iron toroids:	Mix 1 - μ = 20	col. code Blue	f = 8 MHz
	Mix 2 - μ = 10	col. code Red	f = 20 MHz
	Mix 6 - μ = 8	col. code Yellow	f = 30 MHz
	Mix 10 - μ = 6	col. code Black	f = 60 MHz
	Mix 12 - μ = 3.5	col. code Green	f = 150 MHz
Ferrite toroids:	Mix 43 - μ = 850	f = 4 MHz (tuned), 30 MHz (broadband)	
	Mix 61 - μ = 125	f = 25 MHz (tuned), 200 MHz (broadband)	

6. Powdered-iron toroids are named with the prefix T, whereas Ferrite toroids are named with the prefix FT. Examples:

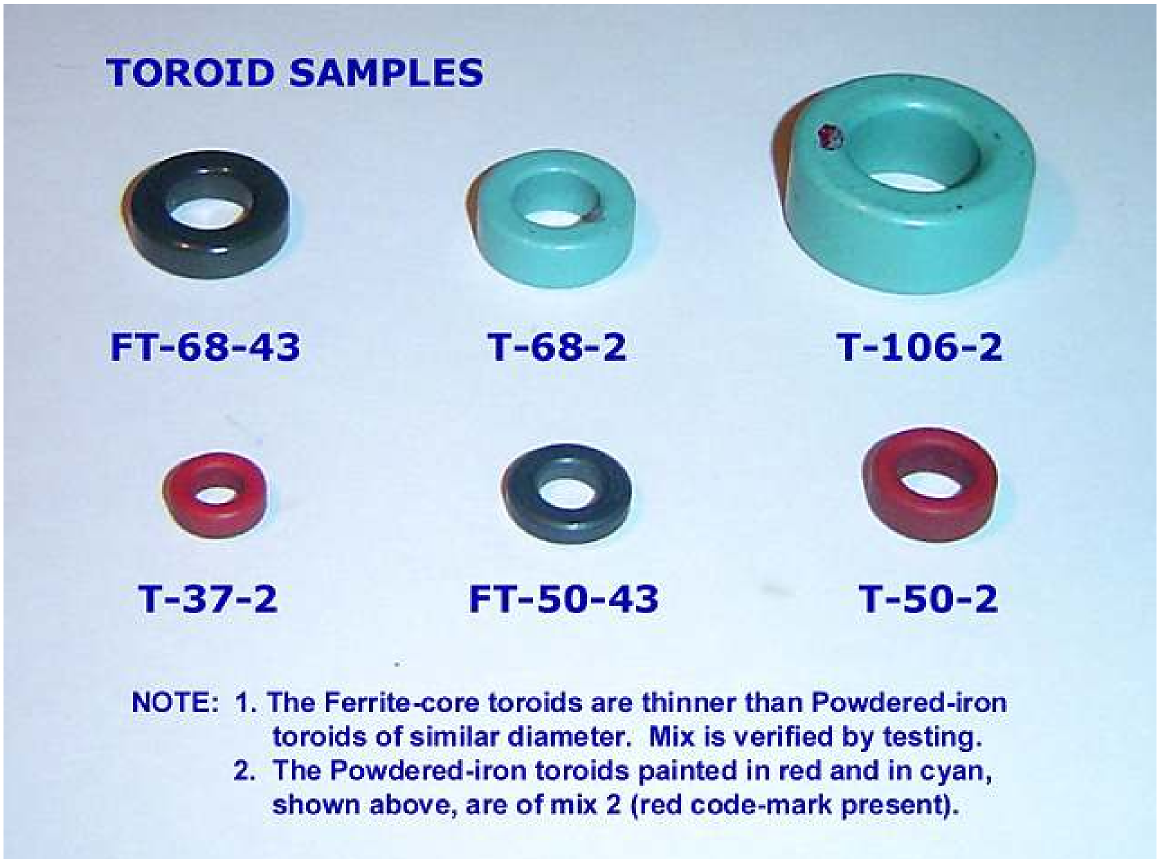
T-37-2 :	powdered-iron core, 0.37"o.d., mix 2.
FT-50-43:	ferrite core, 0.50"o.d., mix 43.

7. The inductance of a toroidal coil is given by the expression:

$$L \text{ (in } \mu\text{H)} = N^2 . A_L / 10000$$

where N is the no. of turns, and the A_L value (unit μH) depends on the dimensions of the toroid as well as its permeability.

8. For a particular toroid diameter, the A_L value is proportional to the permeability and the cross-sectional area of the core. A_L values for some common toroid types are:



Type	*μ*	*A_L (unit μH)*	*Type*	*μ*	*A_L (unit μH)*
T-37-2	10	40	FT-37-43	850	420
T-37-6	8	32	FT-37-61	125	55
T-50-2	10	50	FT-50-43	850	523
T-50-6	8	40	FT-50-61	125	68
T-68-2	10	57	FT-68-43	850	540
T-106-2	10	135	FT-82-43	850	557
T-157-2	10	140	FT-114-43	850	603
T-200-2	10	120	FT-240-43	850	1249

A 20-turn test winding on a T-50-2 toroid would show an inductance of 2 μH. A similar winding on a FT-50-43 toroid would show an inductance of 21 μH.

9. There are no clear-cut rules on the RF power that Powdered-iron toroids can handle. In circuits meant only for impedance transformation, they can be allowed to get moderately warm. In circuits where there is a DC flow or some selectivity is also desirable, the power has to be reduced. So, a particular toroid is usable at the highest power in a balun, and at progressively less power in an ATU, a broadband PA stage, and a tuned PA stage. Approximate ranges are: T-68-2: 40/10 W; T-106-2: 120/30 W; T-157-2: 200/50 W.

Compiled by: VU2JN, Feb. 2013.

■