

## TOROIDAL CORES : IRON POWDER CORES

Iron Powder Cores are made in numerous shapes and sizes: such as Toroidal Cores, E- cores, Shielded Coil Forms, Sleeves etc., each of which is available in many different materials. There are two basic groups of iron powder material: (1) The Carbon Iron and, (2) The Hydrogen Reduced Iron.

The Carbonyl iron cores are especially noted for their stability over a wide range of temperatures and flux levels. Their permeability range is from less than 3  $\mu$ i to 35  $\mu$ i and can offer excellent 'Q' factors from 50 KHz to 200 MHz. They are ideally suited for a variety of RF applications where good stability and good 'Q' are essential. Also, they are very much in demand for broadband inductors, especially where high power is concerned.

The Hydrogen Reduced Iron cores have higher permeabilities ranging from 35 $\mu$ i to 90  $\mu$ i. Somewhat lower 'Q' can be expected from this group of cores. They are mainly used for EMI filters and low frequency chokes. They are also very much in demand for input and output filters for switched mode power supplies.

The next several pages are devoted to iron Powder materials and the toroidal core configuration in particular. You will find physical dimensions of available items, their  $A_L$  values and other magnetic properties, as well as how to select the proper core for your application.

In general, toroidal cores are the most efficient of any core configuration. They are highly self-Shielding since most of the flux lines are contained within the core. The flux lines are essentially uniform over the entire length of the magnetic path and consequently stray magnetic fields will have very little effect on a toroidal inductor. It is seldom necessary to shield a toroidal inductor.

The  $A_L$  value of each iron powder core can be found in the charts on the next several pages. Use this  $A_L$  value and the formula below to Calculate the number of turns for a specific inductance.

$$N = 100 \sqrt{\frac{\text{desired 'L' } (\mu h)}{A_L (\mu h/100 \text{ turns})}} \quad L(\mu h) = \frac{A_L \times N^2}{10,000} \quad A_L(\mu h/100 \text{ turns}) = \frac{10,000 \times 'L' (\mu h)}{N^2}$$

N = number of turns

L = inductance ( $\mu$ h)

$A_L$  = inductance index ( $\mu$ h)/100 turns)

### IRON POWDER TOROIDAL CORES

(For Resonant Circuits)

Material 0	Permeability <sup>1</sup>		Freq. Range 100MHz-300 MHz			Color-Tan	
Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	$A_e$ (cm) <sup>2</sup>	$V_e$ (cm) <sup>3</sup>	$A_L$ Value $\mu$ h/100 turns
T-12-0	0.125	0.062	0.050	0.740	0.010	0.007	3.000
T-16-0	0.160	0.078	0.060	0.950	0.016	0.015	3.000
T-20-0	0.200	0.088	0.070	1.150	0.025	0.029	3.500
T-25-0	0.255	0.120	0.096	1.500	0.042	0.063	4.500
T-30-0	0.307	0.151	0.128	1.830	0.065	0.119	6.000
T-37-0	0.375	0.205	0.128	2.320	0.070	0.162	4.900
T-44-0	0.440	0.229	0.159	2.670	0.107	0.286	6.500
T-50-0	0.500	0.303	0.190	3.030	0.121	0.367	6.400
T-68-0	0.690	0.370	0.190	4.240	0.196	0.831	7.500
T-80-0	0.795	0.495	0.250	5.150	0.242	1.246	8.500
T-94-0	0.942	0.560	0.312	6.000	0.385	2.310	10.600
T-106-0	1.060	0.570	0.437	6.500	0.690	4.485	19.000
T-130-0	1.300	0.780	0.437	8.290	0.730	6.052	15.000

Note: Due to the nature of the '0' material, the inductance resulting from the use of the given  $A_L$  value may vary greatly depending upon the winding technique. This may cause discrepancy between calculated and measured inductance.

Material 1	Permeability <sup>20</sup>		Freq. Range 0.5 MHz-5 MHz			Color-Blue	
Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	$A_e$ (cm) <sup>2</sup>	$V_e$ (cm) <sup>3</sup>	$A_L$ Value $\mu$ h/100

							turns
T-12-1	0.125	0.062	0.050	0.740	0.010	0.007	48.000
T-16-1	0.160	0.078	0.060	0.950	0.016	0.015	44.000
T-20-1	0.200	0.088	0.070	1.150	0.025	0.029	52.000
T-25-1	0.255	0.120	0.096	1.500	0.042	0.063	70.000
T-30-1	0.307	0.151	0.128	1.830	0.065	0.119	85.000
T-37-1	0.375	0.205	0.128	2.320	0.070	0.162	80.000
T-44-1	0.440	0.229	0.159	2.670	0.107	0.286	105.000
T-50-1	0.500	0.303	0.190	3.030	0.121	0.367	100.000
T-68-1	0.690	0.370	0.190	4.240	0.196	0.831	115.000
T-80-1	0.795	0.495	0.250	5.150	0.242	1.246	115.000
T-94-1	0.942	0.560	0.312	6.000	0.385	2.310	160.000
T-106-1	1.060	0.570	0.437	6.500	0.690	4.485	325.000
T-130-1	1.300	0.780	0.437	8.290	0.730	6.052	200.000
T-157-1	1.570	0.950	0.570	10.050	1.140	11.457	320.000
T-184-1	1.840	0.950	0.710	11.120	2.040	22.685	500.000
T-200-1	2.000	1.250	0.550	12.970	1.330	17.250	250.000

Note: Most Cores can be very useful well below the lower frequency limit shown above.

Material 2	Permeability 10		Freq. Range 2 MHz-30 MHz			Color-Red		
	Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	$A_e$ (cm) <sup>2</sup>	$V_e$ (cm) <sup>3</sup>	$A_L$ Value $\mu$ h/100 turns
T-12-2		0.125	0.062	0.050	0.740	0.010	0.007	20.000
T-16-2		0.160	0.078	0.060	0.950	0.016	0.015	22.000
T-20-2		0.200	0.088	0.070	1.150	0.025	0.029	25.000
T-25-2		0.255	0.120	0.096	1.500	0.042	0.063	34.000
T-30-2		0.307	0.151	0.128	1.830	0.065	0.119	43.000
T-37-2		0.375	0.205	0.128	2.320	0.070	0.162	40.000
T-44-2		0.440	0.229	0.159	2.670	0.107	0.286	52.000
T-50-2		0.500	0.303	0.190	3.030	0.121	0.367	49.000
T-68-2		0.690	0.370	0.190	4.240	0.196	0.831	57.000
T-80-2		0.795	0.495	0.250	5.150	0.242	1.246	55.000
T-94-2		0.942	0.560	0.312	6.000	0.385	2.310	84.000
T-106-2		1.060	0.570	0.437	6.500	0.690	4.485	135.000
T-130-2		1.300	0.780	0.437	8.290	0.730	6.052	110.000
T-157-2		1.570	0.950	0.570	10.050	1.140	11.457	140.000
T-184-2		1.840	0.950	0.710	11.120	2.040	22.685	240.000
T-200-2		2.000	1.250	0.550	12.970	1.330	17.250	120.000
T-200A-2		2.000	1.250	1.000	12.970	2.240	29.050	218.000
T-225-2		2.250	1.405	0.550	14.560	1.508	21.956	120.000
T-225A-2		2.250	1.485	1.000	14.560	2.730	39.749	215.000
T-300-2		3.058	1.925	0.500	19.830	1.810	35.892	114.000
T-300A-2		3.048	1.925	1.000	19.830	3.580	71.991	228.000
T-400-2		4.000	2.250	0.650	24.930	3.660	91.244	180.000
T-400A-2		4.000	2.250	1.300	24.930	7.432	185.280	360.000
T-520-2		5.200	3.080	0.800	33.160	5.460	181.000	207.000

Material 3	Permeability 35		Freq. Range 0.05 MHz-0.5 MHz			Color-Grey		
	Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	$A_e$ (cm) <sup>2</sup>	$V_e$ (cm) <sup>3</sup>	$A_L$ Value $\mu$ h/100 turns
T-12-3		0.125	0.062	0.050	0.740	0.010	0.007	60.000
T-16-3		0.160	0.078	0.060	0.950	0.016	0.015	61.000
T-20-3		0.200	0.088	0.070	1.150	0.025	0.029	76.000
T-25-3		0.255	0.120	0.096	1.500	0.042	0.063	100.000
T-30-3		0.307	0.151	0.128	1.830	0.065	0.119	140.000

T-37-3	0.375	0.205	0.128	2.320	0.070	0.162	120.000
T-44-3	0.440	0.229	0.159	2.670	0.107	0.286	180.000
T-50-3	0.500	0.303	0.190	3.030	0.121	0.367	175.000
T-68-3	0.690	0.370	0.190	4.240	0.196	0.831	195.000
T-80-3	0.795	0.495	0.250	5.150	0.242	1.246	180.000
T-94-3	0.942	0.560	0.312	6.000	0.385	2.310	248.000
T-106-3	1.060	0.570	0.437	6.500	0.690	4.485	450.000
T-130-3	1.300	0.780	0.437	8.290	0.730	6.052	350.000
T-157-3	1.570	0.950	0.570	10.050	1.140	11.457	420.000
T-184-3	1.840	0.950	0.710	11.120	2.040	22.685	720.000
T-200-3	2.000	1.250	0.550	12.970	1.330	17.250	425.000
T-200A-3	2.000	1.250	1.000	12.970	2.240	29.050	460.000
T-225-3	2.250	1.405	0.550	14.560	1.508	21.956	425.000

<b>Material 6</b>	<b>Permeability 8</b>		<b>Freq. Range 10 MHz-50 MHz</b>				<b>Color-Yellow</b>
<b>Core Number</b>	<b>O.D. (inches)</b>	<b>I.D. (inches)</b>	<b>Hgt. (inches)</b>	<b>(cm)</b>	<b>A<sub>e</sub> (cm)<sup>2</sup></b>	<b>V<sub>e</sub> (cm)<sup>3</sup></b>	<b>A<sub>L</sub> Value μh/100 turns</b>
T-12-6	0.125	0.062	0.050	0.740	0.010	0.007	17.000
T-16-6	0.160	0.078	0.060	0.950	0.016	0.015	19.000
T-20-6	0.200	0.088	0.070	1.150	0.025	0.029	22.000
T-25-6	0.255	0.120	0.096	1.500	0.042	0.063	27.000
T-30-6	0.307	0.151	0.128	1.830	0.065	0.119	36.000
T-37-6	0.375	0.205	0.128	2.320	0.070	0.162	30.000
T-44-6	0.440	0.229	0.159	2.670	0.107	0.286	42.000
T-50-6	0.500	0.303	0.190	3.030	0.121	0.367	46.000
T-68-6	0.690	0.370	0.190	4.240	0.196	0.831	47.000
T-80-6	0.795	0.495	0.250	5.150	0.242	1.246	45.000
T-94-6	0.942	0.560	0.312	6.000	0.385	2.310	70.000
T-106-6	1.060	0.570	0.437	6.500	0.690	4.485	116.000
T-130-6	1.300	0.780	0.437	8.290	0.730	6.052	96.000
T-157-6	1.570	0.950	0.570	10.050	1.140	11.457	115.000
T-184-6	1.840	0.950	0.710	11.120	2.040	22.685	195.000
T-200-6	2.000	1.250	0.550	12.970	1.330	17.250	100.000
T-200A-6	2.000	1.250	1.000	12.970	2.240	29.050	180.000
T-225-6	2.250	1.405	0.550	14.560	1.508	21.956	100.000

<b>Material 7</b>	<b>Permeability 9</b>		<b>Freq. Range 3 MHz-35 MHz</b>				<b>Color-White</b>
<b>Core Number</b>	<b>O.D. (inches)</b>	<b>I.D. (inches)</b>	<b>Hgt. (inches)</b>	<b>(cm)</b>	<b>A<sub>e</sub> (cm)<sup>2</sup></b>	<b>V<sub>e</sub> (cm)<sup>3</sup></b>	<b>A<sub>L</sub> Value μh/100 turns</b>
T-25-7	0.255	0.120	0.096	1.500	0.042	0.063	29.000
T-37-7	0.375	0.205	0.128	2.320	0.070	0.162	32.000
T-50-7	0.500	0.303	0.190	3.030	0.121	0.367	43.000
T-68-7	0.690	0.370	0.190	4.240	0.196	0.831	52.000

<b>Material 10</b>	<b>Permeability 6</b>		<b>Freq. Range 30 MHz-100 MHz</b>				<b>Color-Black</b>
<b>Core Number</b>	<b>O.D. (inches)</b>	<b>I.D. (inches)</b>	<b>Hgt. (inches)</b>	<b>(cm)</b>	<b>A<sub>e</sub> (cm)<sup>2</sup></b>	<b>V<sub>e</sub> (cm)<sup>3</sup></b>	<b>A<sub>L</sub> Value μh/100 turns</b>
T-12-10	0.125	0.062	0.050	0.740	0.010	0.007	12.000
T-16-10	0.160	0.078	0.060	0.950	0.016	0.015	13.000
T-20-10	0.200	0.088	0.070	1.150	0.025	0.029	16.000
T-25-10	0.255	0.120	0.096	1.500	0.042	0.063	19.000
T-30-10	0.307	0.151	0.128	1.830	0.065	0.119	25.000

T-37-10	0.375	0.205	0.128	2.320	0.070	0.162	25.000
T-44-10	0.440	0.229	0.159	2.670	0.107	0.286	33.000
T-50-10	0.500	0.303	0.190	3.030	0.121	0.367	31.000
T-68-10	0.690	0.370	0.190	4.240	0.196	0.831	32.000
T-80-10	0.795	0.495	0.250	5.150	0.242	1.246	32.000
T-94-10	0.942	0.560	0.312	6.000	0.385	2.310	58.000

Material 12	Permeability 4		Freq. Range 50 MHz-200 MHz			Color-Green & White	
Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	A <sub>e</sub> (cm) <sup>2</sup>	V <sub>e</sub> (cm) <sup>3</sup>	A <sub>L</sub> Value μh/100 turns
T-12-12	0.125	0.062	0.050	0.740	0.010	0.007	7.5
T-16-12	0.160	0.078	0.060	0.950	0.016	0.015	8.0
T-20-12	0.200	0.088	0.070	1.150	0.025	0.029	10.0
T-25-12	0.255	0.120	0.096	1.500	0.042	0.063	12.0
T-30-12	0.307	0.151	0.128	1.830	0.065	0.119	16.0
T-37-12	0.375	0.205	0.128	2.320	0.070	0.162	15.0
T-44-12	0.440	0.229	0.159	2.670	0.107	0.286	18.5
T-50-12	0.500	0.303	0.190	3.030	0.121	0.367	18.0
T-68-12	0.690	0.370	0.190	4.240	0.196	0.831	21.0
T-80-12	0.795	0.495	0.250	5.150	0.242	1.246	22.0
T-94-12	0.942	0.560	0.312	6.000	0.385	2.310	32.0

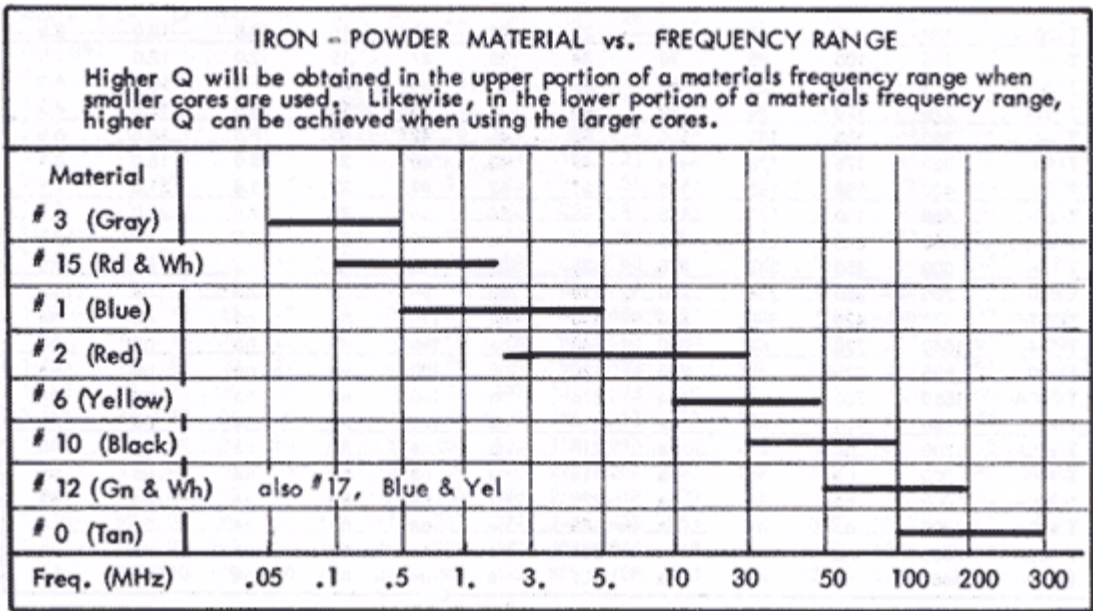
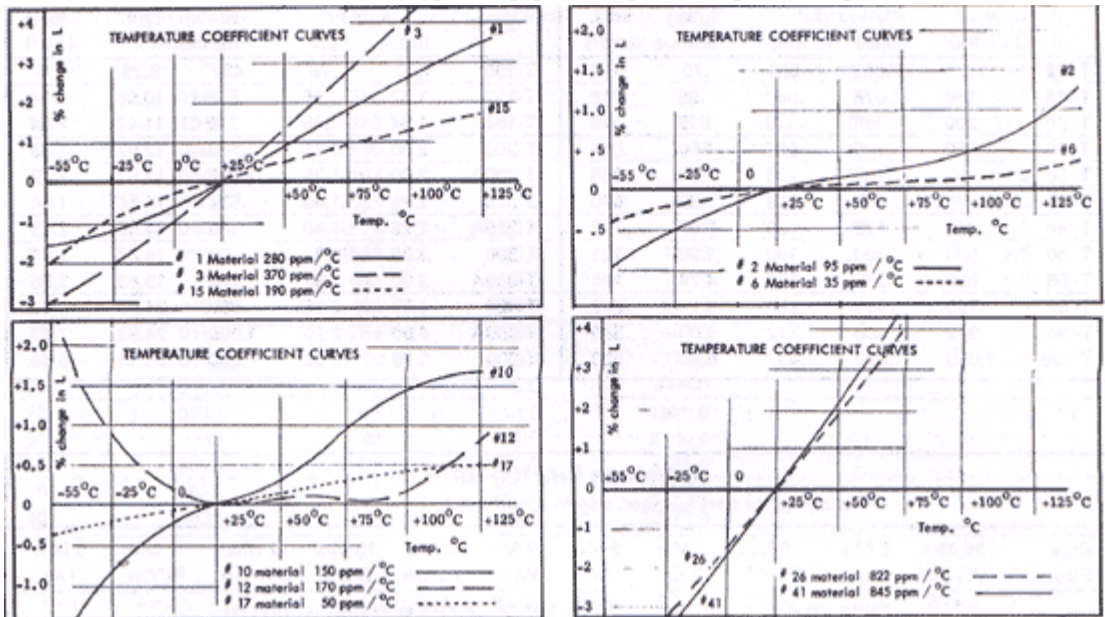
Material 15	Permeability 25		Freq. Range 0.1 MHz-2 MHz			Color-Red & White	
Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	A <sub>e</sub> (cm) <sup>2</sup>	V <sub>e</sub> (cm) <sup>3</sup>	A <sub>L</sub> Value μh/100 turns
T-12-15	0.125	0.062	0.050	0.740	0.010	0.007	50.000
T-16-15	0.160	0.078	0.060	0.950	0.016	0.015	55.000
T-20-15	0.200	0.088	0.070	1.150	0.025	0.029	65.000
T-25-15	0.255	0.120	0.096	1.500	0.042	0.063	85.000
T-30-15	0.307	0.151	0.128	1.830	0.065	0.119	93.000
T-37-15	0.375	0.205	0.128	2.320	0.070	0.162	90.000
T-44-15	0.440	0.229	0.159	2.670	0.107	0.286	160.000
T-50-15	0.500	0.303	0.190	3.030	0.121	0.367	135.000
T-68-15	0.690	0.370	0.190	4.240	0.196	0.831	180.000
T-80-15	0.795	0.495	0.250	5.150	0.242	1.246	170.000
T-94-15	0.942	0.560	0.312	6.000	0.385	2.310	200.000
T-106-15	1.060	0.570	0.437	6.500	0.690	4.485	345.000
T-130-15	1.300	0.780	0.437	8.290	0.730	6.052	250.000
T-157-15	1.570	0.950	0.570	10.050	1.140	11.457	360.000

Material 17	Permeability 4		Freq. Range 20 MHz-200 MHz			Color-Blue & Yellow	
Core Number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	(cm)	A <sub>e</sub> (cm) <sup>2</sup>	V <sub>e</sub> (cm) <sup>3</sup>	A <sub>L</sub> Value μh/100 turns
T-12-17	0.125	0.062	0.050	0.740	0.010	0.007	7.500
T-16-17	0.160	0.078	0.060	0.950	0.016	0.015	8.000
T-20-17	0.200	0.088	0.070	1.150	0.025	0.029	10.000
T-25-17	0.255	0.120	0.096	1.500	0.042	0.063	12.000
T-30-17	0.307	0.151	0.128	1.830	0.065	0.119	16.000
T-37-17	0.375	0.205	0.128	2.320	0.070	0.162	15.000
T-44-17	0.440	0.229	0.159	2.670	0.107	0.286	18.500
T-50-17	0.500	0.303	0.190	3.030	0.121	0.367	18.000

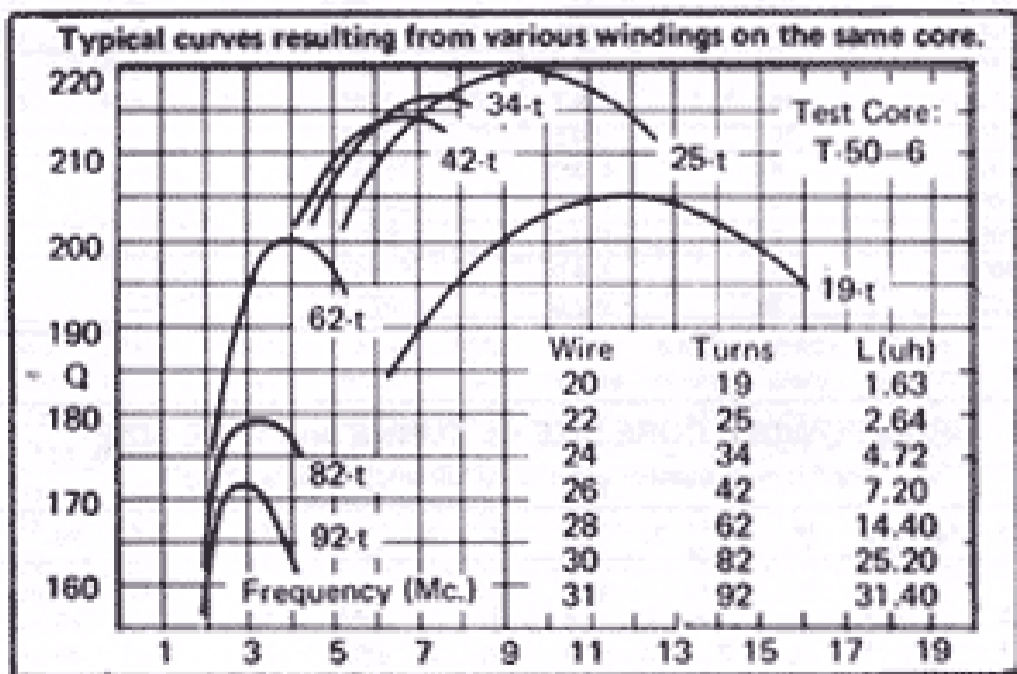
T-68-17	0.690	0.370	0.190	4.240	0.196	0.831	21.000
T-80-17	0.795	0.495	0.250	5.150	0.242	1.246	32.000
T-90-17	0.942	0.560	0.312	6.000	0.385	2.310	32.000

**IRON POWDER TOROIDAL CORES**

**TEMPERATURE COEFFICIENT CHARTS**



TYPICAL 'Q' CURVES  
Various windings, same core



The above chart shows typical Q curves resulting from a number of various windings on the same toroidal core.

The next several pages contain a number of Q curves which were measured and plotted from actual windings.

Inductance charts are given later on in this website which will help you choose a core for a

specific inductance. Since the the charts are in increments of ten turns, a more precise turns-count can be calculated with the turns vs. inductance equation once the core has been selected.

## IRON POWDER TOROIDAL CORES

## Q-CURVES

